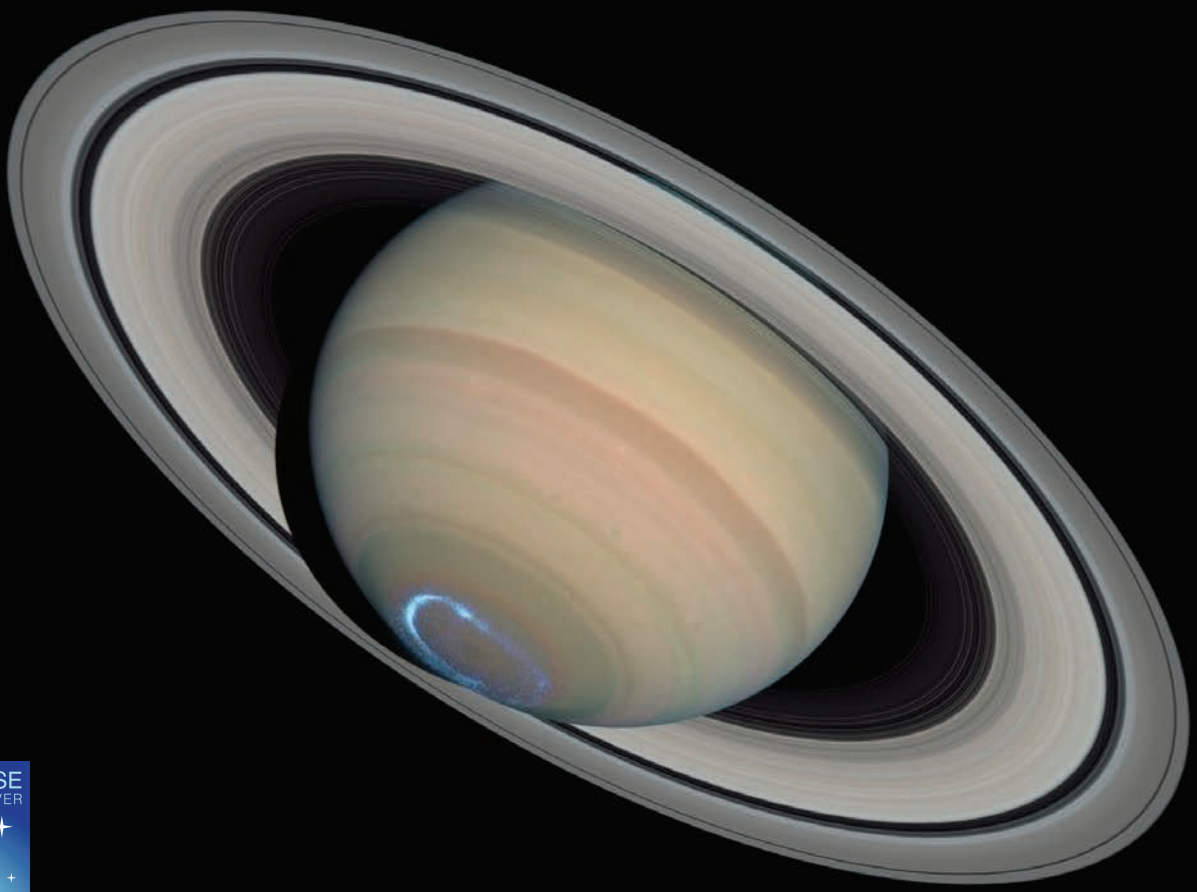
ASTRONOMY 2009 AUSTRALIA



THE UNIVERSE YOURS TO DISCOVER

INTERNATIONAL YEAR OF ASTRONOMY 2009

YOUR GUIDE TO THE NIGHT SKY

Ken Wallace
Glenn Dawes
Peter Northfield

CALENDAR 2009

JANUARY

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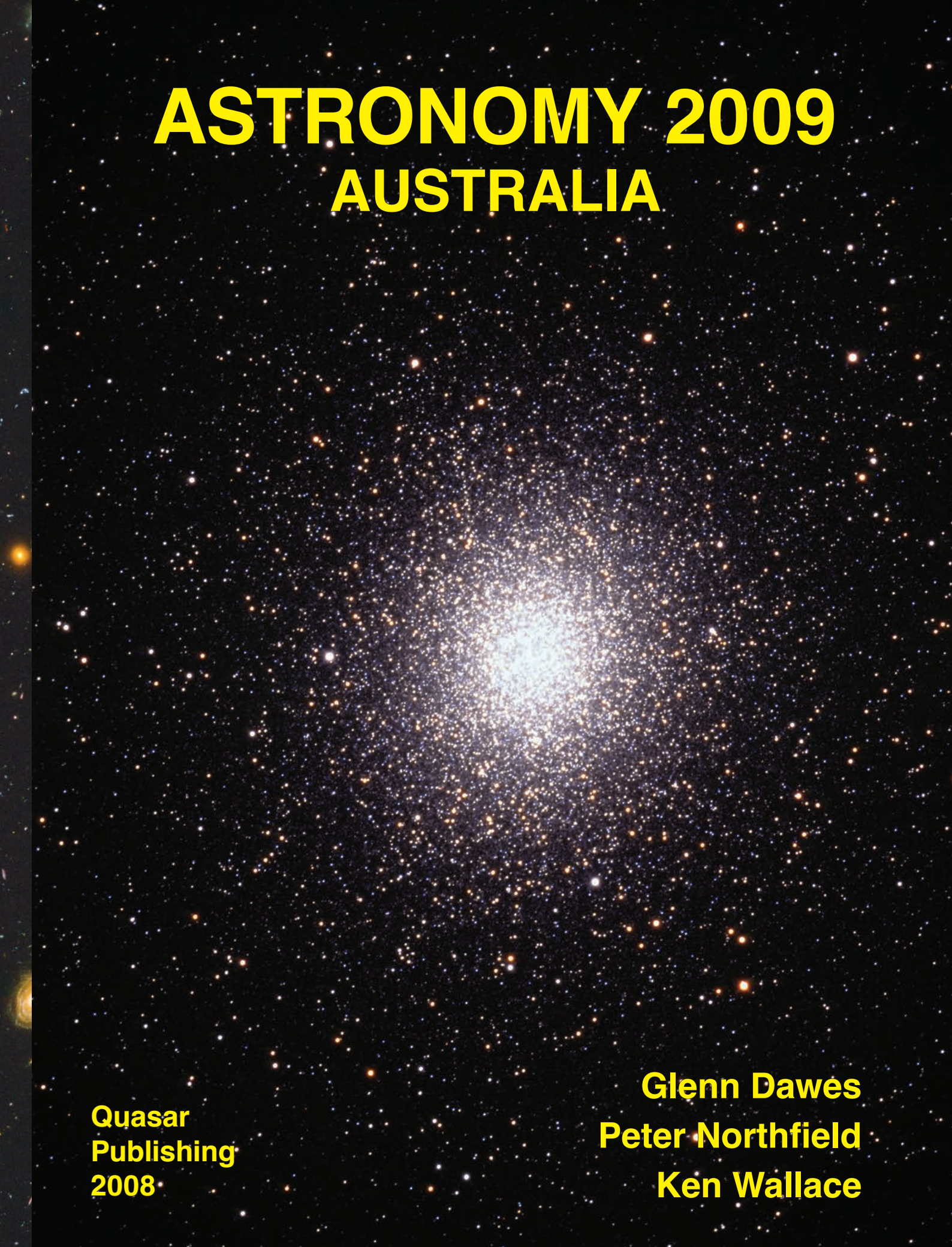
ASTRONOMY 2009
AUSTRALIA



Glenn Dawes
Peter Northfield
Ken Wallace

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- Astronomical Almanac for the Year 2009 (US Naval and Royal Greenwich Observatories)
- Astronomical Tables of the Sun, Moon and Planets (Meeus)
- Comet orbital elements (International Astronomical Union)
- Fifty Year Canon of Lunar Eclipses 1986 – 2035 (NASA RP1216)
- Fifty Year Canon of Solar Eclipses 1986 – 2035 (NASA RP1178)
- International Astronomical Union website
- Mathematical Astronomy Morsels (Meeus)
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- NASA/JPL website
- Deep Sky Field Guide to Uranometria (Cragin, Lucyk, Rappaport)
- Atlas of the Moon (Rukl)
- Sky & Telescope, Pocket Star Atlas (Sinnott)
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- Handbook of the Constellations (Vehrenberg/Blank)
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- Discoveries and Opinions of Galileo (Drake)

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- TheSky for Mac version 5 (Software Bisque)
- Guide 8 (Project Pluto)
- Ephemeris Tool (Dings)

Thanks to Prof Matthew Colless, Donna Burton and Steve Russell for their articles and Greg Bryant for the comet text in part I and II, As always we are pleased to display the astrophotographic (astroimaging) skills of Australian amateur astronomers. In particular, we wish to thank this year's contributors (see below) for allowing us to share with you their wonderful images.

We would like to acknowledge the following individuals for that vital job of proofreading. Our thanks go to Greg Bryant, Brenda McNamara, and Sue Dawes (proofing and typing). The authors reserve the right to deny the existence of any remaining errors (but will take responsibility if backed into a corner!)

Illustrations

The front cover and page 59. Credit: NASA, ESA, J. Carke (Boston University and J. Levay (STScI)

Inside front and rear covers, Hubble Ultra Deep Field in Fornax. Credit: NASA, ESA, S. Beckwith (STScI) and the HUDF Team.

Page 1, Omega Centauri by J. Cauchi

Page 10, The Lambda Cen Nebula in Centaurus by Martin Pugh. Comprised of narrowband data captured in Ha, SII, and OIII using a 12.5" RC telescope, SBIG STL11K and Astrodon 6nm narrowband filters. Data acquisition was through CCD Autopilot and CCDSOFT and the image was AO-L guided throughout. Total exposure time was 30 hours and Maxim DL, CCDSTACK and Photoshop were used to process the image.

Page 10, Five Stages of a Lunar Eclipse by Phil Hart. Canon 20D with Takahashi Epsilon 160 telescope with 2× teleconverter, F=1,060mm at *f*/6.6. Partial=1/45th sec. @ ISO 100, Early Totality=30sec. @ ISO 100, Mid Totality=30 sec. @ ISO 400. Processed with Images Plus and Photoshop. Aligned to show relative size and shape of Earth's shadow.

Page 10, M104, The Sombrero Hat Galaxy by Peter Ward using a 14.25-inch reflector and an SBIG STL11000 CCD camera fitted with AOL adaptive optics. LRGB, L=3 hrs, RGB=2 hrs. Processed using Photoshop CS2. Digital Layering was used to bring out the inner ring and dust lane details.

Page 11, Solar Eclipse images by Steve Russell and Terry Cuttle.

Page 12, Sun viewing, photo by Liz Cutts

Page 13, Star viewing, photo by Liz Cutts; solar observing photo by Mark Doyle

Page 14. Moon image by Shevill Mathers, Hobart Tasmania.

Page 15, 'Boy with Binoculars' painting by Don Davis.

Page 36, Poem by Tim Barritt

Page 39, NGC 5128 (Centaurus A) Galaxy by Fred Vanderhaven. Taken on a Meade 12" LX200R at *f*/10 OTA, Losmandy G11 mount, using a SBIG ST10XME camera with LRGB (Astrodon) filters (160:30:30:30 mins L bin1 RGB bin2).

Page 43, Eta Carinae Nebulae Region by Peter Ward. LRGB (6 minutes each channel) exposure using a SBIG STL11000, RCOS, through a 14.25" RC @ *f*/7.9 and Paramount ME. Image processing with CCDops, MaxImCCD and Photoshop CS3. Four panel mosaic stitched with Panorama Factory.

Page 44, Dark Doodad in Musca, by Albert Van Donkelaar. Canon 5DH, with 300mm F2.8 lens at *f*/2.8, camera cooled by Peltier fridge to –10°C. EQ6 mount autoguided, seven doublings of exposure from 7 sec at ISO 200 to 4min at ISO 800. Ten exposures for each exposure level. Converted from raw to tiff and corrected for flats with ImagesPlus. Stacked and aligned with RegiStar and EasyHDR used to generate an LDR image from this data.

Page 56, SOHO image of Sun. Courtesy of SOHO consortium. SOHO is a project of international cooperation between ESA and NASA.

Page 63, Image of Baade's Window by David Malin, Anglo-Australian Observatory.

Page 70, Milky Way image by Shevill Mathers. Taken through a tripod mounted Nikon D50 DSLR with a Nikkor 10.5 *f*/2.8 ED lens. 30 seconds at ISO 1600 Location was Southern Cross Observatory, Tasmania –42° South.

Page 130, Comet McNaught by Ted Dobosz.

Page 141, Stromlo image from their web site.

Page 142 and rear cover, The Southern Cross and Pointers in the Milky Way by Phil Hart. Canon 40D with 50mm F1.4 lens @ *f*/3.5. Three part mosaic with each part 30×4 min (2 hrs) exp. @ ISO 800. Processed with Images Plus, RegiStar and Photoshop. Blurred stars recorded on a separate night with high cloud.

Page 142, Windswept Stars by Gary Hill. Taken near Wallaby Point, North Coast NSW, with a Canon 300D and 17-70mm lens @ 17mm, *f*/4.5 and ISO 400. Single 8 min exposure. Foreground objects were highlighted with the help of some local light pollution and the use of a torch.

Page 144, Melbourne Planetarium image by Paoli Smith, photographer Rob Blackburn.

Page 146, Border Stargaze group image by Carl Rainer.

Page 147, Solar Eclipse images by Chris Douglass.

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INTRODUCTION TO THE 2009 EDITION

Welcome to Astronomy 2009.

We would also like to welcome you to the International Year of Astronomy (IYA2009). This is a great opportunity for astronomy enthusiasts to promote their hobby and share with the public the joys of observing the heavens — not that these people need much encouragement to spread the word. Donna Burton gives an overview of this International Astronomy Union initiative, how it's being adopted by over 100 countries around the world, and how you can participate.

For the lead article this year we are pleased to have Prof. Matthew Colless, the Director of the Anglo-Australian Observatory, address us on the future of optical astronomy in Australia. It may surprise some that our drive will be involvement in multinational projects from observing sites elsewhere in the world, including the Antarctic!

All of us have felt the effect on our lives brought about by changes in technology. The digital era has revolutionised the life of the astrophotographer (astroimager). Australian amateurs have embraced these advances and it is remarkable what is now being achieved. In recent years the famous Australian *stellar* photographer, David Malin, has held his own awards, in conjunction with the Central West Astronomical Society, acknowledging the *top guns* in this field. The 2008 winners are honoured on page 10. For some more remarkable imaging feats, page 11 gives us a feel for the August 2008 total solar eclipse from an Australian expedition that made the pilgrimage to China.

While on the subject of astrophotographers, we have had a record number contribute to this year's publication and would like to thank all those for sharing their treasures.

With regards to 2009, the year opens with an annular solar eclipse, whose partial phases can be seen from the west and north of Australia. For the first time in 15 years, the Earth passes through the ring plane of Saturn, giving us a unique edge-on view. In fact, August sees the rings disappear for a while! Not only are the rings reduced to a thin line but we see the orbits of the Saturnian moons from the side as well, allowing us to view mutual events as they eclipse and occult each other. At the same time, the Earth passes through the plane of the Galilean satellites of Jupiter and we see mutual events amongst these as well.

The yearbook has all the regular information our readers have come to expect, including our monthly features covering quite a diverse range of interests. Examples are:

- What the unmanned probes to the Solar System have been doing in 2008 and what to expect in 2009.
- What are the best southern deep sky objects?
- Astronomy podcasts, a wealth of information — and they are free!
- Why does poor Pluto have an identity crisis?
- How amateurs can look towards the centre of the Milky Way.
- With all these wonderful astroimages, why do we bother observing?
- Lonely Ceres reaches opposition.

Part I of Astronomy 2009 is intended as a general quick reference to finding and observing the planets. This section is ideal for those just starting to navigate the heavens. The All Sky Maps cover the entire southern hemisphere night sky in nine easy to use charts. Part II leans more heavily towards the needs of the seasoned amateur. Part III, the appendices, includes sections on astronomical places of interest and the amateur societies, ideal for the beginner. We would also recommend you to our website www.quasarastronomy.com.au There are links to all of the sites listed in Part III of this book.

Astronomy, like any science, may seem to be swamped in jargon. Unfortunately, it is impossible to avoid such words. However, where necessary, astronomical terms have been explained in the text or covered in the glossary.

May the Universe reward you with stunning views!

Glenn Dawes ***Peter Northfield*** ***Ken Wallace***

PS. Guess what? We're having a survey and you're invited. You will find the form on our web site www.quasarastronomy.com.au. Please let us know your opinions, your feedback will help.

The Future of Optical Astronomy in Australia

Prof. Matthew Colless

Director,
Anglo-Australian Observatory

Optical astronomy in Australia has a long and proud tradition, stretching as far back as 1770, to the discovery of the eastern coast of the continent by Captain James Cook on a voyage commissioned by the Royal Society primarily for the purpose of observing the transit of Venus from Tahiti.

The Anglo-Australian Telescope

However the modern era of optical astronomy really begins with the decision in the late 1960's to build the Anglo-Australian Telescope (AAT). The 3.9-metre AAT, located at Siding Spring Observatory near Coonabarabran in northwestern NSW, was commissioned in 1974, with science observations starting in 1975.

As its name suggests, the AAT was a joint project of the Australian and British astronomical communities, and was equally funded by both governments. It was one of the 4-metre class telescopes that dominated optical astronomy from the 1970's through to the mid-1990's, when the Keck Telescope heralded the arrival of the new 8-metre class of telescopes. Other 4-metre class telescopes of the same vintage as the AAT include the Mayall telescope at Kitt Peak in Arizona, the Blanco Telescope at Cerro Tololo in Chile, and the European Southern Observatory's 3.6-metre telescope at La Silla, also in Chile.

For two decades, the AAT was one of the most powerful telescopes in the world, but with the advent of the larger and more modern 8-metre class telescopes, most of which are on excellent sites, either on the extinct Mauna Kea volcano in Hawaii or amongst the dry foothills of the northern Andes in Chile, the AAT had to change its scientific strategy. How could it compete with bigger telescopes on better sites?

Current Science with the AAT

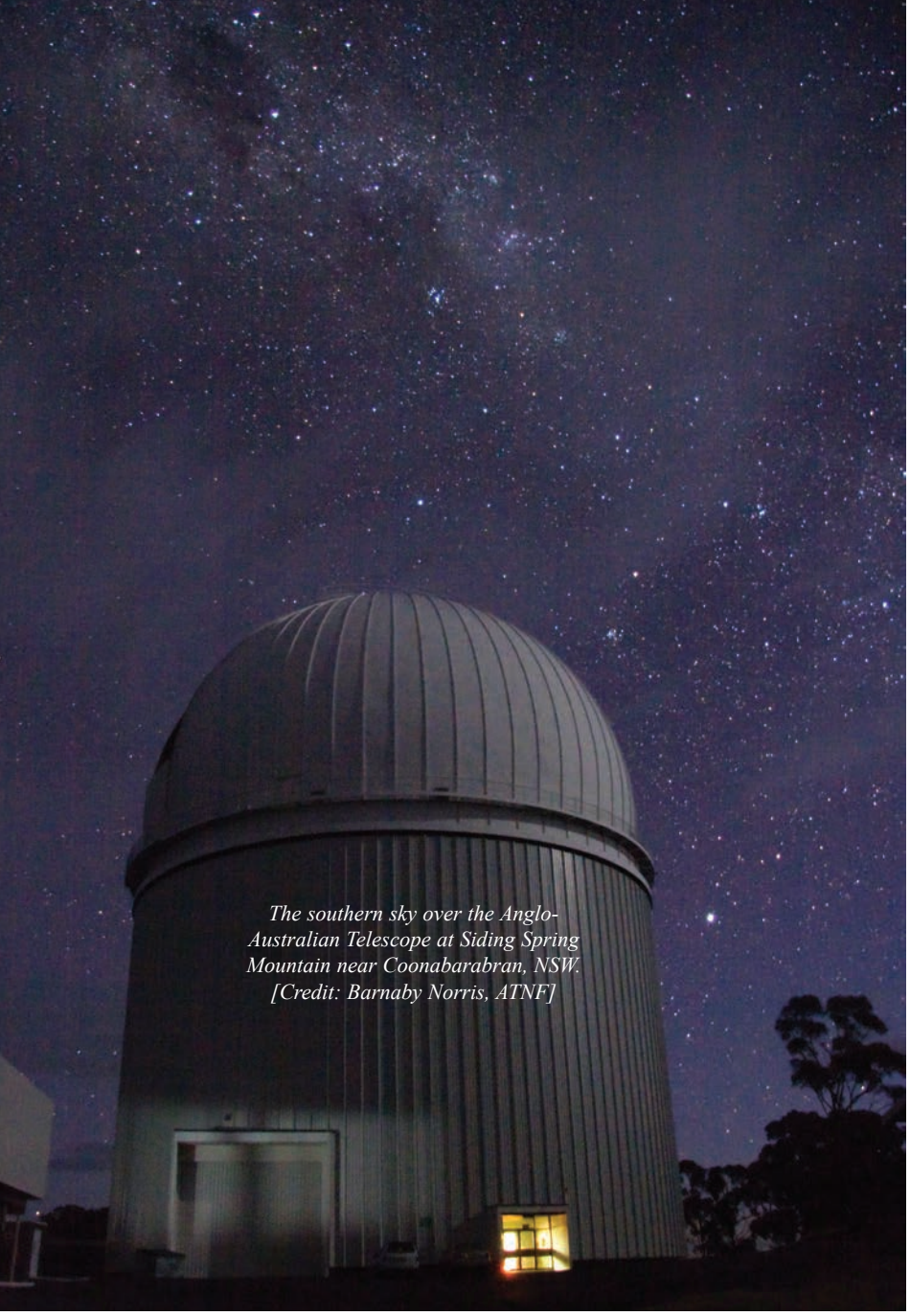
With rare foresight and determination, the AAO set about re-inventing itself as the world's most powerful facility for carrying out spectroscopic surveys. The Two Degree Field (2dF) instrument was born from the combination of two technical innovations and an exciting scientific opportunity. The innovations were a very wide-field optical corrector design for the AAT and the application of optical fibres to multi-object spectroscopy. The scientific question that motivated investing millions of dollars in 2dF, one of the most ambitious and complex instruments ever conceived for optical astronomy, was the origin of the large-scale structure in the Universe and the realization that this structure encoded a wealth of fundamental information on the properties of the Universe.

2dF was completed in 1996 and immediately began carrying out a massive survey of the positions and properties of nearly a quarter of a million galaxies over a huge volume of the Universe. By the time it was completed in 2005, the 2dF Galaxy Redshift Survey had made major contributions to our understanding of cosmology. It mapped the large-scale structure over a representative volume of the Universe and confirmed that these structures result from the gravitational amplification of quantum fluctuations emerging from the Big Bang. By analysing the statistical properties of the structure, the survey measured the total matter density of the Universe with unprecedented accuracy, determining the relative amounts of ordinary matter and dark matter and setting the best upper limit on the mass of the neutrino. In additional to these cosmological results, the survey also provided an incredibly detailed picture of the properties of the galaxy population.

Even while the big 2dF survey was being carried out, the AAT was also being used for a wide range of other observing programs, and these too led to some remarkable discoveries. For example, the Anglo-Australian Planet Search (AAPS) has been measuring the motions of over 240 nearby stars in order to see if they show the tell-tale wobbles caused by planets. To date the AAPS has identified more than 25 new planets orbiting stars other than the Sun. At present these are massive planets in relatively short-period orbits, as these are easier to detect. But over time the AAPS will extend its search to gas-giant planets with orbital periods longer than that of Jupiter and to lower-mass rocky planets. On a very different scale from the planet search, a careful survey of the members of the nearby Fornax and Virgo galaxy clusters revealed an ultra-compact variety of dwarf galaxy, the first new type of galaxy discovered in over 70 years, which may help understand how stars formed in the very early Universe.

One of the largest programs currently being carried out on the AAT is the WiggleZ dark energy survey. This survey uses the AAT's new AAOmega spectrograph, a more efficient and versatile replacement for the original 2dF spectrographs. The eponymous

Wide-angle view of the interior of the Anglo-Australian Telescope dome. [Credit: Barnaby Norris, ATNF]



The southern sky over the Anglo-Australian Telescope at Siding Spring Mountain near Coonabarabran, NSW. [Credit: Barnaby Norris, ATNF]

'wiggles' are not in this case the children's entertainers, but rather the weak enhancement in the galaxy distribution on a scale of about 100 megaparsec (Mpc) that is a frozen remnant of the interaction of light and gravity in the early Universe. This can be used as a 'standard ruler' of known size that can be used to track the expansion history of the Universe. For the last few billion years, the expansion has been accelerating, driven by a mysterious 'dark energy' that accounts for about 75% of all the energy in the Universe. Measuring the expansion rate at different times (i.e., different redshifts) can reveal the properties of the dark energy and so provide clues to help close this gaping hole in our physical understanding of cosmology. The WiggleZ survey is now halfway through observing about 150,000 galaxies with redshifts between about 0.5 and 1.0 in order to obtain the best constraints to date on the nature of dark energy.

Productivity and Impact

The AAT is currently doing outstanding science, especially as a survey telescope. In the most recent review of the professional astronomical literature, published in 2008, Trimble & Ceja examined the productivity (number of research papers) and impact (number of citations to those papers) of all the world's major astronomical facilities.

For the three-year period covered by their study, from 2001 to 2003, the AAT was the most productive and highest impact 4-metre class telescope in the world. In fact, the papers produced using the AAT had more than twice as many citations as those of the next-ranked telescope in this class (the William Herschel Telescope, a 4.2-metre in the Canary Islands).

Even more impressively, the AAT was ranked number five for both productivity and impact out of *all* existing optical telescopes of *any* size, anywhere in the world or in space. Only the Hubble Space Telescope, the twin 10-metre Keck Telescopes, the European Southern Observatory's four 8-metre Very Large Telescopes, and the Sloan Digital Sky Survey had greater impact. The AAT produced 11 of the 100 most-cited papers in astronomy (the top 0.1%) published during these three years.

These results demonstrate that even a mid-sized telescope on a moderate site can have an outstanding impact on the field if it has uniquely powerful instrumentation and works on the most exciting and important science.

The Future of the AAT

The AAO is now planning to reprise this successful strategy with a new instrument called HERMES. HERMES is, in essence, a high-spectral-resolution counterpart to AAOmega – where AAOmega specialises in measuring the spectra of galaxies, HERMES is optimised for measuring stellar spectra. The principal scientific driver for HERMES is what's called the 'Galactic Archaeology' program, which proposes to recover the formation history of the Milky Way by looking at the clues hidden in the present-day stellar population of our Galaxy.

The key to this program is the measurement of the kinematics (orbital motions) and chemical abundances (mix of elements) on the order of a million stars. Stars that formed in the same cloud of gas and dust at the same time have a common 'fingerprint' that is coded in their chemical abundances. Although a group of stars that were all born in the same stellar nursery might today be scattered throughout the galaxy, they will still have the same mix of elements they had when they were formed. By looking at enough stars, HERMES will be able to identify groups of stars that formed together, and by measuring their ages, chemical abundances, and motions, put together a detailed picture of how the Galaxy was assembled.

Together, AAOmega, HERMES and other upgrades to existing instruments will certainly keep the AAT scientifically competitive for another decade. But, given that there are more than a dozen 8-metre class telescopes in operation in the world today, and even more potent Extremely Large Telescopes on the horizon a decade from now, Australian optical astronomy clearly has to evolve towards greater use of these new and larger facilities.

Gemini and Magellan

At present Australia has a 6.2% share in the twin Gemini telescopes, one of which is in the northern hemisphere, atop Mauna Kea on the Big Island of Hawaii, and the other in the southern hemisphere, on Cerro Pachon in northern Chile. The International Gemini Observatory, which owns and runs the two telescopes, is a consortium comprising the USA, the UK, Canada, Australia, Brazil and Argentina.

Each Gemini telescope has an 8.1-metre monolithic primary, and the telescope designs are optimised for high spatial resolution at optical and near infrared wavelengths. The telescopes have a broad

The Gemini-South 8-metre telescope on Cerro Pachon in Chile. [Credit: Gemini Observatory]

complement of instruments for imaging and spectroscopy in the optical and infrared. Gemini-North, on Mauna Kea, saw first light in 1999, while Gemini-South, on Cerro Pachon, came into operation in 2000. Since then, more than 500 research papers have been produced based on data from the two telescopes, with Australian astronomers leading or involved in more than 65 papers.

Scientific highlights from observations with the Gemini telescopes have included surveys of large numbers of supernovae in order to measure the acceleration of the Universe's expansion, measurements of the mass of the enormous black holes at the centres of most galaxies, identification of extreme supernova explosions as the origin bursts of gamma rays from very distant galaxies, and extensive studies of the formation and evolution of galaxies at early times in the history of the Universe.

Australian astronomers have found the Gemini telescopes to be powerful tools for science, but our relatively modest share in the partnership limits our access to these front-rank facilities. Recently, the UK has signalled that it may be interested in selling off part of its share in Gemini because it is also a member of the European Southern Observatory, and therefore has access to four other southern 8-metre telescopes through ESO's Very Large Telescope. Australian astronomers are therefore seeking to double their share in Gemini from 6.2% to 12.4%, giving access equivalent to a 25% share of one 8-metre telescope.

However Australia is also currently buying time on the two Magellan 6.5-metre telescopes run by a consortium of US institutions. The Magellan telescopes are located at Las Campanas Observatory in northern Chile, which is operated by the Observatories of the Carnegie Institute of Washington. The Las Campanas site has been in operation for more than 40 years, and is well known as one of the best sites in the world, with clear skies and superb seeing (with a median around 0.6 arcsec).

The first off-axis 8-metre mirror for the Giant Magellan Telescope being figured at the Steward Observatory Mirror Lab at the University of Arizona in Tucson. [Credit: Steward Observatory Mirror Lab]

At present Australia is buying 15 nights per year on Magellan. This diversifies our 8-metre telescope 'portfolio', and gives researchers access to a broader suite of instruments than can be provided by Gemini (or any other telescope) alone. At present, further funding is being sought to allow Australian astronomers to continue this arrangement for at least the next few years.

Future Facilities

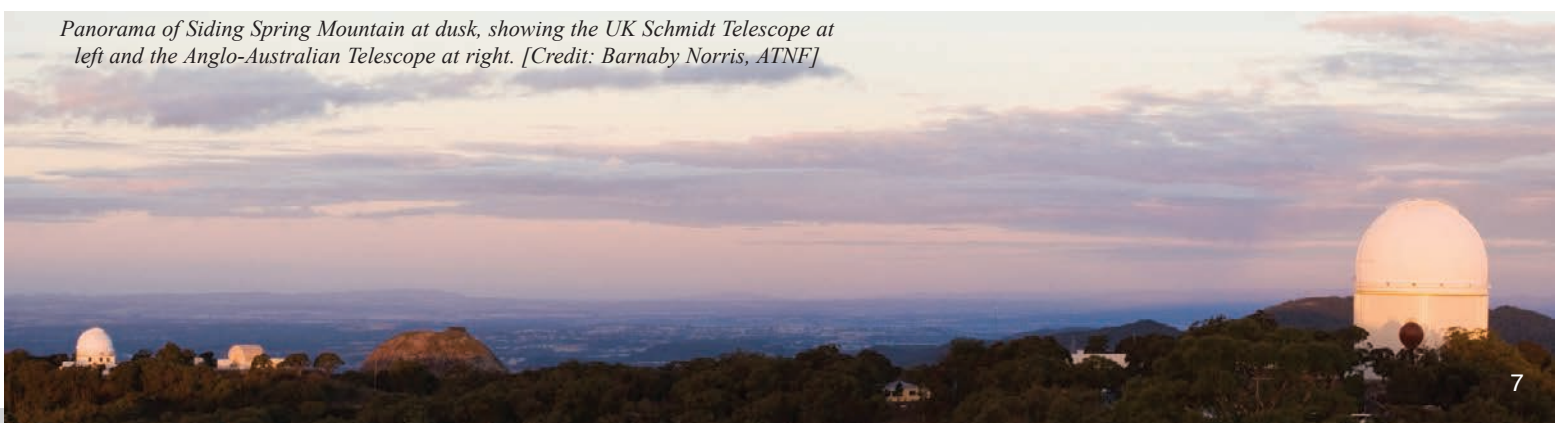
The UK is currently in the process of gradually ramping down its share in the Anglo-Australian Observatory. At present, Australian astronomers have 85% of the AAT and, after 30 June 2010 when the UK finally withdraws, they will have complete control of the telescope. Through Gemini and Magellan, Australia now has the equivalent of a 15% share in an 8-metre class telescope, and in the near future this might be an equivalent 25-30% share. Together, therefore, the AAT, Gemini and Magellan can provide a solid base of front-rank observing facilities for the next 5-10 years.

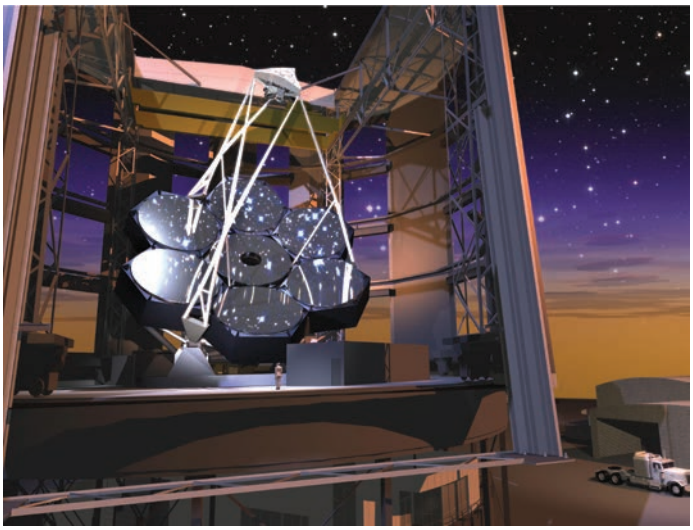
However it takes 5-10 years to build any major new facility, so we need to be starting to get involved now in the next generation of telescopes. In fact there are two major new optical telescopes in which Australian astronomers are interested: the Giant Magellan Telescope, a 25-metre that is one of the next generation of Extremely Large Telescopes (ELTs), and the PILOT Antarctic telescope, a 2.5-metre that would be located on the high Antarctic plateau to exploit what is believed to be the best observing site on Earth.

The Giant Magellan Telescope

At present there are three international consortia with serious plans for ELTs. The Giant Magellan Telescope (GMT) is the most modest, with an effective primary diameter of a 'mere' 25 metres. The self-descriptive Thirty Meter Telescope (TMT) is a segmented-mirror design based on the existing 10-metre Keck telescopes that is being developed by a Californian-Canadian partnership, while the European

Panorama of Siding Spring Mountain at dusk, showing the UK Schmidt Telescope at left and the Anglo-Australian Telescope at right. [Credit: Barnaby Norris, ATNF]





Artist's impression of the Giant Magellan Telescope and its enclosure at night, with a person and a truck to indicate scale. [Credit: Todd Mason, Giant Magellan Telescope project, Carnegie Observatories]

Extremely Large Telescope (E-ELT) is a 42-metre behemoth that is being promoted by the European Southern Observatory.

After reviewing all these projects, the Australian astronomical community has concluded that the GMT is the ELT that is best suited to Australia's needs and budget. The US partners in the GMT Organisation are the Carnegie Observatories, Harvard University, the Smithsonian Astrophysical Observatory, the University of Arizona, the University of Texas at Austin, and Texas A&M University. The Australian partners are the Australian National University and Astronomy Australia Limited (AAL), a consortium of almost all the institutions doing astronomical research in Australia.

The GMT design calls for a set of seven 8.4-metre mirrors phased together on a single mount to form an effective 25-metre aperture. The project completed its conceptual design phase in 2006, and is currently in the design development phase. At the same time, the first of the 8.4-metre off-axis primary mirror elements has been cast and is now being figured and polished at the Steward Observatory Mirror Lab in Tucson, Arizona. The consortium plans to begin construction of the telescope at the Las Campanas Observatory site in northern Chile in 2010, with the aim of achieving first light in 2017 and commencing science operations in 2018.

The scientific capabilities of the GMT span the whole of optical and infrared astronomy and address a diverse range of scientific questions, including the origin and evolution of planetary systems, star formation and the evolution of the chemical elements, the growth of black holes, the nature of dark matter and dark energy, the formation and evolution of galaxies, and the first light in the Universe from stars and quasars.

One of the features of the GMT (and indeed all the ELTs) will be the use of adaptive optics to take full advantage of the extraordinary spatial resolution offered by the massive mirrors. By using such techniques the GMT should be able to image massive planets around other stars in their own reflected near-infrared light, while at mid-infrared wavelengths, the GMT will be able to see young planets directly by the light they emit. Hundreds of young, forming stars are within the reach of GMT, and objects with masses substantially less than Jupiter's will be readily detected.

The other great advantage of the GMT (and other ELTs) is their enormous light-collecting area. In combination with the high spatial resolution, this will allow the GMT to probe star and galaxy formation at very high redshift. The GMT will therefore be able to probe the final stages of the Universe's 'dark ages' and potentially see the formation of the very first stars, galaxies and quasars.

PILOT and Antarctic Astronomy

PILOT is a 2.5-metre telescope that is intended, as it acronym implies, to serve as a Pathfinder for a Large Optical Telescope in Antarctica. As readers of last year's Astronomy 2008 will be aware, the Antarctic plateau offers potentially the best optical/infrared observing sites on Earth; it is high, cold and dry, with superb seeing (at least above the surface boundary layer).

Over the last year, the AAO has been working with the University of NSW on an initial design for PILOT. A number of unique challenges have to be overcome for an Antarctic telescope. In order to take full

The French-Italian Concordia base at Dome C on the Antarctic plateau, with the UNSW site-testing station in the foreground (green and yellow). [Credit: INAF - Astronomical Observatory of Padova]

advantage of the seeing above the boundary layer, PILOT is placed on a 30-metre tower. However this leads to further problems, as although the air has very little water vapour, the temperature is so low that the air is still supersaturated. This leads to frost forming on every surface that is slightly below ambient temperature. In order to avoid this problem, colder drier air from nearer the surface will be pumped up the tower and out through the telescope dome.

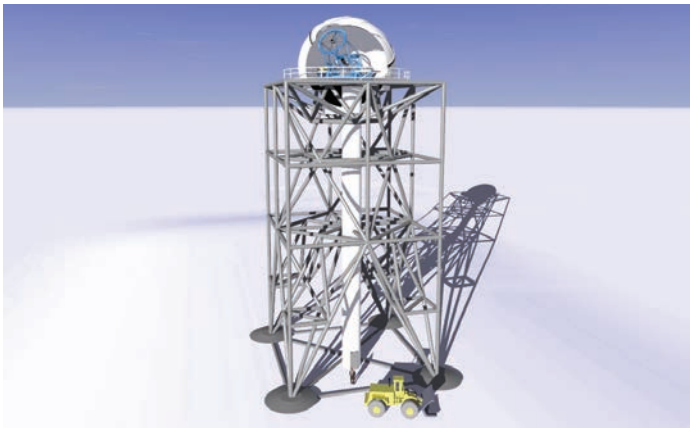
PILOT will excel at doing science that takes advantage of its strengths, which include high spatial resolution over a wide field of view, the low infrared background, photometric stability, and continuous observations for extended periods. The major science drivers for PILOT that have been identified include mapping the distribution of molecular hydrogen gas in the Galaxy, searching for the explosions of the first stars in the Universe, studying the earliest populations of stars, and using weak gravitational lensing to determine the nature of dark energy.

The Future

Australian astronomers are at the front rank of international research. However this position can only be maintained if they continue to have adequate levels of access to the world's best facilities and some unique capabilities of their own. For the next several years the AAT and a doubling of our current access to 8-metre class telescopes would represent a solid basis for optical astronomy in this country. For the longer term the GMT provides us with suitable access to one of the next generation of world-leading facilities, while PILOT offers a potentially powerful and distinctly different capability. In combination with the Australian Square Kilometre Array Pathfinder (ASKAP), the next-generation radio facility being built in a remote part of Western Australia, these telescopes will provide Australian astronomers with outstanding research capabilities.

However all these facilities are expensive to build and operate, and it will require strong support from the Australian Government if they are to be realised. Nonetheless it is a reasonable ambition for Australia's optical astronomers to aim for both a 10% share in the GMT and 100% of PILOT. The corresponding shares of the construction costs of GMT and PILOT are each comparable, in inflation-adjusted dollars, to the construction cost of the AAT back in the 1970's. The outstanding success of the AAT, and Australia's consequent strength in optical astronomy, should be guiding examples in shaping the future of optical astronomy in this country.

Matthew Colless is the Director of the Anglo-Australian Observatory. He studied at the Universities of Sydney and Cambridge and has worked at Kitt Peak National Observatory, Durham, Cambridge and the Australian National University. He is a Fellow of the Australian Academy of Science and one of 250 Highly-Cited Researchers in Space Science worldwide. His main research interests are cosmology, the large-scale structure of the Universe and galaxy evolution.



The PILOT telescope on top of its 30-metre tower, which lifts it out of the turbulent boundary layer in order to exploit the excellent seeing above. [Credit: Andrew McGrath, AAO]

PLANISPHERE

A planisphere makes a great companion to our book. It is a hand-held aid used to identify which stars and constellations are visible on any particular date and time.

Designed for the southern hemisphere, the Night Sky planisphere is printed with dark stars on a light background for easy night time readability. The constellations are drawn simply, emphasizing the brighter stars. A selection of deep sky objects for binocular viewing is included.

The map scale is larger than on similar-size planispheres because the whole sky does not have to be shown on a single map. The Night Sky's design corrects for distortion of the constellations around the horizon, inherent on single sided planispheres. Its plastic construction makes for a durable and moisture resistant product.

To use this planisphere is easy. Just turn the disc so the date lines up with the time and it will show you what the sky looks like now. It's that simple!

PLANET FINDER

Each planisphere comes in a reusable plastic sleeve and also with Quasar's Planet Finder card. This card includes information allowing you to easily locate the position of the five naked-eye planets on the planisphere.

These planispheres are available direct from Quasar Publishing. They come in two sizes: the large 22cm version is $24, the small 13cm one is $14, price includes postage within Australia. Payment can be by cheque, money order or credit card (VISA or MC). Orders should be sent to:

Quasar Publishing,

PO Box 85, Georges Hall NSW 2198

Fax: (02) 8814 5331 or Email: sales@quasarastronomy.com.au

The 2008 David Malin Awards

The Lambda Cen Nebula in Centaurus

Overall winner and winner in the amateur section (deep sky) was Martin Pugh.

"In broadband images, this nebula is a bland patch of red with these distinctive globules of dust. However, demonstrating his versatility, Martin used narrowband filters in his 12.5 inch telescope to reveal the different ionisation conditions in the nebula. This picture combines 11 hours of Ha exposure (red, mapped the green here), 12 hours SII exposure (also red, and mapped to red here), and 7 hours of OIII exposure, mapped to blue here, for a terrific result."

In 2008, the Central West Astronomical Society held their annual astrophotography exhibition and competition. Amateur astronomers and photographers from around Australia submitted their images for judging by world-renowned astrophotographer, Dr David Malin. Shown here are the winning entries from the three categories in the amateur section as well as the semi-professional and open sections. Each image is accompanied by a citation from David Malin. The judged photographs were exhibited in July at the Parkes Observatory's Visitors Centre before moving on to Sydney Observatory. For further dates and locations see www.parkes.atnf.csiro.au/news_events/astrofest/awards/.

… continued on page 142.

Five Stages of a Lunar Eclipse

Winner of the amateur section (Solar System) was Phil Hart.

"A very well executed picture was made with a Takahashi Epsilon telescope, which is equivalent to a 1m FL lens working at f/6.6. Phil used a 2× converter to double the focal length. The large range of brightness involved exposures varying from 1/45 sec to 120 seconds (or equivalent – he changed ISO number as well). This is very well done with convincing colours and very good control of contrast."

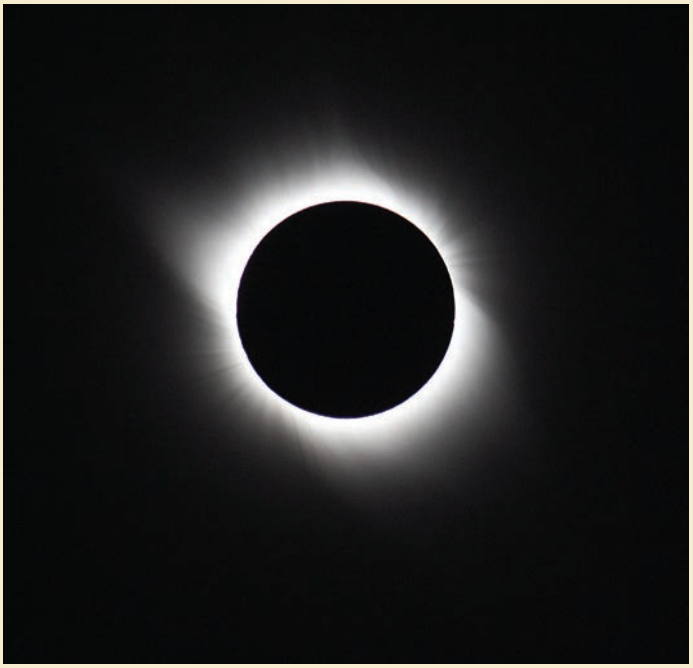
M104, The Sombrero Hat Galaxy

Winner of the semi-professional section was Peter Ward.

"This is a bright galaxy and is not particularly challenging. This was photographed with a 36cm reflector and a fancy CCD using three hours of luminance data combined with two hours of RGB. But what a result. What immediately caught my eye was the luminosity of the print; the brightness really shines out of it. I thought it was beautifully rendered."

China Eclipse 2008

Stephen Russell

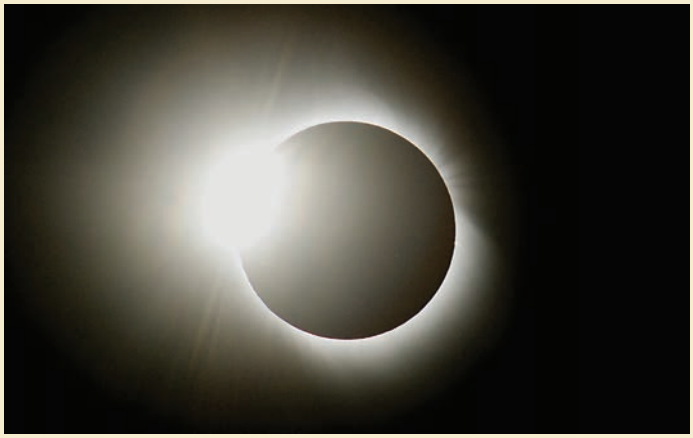


Images by Stephen Russell: Canon 350D, Megrez 72FD f/6 with 0.8 reducer, and Eclipse Orchestrator software. Cropped and processed in Photoshop. Top 1/125, ISO 200, f/4.8; bottom 1/15, ISO 400, f/4.8; above right 1/250, ISO 200, f/4.8.

ECLIPSE AT JIAYUGUAN

Total Solar Eclipse 1 August 2008 over the twin watchtowers of the fort at Jiayuguan at the western end of the Great Wall in Gansu Province in China. The planet Mercury is just above and to the left of the eclipsed sun with Venus at the top centre of the image.

Image by Terry Cuttle. Canon 450D DSLR with 10 – 22mm zoom lens set at 16mm cropped. Composite of five images varying in exposure from f/8, 200 ISO and 1/125× sec to f/5.6, 800 ISO and 1 sec. Photoshop used to combine images using layer masks to mask overexposed areas and show lighter foreground detail.



The wonder of a total solar eclipse entices astronomers to travel from around the world to distant lands and capture another minute or two of totality. In 2008, it was Russia and China's turn to welcome the umbraphiles.

I took a small group of Aussie and Kiwi astronomers to China to observe the 1st August 2008 eclipse. After spending a few days in Xi'an to visit the spectacular Entombed Warriors, we flew out to the city of Jiayuguan in western China, famous for its fort which marks the western end of the Great Wall.

The weather on our arrival was not promising — there had been heavy rain earlier in the day. By eclipse day the skies had cleared and things were looking very good.

We had planned to observe the eclipse from the centreline north of Jiayuguan. Our plans were forcibly changed at the last minute by the local authorities, and we ended up outside the town of Jinta instead.

… continued on page 147.

International Year of Astronomy 2009

Donna Burton

What is all the fuss about, IYA 2009 aka the International Year of Astronomy 2009? This question was recently asked of me during a talk to a group of tourists at Siding Spring Observatory and as I have been around various groups and star parties so many people want to know what they can do to be involved! It is a great opportunity for us to share our love of the sky by day and night with people around us. The theme for the year is *The Universe – Yours to Discover.*

Officially, it was agreed by the International Astronomical Union, and supported by the United Nations (UNESCO), that 2009 would be designated as 'The International Year of Astronomy' (IYA2009).

The year was primarily chosen to coincide with the 400th anniversary of when Galileo first applied his telescope to the study of the night sky. This was one of the most significant events of its time. Galileo discovered things such as the moons of Jupiter, phases of Venus and the cratered surface of our own Moon. These discoveries forever changed so much of mankind's scientific knowledge and religious belief.

This year is also the anniversary of many other important dates in the history of science, such as the publishing of Kepler's Astronomia Nova (1609), Huygens' Systema Saturnium (1659), and it is, of course, also the 40th anniversary of the first Moon landings.

For this celebration, amateur and professional astronomers, around the world will be inviting people to look up in wonder at the night sky and have a great time admiring the heavens.

The author, Donna, showing people the Sun. Photo by Liz Cutts.

The stated intention for IYA2009 is for it to be an international celebration of astronomy. Countries from all over the world will take part. Local, regional and national groups and societies will hold events to explain and encourage widespread interest in astronomy and also other sciences. It is intended for the maximum number of people to become more aware of astronomy and the fundamental questions about the Universe that it seeks to investigate and answer.

According to the IYA 2009 website, the major goals of IYA 2009 are to:

- Increase scientific awareness.
- Promote widespread access to new knowledge and observing experiences.
- Empower astronomical communities in developing countries.
- Support and improve formal and informal science education.
- Provide a modern image of science and scientists.
- Facilitate new networks and strengthen existing ones.
- Improve the gender-balanced representation of scientists at all levels and promote greater involvement by underrepresented minorities in scientific and engineering careers.
- Facilitate the preservation and protection of the world's cultural and natural heritage of dark skies in places such as urban oases, national parks and astronomical sites.

Planning has been underway for some months now; with coordinators in many countries being appointed to oversee the many events that are planned to take place. More than 100 countries are already involved, with well over 140 expected to take up the challenge.

Internationally, IYA2009 is being coordinated by the International Astronomical Union, the international body that represents the world's professional astronomers. The IYA2009 activities will take place at the global and regional levels, and especially at the national and local levels. National Nodes in each country have been formed to prepare activities for 2009. These Nodes establish collaborations between professional and amateur astronomers, science centres, educators, and science communicators.

In Australia it is coordinated by a working group, based at the Anglo-Australian Observatory and CSIRO Australia Telescope National Facility, which are Australia's national optical and radio observatories. Our national single point of contact (SPOC) is Helen Sim who works for both the AAO and ATNF.

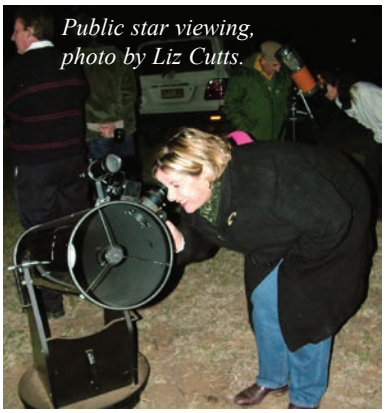
There are a number of identified global cornerstone projects. One of these projects is the 100 Hours of Astronomy and it will also be one of the highlights of IYA in Australia. A 24-hour global webcast from professional observatories is already being organized. Public star parties and sidewalk astronomy outreach events which can be organised and run by amateur astronomers can be the key to making the 100 Hours a highly visible public event. This should help achieve one of the global key goals of the project which is to have as many people as possible look through a telescope as Galileo did for the first time 400 years ago. Keep checking out www.100hoursofastronomy.org for more information as it becomes available.

The 40th anniversary of man's landing on the Moon will be commemorated in the Canberra region over 18-21 July in conjunction with those associated with the Honeysuckle Creek tracking station. There will also be a commemoration held at the Parkes Observatory (The Dish) in NSW on 18-19 July.

Other events in Australia already being planned include the Australian Science Festival, in Canberra next May. This will have astronomy and space as its theme and will most likely incorporate activities marking the launch of the new ANU Skymapper robotic telescope.

AstronomyWA, a collaboration between nine Western Australian institutions, is planning two Space Trail Weekends, currently slated for late February and early March 2009. The event is a physical trail of events and facilities including planetarium shows, nighttime and daytime sky

Children constructing sundials at the 2004 South Pacific Star Party.



Public star viewing, photo by Liz Cutts.

viewing, rarely available tours of the European Space Agency facility at New Norcia and the Australian International Gravitational Observatory, a visit to a meteorite impact crater, and public talks and presentations on Mars, the SKA (Square Kilometre Array radio telescope), and more.

The National Museum of Australia will run three events that touch on astronomy: an exhibition, 'Australian Journeys' that incorporate Aboriginal paintings of the sky (on bark); an exhibition from New Zealand on navigating across the Pacific and an exhibition centred on a Grubb telescope used by an amateur.

The David Malin Awards (see p. 10) are a popular and successful annual astrophotography competition for amateurs. The best entries submitted are then used to form an exhibition that travels to several venues throughout the year. The 2007/08 exhibition, shown at six venues, was seen by more than 130,000 people. Imagine what could be achieved in 2009!

The National Gallery of Victoria is planning two astronomy-related exhibitions in 2009: 'Light Years', an exhibition of NASA imagery from the 1960's, and 'Shared Skies', on indigenous interpretations of the sky.

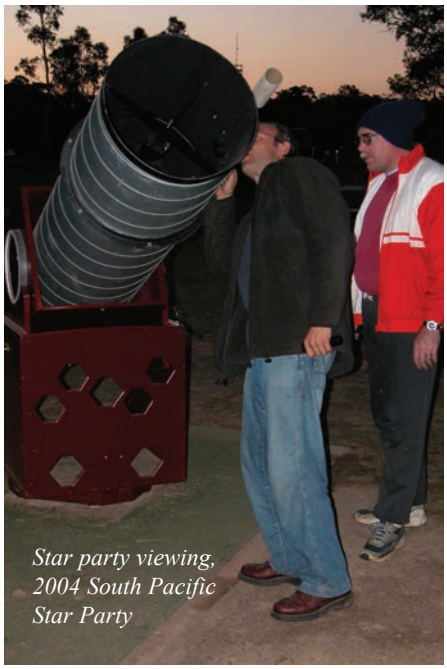
So what can you do in your small or not so small part of the down-under global community? You are limited only by your enthusiasm and imagination. IYA2009 is a great opportunity to shine a spotlight on astronomy — a chance for you to show and tell people in the general community why you love the subject and how they can get involved. Around the world, amateur groups will be planning viewing experiences for the general public: star parties, sidewalk astronomy, and even vans to ferry around sets of telescopes to public places. Why not find someone to dress up as Galileo, make a how-to video for YouTube, create a blog, podcast or webcast to share your ideas? You could consider joining forces with a public observatory, science centre or planetarium to create an event, or link up with an amateur group in another country.

Here are some brief ideas on how you can get involved as an amateur astronomer in your community.

'Sidewalk astronomy' is an ideal vehicle for astronomy clubs and individual amateur astronomers to participate in IYA2009. In addition to their own programs, local amateurs can set up their scopes at events held by community, educational and service professional organizations, including Scouts, Rotary, universities, observatories, planetariums, and local festival events. The relationships that will be forged during this collaboration for public outreach in astronomy will continue well beyond 2009.

Solar viewing at the Border Stargaze, 2008. Photo by Mark Doyle.

In Australia we could aim, for example, to give one million people their first look through an astronomical telescope in 2009. This is achievable if, for example, 10,000 amateur observers each show the sky to 100 people over the year.



Star party viewing, 2004 South Pacific Star Party

Thousands of small telescopes are sold every year, but as many of us know, most are rarely used for astronomy. Why not run a 'telescope amnesty' programme and invite people to bring their little-used telescopes to IYA 2009 events, where amateur astronomers can teach them how to use them and offer advice on repairs, improvements, and/or replacements, encouraging more people to get and stay involved in the hobby.

Smaller regional astronomy groups could combine resources and organise public outreach star parties in co-operation with groups like National Parks and Wildlife Services. City groups could combine to run citywide events. You could 'Adopt a Professional Astronomer'. Someone in your group may know a professional who can be approached during the year to be a part of a special outreach by your club or organization.

After you plan your event, make sure you go to the Australian IYA2009 website www.astronomy2009.org.au and enter it into the events calendar to make sure everyone knows about it. Check out the website for ideas and other exciting news throughout the year. Look forward to a mighty opening event planned to be incorporated into the Sydney New Year's Eve celebration. Remember the Universe – it's Yours to Discover!

So, as I see it, IYA2009 is, first and foremost, an opportunity for all of us who love the night sky to share that love and do what we can to promote astronomy and dark skies. It aims to convey the excitement of personal discovery, the pleasure of sharing fundamental knowledge about the Universe and our place in it and the value of the scientific culture.

We are currently living through a renaissance of astronomical exploration and I think most of the world's citizens are missing out on the excitement. This is a great time to throw a year long party for astronomers and astronomy!

An outdoor astronomy exhibition.

We Are All Beginners

So you are uneasy being a novice — we were all beginners once. One of the pleasures of astronomy is you don't need much to enjoy the wonder of the night sky. You don't need to know a lot either. You already have the important part — the interest; the knowledge (including the jargon) will come when it is required. Have you ever listened to enthusiasts at flower shows expounding the virtues of their prize winning orchid? To a novice it can sound like they are speaking in Greek — amateur astronomy is no different and we do talk Greek (well the alphabet anyway). By the way, the flower people didn't learn their language overnight either.

On this page we concentrate on the attractions of naked-eye astronomy. Some basic equipment will help — this book and a red light torch are a good start. The red light can be as simple as a piece of red cellophane wrapped around the end of the torch and secured with an elastic band. The red light is to help preserve your night vision when reading charts and books at night. Even if you are forced to observe under the light polluted skies of the suburbs, it is still important to eliminate direct lights in your eyes. If you have a neighbour with that annoying backyard light that seems to be always on, invite them over to enjoy the sky — they will soon get the message. Also, don't underestimate the importance of being comfortable. A reclining chair and warm clothing are soon appreciated.

Perhaps a good place to start is to become familiar with the constellations. This is where the All Sky Maps (pp. 70-79) or a planisphere can come in handy. A planisphere, a good companion to this yearbook, shows all of the sky, except for the Sun, Moon and planets because they move. You will see at a glance all of the constellations visible at the time you are observing. An example is shown on page 9. Once you start to look around the sky using a planisphere or the All Sky Maps, you may be pleasantly surprised how easy it is to recognise some of the constellations. These star patterns will quickly become familiar and soon be like old friends. Learning the sky under light polluted city skies is easier than under dark rural skies because there are fewer faint stars visible to confuse the patterns. When it comes to the minor constellations, like those in the far south such as Octans or Mensa, you will need binoculars or dark country skies to view them.

Once you have a working knowledge of the prominent stars, the brighter planets can be much easier to recognise. Besides the Sun and Moon, five of the planets are easily seen with the naked-eye: Mercury, Venus, Mars, Jupiter and Saturn. Venus, the evening or morning star, is quickly recognised as it is by far the brightest 'star' in the sky. Jupiter is also easy to find, for only Sirius can rival its brilliance. Mercury, Mars and Saturn can be a little less obvious and this is where the Sky Views, in the monthly sections, can help.

The night sky regularly puts on displays for us called conjunctions. Since the planets, including Earth, are moving around the Sun, their positions change constantly with respect to the background stars. As seen in the sky, the planets seem to pass by each other and bright stars. When a planet is near another planet, the Moon or a star, it's called a conjunction. Those including the Moon can be a wonderful sight. The Sky View diagrams are designed to display the most spectacular conjunctions during the year. A good example is the one between the Moon, Venus, Mars and Aldebaran on July 19 (see Sky View p. 49). These objects form an approximate 8° square in the northeastern dawn sky. This is simply a chance alignment of these celestial bodies, they only look close together; in space they are still separated by enormous distances. When talking distances beyond the Earth, it is difficult to use normal scales such as kilometres because the numbers would be so large. Instead, we use the time it takes for light to travel from these objects to get a feel of the true separations. At the time of this conjunction, the light from the Moon takes a little over one second to reach us, Venus 9 minutes, Mars 15 minutes and Aldebaran 65 years! If you include the open star cluster, the Pleiades, we are now out to 370 years (most commonly referred to as light years). Distances in astronomy do challenge the imagination and, on the scale of the Milky Way, the Pleiades is just in our neighbourhood. Light takes some 100,000 years to cross from one side of the Milky Way to the other!

While on the subject of naked-eye Solar System objects, here is a good beginner challenge. The planet Uranus can be glimpsed under ideal dark skies, but you will need a finder chart (p. 126). The All Sky Maps (map 8 p. 78) will show you where in the sky the field of the finder chart can be found, which is near the Circlet of Pisces.

The following events are ideal for naked-eye observations:

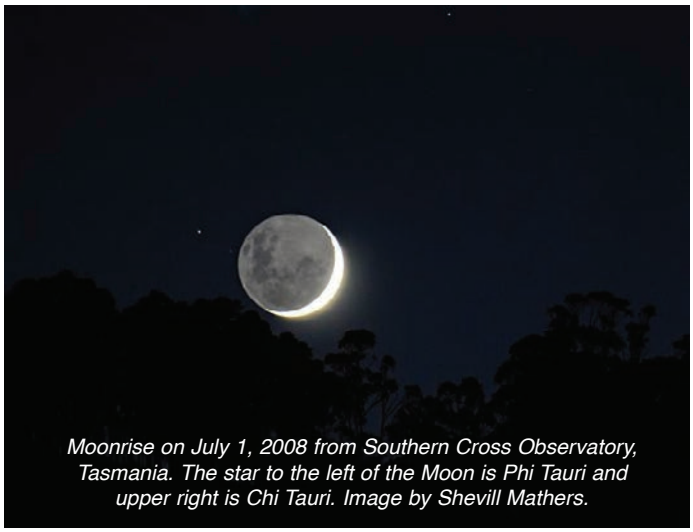
- Meteor showers (which are described in Part I)
- Observing artificial satellites. These can be fun to look for up to a couple of hours before sunrise or after sunset (the Heavens Above website www.heavens-above.com will give you tailored predictions for your latitude and longitude).
- Aurorae, if you live far enough south.
- The phases of the Moon. Don't forget that the Moon can be followed into the daytime sky. For a brief period (up to 3 days) either side of a New Moon, it can be difficult to see in daylight.

While talking daytime viewing, if a Sky View shows Venus very close to the Moon in the early evening, try finding the planet in the daytime sky late in the afternoon. Venus is bright enough to see in broad daylight, provided it is not too close to the Sun. The challenge is knowing where to look in the featureless daytime sky and getting your eyes focused correctly. Having the Moon nearby helps in both these areas. An example this year would be January 30, even though at first you might need binoculars to find the thin crescent Moon. For your comfort and safety ensure the Sun is well out of sight, preferably hidden behind a building.

Try to get out under dark country skies, preferably when the Moon is not around. Now we begin to see naked-eye deep sky objects. Autumn and winter evening skies give us in the southern hemisphere a magnificent view of our home galaxy, the Milky Way. It is amazing the detail that can be seen with the unaided eye such as the bright central bulge around Sagittarius and the numerous dark lanes running along its length. Have a look for the Aboriginal 'emu' constellation. The head is the dark nebula, the Coal Sack, near the Southern Cross (complete with its faint 6th magnitude 'eye' star). The neck is the dark nebulae running through Centaurus towards Scorpius and the body is the complex of dark lanes in the region of the galactic bulge. It is best seen sitting on the southwestern horizon in the early evening autumn sky. The dark lanes in the Milky Way are clouds of gas and dust silhouetted against the bright galactic carpet of stars.

The list of naked-eye galaxies doesn't stop here. The Magellanic Clouds can be seen appearing like small detached sections of the Milky Way, in the far south. In the north we have M31, the Great Galaxy in Andromeda. There are also a number of open star clusters (such as M44 and M45) visible. When you see the obvious fuzzy patch we know as the globular cluster Omega (ω) Centauri, it can leave you wondering how it got a normal star name. There are a number of other naked-eye objects and the All Sky Maps will help you identify these.

A final word of warning. By purchasing this book you may have started on a lifetime of frustration at the weather and having to train your family to organise events so they don't clash with New Moon weekends. The uncertainty of the weather can even add spice to the hobby. To pull up your car, having driven through rain for the last hour, to see a magnificent winter's evening sky with the Milky Way stretching from horizon to horizon can be a fantastic adrenalin rush. Enjoy the buzz.



Moonrise on July 1, 2008 from Southern Cross Observatory, Tasmania. The star to the left of the Moon is Phi Tauri and upper right is Chi Tauri. Image by Shevill Mathers.

A Word About Binoculars

Probably the most cost-effective accessory for the beginner are binoculars. A reasonable quality pair can be purchased for the same cost as a cheap, low-quality telescope. Binoculars can also be useful for Mum and Dad, especially if their budding junior astronomer loses interest. They can at least be used for more terrestrial pursuits. Such an investment can be a low cost way of gauging their child's level of interest. This does not mean the quality of the binoculars should be poor. We suggest that binoculars should be purchased from a reputable optics or telescope dealer. These people appreciate the quality required for stargazing. Astronomy is indeed a severe test on optics. To observe details on the Moon or look for Jupiter's moons, avoid just holding them in your hands. Try bracing yourself on the arms of a chair or the roof of a car. Telescope dealers can also assist with mounts to hold the binoculars steady. There are also brackets designed to attach binoculars to a camera tripod. This is probably the cheapest option, especially if you already have a tripod. Keeping the binoculars steady is important if the power of the binoculars is more than 10×. A power of 7× is a reasonable compromise. It can give a good field of view with adequate magnification to glimpse some of the moons of Jupiter. The size of the aperture normally comes down to what is comfortable for the person to handhold and the budget. 7×50 binoculars (7 times magnification, 50mm diameter front lens) are fairly popular with amateurs.

For the novice, finding your way around the sky is far easier with binoculars than with a telescope. A telescope is a bit like looking at the sky through a straw and the view is usually upside down and sometimes mirror-imaged! Even when using a low power in a typical amateur telescope, the field of view is only about a degree. A pair of 7×50 binoculars can give a field of about seven degrees in diameter (about the size of the Southern Cross), or if you like 40 to 50 times the area visible through a small telescope. It is not unusual for the general public to ask when looking through a telescope, 'where in the sky is that?' — looking at the star field doesn't make the location obvious. Having a larger field will help with knowing exactly where you are. The field size in degrees is normally marked on the binoculars. You can get a feel for how that translates to the sky by looking at our All Sky Maps. The declination lines are 10° apart.

Even with binoculars you still need to practice pointing the instrument. There is a tendency to look too low, so if you don't see what you are after, the first thing to try is tilt the binoculars up. One method that may help is to find an obvious nearby bright star, or better still, a bright star pattern (called an asterism) and star hop across. If your object isn't too high in the sky you can try finding something on the horizon directly under it, like a distinctive tree outline, and move the binoculars up. Another method, that might take a little getting used to, is to stare intently at the area of the sky with your unaided eyes and then moving the binoculars into place without moving your eyes. Practice on bright stars first until you are comfortable. Talking of comfort, plan your observing, for it could be very difficult to look directly up (near the zenith), especially if the binoculars are mounted on a tripod. This is where sitting back in a reclining chair and hand holding the binoculars makes it easier. If your seat does not recline, try leaning the tripod on two legs (or a monopod - single leg tripod).

Also, it is worth remembering that a pair of binoculars is prone to dewing just like a refracting telescope. A couple of cardboard tubes on the front, sticking out about 7cm, can prevent dew and also help eliminate stray light. If you do strike dew, warm air from a portable (12V) hair dryer, blown gently across the lens, is the safest way to fix the problem and be back observing a few minutes later.

Taking your binoculars out under dark country skies at some stage is a must. It has been said that one of the joys of the Milky Way's satellite galaxies, the Magellanic Clouds, is that they show as much detail through a moderate size amateur telescope as that seen by large professional telescopes looking at distant galaxies (outside our Local Group). This argument can be extended to our own Milky Way, but in this case a humble pair of binoculars is sufficient. The wide field of binoculars is ideal to show detail in the complex dark lanes and star clouds running through our galaxy, especially around the central galactic bulge region in Sagittarius. Some of these dark rifts and star cluster regions are sometimes barely visible to the unaided eye but quite obvious through binoculars. Their wide fields can also show some larger open star clusters such as the Beehive (M44) and the Pleiades (M45) better than they look through the narrow field of view of a telescope.

Buying your First Telescope

There will come a time when you will want to take the plunge and buy a scope. Obviously you can only go so far with binoculars and the chance of seeing the Universe up close, live and personal has to be experienced. Those of you who have read our yearbooks in the past will be sick of hearing this advice, but it is still very true. Don't buy anything without spending some time evaluating the various telescopes available to establish what suits you best. This is where your local astronomical society can be a gold mine of information (see Part III). These people are more than willing to show off their scopes and discuss the various features available and their associated pros and cons. Learn from these experts. If you can look through their instruments under light polluted conditions as well as in dark, country skies, all the better. This gives you a realistic feel of what to expect. The telescope shops and public observatories also have many years of experience in this area — draw on their advice as well.

There are a multitude of uses for binoculars in amateur astronomy. Some of these include:

- Helping to find stars and planets in a bright twilight sky.
- Looking at the larger craters and rays on the Moon.
- Looking for fainter stars marked in star atlases or on the Sky Views, All Sky Maps and finder charts in this publication. This can be important in bright, light polluted skies.
- Looking for stars dimmed by the nearby Moon.
- The colours of the stars and planets are more obvious through binoculars. Check out the red colour of Mars, Aldebaran, Betelgeuse and Antares. Contrast the yellow of Alpha (α) Centauri with the blue of Beta (β) Centauri.
- Stars and planets close to the horizon.
- Looking at artificial satellites in the early evening sky. You might find them with the naked-eye, but binoculars will help you see them sometimes vary in brightness as they tumble, and allow you to follow them further into the Earth's shadow before disappearing.
- Monitoring the change in magnitude of some of the brighter variable stars. There are also a number of organisations that can help with finder charts and predictions. Start with your local astronomical society (p. 149).
- Looking at wide double stars.
- Observing the moons of Jupiter as they oscillate across the planet from night to night, see the diagrams on pages 108 and 109. The magnification of the binoculars will dictate how close to Jupiter you can see these satellites.
- Lunar occultations of some of the brighter stars (see also Part II). Small binoculars are well suited for magnitude 4 or brighter events, preferably on a dark limb.
- Looking for bright comets (from dark skies).
- Some of the bright deep sky objects such as star clusters, Milky Way regions, and the Magellanic Clouds. The galaxies M33 in Triangulum and NGC 253 in Sculptor are worth going after with binoculars.
- Looking for some of the brighter minor planets near opposition. A good exercise is to sketch the field a couple of times a few days apart to see which 'star' has moved. Taking the coordinates of a minor planet from Part II (pp. 128-129), and plotting that position on the All Sky Maps, will help you find the correct area.
- Searching out Uranus and Neptune, using the finder charts, see page 126 and All Sky Map 8.

A lot of the above can be done from a typical suburban backyard. It is not always necessary to drive for hours to reach dark skies.

Using This Book To Plan My Observing?

To get the most out of observing often requires a little planning and that's where this book comes in. This publication is a bit like a travel or tourist guide to the heavens, telling you not only what is available but also their opening hours or show times. Obviously attractions can't appeal or be suitable for everyone and the same can be said about the sky depending on whether you are using your eyes, binoculars, or a telescope. To illustrate how to use this book we will work through an example.

You live near Canberra and are planning to go out and observe on the evening of July 24 and hoping to push on all night. Being in an eastern state, you will use times in EST, when given. A good place to start is the Visibility of the Planets chart (p. 20). Looking in late July the diagram shows Mercury, Saturn and Pluto in the evening sky with Venus, Mars, Uranus, Neptune and Jupiter in the morning.

You will notice Jupiter and Neptune are not far from the midnight line, so you would expect them to be close to opposition and visible most of the night (in fact, their opposition dates are the 15th and 18th August respectively, see page 50). A quick check of the Rise–Set Chart for July (p. 46) confirms Jupiter and Neptune rising just after the end of twilight and visible for the rest of the night.

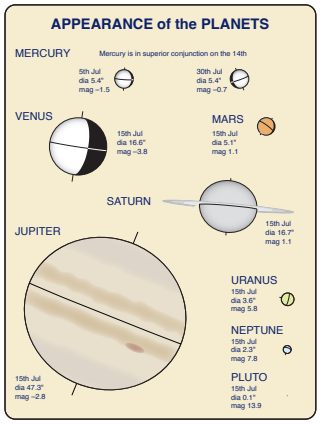
On this date you will also see the Moon setting about an hour before Saturn sets. This might indicate we are close to a conjunction and there may be a Sky View showing this — which there is; see 'July 23 to 26' on page 49. The young (3 day old) crescent Moon is to the lower left of Saturn (near the star Regulus), with the actual conjunction (closest) on the following night.

We will now attack each object starting with those that set in the evening.

Mercury is difficult to observe, having just come out of superior conjunction on the 14th (close to the Sun and on the opposite side from the Earth). It is a tiny 5 arcsecond, near-full disc (see Appearance of the Planets diagram, page 46), setting only 45 minutes after the Sun.

With the Moon setting around 8:30pm, there is not much time for a reasonably bright occultation to happen, and none is shown for the 24th (see p. 96). If you wait until tomorrow night (25th) the dark limb of the Moon will cover the 5.6 magnitude star, 65 Leo, at 6:47pm (18:47hr), see page 96.

Next to leave is Saturn, setting around 9pm. The appearance diagram shows how edge-on the rings are. Let's have a look at where it's brightest moon, Titan, should be. Page 119 shows its most recent greatest elongation east was on July 14.113 UT, therefore, early in the evening of the 24th we are about 10.3 days past this elongation. Looking at the Apparent Orbits diagram (p. 118), Titan is west of Saturn, around half way between a greatest elongation west and a superior conjunction. To help identify the moon, looking through a non-tracking telescope, the satellite would leave the field of view before the planet. When viewing Saturn under dark skies, with telescopes 15cm or larger, you will see a sprinkling of satellites. There are six other moons 13th magnitude or brighter and pages 118-119 can help you work out their positions as well. Pages 29, 33 and 37 also have diagrams showing some impressive configurations of the satellites for the three months centred on its opposition.



As previously mentioned, Jupiter is visible most of the night, rising around 7pm. In fact it doesn't transit the meridian (due north and its highest in the sky) until 2am (see Rise/Set chart). The Great Red Spot (GRS) is well placed to observe this evening with a predicted crossing of Jupiter's central meridian at 10:44pm (22:44hr), see page 107. The satellites are busy that night as well. The Jupiter's Moons diagram on page 109 shows satellites Io (I) and Europa (II) going behind Jupiter in the evening with Ganymede (III) and Callisto (IV) together west of Jupiter's disc. The detailed Jupiter Moon Events (p. 112) confirms this, with Io being occulted and both Io and Europa reappearing from eclipse during the evening. There is an extra bonus in the morning sky with a mutual event, a penumbral eclipse of Ganymede (III) by Callisto (IV) – see pages 23 and 115.

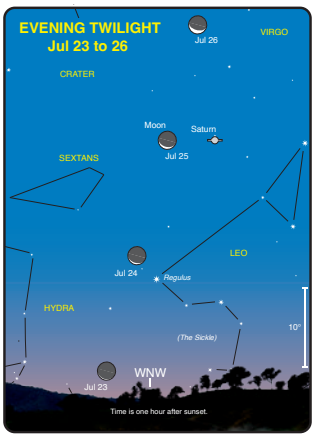
Neptune is not far from Jupiter and the All Sky Map No. 8 (page 78) gives its approximate position in Capricornus. Once you're in the neighbourhood, use the finder chart (p. 126) to determine which 'star' it is. The appearance diagram (p. 46) shows Neptune to be a tiny (2.3 arcsecond), 7.8 magnitude, blue disc.

Next to enter the celestial showcase is Uranus, rising around 10pm. The Appearance diagram shows it to be a 3.6 arcsecond, 5.8 magnitude, greenish disc. Like Neptune, the All Sky Map No. 8 and the finder chart (p. 126) can be used to locate Uranus.

If you have a large enough telescope (minimum 20cm) and dark skies, you may enjoy the challenge of observing some of the moons of Uranus and Neptune. But beware their brightest satellites, Titania (Uranus) and Triton (Neptune), are only 13.5 magnitude. Page 123 can be used to work out their positions relative to the parent planet.

While waiting for the morning planets, there are certainly other diversions.

The monthly text (p. 48) shows the brightest comet in the sky (known at the time of printing) is 22P/Kopff. It is rising in the mid-evening at around magnitude 9 in Aquarius. If you want a more accurate location, its ephemeris (p. 132) has the position on July 25th as RA 22hr 59.4m, Dec. –9° 59' at magnitude 8.8. Looking at All Sky Map No. 8 (p. 78) places the comet about 3° east of the naked-eye multiple star Psi (ψ1, 2, 3) Aquarii. In general when looking for any object where you don't have a position for the date of interest, you can always plot a few data points around this date and make an estimate by interpolation.



The diary (p. 48) shows an interesting event this evening involving a minor planet. 7 Iris is crossing the open star cluster M25 in Sagittarius. Its ephemeris (p. 128) shows it as 9th magnitude.

Turning to the morning sky.

Mars rises just after 3am, near the A-shaped Hyades cluster in Taurus (see All Sky Map No. 3, p. 73). The appearance diagram shows it to be a rather poor 5.1 arcsecond, magnitude 1.1, red disc.

Shortly after 4am (see Rise/Set diagram), the beacon of Venus makes its usual grand entrance. At magnitude –3.8 it is without doubt the most brilliant object in the sky! Its disc has a gibbous appearance, about 16 arcseconds in diameter (see Appearance diagram, p. 46 and Planetary Angular Size diagram p. 81). Like Mars, Venus is in Taurus – see the Sky View on page 49. Also the planet text on page 47 tells us Venus will be close to Zeta Tauri on the 28th.

During the night, don't forget to have a break occasionally and sit back and enjoy the view. This is a great time to look for meteors. The monthly text (p. 48) shows we are approaching the maximum for the Pisces Austrinids (28th), the Southern delta-Aquarids (28th-30th) and for the alpha Capricornids (30th and 31st). You also never know when a sporadic negative magnitude fireball might streak across the sky from any direction!

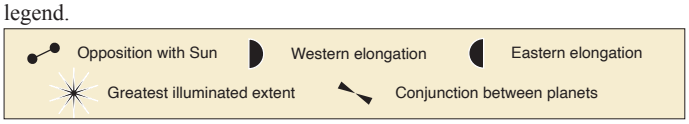
These are just a few examples of the way to apply the information in this book and how it can be a lot of fun planning an observing session.

The Monthly Sections

Each monthly chapter in Part I contains the following:

Rise–Set Chart

This will enable the reader to quickly determine when (or if) a planet or the Moon is visible in the night sky for any day in that month. Each chart has the midnight line centred, with the evening sky below this line and the following morning sky above. The ideal time to observe an outer planet is at the time of transit (represented by dashed lines), which is when it is due north and has reached its maximum altitude. Also a number of events during the year have been shown using symbols, as per the following legend.



These charts only give an approximate local standard time and you will see from the specific rise/set times in Part II that there is variation from city to city. This reflects the effects of your position relative to the standard meridian and differing latitudes, as well as an object's declination. If more accurate rise/set times are required, see the tables for the object of interest in Part II. You can also adjust for rural locations using the appendix on page 135.

Highlights

This lists a few interesting events during the month.

Appearance of the Planets

This diagram provides the reader with a telescopic view of each planet at the same scale. With each image are the date, the planet's angular diameter and magnitude. Phases are also shown for Mercury, Venus and Mars. The top of the diagram is north.

The Moon

This provides information on major events relating to the Moon. The data include the Moon's phases, apogee, perigee, librations, occultations of planets or bright stars and lunar and solar eclipses. An event does not have to be visible from Australia to be included. The description will normally indicate whether or not it can be seen.

The Planets

Presented are general notes on each planet. Emphasis is placed on their suitability for observation and any interesting conjunctions and patterns between the Moon, other planets and bright stars.

Minor Planets (or Asteroids)

This section deals with the brightest asteroids that reach opposition each month (approximately 12th magnitude or brighter). An entry includes the date of opposition (when it is brightest), its magnitude and the constellation the asteroid is in at the time of opposition. Ephemerides for the 22 brightest minor planets are included in Part II.

Comets

This section deals with the comets expected to be visible during the year. It points out those that are observable during the month and includes any interesting conjunctions. Note, most of the known comets this year are relatively faint and will need a telescope, although keep an eye on C/2007 N3 (Lulin) around February where it might just be visible to the naked-eye. It is likely that many other comets will be discovered during the year, so who knows what surprises lie ahead!

Meteor Showers

On any clear night we can sometimes see up to five shooting stars per hour. These are known as random or sporadic meteors. There are also annual showers, which return at the same time each year. Each shower seems to radiate from a focal point in the sky and is named after the constellation or a bright star the radiant lies near. For example, the radiant for the Leonids lies within the constellation of Leo. The monthly section lists the major showers that are suitable for observation — those largely unaffected by moonlight during their peak period. Information for all the known showers is given in Part II. It takes great patience to watch for meteors, but the occasional fireball makes it all worthwhile. It is best to do your searching on moonless nights, away from light polluted cities. As a general rule, more meteors are seen after midnight.

Diary of Events

This is a list of all general phenomena associated with the planets and Moon. These show what's happening tonight — astronomically speaking. Included are:

- Phase of the Moon
- Key events in a planet's orbit
- Selected conjunctions between the Sun, Moon, planets, comets, minor planets (asteroids), brighter stars and deep sky objects.

WHAT TIME IS IT?

Unless a time zone or a location is specifically mentioned, times given in the Monthly Section will be approximate local standard time. There are no adjustments made for Daylight Saving (or Summer Time) anywhere in this book. When Daylight Saving is in force you will need to add one hour to times given here. For example, any rise/set time from the charts will need to have one hour added to get daylight saving time.

When specific times are referred to in Part I they can be Eastern Standard Time (EST) or Western Standard Time (WST). They are the mean solar time on the meridian of longitudes of 150° E and 120° E respectively. For Central Standard Time (CST) subtract 30 minutes from the EST times given. Any times specifically given for Darwin or Adelaide are CST.

Queensland, NSW, ACT, Victoria and Tasmania use EST as their time zone. South Australia and the Northern Territory use CST and Western Australia uses WST.

SOME ASTRONOMICAL TERMS TO GET YOU STARTED

There are several astronomical terms you'll come across in Astronomy 2009, many of which are defined in the glossary at the end of the book. Here are a few of the more common ones, just to get you started.

Planet. Just like the Earth! A planet is a sphere of either rock or gas that orbits the Sun or another star. Traditionally there are nine planets in our Solar System (if you wish to retain Pluto). The diagram on page 21 gives a good overview. The Moon and all the planets we see in the sky do not glow in their own right. They are only visible because of reflected sunlight.

Minor Planet. These are minor 'rocky' bodies in the Solar System that vary from a few to hundreds of kilometres in diameter. There are hundreds of thousands of known minor planets, mostly in the main belt between the orbits of Mars and Jupiter.

Star. Just like the Sun. Stars are enormous spheres of glowing gas that give off tremendous amounts of light and heat. They shine by their own light caused by nuclear reactions going on deep inside them.

Magnitude. The brightness of an object in the sky is known as its magnitude (sometimes abbreviated to 'magn.'). The numbers work backwards. The faintest star you're likely to see with the naked-eye is about 6.0 magnitude (under country skies), while the brightest stars are –1.0 magnitude. Planets can be much brighter. Venus, for example, can be as bright as –4.0 magnitude, the Full Moon, –12 magnitude!

Waxing, waning, gibbous and crescent. The Moon is considered waxing between New and Full, after this time it is said to be waning. The Moon is gibbous when more than half is illuminated i.e., from after First Quarter to just before Last Quarter. On either side of New Moon, when less than half is lit it is a crescent. Gibbous and crescent are also sometimes used to describe the appearance of Mercury or Venus. Mars can also be gibbous.

Angles in the sky are measured in degrees. You'll see that the Sky Views have a line showing what an angle of 10° looks like on the scale of these drawings. On the back cover is a scale that can help you measure angles.

Twilight does not formally end until the Sun is 18° below the horizon; this is called astronomical twilight. This happens about 90 minutes after sunset (or before sunrise) but it does vary with latitude. Only when astronomical twilight has ended is the sky considered truly dark. There is also civil and nautical twilight, see the glossary.

Culmination. When an object culminates it has reached its highest point in the sky and is generally considered to be the best time to observe it. For the outer planets, this is normally when they are due north or crossing the meridian.

Conjunctions. Differences will be often found between the separation distances (and times quoted) and those found in the remainder of Part I. Conjunctions involving only the bright stars, the planets and the Moon are geocentric. This is how they would look from a position corresponding to the centre of the Earth. The times and separations given in the text or Sky Views are the best as seen from Australia. Sometimes a lunar conjunction is followed by 'Occn.', this indicates that from somewhere in the world the object will be occulted (covered) by the Moon. The distance given is measured from the centre of the Moon (remember, the Moon has a radius of about one quarter of a degree). Occultations involving the planets or the brightest stars are also mentioned in the 'Moon' text.

Abbreviations. These include:

- G is galaxy (or sometimes extended to SG for spiral galaxy, IG irregular, EG elliptical and LG lenticular)
- OC represents an open cluster
- GC is a globular cluster
- DS is a double star
- N is nebula (PN planetary, BN bright and DN dark nebula)
- m.p. refers to a minor planet

There are also some astronomical catalogues including:

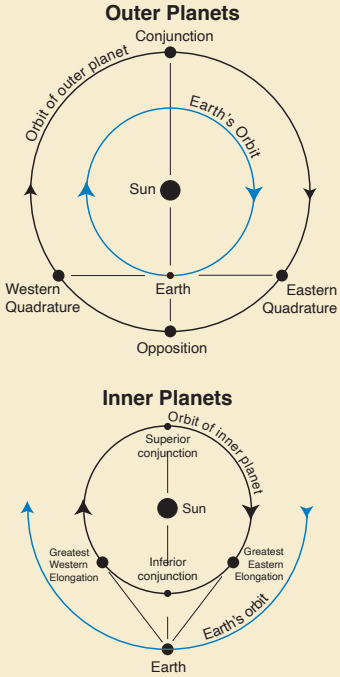
- NGC — New General Catalogue
- IC — Index Catalogue
- M — Messier Catalogue

Time. When times are given, both EST and WST are presented. With the exception of lunar phases (which are given to the nearest minute) times are rounded to the nearest hour, it is unnecessary to include a separate entry for CST seeing there is only a 30-minute difference to EST. The remaining entries are less time sensitive and either have no time (i.e., closest day) or a PM or AM designation for an evening or morning event respectively. For 'timed' events that occur in the very early hours (before 2am) for EST, the WST conversion (subtracting 2 hours) takes it into the previous day and are shown as 'prev day'.

Feature Article

This section concentrates on some topics in popular astronomy. It can include observation, events, history, profiles of astronomy enthusiasts, astronomical equipment and techniques. Some of these are written specifically for beginners.

ORBITAL ASPECTS



A **conjunction** of a planet and the Sun is when they are closest together in the sky (not the best time to observe the planet). When an inner planet is between us and the Sun it is said to be at inferior conjunction; when on the far side of the Sun we have a superior conjunction. It is also common to hear this word referring to any two or more objects when they are closest to each other in the sky, i.e., at their minimum angular separation.

Opposition refers to the time a planet is opposite the Sun in the sky. An object in opposition will rise around sunset and will be visible the entire night (like the Full Moon). The inner planets, Mercury and Venus, can never reach opposition. Their orbits are both inside Earth's. We need to pass between an object and the Sun for opposition to occur.

Elongation is often used in reference to the inner planets and their greatest angular distance from the Sun, that is greatest western elongation (in the eastern morning sky just before sunrise) and eastern elongation (a western evening sky object just after sunset). This is generally the best time to observe Mercury and Venus.

Sky Views

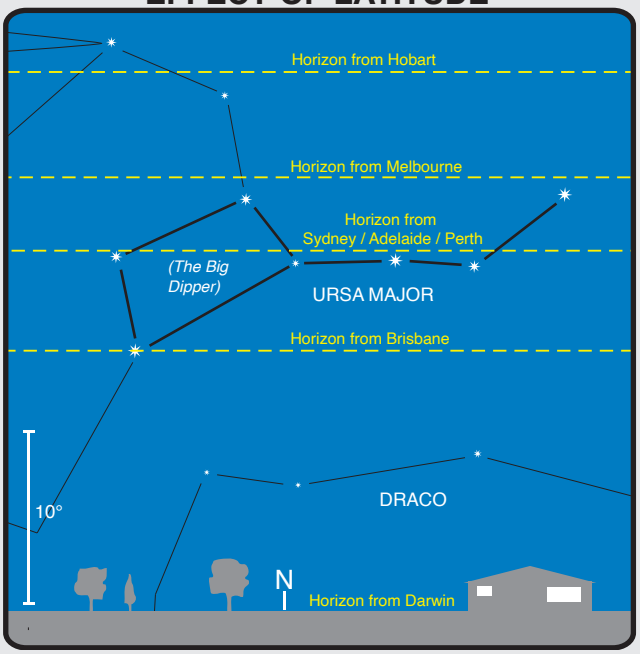
These diagrams are designed to help you find the planets. The date and time of each diagram has been carefully chosen to show the most interesting patterns of the planets and Moon. Sometimes the times chosen correspond to about one hour (or even down to 30 minutes) before sunrise or after sunset. Although, astronomically speaking, this would still be considered twilight, this is sometimes necessary to catch a glimpse of the planets when they are close to the Sun. This is especially needed for Mercury because it never wanders more than 28° from the Sun. Sky Views which show a twilight view after sunset are called *Evening Twilight* and morning twilights are *Dawn Sky*. Those before midnight are *Evening Sky* and after midnight, *Morning Sky*.

The Sky Views (see also the legend opposite) include:

- The Moon (showing approximate phase) and the planets visible with the naked-eye.
- All stars down to about 4.5 magnitude.
- Names of the brightest stars.
- Bright star clusters, nebulae and galaxies (down to approximately 5.5 magnitude). A prefix of 'N' means the object is in the New General Catalogue (NGC), an 'I' is the Index Catalogue (IC) and 'M' is a number in the Messier Catalogue.
- Constellations are labelled (capital letters) and have black lines joining key stars. This is to show the common pattern associated with the constellation.

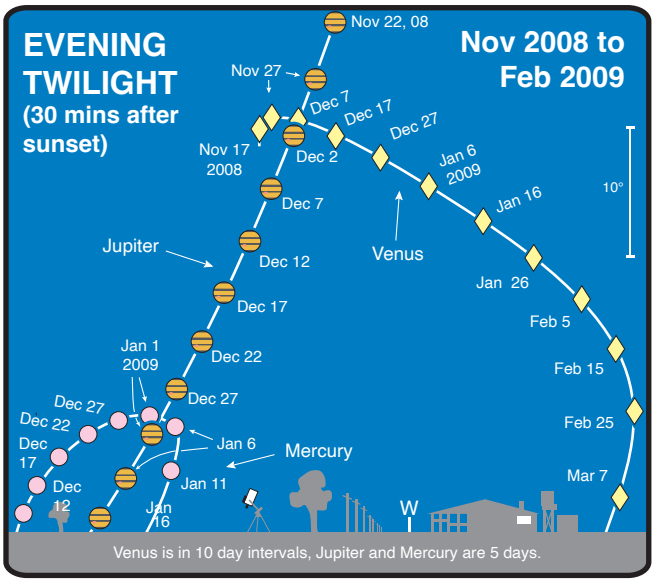
Uranus, Neptune and Pluto have been excluded from the Sky Views, as they are not generally visible to the naked-eye. To see Uranus you would certainly need dark sky conditions. Neptune will need binoculars, while Pluto will need at least a 20cm telescope to glimpse this faint 'Plutoid' of our Solar System. In any case, because of the many faint stars of similar brightness close by, separate finder charts are needed to find these outer worlds. These are on pages 126-127.

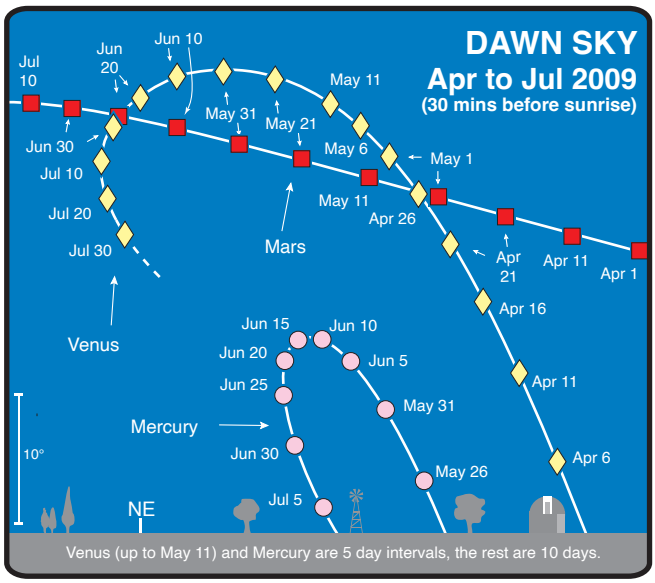
EFFECT OF LATITUDE

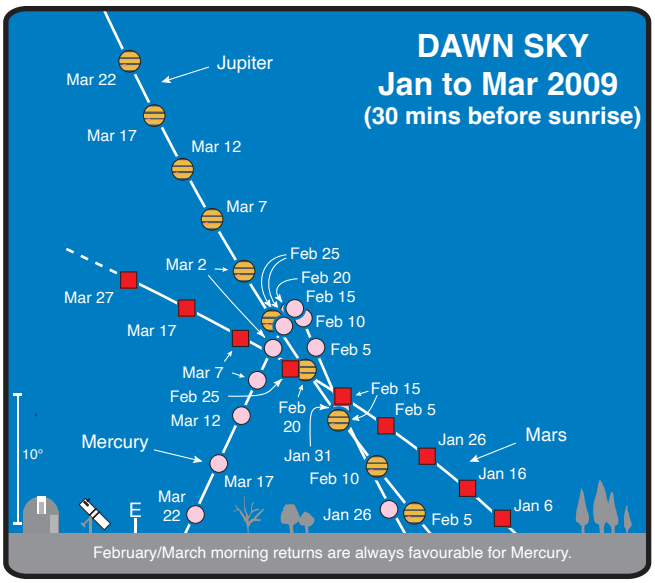


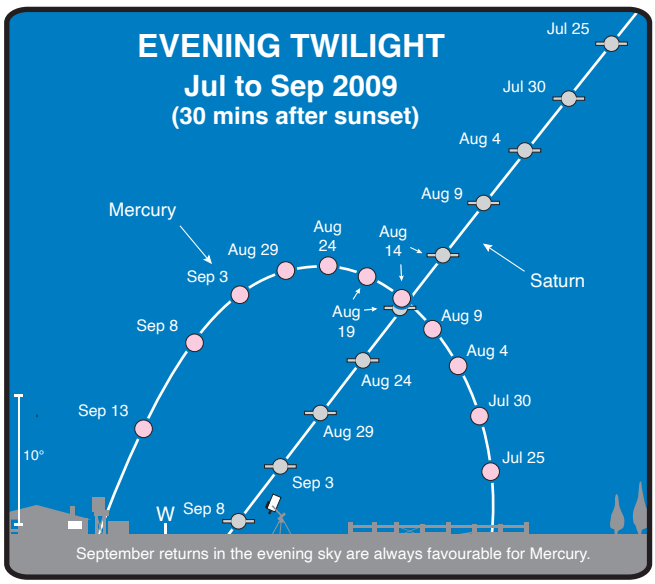
The Sky Views (see the monthly sections) have been drawn for a latitude of approximately 33° south of the equator. This is reasonably central for the population distribution of Australia. However, we live in a large continent which covers a wide range of latitudes. The further you go north the more stars you see familiar to our northern hemisphere friends. As an example, let's take the Big Dipper. You may have first heard about this in books written in England or America. This group of stars is part of a larger group known as the constellation Ursa Major, the Great Bear. From Darwin the group is clearly visible above the horizon (but upside down). However, from the southern states not all of it is visible. The Big Dipper is best placed in the northern sky in mid-May around 9 pm (mid-June, 7 pm). Also from the south we see very little of the constellation Draco. The diagram is drawn to the same scale as a Sky View.

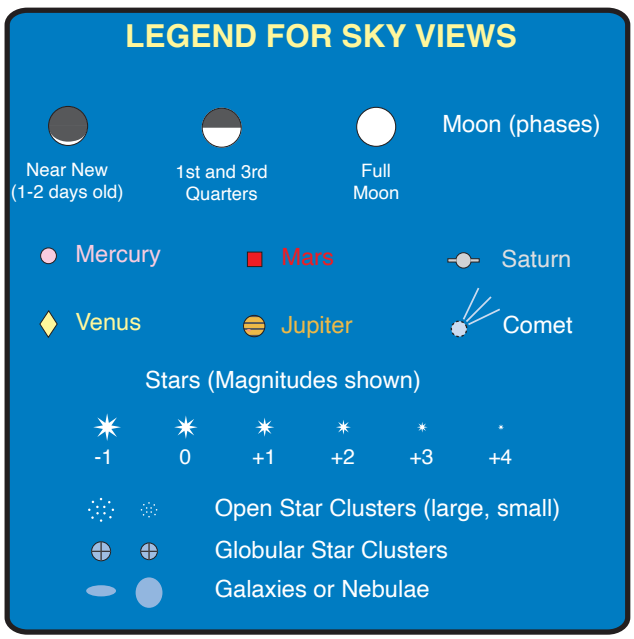
MOVEMENT OF THE PLANETS

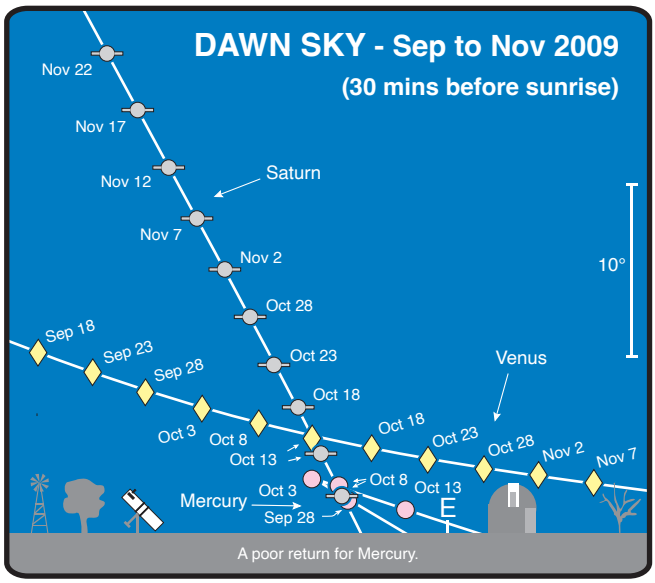






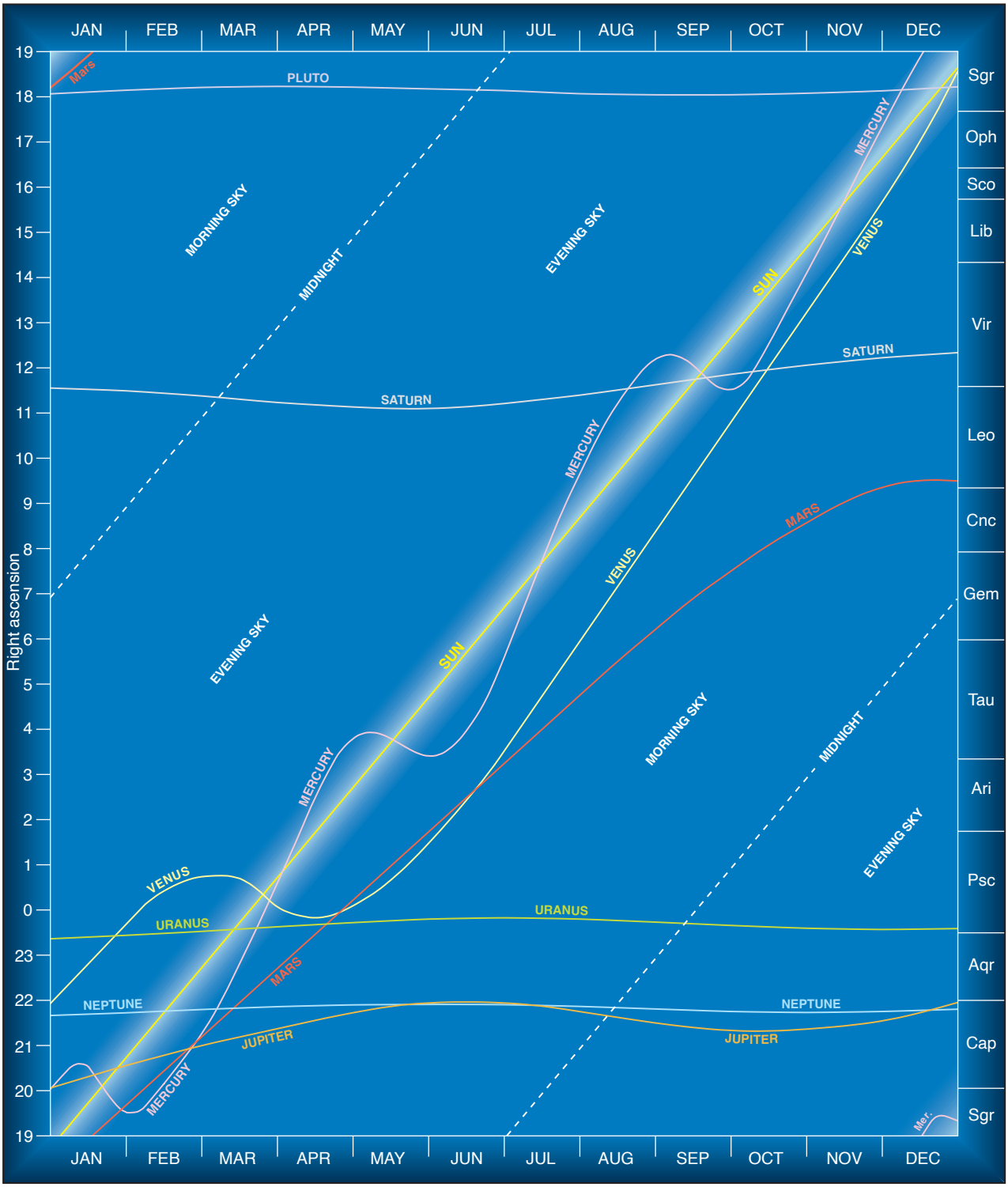






These diagrams are designed to help observers know when a planet first becomes observable after being in conjunction with the Sun, or is about to go into conjunction with our star. They are particularly useful as an observing guide for Mercury. Also the Visibility of the Planets diagram (p. 20) allows you to see at a glance whether an object is in the morning or evening sky.

VISIBILITY of the PLANETS



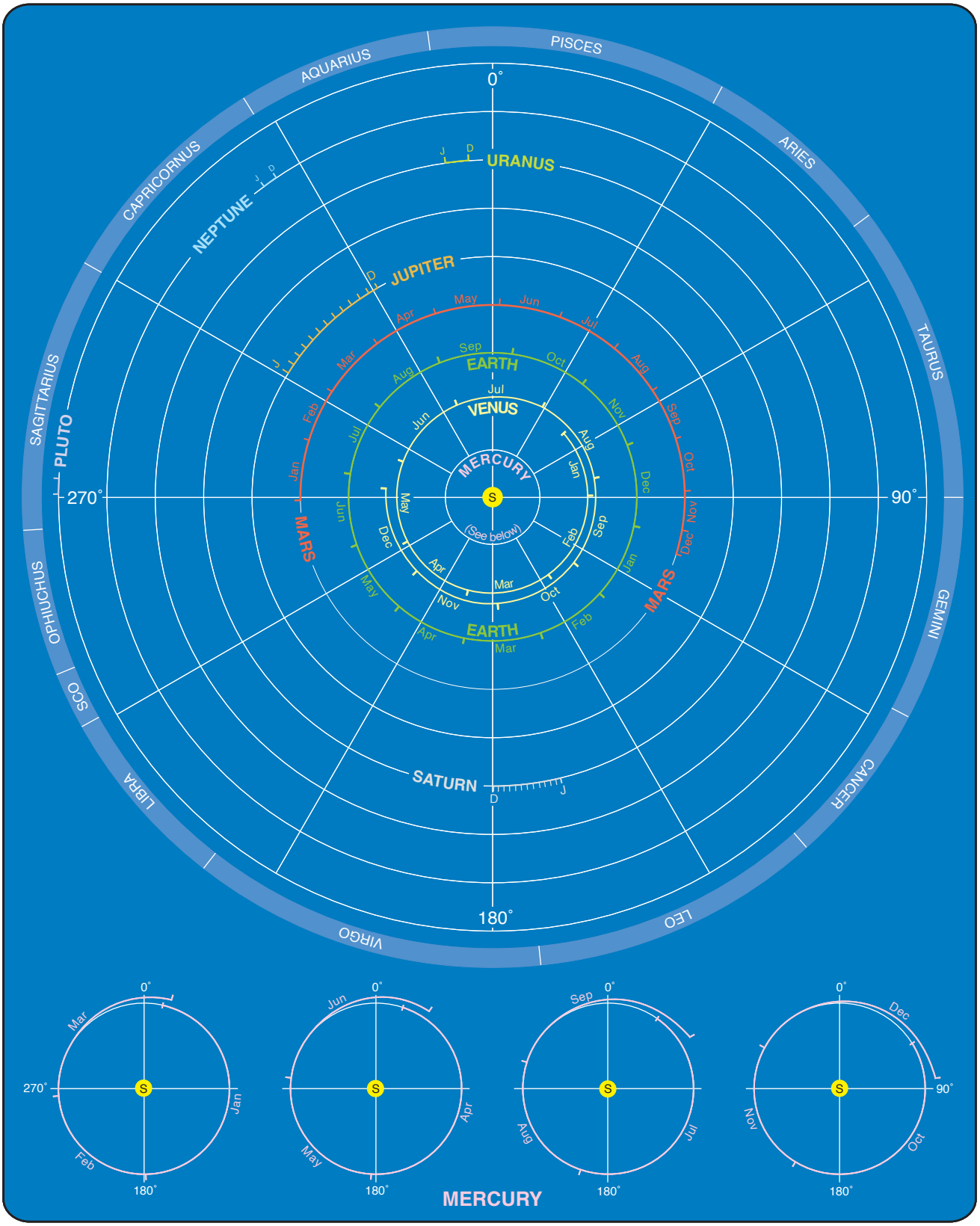
This diagram plots the right ascension of the Sun and planets throughout the year. The light area on either side of the Sun line is that part of the night sky affected by twilight. From this relatively simple diagram a wealth of information can be determined. For example, find your date of observation along the bottom and look up the page until it intersects a planet line. This will show if it is best to view the planet in the morning or evening sky. From the intersection point, a horizontal line to the right vertical axis will show which constellation the planet is in (Mars for example, will be in Taurus during August).

Mercury and Venus are in either inferior or superior conjunction when they cross the Sun line and at their greatest elongation when furthest from it. The best time to observe these inner planets is when their path extends beyond the twilight. For Mercury, the optimum period in the evening sky is from mid-August to early September — in the mornings from early February to the start of March. Venus is an evening object until late March when it moves into the morning sky for the remainder if the year.

When an outer planet crosses the midnight line, it is at opposition and is visible the entire night, and when crossing the Sun line it is in conjunction. Where an outer planet's line shows a downward slope, it is in retrograde motion.

The diagram also shows when conjunctions between the planets occur. When two or more lines cross, the planets will be close together in the sky. A fine example this year is the appearance of Mercury, Mars and Jupiter in the late February morning sky.

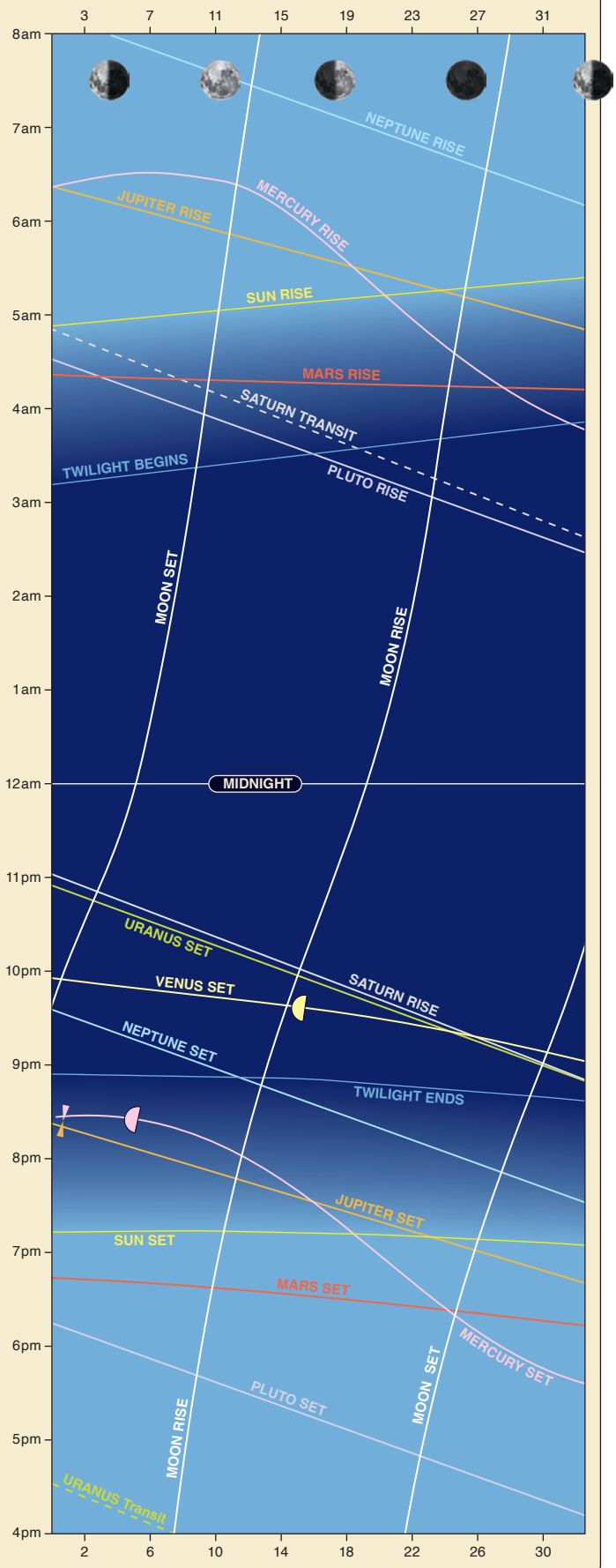
PLANET POSITIONS



This diagram illustrates the relative positions of the planets during the course of their orbits in 2009. The relationships between the major Solar System bodies are clearly shown. For example, this year's opposition of Jupiter occurs mid-August when the Earth appears closest. A line extended from Earth, through and beyond Jupiter shows that the planet is located in the constellation Capricornus. The diagram is drawn as viewed from below (south of) the Solar System. The drawing has been simplified in that the planetary orbits are not shown as ellipses and the Sun and planet distances are not drawn to scale. The thirteen named constellations are those situated on the ecliptic.

JANUARY

RISE–SET CHART



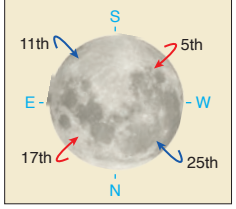
Approximate local standard time, for daylight saving add 1 hour.

HIGHLIGHTS

- Mercury and Jupiter close
- Venus and Moon close, twice this month
- Partial Solar Eclipse
- Comet 2007 N3 (Lulin) brightening in the predawn sky.

THE MOON

LUNAR LIBRATION



5th 11am (9am WST). Maximum Libration (9.8°), dark SW limb.

4th First Quarter.

10th 9pm (7pm WST). Moon at perigee (closest to Earth at 357,497km).

11th Full Moon.

11th 2pm (12pm WST). Minimum Libration (2.7°), Full Moon.

17th 10pm (8pm WST). Maximum Libration (9.7°), dark NE limb.

18th Last Quarter.

21st Occultation of Antares by the Moon, not visible from Australia. However, Antares and the 25-day old waning crescent Moon appear close on rising in the early morning sky on the 22nd. This is the 55th in a marathon series of 69 occultations of Antares that began in January 2005 and will end in February 2010.

23rd 10am (8am WST). Moon at apogee (furthest from Earth at 406,118km).

25th 7pm (5pm WST). Minimum Libration (2.5°), unobservable – too close to New Moon.

26th New Moon, annular eclipse of the Sun. The path of this eclipse is mainly over water from the South Atlantic to the Indian Ocean, ending with landfall in Indonesia. A partial eclipse will be visible across most of Australia although the east coast and southern regions are not favoured. See Part II for more information.

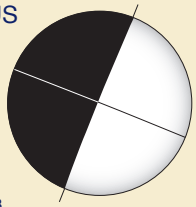
APPEARANCE of the PLANETS

MERCURY

4th Jan
dia 6.9"
mag –0.6
Greatest elongation east

30th Jan
dia 9.2"
mag 0.5

VENUS

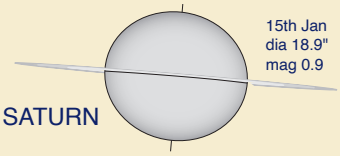


15th Jan
dia 24.4"
mag –4.3
Greatest elongation east

MARS

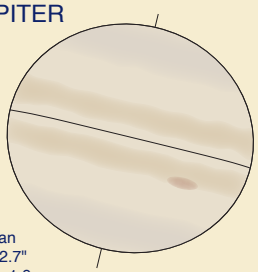
15th Jan
dia 3.9"
mag 1.3

SATURN



15th Jan
dia 18.9"
mag 0.9

JUPITER



1st Jan
dia 32.7"
mag –1.9
Jupiter is in conjunction on the 24th

URANUS

15th Jan
dia 3.4"
mag 5.9

NEPTUNE

15th Jan
dia 2.2"
mag 8.0

PLUTO

15th Jan
dia 0.1"
mag 14.1

THE PLANETS

Mercury is visible in the evening sky just 1.5° above Jupiter after sunset on the 1st. The planets separate as Jupiter heads toward the Sun and Mercury reaches its greatest elongation east of the Sun (19°) on the 5th. This elongation is not overly favourable and Mercury rapidly sinks sunward and into inferior conjunction (between the Earth and the Sun) on the 21st, reappearing at month end in the eastern dawn sky.

Venus begins the month in the early western evening sky 8° south of the 4-day old Moon in Aquarius (see Sky View). Although widely separated, the bright planet and the earthshine illuminated crescent Moon make for a pleasant sight. On the 22nd and 23rd, Venus will be within 1.3° of the outer planet Uranus. In the last week of the month, Venus crosses the border into Pisces and appears near the asterism known as The Circlet. On the 30th, the 4-day old Moon appears near the planet for the second time this month, this time closer at about 2.5° apart (see Sky View). Venus reaches its greatest elongation east of the Sun (47°) on the 15th, and thereafter will be seen losing altitude each evening as it approaches inferior conjunction with the Sun in late March.

The **Earth** is at perihelion on the 5th, the closest point in its orbit to the Sun (147,095,547km or 0.983273 AU distant).

Of Satellites and Rings

Saturn in 2009

The Rings. There is no doubt one of the draw cards in astronomy is the view of Saturn with its magnificent ring system, which is visible through any amateur telescope. The detail that can be seen in the rings such as Cassini's division is memorable. However, 2009 will see the Earth pass through the plane of the rings and briefly this sight will be replaced by a bright, straight pencil-thin line across the planet (see Appearance of the Planets diagram on page 54). Going back to the Eighteenth Century there have been reports of an outer dusky ring and even bright knots briefly glimpsed when the rings are edge-on. These have been in relatively large instruments but there have been sightings using telescopes as small as 300mm in size. Unfortunately in 2009 the edge-on period happens in early September with Saturn quite close to the Sun and difficult to observe. On September 4th Saturn sets only 45 minutes after sunset, with conjunction on the 18th.

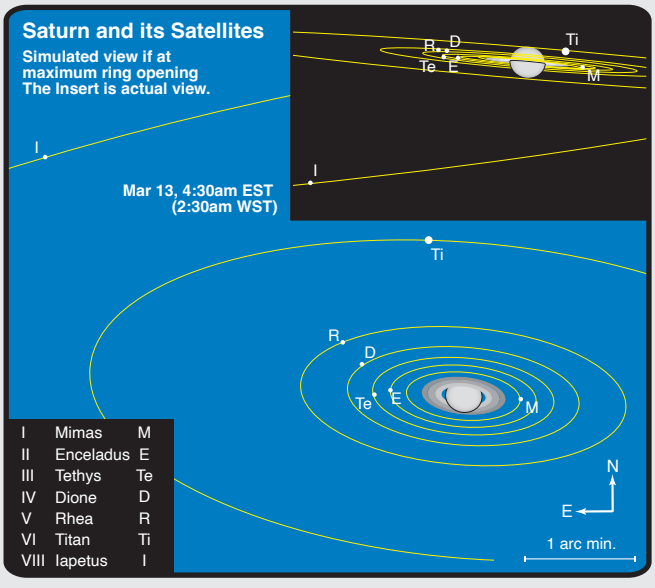
During 2009 it is not only the Earth that passes through the plane of the rings, the Sun does as well (both cross from south to north). The Sun crosses on August 10, followed by the Earth's crossing on September 4. During this 25-day period the south side of the rings, that we can still glimpse, are no longer illuminated by the Sun, so the rings effectively 'disappear'. This is quite rare for it can only happen during a ring plane crossing.

The Satellites. The rings were last wide open in 2001 (maximum tilt is 27°) and have been slowly closing up ever since. At opposition this year (March 9th) the ring angle is already less than 3° and the satellites give us a different perspective. To understand this change of view we need to keep in mind that nearly all the orbits of the satellites visible through average amateur telescopes (down to magnitude 13) are close to the plane of the rings (Iapetus is the exception). Normally we see the moons scattered around the planet appearing like a sprinkling of star dust against the glare of the nearby brilliant rings. With the rings near edge-on, Saturn's satellites' behaviour briefly resemble Jupiter's Galilean moons, moving east to west, passing across, behind or close to the disk of the planet and rings. At this time, the glare from the rings is reduced, making it easier to spot the moons. It also gives us a chance to observe close conjunctions and watch them move relative to each other or close to the rings or Saturn. It's a great time to compare their brightness. Another trait that Saturn's satellites share with Jupiter's moons is that when their orbits are edge on they can have mutual events. See Jupiter and its Satellites above right and page 120.

The diagrams on pages 29, 33 and 37 show some interesting configurations of the satellites. Although Saturn has over 60 satellites we have concentrated on the seven most likely to be visible to amateurs. While Titan, the brightest at magnitude 8.4, is visible through any sized telescope, you may need a large instrument to see its red colour. Tethys (10.3), Dione (10.4) and Rhea (9.6) should be relatively easy for a 150mm scope. The inner moons Mimas (12.8) and Enceladus (11.8) might need a 200mm and a bit of power plus good seeing to glimpse them next to the rings (especially Mimas). Iapetus is a challenge, it has quite a wide orbit (an orbital period of 80 days versus Titan's 16 days) ranging out to a maximum elongation of 9' 35", or about 13 ring diameters. Iapetus' nominated magnitude is 11, but at its western elongation it brightens to 10.2 and eastern elongations fades to 11.9. This is due to the moon being gravitationally locked and having one highly reflective, snow-like hemisphere in contrast to its other half, which is pitch black. Its inclination to the planet's equator is 7°, with Mimas at 1.6° and the others mentioned 1° or less. Although not sounding like a large tilt, when you take into account its distance from Saturn, Iapetus often appears totally out of place, especially around the time of a ring plane crossing when the inner satellites' orbits are nearly edge-on (see diagram below). Just outside the orbit of Titan is Hyperion. It has been excluded from the diagrams mentioned here, being magnitude 14.4, but has been kept in the data in part II (see page 119) for the more advanced amateur. Because of their faintness and distance, Iapetus and Hyperion may be difficult to spot against the star field and the observer may need to work out their approximate positions, using pages 118-119, draw the field and come back a couple of days later to see which *star* has moved. It is also an interesting exercise for astroimagers.

Jupiter and its Satellites.

In part II (pages 110-114) we have predictions for events involving the four main (Galilean) satellites: Io (I), Europa (II), Ganymede (III) and Callisto (IV). This includes transits of the moons and their shadows, occultations and eclipses with Jupiter. Every six years the Earth and Sun are in the orbital planes of these satellites and we see a brief series of mutual events. This is when the moons occult each other (go in front of) or pass into another's shadow (an eclipse). These events can be partial as well as total. Such a series occurs this year and those favourable for Australia have been listed on page 115. Also, we have again included diagrams illustrating some interesting configurations (patterns) of the moons around the best observing time for Jupiter – the three months centred on opposition (pages 49, 53 and 57). If a mutual event is about to happen that night, it is mentioned in the diagram.



***Saturn and its Satellites**. The black insert (top right corner) shows an actual satellite configuration (see page 33) with their orbits included. The ring opening is 2.7° at this time. The main view has been drawn to show the satellites positions as if the rings had been wide open i.e., tilted at 27° (showing the southern hemisphere of Saturn). You can see from the satellites orbits how difficult it is to get the multiple close conjunctions we are seeing this year.*

Mars moves to the west of the Sun after its conjunction in December. It will still be too close to the Sun for observation until late in the month when it reappears in Sagittarius in the dawn (see Sky View). Telescopically Mars will disappoint observers through most of the year, but by December the disc will be large enough for high magnification views under steady seeing. The next opposition occurs on 30th January 2010, although this will be a poor aphelic one with the disc only 14 arcseconds in diameter.

Jupiter is visible for a short period after sunset as the sky darkens in the west. As the month progresses the planet is absorbed into the bright twilight as it nears the Sun and conjunction on the 24th, returning to the morning sky in February. On the 1st, Jupiter will be 1.5° below Mercury. The planet spends the first few days of January in Sagittarius before crossing over into Capricornus, remaining in this constellation for the rest of the year.

Saturn rises around 10pm mid-month in Leo, remaining in this constellation until moving into Virgo in September. Saturn appears stationary against the stellar background on the 2nd, and thereafter will be in retrograde motion until May (see retrograde motion page 80). On the 15th, the 20-day old waning gibbous Moon will be south of the planet (see Sky View). During the year, it will be interesting to follow the aspect of the rings as our view changes from the south to the north side (see Appearance of the Planets diagrams). From November this year, the northern side of the rings will be presented to us until 2025 when the Earth next passes through the ring plane.

Uranus sets in the western evening sky around 10pm mid-month. The planet is in Aquarius until late March when it moves into Pisces. It returns to Aquarius from mid-October where it remains for the rest of the year, and again rejoins Pisces in January 2010. On the 22nd and 23rd, Venus will be within 1.3° of this fainter outer member of our Solar System.

Neptune in Capricornus is lost in the western evening twilight as it nears its conjunction with the Sun next month.

Pluto returns to the morning sky late this month after having been in conjunction with the Sun last December. Pluto, in Sagittarius, will be 0.6° from the 5.5 magnitude star HR6769 on the 21st.

MINOR PLANETS. Three of the brighter minor planets reach opposition this month in Cancer. They are: 129 Antigone on the 26th at magnitude 11.2, 63 Ausonia on the 30th at magnitude 10.9 and 192 Nausikaa on the 30th at magnitude 10.4. There are two at opposition in Hydra, 185 Eunike on the 25th at magnitude 11.6 and 230 Athamantis on the 26th at magnitude 10.5. Also at opposition this month is 194 Prokne on the 3rd at magnitude 12.2 in Monoceros, 40 Harmonia on the 12th at magnitude 9.5 in Gemini, 654 Zelinda on the 21st at magnitude 9.9 in Canis Minor and 12 Victoria on the 23rd at magnitude 11.2 near the Hydra/Cancer border.

1 Ceres has a tour of a few galaxies in Leo during January. A faint (12th magnitude) 42 Isis goes on a tour of some deep sky objects in Sagittarius in January and February.

COMETS

Comet C/2007 N3 (Lulin) opens January at 9th magnitude in Libra. Rising a few hours before dawn, comet Lulin is at perihelion (1.2 AU from the Sun) on January 10. However, its closing distance to Earth will see the comet continue to brighten through January and February. By the end of the month, comet Lulin is expected to be around 7th magnitude.

Comet C/2007 G1 (LINEAR) is in Apus at the start of 2009. The 12th magnitude comet is circumpolar (visible all night, but low in the south). During January, LINEAR will move southeast into Pavo and then Octans. On January 13, LINEAR will be 0.5° from Zeta Pavonis.

Comet 22P/Kopff moves through Libra, Scorpius, and Ophiuchus during January. Moving southeast, the 12th magnitude comet is rising in the early hours of the morning.

Comet 144P/Kushida will remain around 11th magnitude in January. Moving eastward through Taurus in the northern sky, Kushida is visible from the end of twilight setting in the early hours of the morning. The comet is at perihelion (1.4 AU) on January 26. On the 30th, Kushida will be 0.5° north of Gamma Tauri, commencing a transit of the Hyades Star Cluster.

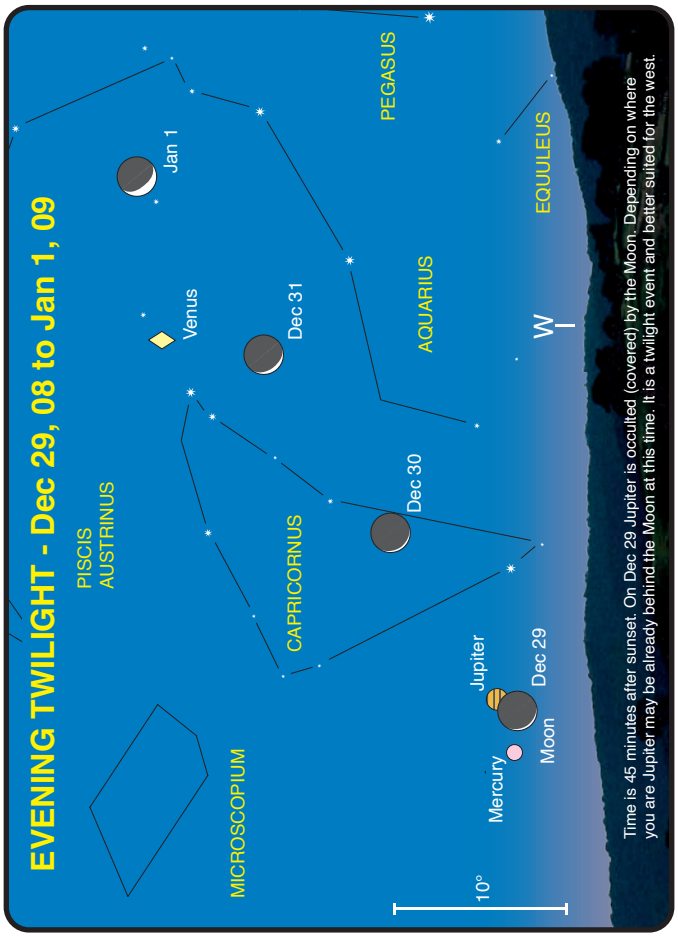
DIARY

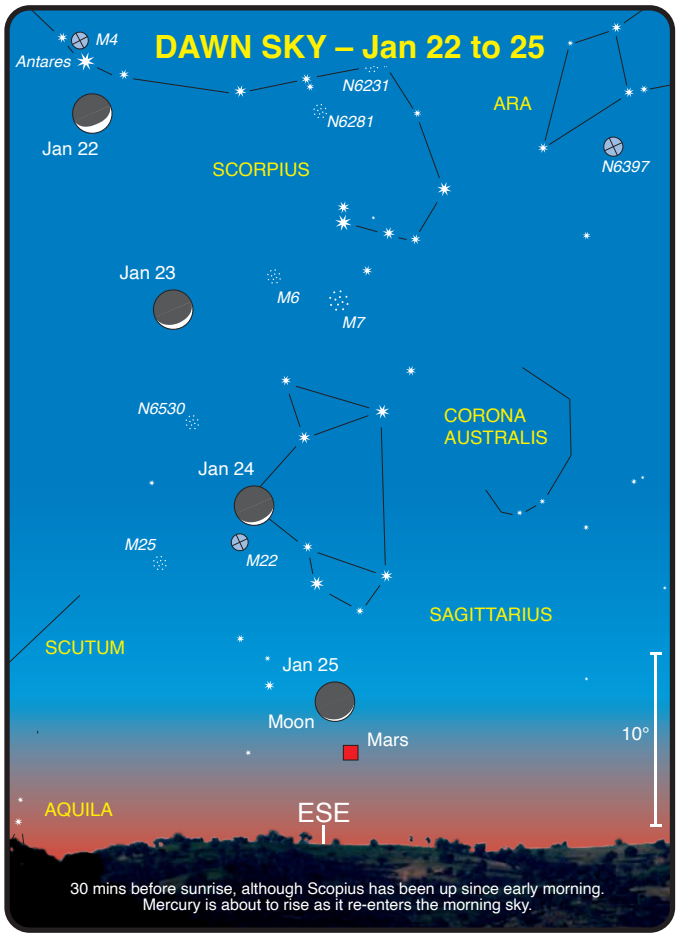
1st		Mercury 0.8° E of M75 (GC) in Sagittarius
1st		m.p. 1 Ceres 0.1° SE of NGC 3607 (G) in Leo
1st		Comet C/2007 N3 (Lulin) 1.2° W of star Beta Scorpii
1st	pm	m.p. 2 Pallas 0.5° NE of NGC 1679 (G) in Caelum
2nd	6am	(4am WST) Saturn stationary
3rd	3am	(1am WST) Uranus 5° S of Moon
3rd	am	m.p. 1 Ceres 0.2° E of NGC 3608 (G) in Leo
4th	Midnight	(10pm WST) Mercury greatest elongation east (19°)
4th	9:56pm	(7:56pm WST) First Quarter Moon
5th	1am	(11pm WST, prev day) Earth at perihelion
7th	am	m.p. 1 Ceres 0.1° W of NGC 3626 (G) in Leo
8th		Mercury at ascending node
10th	9pm	(7pm WST) Moon at perigee
11th	1:27pm	(11:27am WST) Full Moon
11th	5pm	(3pm WST) Mercury stationary
13th		Mercury at perihelion
14th	8pm	(6pm WST) Venus 0.2° SW of star Lambda Aquarii
15th		m.p. 8 Flora 0.1° S of NGC 5427 (G) in Virgo
15th	7am	(5am WST) Venus greatest elongation east (47°)
15th	10pm	(8pm WST) Saturn 6° N of Moon
18th		Venus at ascending node
18th	4am	(2am WST) Ceres stationary
18th	12:46pm	(10:46am WST) Last Quarter Moon
19th		m.p. 8 Flora 0.3° S of NGC 5476 (G) in Virgo
19th	4am	(2am WST) m.p. 42 Isis 0.1° SE of NGC 6469 (OC) in Sagittarius
19th	8am	(6am WST) Juno in conjunction with Sun
20th		m.p. 11 Parthenope 0.5° N of NGC 7606 (G) in Aquarius
21st		Venus 0.4° NW of NGC 7585 (G) in Aquarius
21st		Pluto 0.6° S of star HR 6769
21st	2am	(Midnight WST, prev day) Mercury in inferior conjunction with Sun
21st	11pm	(9pm WST) Antares 0.02° S of Moon; Occn.
21st	11pm	(9pm WST) Pallas stationary
22nd		Neptune 0.2° SE of star BY Capricorni
23rd		m.p. 42 Isis 0.4° N of Trifid Nebula (M20) in Sagittarius
23rd		Mercury at greatest latitude north
23rd	10am	(8am WST) Moon at apogee
23rd	pm	m.p. 1 Ceres 0.2° W of NGC 3646 (G) in Leo
24th		m.p. 42 Isis 0.2° SE of M21 (OC) in Sagittarius
24th		m.p. 88 Thisbe 0.1° NW of M22 (GC) in Sagittarius
24th	2am	(Midnight WST, prev day) Venus 1.4° N of Uranus
24th	4pm	(2pm WST) Jupiter in conjunction with Sun
25th		m.p. 42 Isis 0.7° N of NGC 6546 (OC) in Sagittarius
26th	5:55pm	(3:55pm WST) New Moon; Eclipse
28th	4am	(2am WST) Neptune 1.8° S of Moon
29th		m.p. 42 Isis 0.6° S of NGC 6583 (OC) in Sagittarius
29th	3am	(1am WST) m.p. 7 Iris 0.1° SW of NGC 6401 (GC) in Ophiuchus
30th	11am	(9am WST) Uranus 5° S of Moon
30th	10pm	(8pm WST) Venus 3° S of Moon
30th	pm	Comet 144P/Kushida 0.5° N of star Gamma Tauri

Comet P/2003 K2 (Christensen), which reaches perihelion this month, commences January in Capricornus setting at the end of twilight, at magnitude 12. After about the 10th it quickly moves into conjunction with the Sun, reappearing in the morning sky. At month's end, now in Aquila, it is rising just before the start of dawn

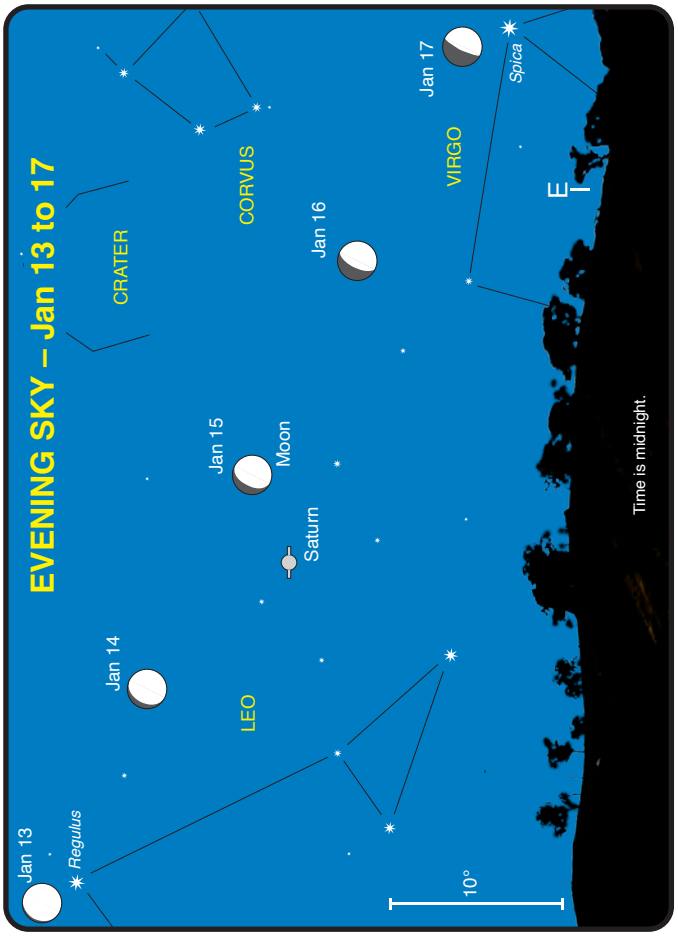
METEOR SHOWERS

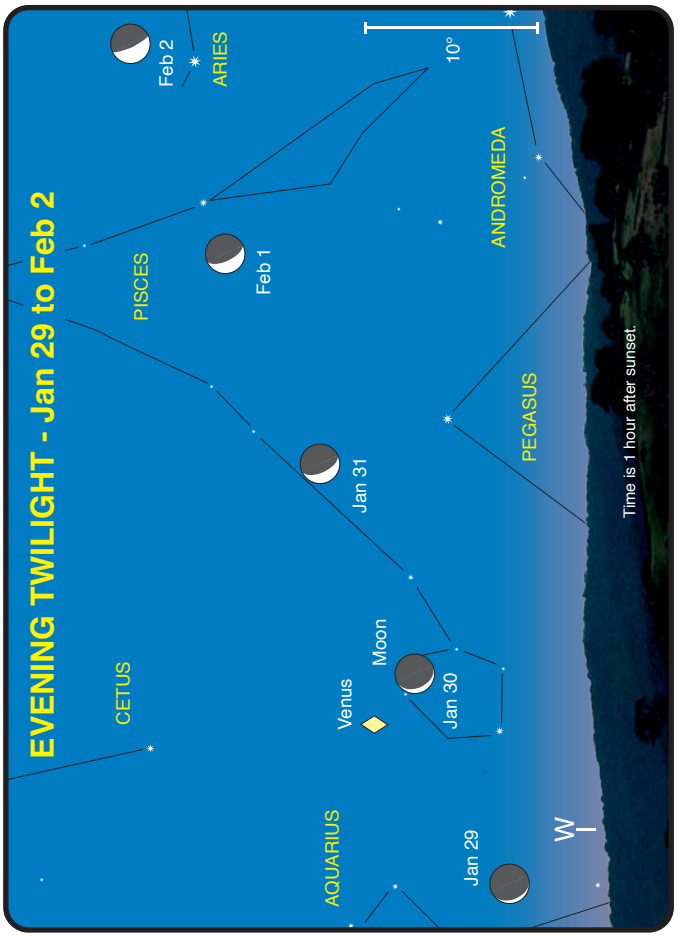
The **Quadrantids** are a strong and consistent northern hemisphere shower. They are active from 1st to 5th January with maximum on the 3rd, the zenith hourly rate is typically 120, but can vary from 60 to 200 per hour. The best that can be expected from the southern hemisphere is catching an occasional long-pathed member coming over the northern horizon around dawn.





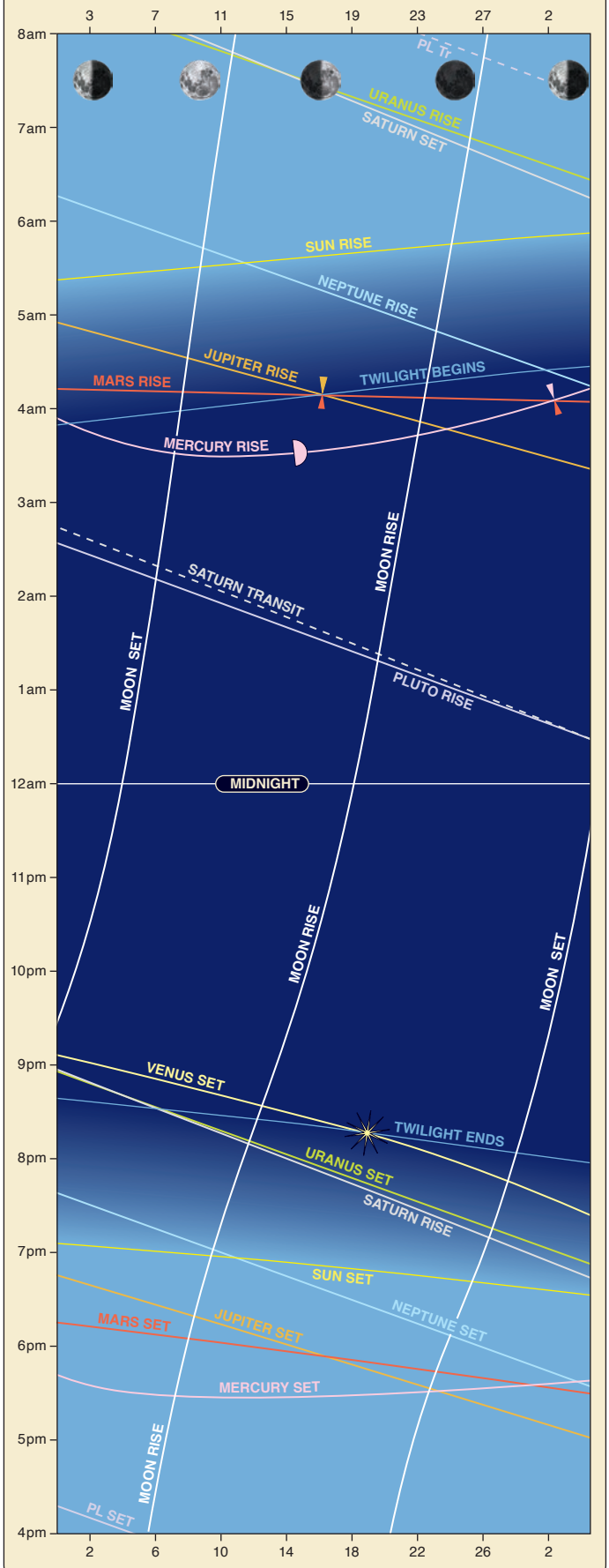
Approximate local standard time, for daylight saving add one hour.





FEBRUARY

RISE–SET CHART

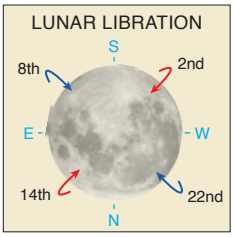


Approximate local standard time, for daylight saving add 1 hour.

HIGHLIGHTS

- Mercury at best in morning sky
- Moon, Mercury, Jupiter and Mars close in the morning sky
- Jupiter and Mars close
- Jupiter and Mercury close
- Moon and Antares together
- Comet C/2007 N3 (Lulin) may be naked-eye

THE MOON



2nd 5am (3am WST). Maximum Libration (9.3°), dark SW limb.

3rd First Quarter.

8th 6am (4am WST). Moon at perigee (closest to Earth at 361,488km).

8th 3pm (1pm WST). Minimum Libration (1.4°), bright SE limb.

10th (9th WST) Full Moon. Penumbral eclipse visible across Australia, see Part II for more detail.

14th 9pm (7pm WST). Maximum Libration (9.3°), dark NE limb.

17th Last Quarter.

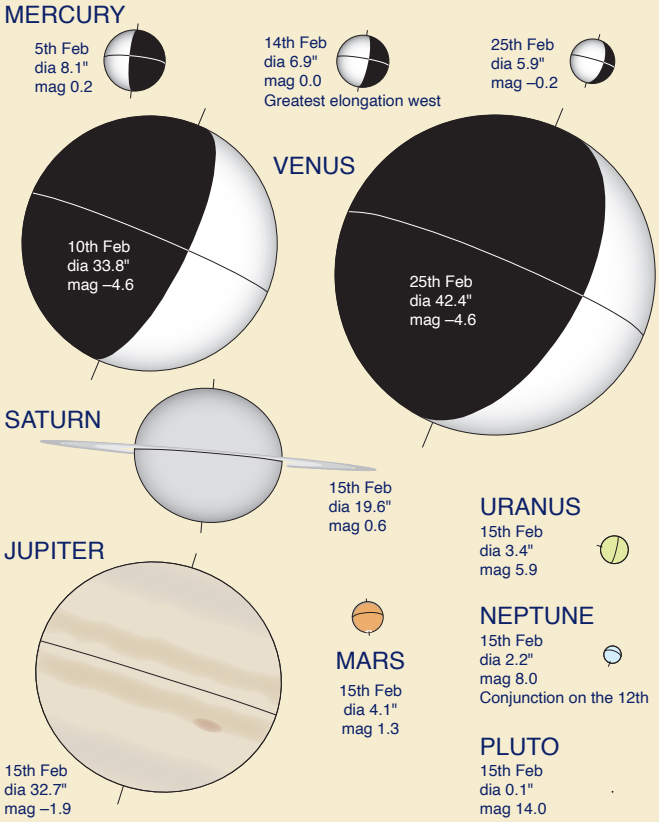
18th Occultation of Antares by the Moon, visible from northwestern Australia, a daylight event for much of the rest. In the eastern states Antares appears around 1° from the Moon in the early morning sky before the beginning of dawn. From Perth, Antares will be very close to the lunar dark limb around 4am.

20th 3am (1am WST). Moon at apogee (furthest from Earth at 405,129km).

22nd 4am (2am WST). Minimum Libration (2.3°), bright NW limb.

23rd Occultation of Mercury by the Moon. Not visible from Australia, although the planet appears close to the Moon in the morning sky.

APPEARANCE of the PLANETS



23rd Occultation of Jupiter by the Moon. Not visible from Australia, although the planet appears close to the Moon in the morning sky.

25th New Moon.

28th Occultation of Venus by the Moon. Not visible from Australia, although the planet appears near the Moon in the evening sky.

THE PLANETS

Mercury returns to the eastern morning sky this month, reaching its greatest elongation west of the Sun (26°) on the 14th. February and early March marks the best period to view this elusive planet in the morning sky this year. At mid-month Mercury moves across the border of Sagittarius into Capricornus, joining Mars, Jupiter, Neptune and the Sun in this ancient constellation of the Sea Goat (whatever that may be). On the 23rd, the 27-day old crescent Moon appears about 1° north of Mercury, with Jupiter and Mars below (see Sky View). On its descent back toward the Sun the planet passes within 1° of Jupiter on the 24th and 25th, and appears 1.5° directly above Mars on the 28th.

Venus meanders through Pisces this month, gradually sinking towards the horizon each evening as it nears inferior conjunction late next month. Although we are used to seeing Venus as a brilliant beacon in the sky, it is at its brightest in the last three weeks of February for this evening apparition. On the last day of February there is a final chance to see Venus and the Moon together in the evening sky this year, when the 3-day old Moon appears 4.5° above and north of the planet (see Sky View).

Mars is visible in the dawn sky early in the month in Sagittarius. It then slips over the border into Capricornus, joining Jupiter, Neptune and the Sun in that constellation. On the 4th, the planet passes within 0.5° of the globular star cluster M75. This 8.5 magnitude cluster is one of the most distant in Messier's catalogue, and is one of the more concentrated of the globulars. Because of its compactness and distance (around 67,500 light years), large telescopes are required to resolve it into stars. Between the 17th and 19th Mars will be less than 1° from Jupiter, the pair closest on the 18th at 0.6° (see Sky View).

Jupiter, in Capricornus, returns to the morning sky this month. A spectacular meeting with Mars occurs on the 18th when the planets are just 0.5° apart in the dawn sky, with Mercury 7° above (see Sky View). Early risers will be rewarded with pleasant views of the three planets in various configurations over the last two weeks of February. Particularly nice will be the morning of the 23rd with the 27-day old slender crescent joining the trio of planets, all fitting within a 5° circle (see Sky View).

1 CERES at OPPOSITION – 25th February 2009

While compiling a star catalogue, Giuseppe Piazzi came across Ceres on 1st January 1801, the first asteroid to be discovered. Ceres was thought to be a planet during the early 19th century, but as increasingly smaller objects were located in similar orbits, it was reclassified as a minor planet in 1851 (shades of Pluto).

Minor planets are numbered in order of discovery and to date well over 192,000 have been listed in the Minor Planet Catalogue. As the first, Ceres is formally known as 1 Ceres, and Pluto, had it been recorded as a minor planet in 1930 would have been 1164 Pluto. However, with Pluto's demotion in 2006 it is now way down the list as 134340 Pluto.

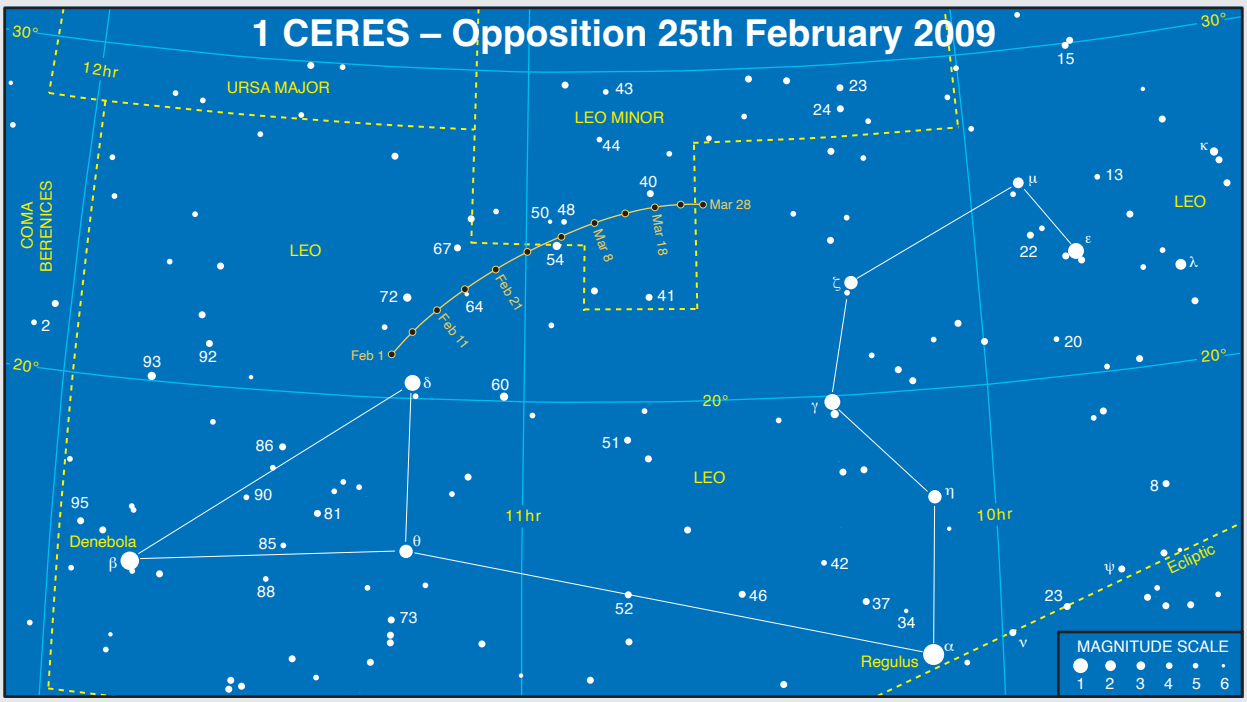
Ceres was classified as a dwarf planet along with Pluto and other Kuiper belt objects in 2006. In 2008, it was deemed that Pluto and the other transneptunian bodies come under a new class of Solar System bodies known as plutoids. Because of its location, Ceres now holds the unique position as being the only dwarf planet that isn't a plutoid.

Ceres orbits with over a hundred thousand other bodies in a region known as the asteroid belt between Mars and Jupiter. At approximately 930km in diameter, it is the largest known asteroid and contains around one third of the belt's total mass.

In December 2003 and January 2004, the Hubble Space Telescope took some tantalising images of Ceres, but with a resolution of around 30km, no fine detail of surface features was possible. NASA's Dawn Mission, launched in September 2007 will visit 4 Vesta in 2011 before arriving at 1 Ceres in 2015. It is anticipated that this unique ion propulsion craft will unlock many secrets of these asteroids.

During February and March, there is an excellent window of opportunity to observe this world as it comes to opposition. The magnitude of Ceres varies from 6.7 (just beyond the theoretical naked-eye limit) at a favourable opposition to 9.3 at conjunction. This year, at 6.9 magnitude all that will be required to see this dwarf will be a pair of 7 × 50 binoculars.

From our finder chart, there are several opportunities when Ceres can be located when near brighter naked-eye stars in Leo. At the time of opposition on the 25th February the sky will be Moon free, and Ceres will be 1.5° from the 4.5 magnitude double star 54 Leonis, passing within 0.3° on the 3rd March.



Also on the morning of the 23rd Jupiter has a close conjunction with 5th magnitude 19 Capricorni. The eastern states see the star three arcminutes to the west of Jupiter (near Ganymede) one hour before sunrise (note Callisto is in transit at this time). This is better seen from WA in the predawn.

Saturn rises in the northeast as the evening sky darkens. On the 11th, the 17-day old waning gibbous Moon will be near the planet (see Sky View). At the end of the month Saturn will be 0.6° from 4th magnitude Sigma (s) Leonis, the star marking the hind leg of the Lion. With opposition early next month Saturn will be at its best over the coming weeks.

Uranus is very low to the western horizon early in the month and quickly gets overtaken by evening twilight as it approaches the Sun and conjunction. Uranus reaches aphelion on the 27th, the point in its orbit most distant from the Sun (20.09888 AU or 3,006,749,651km). Since it takes 84 years to complete an orbit of the Sun its last distant passage was in 1925. When at its closest (perihelion) Uranus is some 272,000,000km closer to the Sun than now, and would be around half a magnitude brighter to an observer on Earth. If you are having trouble seeing Uranus at 5.9 magnitude with the unaided eye (under dark sky) at present, you will have a better chance in 2050 when the planet is next at perihelion.

Neptune is in conjunction with the Sun on the 12th and will not be readily observable until its reappearance in the morning eastern sky next month.

Pluto rises around 1:30am in the early morning eastern sky. On the 10th and 11th, Pluto passes within 1 arcminute of the 8th magnitude star HD166165, and on the 14th less than 2 arcminutes from the 8th magnitude double star HD166261 (see diary and finder chart). This pair of suns are 5.5 arcminutes apart and could serve as handy markers to detect Pluto's movement over a few days.

MINOR PLANETS. Three of the brighter minor planets reach opposition this month in Leo. They are: 511 Davida on the 10th at magnitude 10.1, 30 Urania on the 18th at magnitude 10.5 and 349 Dembowska on the 27th at magnitude 10.3. Also at opposition this month is 27 Euterpe on the 4th at magnitude 8.8 in Cancer, 80 Sappho on the 4th at magnitude 11.5 in Hydra, 13 Egeria on the 18th at magnitude 10.1 and 1 Ceres on the 25th at magnitude 6.9, both near the Leo/Leo Minor border.

COMETS

Comet 22P/Kopff moves east through Ophiuchus and Sagittarius during February. Rising shortly after midnight, Kopff is expected to brighten from 12th to 11th magnitude by month's end.

Comet P/2003 K2 (Christensen), which reached perihelion last month (0.5 AU), should be visible in the pre-dawn sky this month, fading from 11th to 13th magnitude. Its proximity to Earth (0.33 AU in early February) sees Christensen move quickly through Aquila, Scutum, Serpens, and Ophiuchus, before ending the month in Hercules.

Comet C/2007 N3 (Lulin) could become faintly visible to the unaided eye towards the end of this month as it nears Earth. Beginning February at 7th magnitude, it will be within 1° of 3rd magnitude Alpha Librae on February 7, and rising around midnight. Crossing into Virgo on February 11, Lulin glides past 5th magnitude Lambda Virginis that same day. Mid-month will see comet Lulin, now at 6th magnitude, within 4° of Spica. Closest approach to Earth (0.41 AU) occurs on February 24, with Lulin (now in Leo) rising after sunset and visible throughout the night. The end of February sees Lulin passing close to Regulus.

Comet C/2007 G1 (LINEAR) moves eastward through the far southern sky during February. Slowly fading from 12th to 13th magnitude, LINEAR begins the month in Octans before crossing over into Tucana. From February 27 to March 4, the comet will be passing across the Small Magellanic Cloud (SMC). Good luck finding this 12th magnitude fuzzy amongst all the nebulae and star clusters of this companion galaxy to the Milky Way.

Comet C/2007 Q3 (Siding Spring) moves northward through Pictor and Columba during February. This 12th magnitude comet is visible most of the night, setting in the late morning.

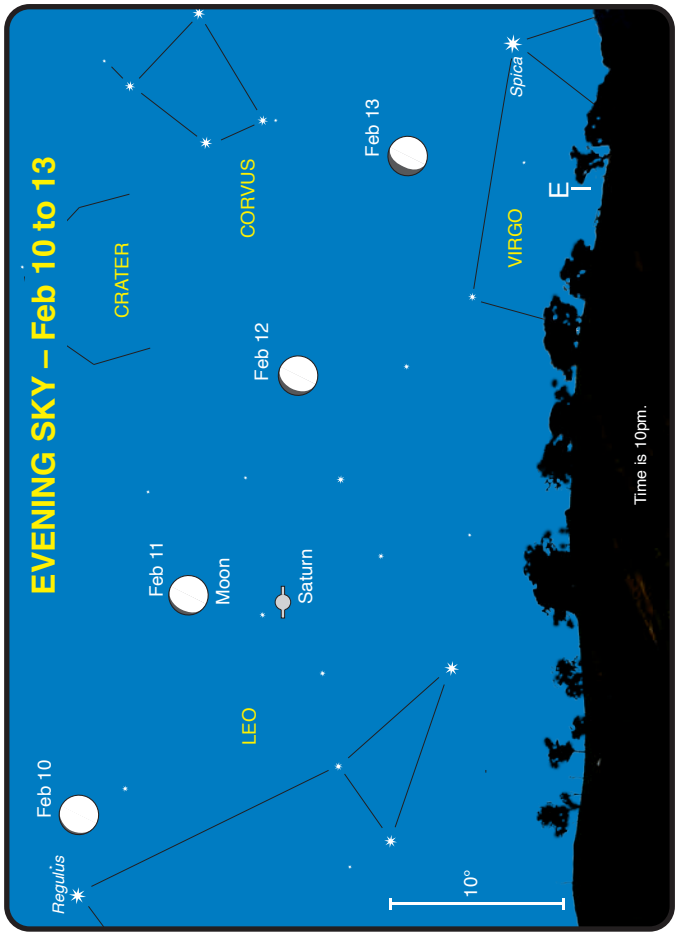
Comet 144P/Kushida spends all of February in Taurus, during which time it will fade from 11th to 12th magnitude. It will be setting around midnight. The month opens with the comet crossing the Hyades star cluster. On the 5th and 6th the comet is within 0.5° of Aldebaran. Later in February it visits some open star clusters in Taurus, including the large and sparse cluster Collinder 65 from the 21st to 27th.

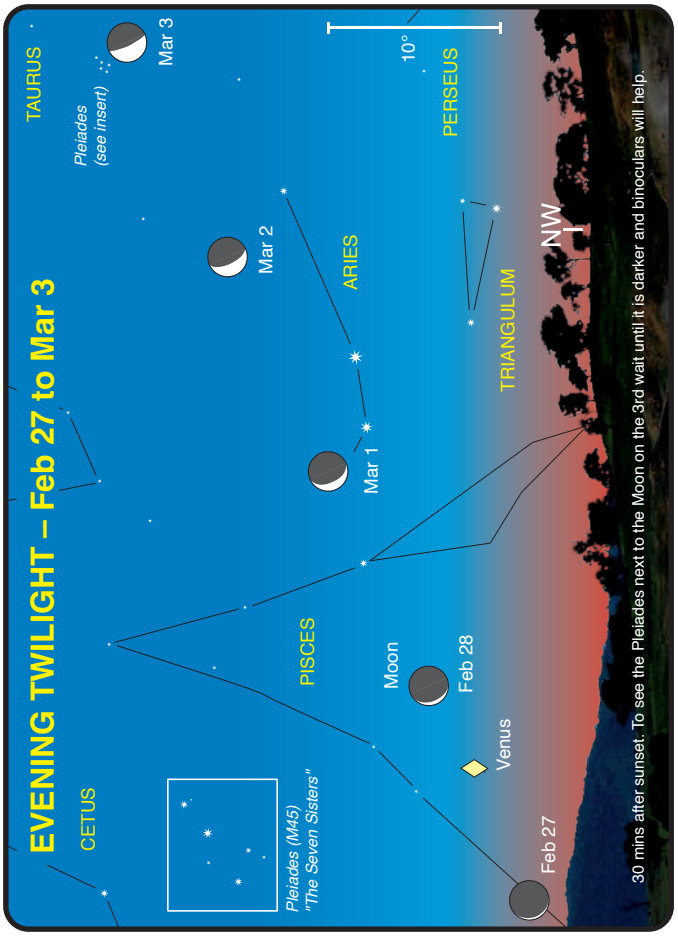
DIARY

1st		Comet P/2003 K2 (Christensen) 1.0°S of star Lambda Aquilae
1st	Noon	(10am WST) Mercury stationary
2nd		m.p. 88 Thisbe 0.5°S of NGC 6717 (GC) in Sagittarius
3rd		Comet P/2003 K2 (Christensen) 0.8°N of NGC 6704 (OC) in Scutum
3rd	9:13am	(7:13am WST) First Quarter Moon
3rd	pm	Comet 144P/Kushida 0.4°NE of star Theta Tauri
4th		m.p. 42 Isis 0.6°N of NGC 6642 (GC) in Sagittarius
5th	9pm	(7pm WST) Comet 144P/Kushida 0.3°W of star Aldebaran
6th		m.p. 42 Isis 1.0°N of M22 (GC) in Sagittarius
7th		Comet C/2007 G1 (LINEAR) 0.7°S of NGC 7098 (G) in Octans
7th	am	Comet C/2007 N3 (Lulin) 0.7°NW of star Alpha Librae
8th		m.p. 16 Psyche 0.5°N of star Pi Sagittarii
8th	6am	(4am WST) Moon at perigee
10th	12:49am	(10:49pm WST, prev day) Full Moon; penumbral eclipse
11th	3am	(1am WST) Pluto 48"E of star HD 166165
12th		m.p. 15 Eunomia 0.8°W of star Gamma Hydrae
12th	4am	(2am WST) Comet P/2003 K2 (Christensen) 0.1°SE of Collinder 350 (OC) in Ophiuchus
12th	6am	(4am WST) Saturn 6°N of Moon
12th	11pm	(9pm WST) Neptune in conjunction with Sun
14th		m.p. 7 Iris 0.9°S of Trifid Nebula (M20) in Sagittarius
14th		m.p. 42 Isis 0.1°SW of NGC 6717 (GC) in Sagittarius
14th	3am	(1am WST) Pluto 104"N of star HD 166261
14th	7am	(5am WST) Mercury greatest elongation west (26°)
15th		m.p. 7 Iris 0.4°N of Lagoon Nebula (M8) in Sagittarius
16th		Mercury at descending node
17th		m.p. 7 Iris 0.5°S of NGC 6546 (OC) in Sagittarius
17th	7:37am	(5:37am WST) Last Quarter Moon
17th	8pm	(6pm WST) Mars 0.6°S of Jupiter
18th		Comet 22P/Kopff 0.4°S of M9 (GC) in Ophiuchus
18th	3am	(1am WST) Comet C/2007 N3 (Lulin) 0.1°E of NGC 4981 (G) in Virgo
18th	7am	(5am WST) Antares 0.04°S of Moon; Occn.
19th		Comet 144P/Kushida 0.6°N of NGC 1807 (OC) in Taurus
19th		Comet 144P/Kushida 0.5°NW of NGC 1817 (OC) in Taurus
19th		Comet 22P/Kopff 0.7°N of NGC 6342 (GC) in Ophiuchus
20th	1am	(11pm WST, prev day) Venus greatest illuminated extent
20th	3am	(1am WST) Moon at apogee
20th	11pm	(9pm WST) Comet C/2007 N3 (Lulin) 0.4°NW of m.p. 29 Amphitrite
21st		Venus at perihelion
23rd	5am	(3am WST) Jupiter 0.05°E of star 19 Capricorni
23rd	8am	(6am WST) Mercury 1.1°S of Moon; Occn.
23rd	11am	(9am WST) Jupiter 0.7°S of Moon; Occn.
23rd	6pm	(4pm WST) Mars 1.7°S of Moon
24th		Comet 144P/Kushida 0.5°N of Collinder 65 (OC) in Taurus
24th	1pm	(11am WST) Mercury 0.6°S of Jupiter
25th	Midnight	(10pm WST) Ceres at opposition
25th	11:35am	(9:35am WST) New Moon
26th		Mercury at aphelion
26th	pm	Comet C/2007 Q3 (Siding Spring) 0.5°E of NGC 1851 (GC) in Columba
27th		Uranus at aphelion
27th	pm	m.p. 8 Flora 0.2°NE of NGC 5634 (GC) in Virgo
27th	11pm	(9pm WST) Comet C/2007 N3 (Lulin) 2.0°E of star Regulus
28th		Saturn 0.4°NE of star Sigma Leonis
28th		Comet C/2007 G1 (LINEAR) 1.5°SE of 47 Tuc (GC) in Tucana
28th	9am	(7am WST) Venus 1.3°N of Moon; Occn.

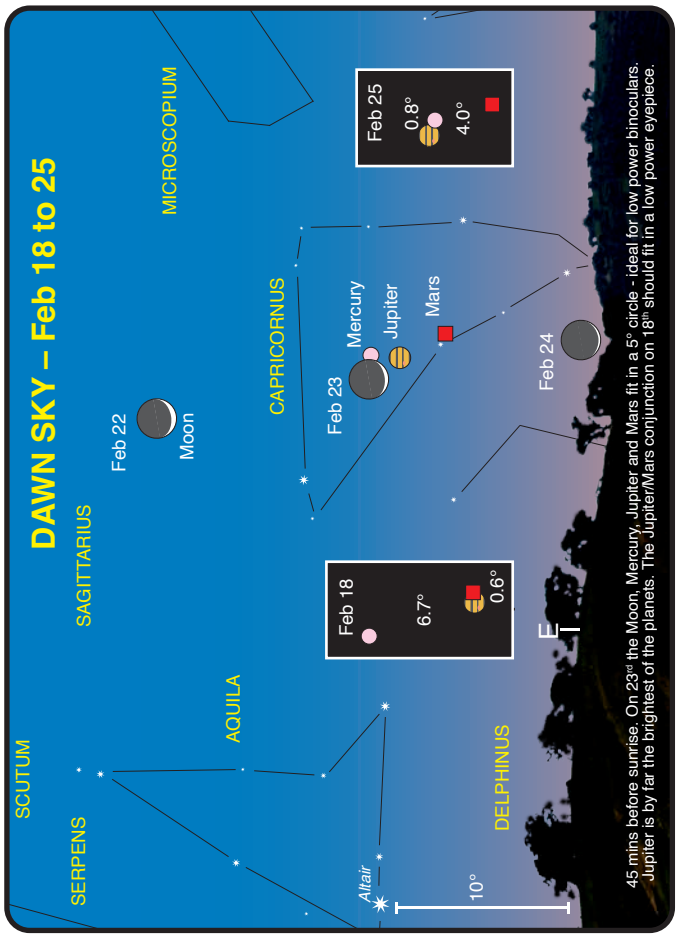
METEOR SHOWERS

The **delta-Leonids** are reasonably placed for southern observers, with the radiant crossing the meridian around midnight. With predominately faint meteors, this shower is considered a minor one, active from 15th February to 10th March, with maximum on the 25th; a low zenith hourly rate of around two can be expected.



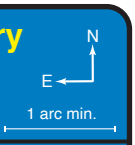


Approximate local standard time, for daylight saving add one hour.



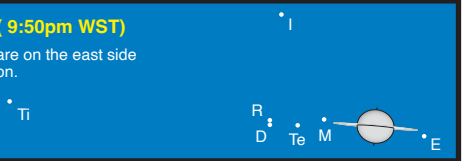
Saturn's Satellites for February

Below are a few interesting configurations of the 7 brightest moons that occur during the month. Unless otherwise indicated the scale is as shown to the right. See page 23 for further explanation and below for satellite abbreviations.



Feb 4, 11:50pm EST (9:50pm WST)

Six of the brightest moons are on the east side with Iapetus near conjunction.



Feb 11, 2:00am EST (midnight WST on 10th)

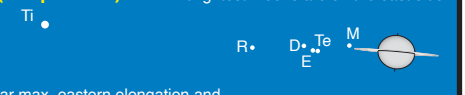
A tight group of 3 satellites

Feb 18, 1:10am EST (11:10pm WST on 17th)

Six of the brightest moons on the east side.

Feb 21, 11:30pm EST (9:30pm WST)

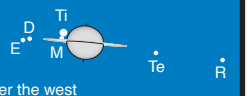
All 7 brightest moons are on the east side.



Iapetus is near max. eastern elongation and is 9' 30" from Saturn (139mm on this scale)

I	Mimas	M
II	Enceladus	E
III	Tethys	Te
IV	Dione	D
V	Rhea	R
VI	Titan	Ti
VIII	Iapetus	I

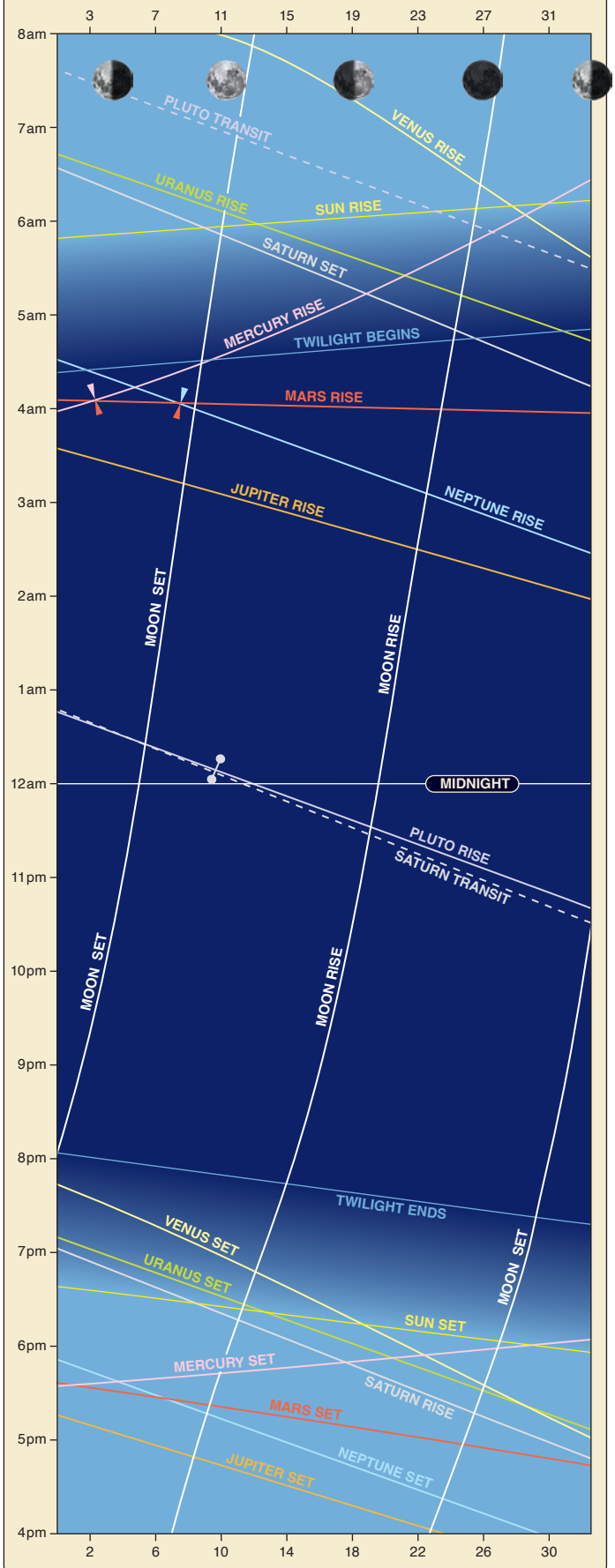
Feb 24, 9:30pm EST (7:30pm WST)



Not ideal for WA, however the west can look for Titan after it transits in the morning sky.

MARCH

RISE–SET CHART

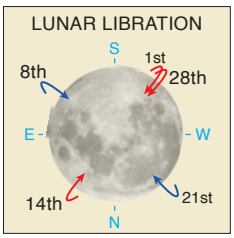


Approximate local standard time, for daylight saving add 1 hour.

HIGHLIGHTS

- Jupiter, Mars and Mercury in the dawn sky
- Mercury and Mars close
- Mars and Neptune close
- Saturn at Opposition
- Comet C/2007 N3 (Lulin) near Regulus at 6th magnitude
- Comet 22P/Kopff has close encounters with M23 and M25

THE MOON



1st 9am (7am WST). Maximum Libration (8.4°), dark SW limb.

4th First Quarter.

8th 1am (11pm WST prev. day). Moon at perigee (closest to Earth at 367,017km).

8th 5am (3am WST). Minimum Libration (0.9°), bright SE limb.

11th Full Moon.

14th 2pm (12pm WST). Maximum Libration (8.5°), dark NE limb.

17th Occultation of Antares by the Moon. Not visible from Australia, although Antares appears around 5° above the rising Moon in the late evening sky.

19th Last Quarter.

19th 11pm (9pm WST). Moon at apogee (furthest from Earth at 404,299km).

21st 8am (6am WST). Minimum Libration (2.3°), bright NW limb.

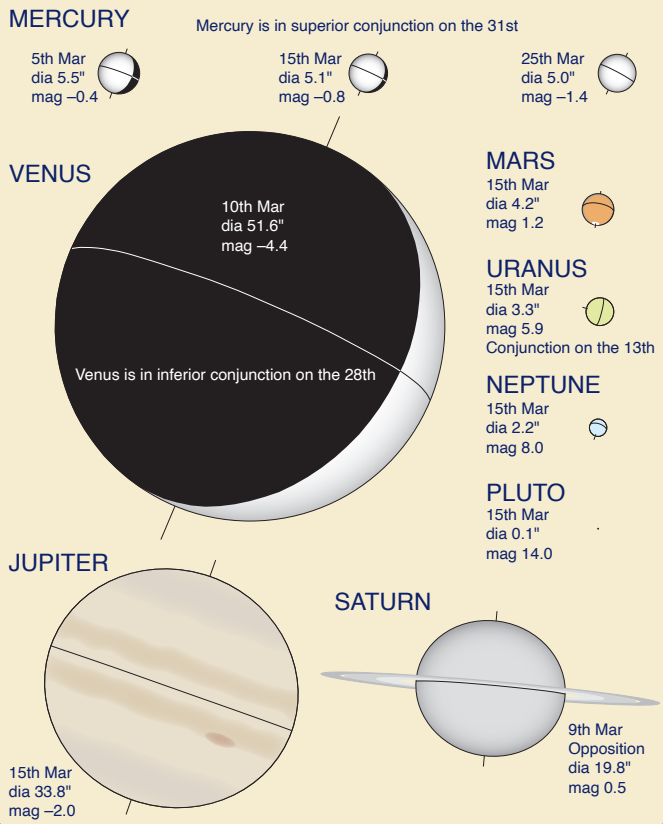
27th New Moon.

28th 4am (2am WST). Maximum Libration (8.0°), dark SW limb.

THE PLANETS

Mercury appears close to Mars in the eastern dawn sky at the beginning of the month, passing less than 1° from each other on the 2nd and 3rd

APPEARANCE of the PLANETS



(see Sky View). On the 5th and 6th, the planet will be less than 2° south of Neptune, the pair forming a right angle triangle with Mars on the 6th. In the last two weeks of March, this speedy messenger slips back to the horizon, gradually being consumed by the brightening dawn sky as it makes a rendezvous with the Sun and superior conjunction (Mercury and Earth on opposite sides of the Sun) on the 31st.

Venus is low in the western evening sky at the beginning of the month, but is soon absorbed into the brightening twilight as it nears the Sun. The planet is in inferior conjunction (between the Earth and the Sun) on the 28th, returning to the morning sky in April. Venus remains the Morning Star until mid-December when again it is too close to the Sun to observe.

The **Earth** is at its autumnal equinox on the 20th. An observer on the equator will see the Sun rise due east and set due west. At this location, day and night are equal.

Mars spends the first third of March in Capricornus before crossing over into Aquarius in the morning sky, rising around 4am mid-month. Mars and Mercury are 0.6° apart on the 2nd (see Sky View), and quickly separate as the inner planet moves towards the horizon. On the 9th, the Red Planet will be 0.8° from the blue planet, Neptune.

Jupiter begins the month in the morning eastern sky, rising one hour before dawn, about 5° above Mercury and Mars. On the 8th, Jupiter will be just four arcminutes from the 4th magnitude star Theta (q) Capricorni. On the 23rd, the 26-day old waning crescent Moon appears less than 2° north of the planet (see Sky View).

Saturn rises around 6pm mid-month in the east, and can be seen directly above 2nd magnitude Beta (β) Leonis, the star marking the tail of the Lion. The ringed planet is at opposition on the 9th and is visible the entire night. The views of this striking world are nothing short of spectacular in any telescope. With the rings close to edge-on all year, near unobstructed views of both hemispheres can be seen. The Full Moon will be near Saturn on the 10th and 11th (see Sky View). If viewing through a telescope on the 5th, do not confuse the 7th magnitude star (HD98697) close to the planet with Saturn's moon Titan. The Solar System's second largest moon is closer to the planet and around one magnitude fainter than the star. As a matter of interest Jupiter's Ganymede just beats Titan by a little over 110km in diameter and our own Moon comes in as the 5th largest.

Uranus is in conjunction with the Sun on the 13th and returns to the morning sky in April. The planet moves into Pisces late in the month, after having resided in Aquarius since 2003. It returns to Aquarius briefly toward the end of the year due to retrograde motion, then back into Pisces.

Neptune in Capricornus returns to the morning sky this month and has two planetary encounters. On the 6th, Mercury will be 2° south, and on the 9th, Mars will be 0.8° south of Neptune.

Pluto rises around midnight mid-month in the east with the magnificent Milky Way regions of Sagittarius, Ophiuchus and Scorpius.

MINOR PLANETS. Three of the brighter minor planets reach opposition this month in Virgo. They are: 45 Eugenia on the 15th at magnitude 10.8, 29 Amphitrite on the 21st at magnitude 9.1 and 68 Leto on the 22nd at magnitude 11.5. Also at opposition this month are 704 Interamnia on the 2nd at magnitude 11.2 in Hydra and 115 Thyra on the 8th at magnitude 11.0 near the Leo/Crater border.

On the 27th 2 Pallas passes between 2nd magnitude Kappa Orionis and the Orion Nebula.

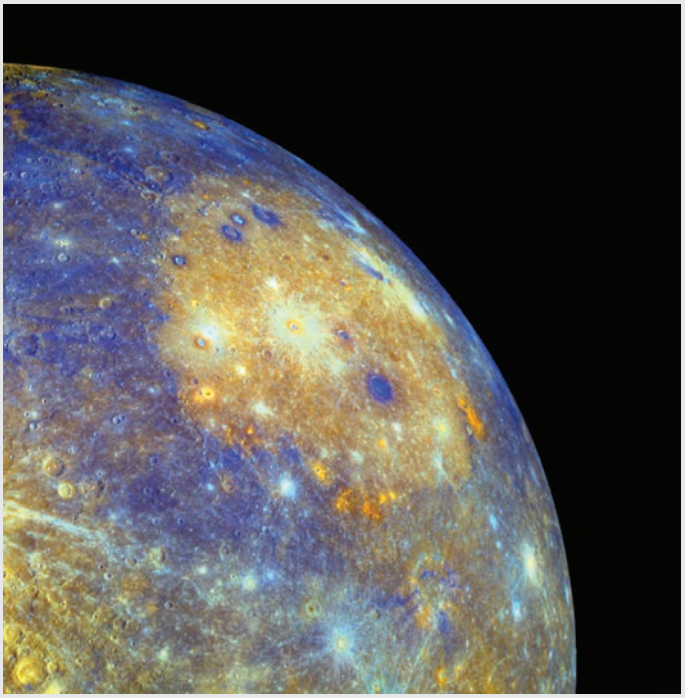
Probing the Solar System

THE MOON

Kaguya — Japan's first large lunar explorer — has been conducting science since late 2007. The Laser Altimeter (LALT) has acquired data covering the entire Moon's surface and produced a topographical map of the Moon ten times more accurate than before. www.kaguya.jaxa.jp/en

MERCURY

NASA's **Messenger** probe passed by Mercury during January 2008 in the first of three flybys before finally settling into orbit in March 2011. Further encounters will be on October 6th 2008 and September 29th 2009. Analyses of data from the January flyby have shown that volcanoes were involved in plains formation and suggest that its magnetic field is actively produced in the planet's core. messenger.jhuapl.edu/



False-colour image of Mercury, showing the great Caloris impact basin. Image produced by NASA/Johns Hopkins University Applied Physics Laboratory/Arizona State University/Carnegie Institution of Washington. Image reproduced courtesy of Science/AAAS.

VENUS

The **Venus Express** mission aims at exploring the Venusian atmosphere, the plasma environment and the surface characteristics of Venus from orbit. With the mission extended to May 2009, it will have spent over 1,000 days orbiting our evening star. www.esa.int/esaMI/Venus_Express/

MARS

Mars Express closed in on the intriguing Martian moon Phobos in July 2008, flying only 100km from the centre of the moon. The flybys have returned its most detailed full-disc images ever, also in 3-D, using the High Resolution Stereo Camera. www.esa.int/esaMI/Mars_Express/

Spirit and **Opportunity**, the two Mars Exploration Rovers, have now operated on the surface for well over four years. In August 2008, Opportunity climbed out of Victoria Crater which it had been exploring since September 2007. It has focused on this crater for more than half of the 55 months since the rover landed in the Meridiani Planum region of equatorial Mars. www.nasa.gov/mission_pages/mer/

Mars Odyssey is an orbiter carrying science experiments designed to make global observations of Mars to improve our understanding of the planet's climate and geologic history, including the search for water and evidence of life-sustaining environments. Odyssey also serves as a communications relay for the Mars Exploration Rovers (Spirit and Opportunity) and future missions. mars.jpl.nasa.gov/odyssey/

Mars Reconnaissance Orbiter is continuing to image the entire surface at a high resolution, generating mineral composition maps and subsurface radar profiles. marsprogram.jpl.nasa.gov/mro

Mars Science Laboratory (scheduled for launch in September or October 2009). Building on the success of the two rover *geologists* that arrived at Mars in January 2004, NASA's next rover mission is being planned for travel to Mars before the end of the decade. Twice as long and three times as heavy as the Mars Exploration Rovers Spirit and Opportunity, the Mars Science Laboratory will collect Martian soil and rock samples and analyse them for organic compounds and environmental conditions that could have supported microbial life now or in the past. marsprogram.jpl.nasa.gov/missions/future/msl.html

continued next page

COMETS

Comet C/2007 N3 (Lulin) is in Leo at the start of March, 5° northwest of Regulus and visible until just before dawn. Expected to initially be around 6th magnitude, though fading as it moves away from both Earth and the Sun, Lulin quickly crosses into the constellation of Cancer. On March 6, the comet is 2° south of M44 (the Beehive Cluster). By mid-March, Lulin has moved into Gemini. Month's end should see the comet at 10th magnitude and setting before midnight.

Comet C/2007 Q3 (Siding Spring) arcs northward through Columba during March. Setting around 1am mid-month, the comet is expected to be 12th magnitude in brightness.

Comet 22P/Kopff moves eastward through Sagittarius during March. Rising around midnight, the comet should brighten from 11th to 10th magnitude by month's end. On the mornings of the 4th and 17th, Comet 22P/Kopff has close encounters with M23 and M25 respectively – two open star clusters in Sagittarius.

Comet 144P/Kushida is in Taurus as March begins, setting around midnight. Continuing its eastward trek, Kushida passes through Orion and ends the month in Gemini. On March 21, the comet will be 1° from Gamma Geminorum. By the end of March, Kushida will have faded from 12th to 13th magnitude.

Probing the Solar System

… continued.

Phoenix landed on May 25 2008 in the northern polar region. Since then, it has used a robotic arm to dig into the Martian soil, delivered that soil to the different instruments on board the lander, and used two cameras to document its surroundings, all while measuring Martian atmospheric properties. It has confirmed the presence of water in the form of ice in the Martian soil. phoenix.lpl.arizona.edu/index.php

MINOR PLANETS

Hayabusa, on its way back to Earth from Itokawa, is due back in 2010.

The **Dawn** mission to visit two of the largest asteroids, Vesta (2011) and Ceres (2015), was launched on September 27 2007. dawn.jpl.nasa.gov

SATURN

The **Cassini** probe has been orbiting Saturn since June 2004, studying the planet, its rings and moons. Between September and planned mission end in 2010, there are a total 152 flybys; 34 close (< 10,000km) and 118 distant, scheduled for Titan and the other moons. saturn.jpl.nasa.gov

PLUTO

New Horizons is on its way to Pluto and the Kuiper Belt. It will fly past Pluto in 2015. pluto.jhuapl.edu

COMETS

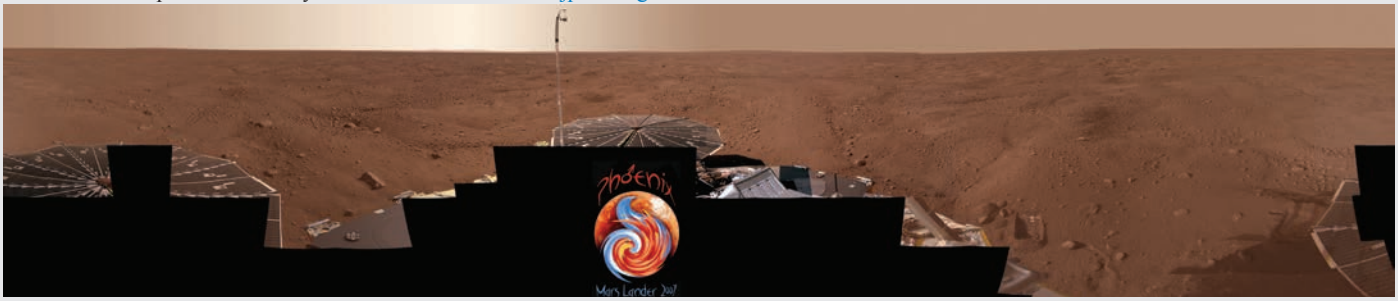
Epoxi is using the surviving Deep Impact spacecraft for observations of a number of extrasolar planets during 2008. It will then go into hibernation for approximately two years before a planned encounter with Comet 103P/Hartley 2, in October 2010. epoxi.umd.edu

ESA's **Rosetta** spacecraft is on its way to land on Comet Churyumov-Gerasimenko in November 2014. On the way it passed by asteroid 2867 Steins in September 2008 and will pass again by the Earth in November 2009, then flyby asteroid 21 Lutetia in July 2010. rosetta.esa.int

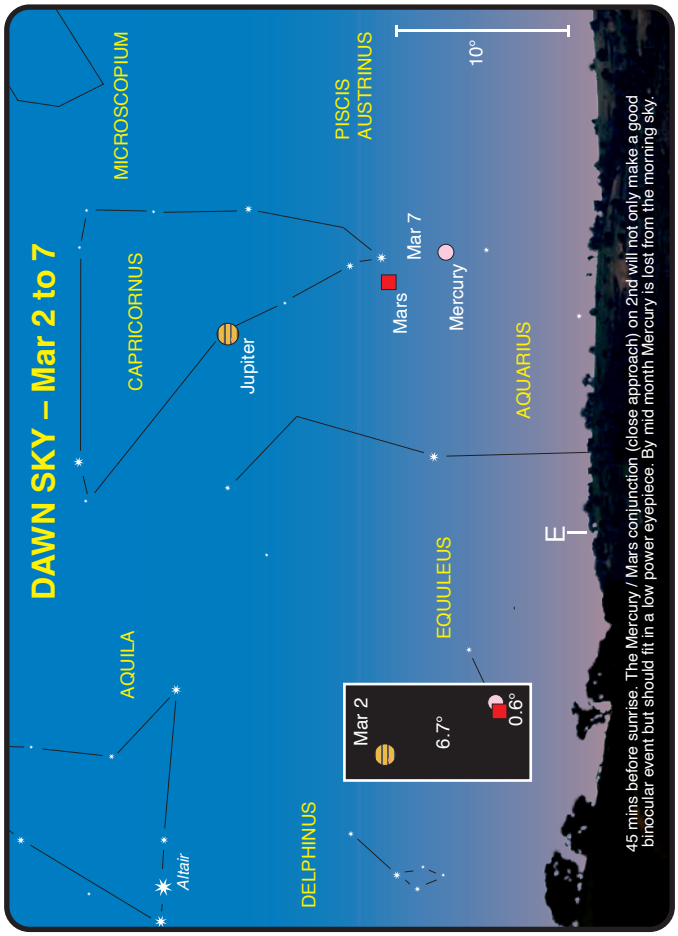
The **Stardust-NExT** spacecraft encountered Comet Wild 2 in January 2004, collecting particles of dust as it flew by. This dust was returned to Earth in January 2006. Currently the probe is on its way to an encounter with Comet Tempel 1 in February 2011. stardust.jpl.nasa.gov

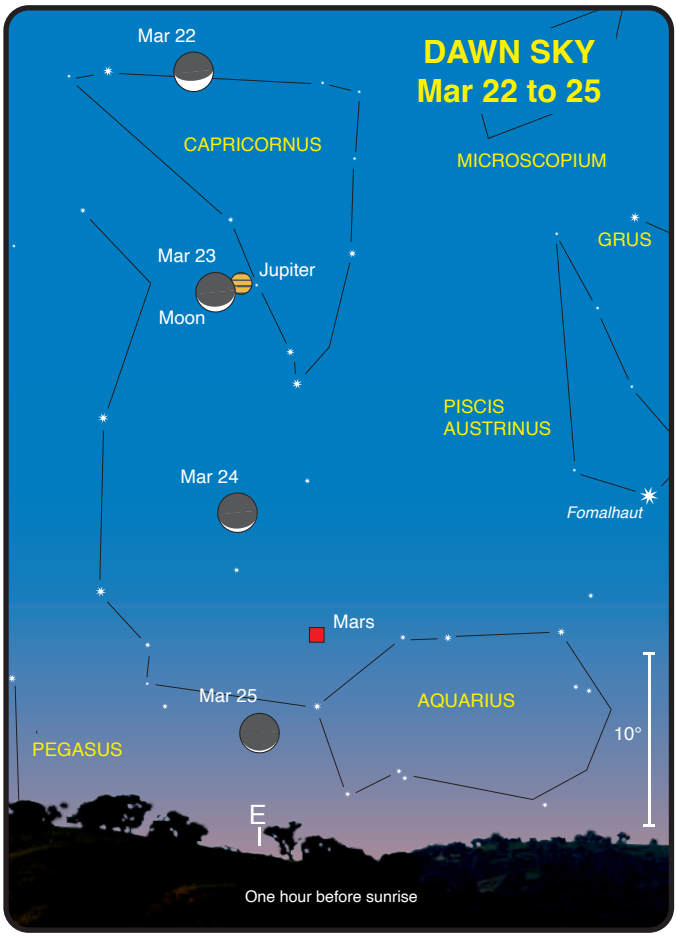
DIARY

2nd		m.p. 2 Pallas 0.9°NW of NGC 1832 (G) in Lepus
2nd	6am	(4am WST) Mercury 0.6°S of Mars
4th		Mercury 0.7°N of star Delta Capricorni
4th	3am	(1am WST) Comet 22P/Kopff 0.2°S of M23 (OC) in Sagittarius
4th	5:46pm	(3:46pm WST) First Quarter Moon
5th		Comet C/2007 G1 (LINEAR) 1.2°SE of NGC 362 (GC) in Tucana
5th	11am	(9am WST) Venus stationary
5th	11pm	(9pm WST) Comet C/2007 N3 (Lulin) 2.3°SE of Beehive Cluster (M44) in Cancer
7th	3am	(1am WST) m.p. 7 Iris 0.1°N of NGC 6642 (GC) in Sagittarius
7th	4am	(2am WST) Jupiter 0.1°NW of star Theta Capricorni
8th	1am	(11pm WST, prev day) Moon at perigee
8th	2pm	(Noon WST) Mars 0.8°S of Neptune
9th	6am	(4am WST) Saturn at opposition
10th		m.p. 7 Iris 0.6°N of M22 (GC) in Sagittarius
11th		Neptune 0.9°S of m.p. 20 Massalia
11th	12:38pm	(10:38am WST) Full Moon
11th	1pm	(11am WST) Saturn 6°N of Moon
13th	11am	(9am WST) Uranus in conjunction with Sun
14th		m.p. 18 Melpomene 0.1°S of M72 (GC) in Aquarius
14th	pm	m.p. 14 Irene 0.7°SW of NGC 5691 (G) in Virgo
15th		Venus at greatest latitude north
15th	9pm	(7pm WST) Comet C/2007 N3 (Lulin) 0.4°NW of Eskimo Nebula (NGC 2392) in Gemini
16th		m.p. 18 Melpomene 0.4°NW of M73 (OC) in Aquarius
16th		m.p. 42 Isis 0.4°NW of M75 (GC) in Sagittarius
17th	2am	(Midnight WST, prev day) Comet 22P/Kopff 0.2°NE of M25 (OC) in Sagittarius
17th	3pm	(1pm WST) Antares 0.2°S of Moon; Occn.
17th	9pm	(7pm WST) Comet C/2007 N3 (Lulin) 0.5°SW of star Delta Geminorum
18th		Mercury at greatest latitude south
19th	3:47am	(1:47am WST) Last Quarter Moon
19th	11pm	(9pm WST) Moon at apogee
19th	pm	m.p. 1 Ceres 0.9°N of NGC 3344 (G) in Leo Minor
20th	10pm	(8pm WST) Equinox
21st		Comet 144P/Kushida 1.0°N of star Gamma Geminorum
23rd	Midnight	(10pm WST) Neptune 2°S of Moon
23rd	7am	(5am WST) Jupiter 1.5°S of Moon
24th	Midnight	(10pm WST) Mars 4°S of Moon
24th	9pm	(7pm WST) m.p. 29 Amphitrite 0.1°N of NGC 4030 (G) in Virgo
25th		Jupiter 0.8°N of star Iota Capricorni
25th		Neptune 0.3°W of m.p. 89 Julia
26th		Mars at greatest latitude south
26th	3am	(1am WST) m.p. 7 Iris 0.1°NW of NGC 6717 (GC) in Sagittarius
26th	9pm	(7pm WST) Comet C/2007 N3 (Lulin) 5°N of Comet 144P/Kushida
27th		Comet 144P/Kushida 0.9°S of NGC 2304 (OC) in Gemini
27th	2:06am	(12:06am WST) New Moon
28th	5am	(3am WST) Venus in inferior conjunction with Sun
31st	1pm	(11am WST) Mercury in superior conjunction with Sun

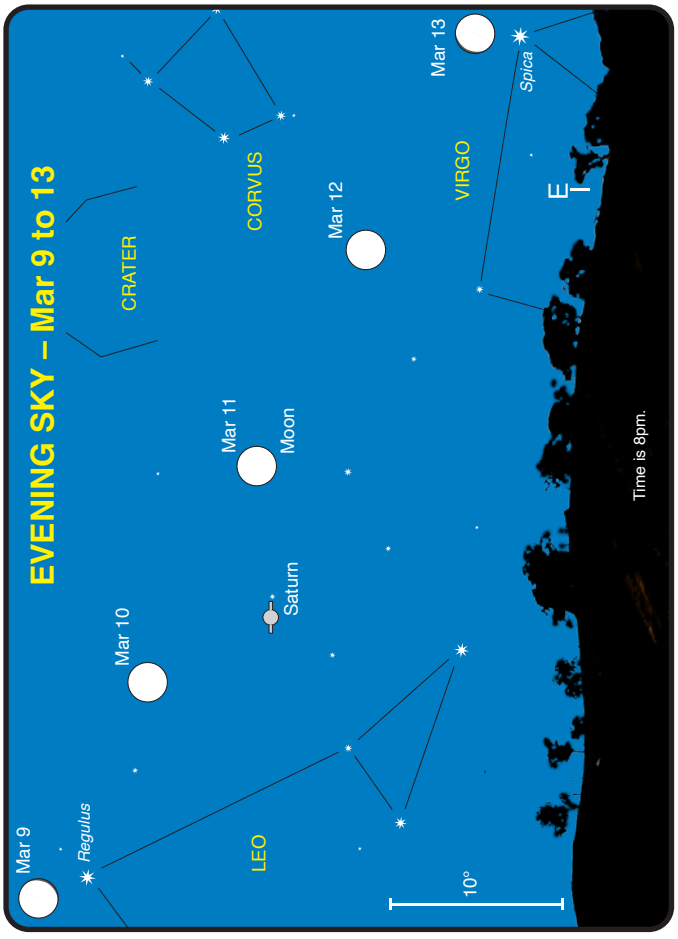


Full-circle colour panorama of Phoenix landing site on northern Mars. Credit NASA/JPL/Caltech/University Arizona/Texas A&M University



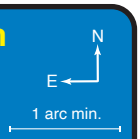


Approximate local standard time, for daylight saving add one hour.



Saturn's Satellites for March

Below are a few interesting configurations of the 7 brightest moons that occur during the month. Unless otherwise indicated the scale is as shown to the right. See page 23 for further explanation and below for satellite abbreviations.



Mar 5, 3:50am EST (1:50am WST)

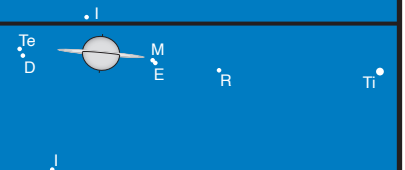
Cluster of 5 moons on the east side.

Mar 13, 4:30am EST (2:30am WST)

4 satellites in conjunction on the east with bright Titan sitting over the western side of the rings.

Mar 15, 3:10am EST (1:10am WST)

Paired moons with Iapetus nearing conjunction



Mar 19, 9:00pm EST (7:00pm WST)

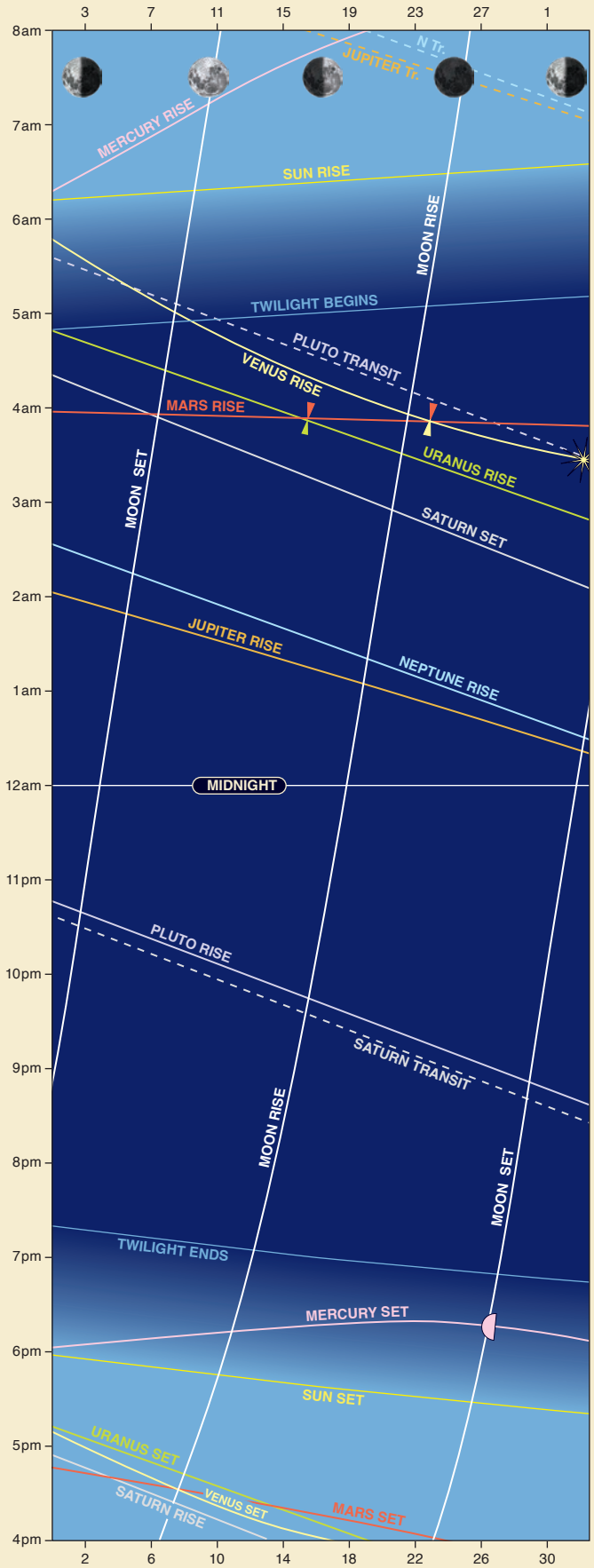
I	Mimas	M
II	Enceladus	E
III	Tethys	Te
IV	Dione	D
V	Rhea	R
VI	Titan	Ti
VIII	Iapetus	I

Mar 29, 2:40am EST (12:40am WST)

A clustering of satellites on the west.

APRIL

RISE–SET CHART

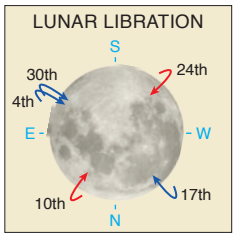


Approximate local standard time, for daylight saving add 1 hour.

HIGHLIGHTS

- Moon and Antares close
- Mars and Venus close
- Mars, Venus and the Moon together in the morning sky
- Mars and Uranus close
- Jupiter gains an extra ‘moon’
- The pi-Puppids meteor shower

THE MOON



2nd 12pm (10am WST). Moon at perigee (closest to Earth at 370,013km).

3rd (2nd WST) First Quarter.

4th 5am (3am WST). Minimum Libration (1.5°), bright SE limb.

10th (9th WST) Full Moon.

10th 10pm (8pm WST). Maximum Libration (8.0°), Full Moon, Mare Humboldtianum on NE limb, Mare Crisium seen to best advantage.

13th Occultation of Antares by the Moon. Not visible from Australia, although Antares appears around 1° from the Moon in the evening sky from the eastern states. From WA the Moon rises with Antares 1° from the Moon, the separation increasing to 2° by midnight.

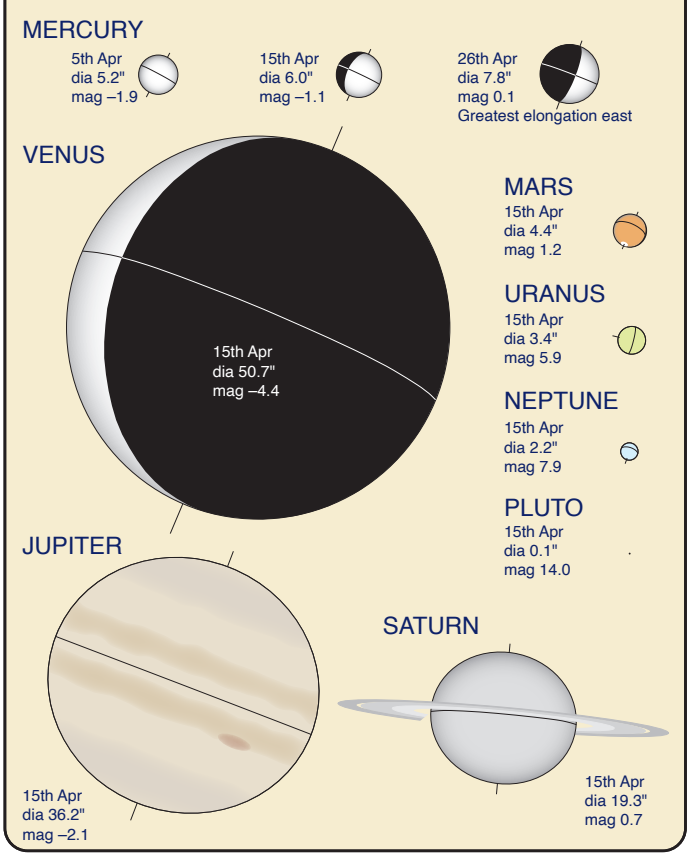
16th 7pm (5pm WST). Moon at apogee (furthest from Earth at 404,232km).

17th Last Quarter.

17th 10am (8am WST). Minimum Libration (2.2°), bright NW limb.

23rd Occultation of Venus by the Moon. Not visible from Australia, although Venus appears above the rising Moon in the early morning sky.

APPEARANCE of the PLANETS



24th 2am (12am WST). Maximum Libration (8.4°), unobservable – too close to New Moon.

25th New Moon.

28th 4pm (2pm WST). Moon at perigee (closest to Earth at 366,040km).

30th 9pm (7pm WST). Minimum Libration (2.4°), bright SE limb.

THE PLANETS

Mercury comes out of solar conjunction and into the western evening sky in Taurus this month. The planet reaches its greatest elongation east of the Sun (20°) on the 26th, although it doesn't gain a lot of altitude and will be very difficult to see in the twilight sky (see Sky View).

Venus returns to the morning sky after its conjunction with the Sun late last month. By mid-month the planet is easily visible in the eastern sky, rising just before dawn, near the asterism known as The Circlet in Pisces. On the 23rd, Venus will be around 4.5° above the 26-day old slender crescent Moon, with Mars a similar distance to the south of the planet forming a triangle with the pair (see Sky View).

Mars in the morning eastern sky moves from Aquarius into Pisces mid-month. On the 16th, the Red Planet will be just 0.5° from the green planet, Uranus. Mars comes within 4° of Venus on the 23rd, the pair making a fine sight together with the 26-day old Moon below (see Sky View).

Jupiter spends the month in the eastern portion of Capricornus near the 3rd magnitude star Delta (δ) Capricorni in the morning sky, rising 1am mid-month. On the 20th, the 24-day old waning crescent Moon will be near the planet (see Sky View). On the 26th and 27th, there will be a very interesting incursion into Jupiter's satellite plane by a 6th magnitude star. If you look around 5am EST (3am WST) on the 26th, 44 Capricorni will be so close to Jupiter's moon Callisto (furthest moon to Jupiter's east) that they will appear like a neat double star, almost matched in brightness. On the following morning 44 Capricorni will be found very near to Jupiter's north pole at around 3am EST (1am WST).

Saturn is now a few weeks past opposition and can be seen to good advantage as it transits the meridian (is due north) around 9:30pm mid-month. On the 7th, the 12-day old waxing gibbous Moon will be near the planet (see Sky View). From the end of the month until mid-May Saturn's rings will be at their widest until December when they begin to open up again (see Appearance of the Planets diagrams). The rings will be edge on in September this year.

Uranus, in Pisces, returns to the eastern dawn sky after its solar conjunction last month. On the 16th, Uranus will be 0.5° from Mars, showing a nice colour contrast at low magnification in a telescope.

Neptune rises around 1:30am mid-month in Capricornus, a few degrees east of Jupiter. The planet begins April about 6° from Jupiter, with the gap closing to 2.5° at month's end; keep a watch next month as the pair make their closest approach.

Pluto rises around 9:30pm in Sagittarius mid-month. From the beginning of April through to early September Pluto will be in retrograde motion.

MINOR PLANETS reaching opposition this month include: 25 Phocaea on the 5th at magnitude 11.0 in Corvus, 15 Eunomia on the 8th at magnitude 9.8 near the Corvus/Hydra border, 54 Alexandra on the 14th at magnitude 11.4 in Hydra, 8 Flora on the 19th at magnitude 9.8 in Virgo, 14 Irene on the 20th at magnitude 8.9 in Virgo and 48 Doris on the 26th at magnitude 11.4 near the Virgo/Libra border.

Beginner 101 — Why Observe?

We are all familiar with the impressive amateur astro-images we see in publications (like this one), but do we risk downplaying the pleasures of looking at the cosmos – live?

There is no doubt today the number of astrophotographers has reached record numbers, spurred on by the digital era. CCD cameras, webcams, computer controlled telescopes and PC image processing has revolutionized the hobby. The ability to easily digitally stack images has now even removed the requirements for long single exposures. Even these shorter exposures are today assisted by features such as automatic corrections for periodic errors in the mount! The highly sensitive CCD camera has also allowed the use of narrow band filters, which has given new life to objects you're seen imaged dozens of times before. And to top it off, as the telescope has become more and more sophisticated, having grown more dependent on electronics, the prices have also come down. What a revolution we are living in! Getting professional quality images has never been so easy!

So we've painted a rosy picture for the imager, what about the humble observer? Those who approach the telescope armed with just two eyes and an eyepiece? Firstly, a comment for those thinking of buying their first telescope having drooled over astronomy magazines, don't expect to 'see' what those publications display. The eye just doesn't have the sensitivity or memory of an imaging device. In fact, as the quantum efficiency of CCDs has improved, the gap has widened between the visual and the digital appearance. Quantum efficiency is just a fancy way of saying how well the CCD captures the photons that fall on the chip.

It is true the astroimager can go around proudly displaying his work, like a trophy on the mantelpiece, entering them in competitions and winning the accolades he/she deserves. The visual observer has a much more intangible reward. You, like the guy who took the image, can appreciate the beauty he has captured, but he can't experience your joy from observing the previous evening. While looking through your scope you are as one with the Universe, the only thing separating you from the countless mega light years of space is a thin veneer of atmosphere. It's a bit like watching a sporting event. If you want a great coverage of the cricket, stay at home and watch it on television. If you want to *experience* the game you go to the sports ground — that is the observer. Incidentally, why not soak this up as the Universe intended — in silence, unless you have that truly inspiring music to go with such an event.

The observer may not see the spiral arms of that galaxy, but there are areas where nothing beats the eyeball. The subtle variations in colour between brighter stars can sometimes be more appreciated by the discerning eye – an electronic image can burn this out. Also, visually you can push the resolution limit of the telescope. This may only be for brief periods but the patient observer will be eventually rewarded — sometimes unfortunately having to wait for another night! This wait to see breathtaking detail in the Apennine Mountains on the Moon, the

... continued next page

***Dobsonian Telescope**. This is an example of a relatively low cost telescope designed specifically for the observer who prefers to spend his/her money on light gathering power (large mirror) than on the mount. This 250mm (10 inch) telescope (250mm being the diameter of the mirror) currently sells for under $700 at retail outlets. For beginners on a strict budget a 150mm (6 inch) version can be purchased for around $300.*

COMETS

Comet C/2007 N3 (Lulin) is in Gemini throughout April. Expected to fade from 10th to 12th magnitude, the comet is setting mid-evening.

Comet C/2007 Q3 (Siding Spring) is moving northeast through Columba, Lepus, and Canis Major during April. Predicted to be 12th magnitude, the comet is setting late in the evening.

Comet 22P/Kopff moves eastward through Sagittarius and Capricornus during April. Now rising before midnight, Kopff is expected to be 9th magnitude by the end of April.

METEOR SHOWERS

The **Lyrids** are a northern hemisphere shower, but they are visible south of the equator. They are best seen well past midnight in the southern hemisphere from the 16th to 25th, with maximum on the 22nd. Maximum rates may only last an hour or so, and typically, the zenith hourly rate is around 18. The Lyrids have on occasion produced higher rates, and because of their erratic nature, they are a shower to be watched. In 1982, American observers noticed a short peak of 90 per hour.

The **pi-Puppids** are a young southern shower first observed in 1972, and produced by Comet 26P/Grigg-Skjellerup. They are best seen from 15th to 28th, with maximum activity on the 23rd. Leading up to and after maximum the rates are low and difficult to separate from sporadic meteors. The peak can vary greatly in intensity, sometimes nil, occasionally three to four per hour or more (40 in 1977 and 1982, 13 in 1983). The pi-Puppids are noted for their very slow speed, brightness, persistent trains, large proportion of yellow meteors and occasional fireballs. Conditions for the pi-Puppids are excellent this year with New Moon on 25th. They are best seen prior to local midnight, before the radiant becomes too low.

... continued from previous page

delicate swirling cloud tops of Jupiter or perhaps that elusive 6th magnitude companion peaking out from behind the glare of Antares is worth it! Yes, it is true you are at the mercy of the 'seeing' gods, but the ever changing atmosphere will deliver a unique vista each time, even if using the same telescope and eyepiece. Just when you thought it couldn't get better, you might be surprised.

To be a good observer takes practice over many years. But here are a few tips worth keeping in mind:

- Dark adaptation is a must and can take up to 30 minutes.
- Try and avoid observing over large concrete or rocky areas. They absorb a lot of heat during the day and radiate it at night setting up unwanted thermal currents, which destroy seeing. Observing over grass is ideal. An extreme example of these heat currents is the boiling effect you see above roads on a hot day.
- Minimise thermal currents within your telescope by allowing sufficient time for equilibrium with the surrounding night air. Sometimes large aperture scopes require fans to help cool the mirror.
- When straining to see faint nebula, don't only try averted vision, but try tapping your telescope tube – the eye is more sensitive to moving objects.
- Sometimes deliberately defocusing the telescope can help see colour in stars. This can be very effective when comparing two bright components in a double star.
- Make good use of different eyepieces, low power to enjoy the expanse of an open cluster, high power to increase the contrast (darken the background) to glimpse those faint nebulae and galaxies.
- There are a number of coloured or narrow band filters worth experimenting with. An example is the OIII (pronounced "oh 3"), which bring out planetary nebulae.

Providing you are comfortable with finding your way around the sky (either through practice or GOTO type instruments), observing is relatively stress free, without the technical challenges of imaging and processing. If you want to see more consider a larger telescope. These days you get more light gathering power for your dollar than ever before. Check out the mass-produced large Dobsonians available today – ideal for the aperture hungry visual observer!

In conclusion, observing is like looking at a grand master painting, just let the Universe wash over you — the more you look the more you see. What you can't see let your imagination fill the gaps, after all it's your experience, no one else's.

DIARY

2nd	Noon	(10am WST) Moon at perigee
3rd	12:34am	(10:34pm WST, prev day) First Quarter Moon
4th		Comet 144P/Kushida 0.2°NE of star Lambda Geminorum
5th	2am	(Midnight WST, prev day) Pluto stationary
6th		Mercury at ascending node
7th	5pm	(3pm WST) Saturn 6°N of Moon
10th	12:56am	(10:56pm WST, prev day) Full Moon
11th		Neptune 0.3°NW of star Mu Capricorni
11th		m.p. 7 Iris 0.9°S of star Pi Sagittarii
11th		Mercury at perihelion
13th	11pm	(9pm WST) Antares 0.4°S of Moon; Occn.
15th	am	m.p. 15 Eunomia 1.0°N of star Beta Corvi
15th	2pm	(Noon WST) Mars 0.5°S of Uranus
15th	6pm	(4pm WST) Venus stationary
16th	7pm	(5pm WST) Moon at apogee
17th	11:36pm	(9:36pm WST) Last Quarter Moon
18th	1am	(11pm WST, prev day) Ceres stationary
19th	3am	(1am WST) Venus 6°N of Mars
20th	2am	(Midnight WST, prev day) Jupiter 2°S of Moon
20th	10am	(8am WST) Neptune 2°S of Moon
20th	9pm	(7pm WST) m.p. 40 Harmonia 0.1°E of star Kappa Geminorum
21st		Mercury at greatest latitude north
21st		Mars at perihelion
22nd	Midnight	(10pm WST) Venus 1.1°S of Moon; Occn.
22nd		m.p. 20 Massalia 0.9°N of star Lambda Aquarii
22nd	6pm	(4pm WST) Uranus 5°S of Moon
23rd	5am	(3am WST) Mars 6°S of Moon
24th		m.p. 18 Melpomene 0.7°N of star Theta Aquarii
25th	1:23pm	(11:23am WST) New Moon
26th	6pm	(4pm WST) Mercury greatest elongation east (20°)
27th	2am	(Midnight WST, prev day) Mercury 1.9°S of Moon
27th	3am	(1am WST) Jupiter 0.06°S of star 44 Capricorni
28th	4pm	(2pm WST) Moon at perigee
29th		Comet C/2007 Q3 (Siding Spring) 0.1°S of NGC 2204 (OC) in Canis Major

Bringing Home the Gold

The night after
The Games had finished,
With twilight passing by,
Our Planets, five were waiting…
To put on a dazzling star show,
In a cloudless, night time sky.

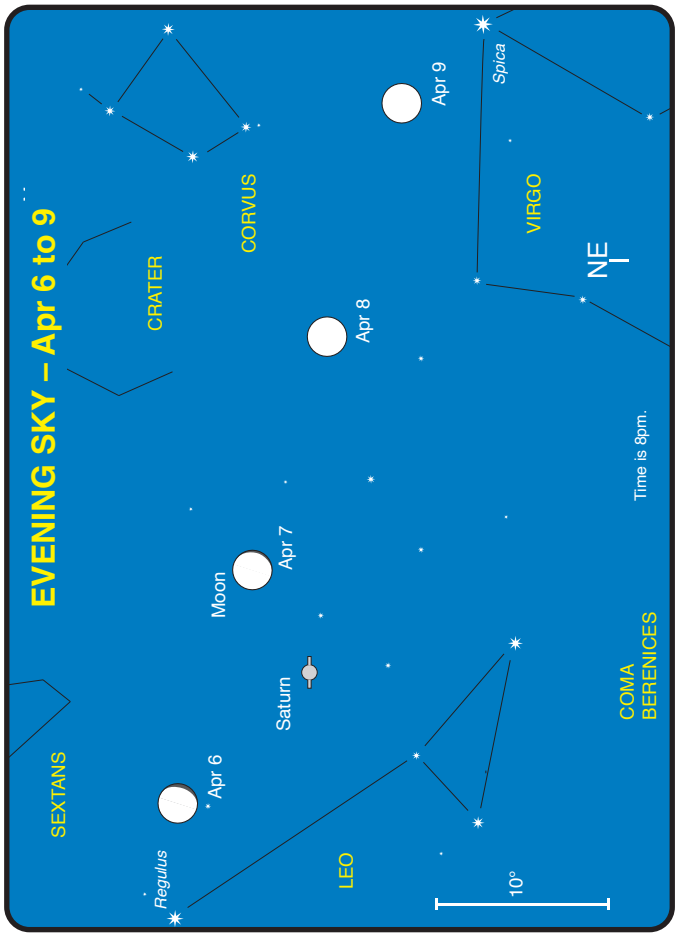
Twilight *Venus,*
In a sparring clinch with *Saturn*,
Our Lady – and keeper of "The Rings",
The winner to take on *Mercury* –
Champion feather-weight, amongst stars,
Closely watched and refereed,
By an ancient fighter, *Mars*!

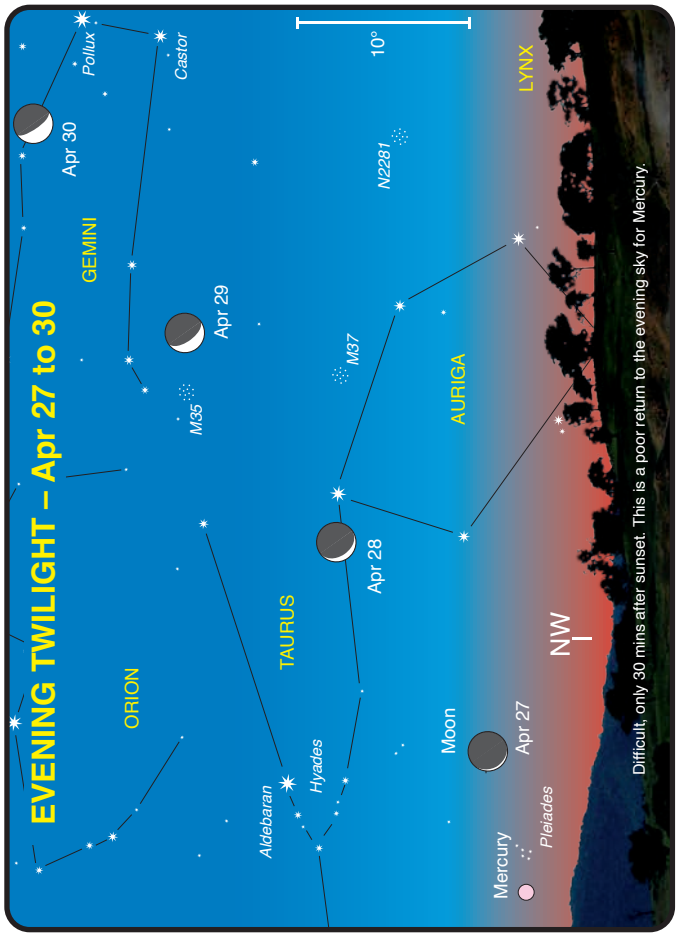
While high above, Lord *Jupiter*…
"Superstar",
Of any ring, pool or track,
An asset to any team,
Intent on bringing medals back!

Five circles, joined in our heavens
By one powerful, pulling hold…
Each and every cloudless night,
Bringing home the Gold.

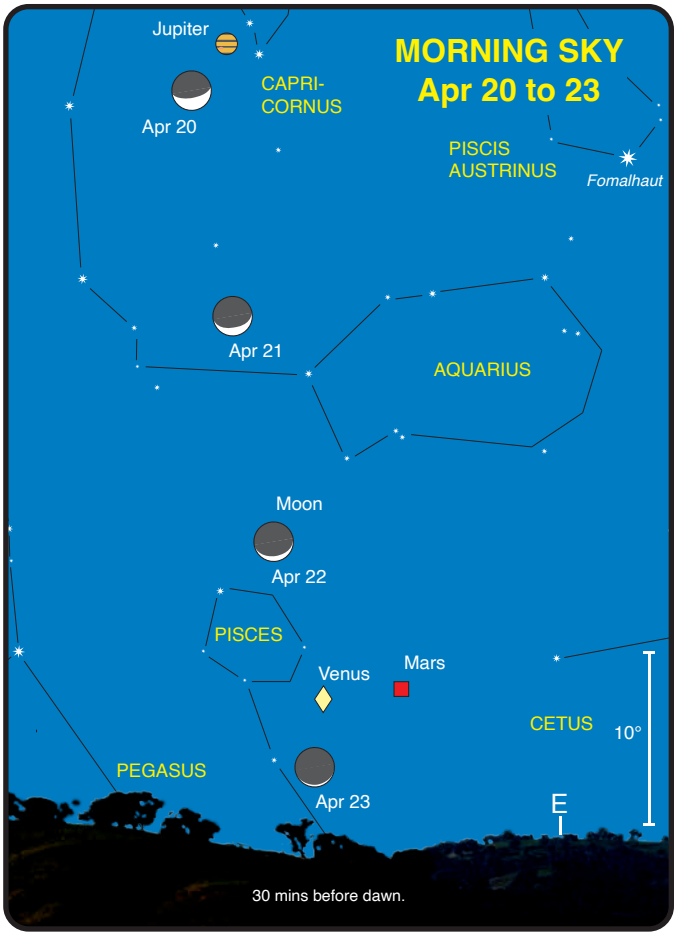
Tim Barritt.

Tim's inspiration for this poem was the dance of the five naked-eye planets in the evening sky in August 2008.



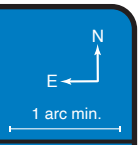


Approximate local standard time, for daylight saving add one hour.



Saturn's Satellites for April

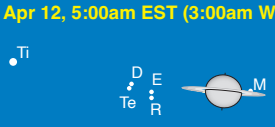
Below are a few interesting configurations of the 7 brightest moons that occur during the month. Unless otherwise indicated the scale is as shown to the right. See page 23 for further explanation and below for satellite abbreviations.



Apr 1, 11:20pm EST (9:20pm WST)

All 7 bright moons are on the west side. Iapetus is near maximum elongation, being 9' 21" from Saturn (137mm on this scale).

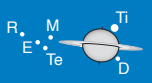
Apr 12, 5:00am EST (3:00am WST)



4 moons in a group with Titan nearby. Mimas is difficult to see being so close to the rings.

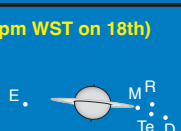
Apr 13, 8:00pm EST (6:00pm WST)

6 of the bright moons are a tight grouping around Saturn. Not the best time for WA but Titan remains close to Saturn for the rest of the evening.



Apr 19, 1:00am EST (11:00pm WST on 18th)

Iapetus is directly above Titan, just outside this box.



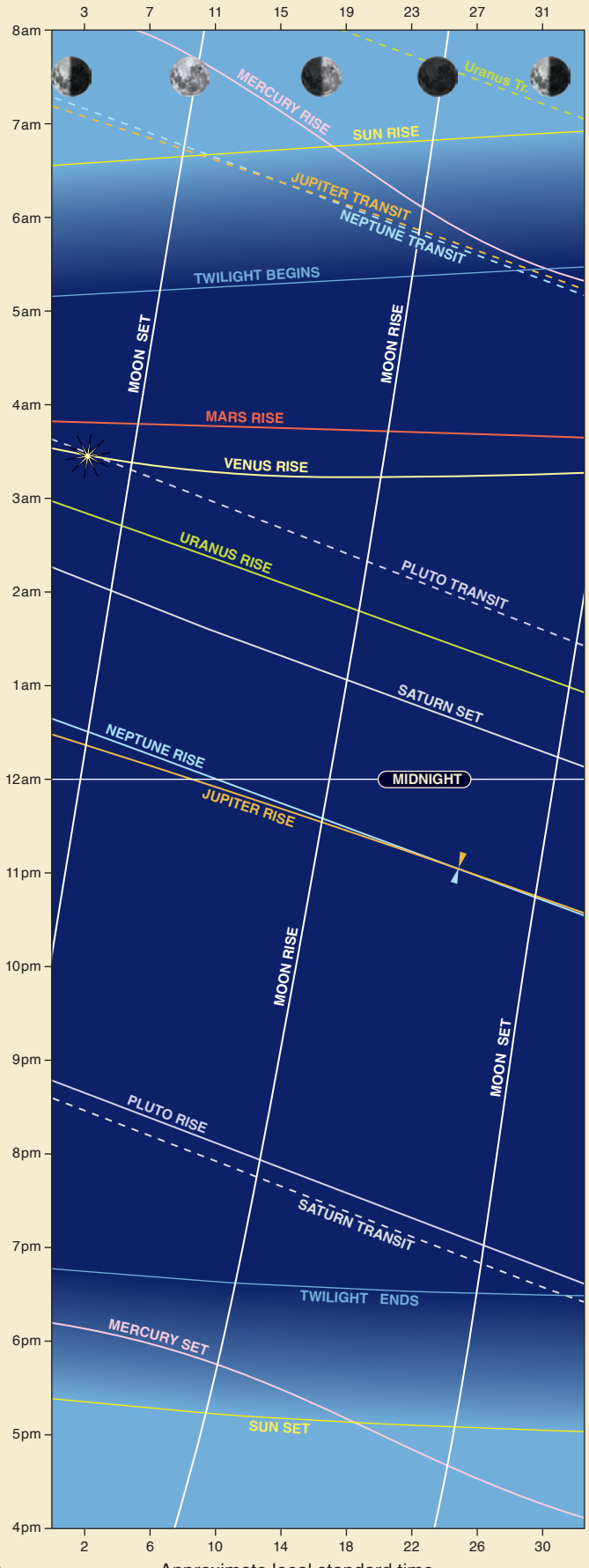
I	Mimas	M
II	Enceladus	E
III	Tethys	Te
IV	Dione	D
V	Rhea	R
VI	Titan	Ti
VIII	Iapetus	I

Apr 25, 11:00pm EST (9:00pm WST)

Tethys is currently in transit.

MAY

RISE–SET CHART

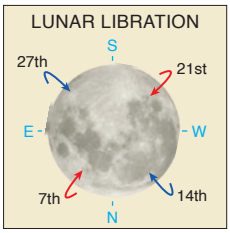


Approximate local standard time.

HIGHLIGHTS

- Moon, Venus and Mars together in the morning sky
- Jupiter and Neptune close
- The eta-Aquarids meteor shower

THE MOON



2nd First Quarter.

7th 9pm (7pm WST). Maximum Libration (8.2°), Mare Humboldtianum on bright NE limb, Mare Crisium seen to best advantage.

9th Full Moon.

11th Occultation of Antares by the Moon. Not visible from Australia.

14th 1pm (11am WST). Moon at apogee (furthest from Earth at 404,915km).

14th 4pm (2pm WST). Minimum Libration (2.0°), bright NW limb.

17th Last Quarter.

21st 12pm (10am WST). Maximum Libration (9.3°), crater Baade and Mare Orientale on bright SW limb.

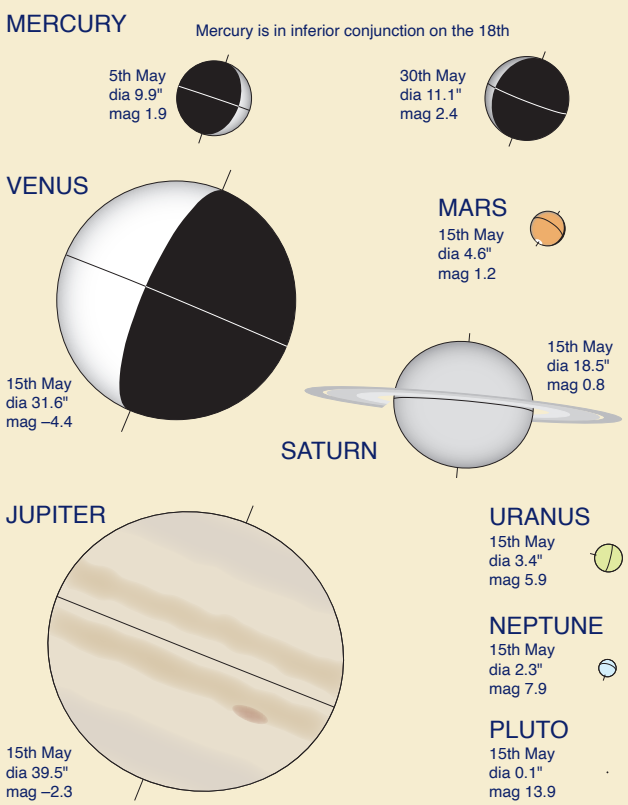
24th New Moon.

26th 2pm (noon WST). Moon at perigee (closest to Earth at 361,153km).

27th 8pm (6pm WST). Minimum Libration (2.5°), bright SE limb.

31st First Quarter.

APPEARANCE of the PLANETS



THE PLANETS

Mercury is effectively lost to evening observers this month as it moves sunward and into inferior conjunction on the 18th. Remaining in Taurus throughout May, the planet can be seen in the early dawn sky at month's end.

Venus and Mars remain companions during May, never straying more than 6° from each other in the pre-dawn sky. Although we are used to seeing Venus as a brilliant beacon in the sky, it is at its brightest from late April to mid-May for this morning apparition. On the 21st, the 26-day old crescent Moon appears 7° north of Venus forming a triangle with Mars (see Sky View). At month's end both planets are nestled in the corner of Pisces near Alpha (α) Piscium. Alpha is a fine double of some note, with observers over a century ago curiously describing the pair with a colour contrast ranging from 'greenish white and blue' to 'pale yellow and brown yellow'. Today most observers describe the 4th and 5th magnitude suns as white. At 1.9 arcseconds apart these stellar gems can be separated in a small telescope under steady seeing.

Mars begins the month a few degrees below and to the south of Venus in the predawn sky. Aside from a little corner cutting across Cetus, the Red Planet remains in Pisces over the course of the month. The most eye-catching view in the morning skies this month will undoubtedly be the views of Mars and Venus attended by the earthshine enhanced crescent Moon on the 21st and 22nd (see Sky View).

Southern Deep Sky Olympics (I)

As an aid to those starting their exploration of the Universe we decided it was worthwhile doing a brief 'best of' article. The following has been restricted to objects south of declination –40° and a telescope no larger than a 150mm to 200mm is required. That's really the only criteria, the individual choices were based on, well … we liked them! Often this opinion was influenced by the object's surroundings. Think of it as a wedding ring; what kind of setting surrounds the diamond? Not very scientific, but if it leads to debate amongst our fellow enthusiasts we have achieved our goal. Why south of –40°? We feel these are the objects northern hemisphere amateurs would rave about if only they could see them or at least as clearly as we do. Besides, it also limited the number of objects to choose from. In some categories, in the deep south, there were already too many impressive contenders! At the time of writing the Beijing Olympics were looming so we adopted their format. The choice of only three, in each category, was tough, but remember in any Olympic final the field is made up of champions but unfortunately there are only three medals awarded.

***NGC 5128, the Peculiar Galaxy in Centaurus**. How much detail can you see in its massive equatorial dark band? Image by Fred Vanderhaven.*

Galaxies

Before anyone asks we have excluded the Magellanic Clouds from this competition — they are in a field of their own!

Bronze: The spiral galaxy NGC 6744 in Pavo. The smallest telescope shows its extremely bright, compact nucleus. Photographically the galaxy extends out to around 20 × 15 arcminutes, but it has a low surface brightness. It only needs a 150mm instrument to start seeing the haze surrounding this central glow. As you increase in aperture this haze grows in size and glimpses of nebula and star forming regions start to show its spiral structure.

Silver: NGC 4945 in Centaurus. This near edge-on spiral galaxy appears as a 20 arcminute long apparition slashing its way across a triangle of stars, which includes the 4th magnitude Xi Centauri pair, making a very attractive wide field.

Gold: NGC 5128, also known as Centaurus A or the Hamburger Galaxy, in Centaurus. Even through a small telescope (100mm) you'll see the equatorial dark band appearing to dissect this 7th magnitude peculiar galaxy. The larger the instrument the further this bar extends and the more detail is visible.

… continued next page

Jupiter is situated on the eastern side of Capricornus, and rises at 11:30pm mid-month. On the 17th and 18th, the Moon at around Last Quarter phase will be nearby the planet (see Sky View). On the 21st, Jupiter will be very close to the 5th magnitude star Mu (μ) Capricorni and at the same time you will be able to pick up Neptune in a low power field 0.6° from Mu and Jupiter. The planet separates from the star and from the 25th to the end of the month Jupiter meanders within 0.4° of Neptune.

Saturn is twice paid a visit by the Moon this month: on the 4th, the 10-day old Moon will be around 5° from the planet and on the 31st the First Quarter Moon will be at a similar distance (see Sky Views). During the month Saturn will be moving slowly against the stellar background as it ends its retrograde loop mid-month, subsequently moving in a west to east direction. Transiting the meridian (due north) around 7:30pm mid-month, the planet is in an ideal position for early evening observing in the cool autumn sky.

Uranus, in Pisces, rises around 2am mid-month.

Neptune rises just before midnight in the eastern night sky directly under Jupiter. The gap between this unequal pair gradually narrows until they are 0.4° apart from the 25th until month's end. The lengthy period of time the two are together is due to Jupiter approaching its stationary point next month.

Pluto will be at opposition next month, rising in the early eastern evening sky in Sagittarius.

MINOR PLANETS. Five of the brighter minor planets reach opposition this month in Libra. They are: 451 Patientia on the 4th at magnitude 11.4, 409 Aspasia on the 5th at magnitude 10.5, 24 Themis on the 6th at magnitude 11.0, 87 Sylvia on the 10th at magnitude 11.9 and 26 Proserpina on the 18th at magnitude 10.3. Also reaching opposition this month are 103 Hera on the 1st at magnitude 11.4 on the Virgo/Libra border, 6 Hebe on the 2nd at magnitude 9.9 in Virgo, 39 Laetitia on the 21st at magnitude 10.3 in Ophiuchus and 92 Undina on the 22nd at magnitude 11.2 on the Libra/Scorpius border.

... continued from previous page

Globular Clusters

This was definitely a *stellar* field of candidates, but there are no prizes for guessing the silver and gold medallists.

Bronze: NGC 6752 in Pavo. This is a distinctive globular with its brighter 10th and 11th magnitude stars appearing like an open cluster overlaying the haze of the globular.

Silver: NGC 105 (47 Tuc) in Tucana. This naked-eye globular looks superb sitting next to the SMC. Its bright, condensed core is so compact it is unresolvable in amateur telescopes.

Gold: NGC 5139 (Omega Cen) in Centaurus. This brilliant, 3rd magnitude, naked-eye globular is approximately 0.5° in diameter. A 150mm telescope resolves it into a myriad of stars, some forming fine lacy patterns.

Open Clusters

What an impressive list of contenders and many in the same constellation — Carina. Our hardest category by far!

Bronze: NGC 4755 (the Jewel Box), a 5th magnitude cluster in Crux. Through binoculars this tight, 10 arcminute, arrowhead shaped group is in the same field as Beta (b) Crucis. A small telescope shows a collection of blue/white stars with a central red star appearing like a ruby in a diamond setting.

Silver: NGC 3532 (the Wishing Well Cluster) is a magnificent 3rd magnitude cluster in Carina. It is approximately 60 × 30 arcminutes in size. Although it is visible to the naked-eye, it looks impressive through any rich field instrument (binoculars or small telescope) being peppered with around one hundred 8 to 9th magnitude, mostly white, stars.

Gold: NGC 2516 in Carina. To the naked-eye this cluster appears as a ghostly apparition about 0.5° in diameter. It is great through any binoculars but a 100mm telescope shows its glorious 100 members to have a large variation in colour and magnitudes, all surrounding its 8th magnitude red central star.

COMETS

Comet C/2006 W3 (Christensen) is moving northwest through Pegasus. Rising before dawn, the comet should be 12th magnitude and slowly brightening.

Comet C/2007 N3 (Lulin) fades from 12th to 13th magnitude during May. Located in Gemini, the comet will be setting early in the evening by the end of the month.

Comet C/2007 Q3 (Siding Spring) moves through Canis Major and Monoceros during May. Expected to brighten from 12th to 11th magnitude, the comet will be setting mid-evening.

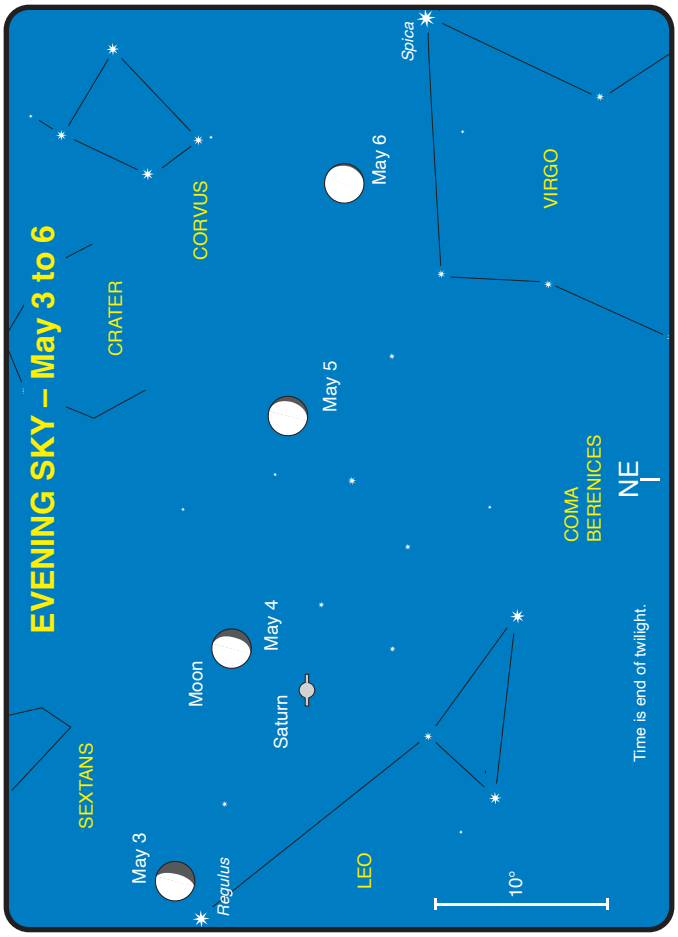
Comet 22P/Kopff moves eastward through Capricornus and Aquarius during May. The 9th magnitude comet is rising late in the evening.

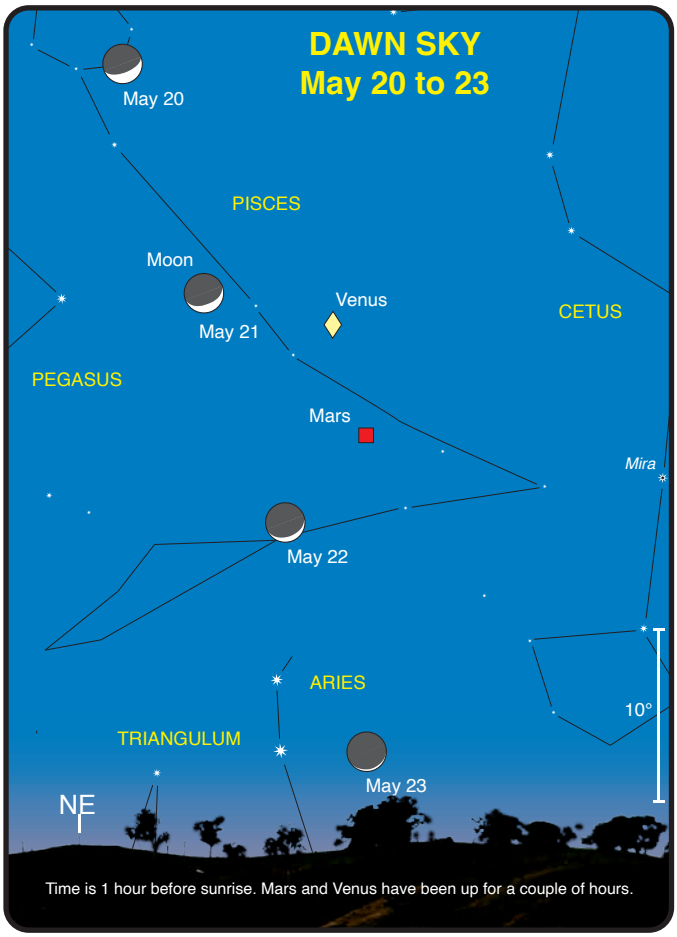
METEOR SHOWERS

The **eta-Aquarids** are linked with Halley's Comet and rank as one of the most popular of the southern hemisphere showers. They are visible for a few hours before dawn, from 19th April to 28th May. They peak this month on the 6th, but the rate is generally above 30 from 3rd to 10th May. The zenith hourly rate will often reach 70 or more meteors per hour (95 in 1975 and 110 in 1980), and the International Meteor Organization is predicting a possible 'very best' 2009 return. The Eta Aquarids are characterised by their high percentage of persistent trains (up to 25% of the meteors). They are very swift and are a striking yellow colour.

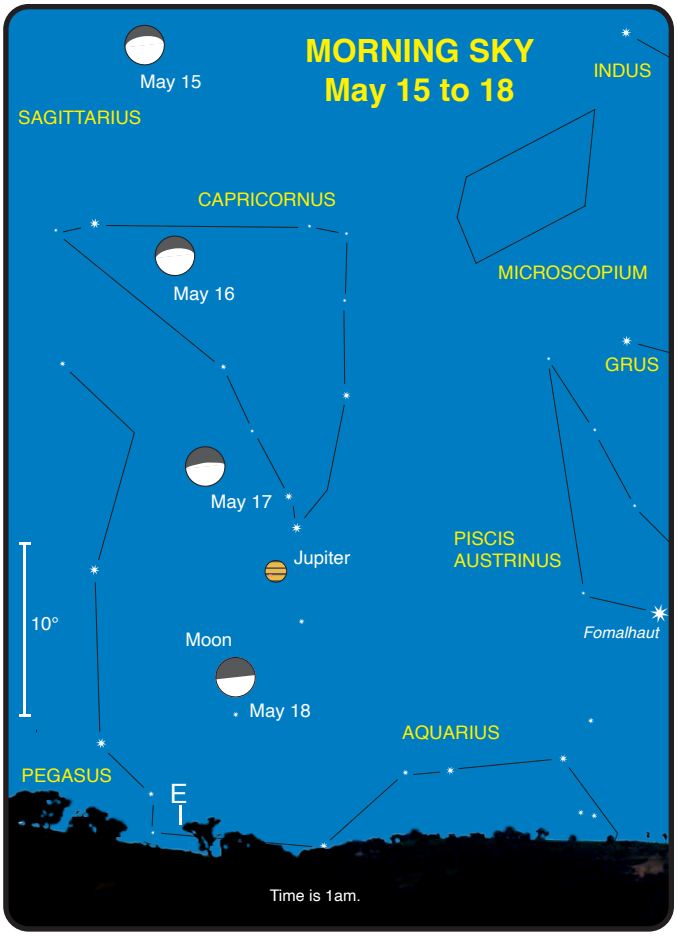
DIARY

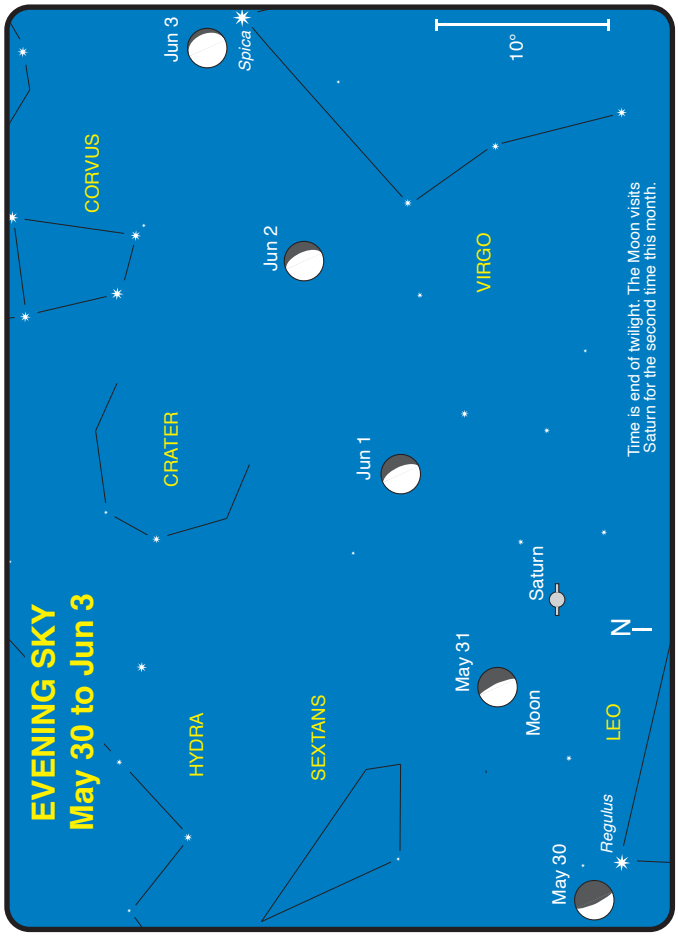
1st		Mercury 1.5°S of The Pleiades (M45) in Taurus
2nd	6:44am	(4:44am WST) First Quarter Moon
3rd		Mars 0.8°S of NGC 128 (G) in Pisces
3rd		Comet C/2007 Q3 (Siding Spring) 0.5°NW of star Beta Canis Majoris
3rd	1am	(11pm WST, prev day) Venus greatest illuminated extent
4th		m.p. 2 Pallas 0.3°N of NGC 2301 (OC) in Monoceros
4th	9pm	(7pm WST) Saturn 6°N of Moon
8th	2am	(Midnight WST, prev day) Mercury stationary
9th	2:01pm	(12:01pm WST) Full Moon
10th		m.p. 2 Pallas 0.6°N of NGC 2324 (OC) in Monoceros
10th		m.p. 20 Massalia 0.7°NW of NGC 7585 (G) in Aquarius
10th		Venus at descending node
10th	pm	m.p. 1 Ceres 0.5°NE of NGC 3301 (G) in Leo
11th		Venus 0.3°W of NGC 128 (G) in Pisces
11th	7am	(5am WST) Antares 0.6°S of Moon; Occn.
14th	1pm	(11am WST) Moon at apogee
15th		Mercury at descending node
17th	5:26pm	(3:26pm WST) Last Quarter Moon
17th	6pm	(4pm WST) Jupiter 3°S of Moon
17th	7pm	(5pm WST) Neptune 3°S of Moon
18th	5am	(3am WST) Saturn stationary
18th	8pm	(6pm WST) Mercury in inferior conjunction with Sun
20th		Saturn 0.8°NE of star Chi Leonis
20th	6am	(4am WST) Uranus 5°S of Moon
21st	Midnight	(10pm WST) m.p. 8 Flora 0.02°S of star Zeta Virginis
21st		m.p. 19 Fortuna 0.2°SW of NGC 524 (G) in Pisces
21st	1am	(11pm WST, prev day) Jupiter 0.1°SE of star Mu Capricorni
21st	6pm	(4pm WST) Venus 7°S of Moon
22nd	6am	(4am WST) Mars 7°S of Moon
24th		m.p. 324 Bamberga 0.4°S of star Eta Piscium
24th	10:11pm	(8:11pm WST) New Moon
25th		Mercury at aphelion
25th	11pm	(9pm WST) Jupiter 0.4°S of Neptune
26th		m.p. 324 Bamberga 0.4°SW of M74 (SG) in Pisces
26th	2pm	(Noon WST) Moon at perigee
29th	9pm	(7pm WST) Neptune stationary
30th		Comet C/2007 Q3 (Siding Spring) 1.0°NW of IC 2177 (Seagull Neb) in Monoceros
31st	2am	(Midnight WST, prev day) Mercury stationary
31st	1:22pm	(11:22am WST) First Quarter Moon





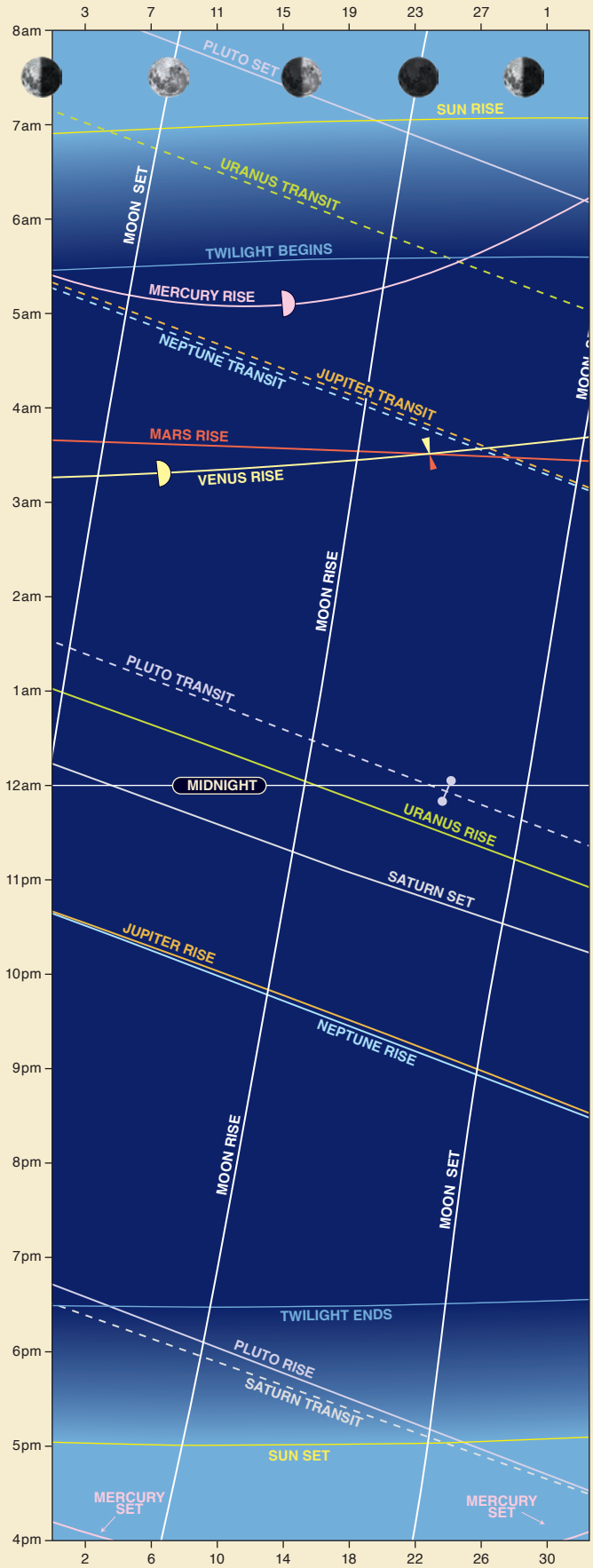
Approximate local standard time.





JUNE

RISE–SET CHART



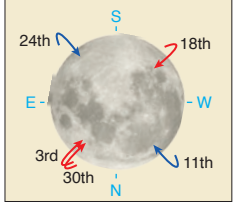
Approximate local standard time.

HIGHLIGHTS

- Venus, Mars and the Moon together in dawn sky
- Mercury, Mars and Venus in dawn sky
- Venus and Mars close
- Venus greatest western elongation.

THE MOON

LUNAR LIBRATION



3rd 4pm (2pm WST). Maximum Libration (8.9°), Mare Humboldtianum on bright NE limb, Mare Crisium seen to best advantage.

7th Occultation of Antares by the Moon. Not visible from Australia.

8th Full Moon.

11th 2am (midnight on 10th WST). Moon at apogee (furthest from Earth at 405,787km).

11th 2am (midnight on 10th WST). Minimum Libration (1.5°), bright NW limb.

16th Last Quarter.

16th Occultation of minor planet Juno by the Moon. Daytime event from northwestern Australia.

18th 6am (4am WST). Maximum Libration (10.0°), crater Baade and Mare Orientale on bright SW limb.

23rd New Moon.

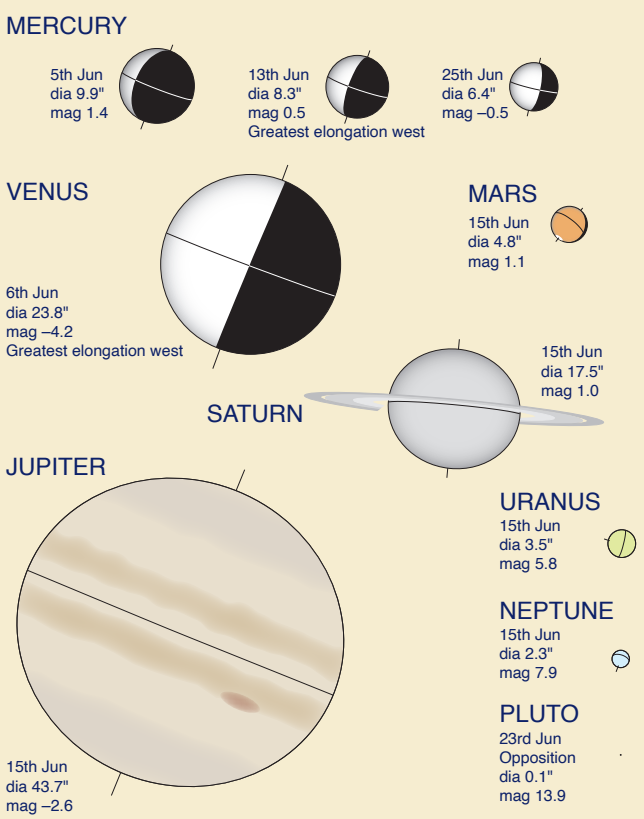
23rd 9pm (7pm WST). Moon at perigee (closest to Earth at 358,014km).

24th 10am (8am WST). Minimum Libration (1.7°), bright SE limb.

29th First Quarter.

30th 11pm (9pm WST). Maximum Libration (9.8°) craters Rayleigh and Hubble on bright NE limb, Mare Crisium seen to best advantage.

APPEARANCE of the PLANETS



THE PLANETS

Mercury is visible throughout June in the dawn sky in Taurus. The planet is at its greatest elongation west of the Sun (23°) on the 13th, and is obvious at this time. If you look around one hour before sunrise, Venus and Mars can be seen above and north of Mercury. On the 21st and 22nd, Mercury passes less than 1° from 3rd magnitude Epsilon (ε) Tauri, the star marking one eye of the Bull (see Sky View).

Venus, in Pisces, is visible at the beginning of the month in the morning sky with Mars 5° directly below. This Goddess of Love rises around 3am mid-month. Venus reaches its greatest western elongation from the Sun (46°) on the 6th, from then on will move closer to the Sun until its superior conjunction in January next year. The planet moves closer to Mars as it crosses the border into Aries mid-month. From the 20th to 23rd, the two planets will be around 2° from each other, presenting a nice colour contrast for early morning risers (see Sky View). Venus increases its angular distance from Mars as it moves into Taurus at month end.

The **Earth** is at Solstice on the 21st, when our daylight hours are shortest. On this day the Sun is at its most northerly position with a declination of +23.5°.

Mars is in the eastern morning sky, rising a couple of hours before dawn. It leaves Pisces and moves across Aries during the month. As Venus moves back toward the Sun, its descent takes it past the Red Planet, and from the 20th to 23rd the pair will be 2° apart.

Jupiter rises late in the eastern evening sky. It is a bright beacon in a barren region of sky, away from the Milky Way, the brightest star nearby being 1st magnitude Fomalhaut (Alpha [α] Piscis Austrini) to the south. On the 16th, the planet appears stationary in its course across the heavens; it then begins four months of retrograde motion. Jupiter's slow movement during the early stage of its retrograde loop keeps it close to the eighth planet, Neptune, the pair separated by 0.5° early in the month and 0.7° at month end. Retrograde motion occurs around the time of opposition for the outer planets, and is clearly shown on the Jupiter Finder Chart and explained on page 80. On the 13th, the 20-day old waning gibbous Moon will be near the planet in the evening sky (see Sky View).

Saturn can be seen in the northern sky in Leo immediately after evening twilight ends. Leo is interesting, being one of the very few constellations that bear some resemblance to the figure it is supposed to represent. For southern observers, the lion is probably best recognised by the asterism of the Sickle, looking like a backward upside down question mark, below and west of the planet. On the 27th and 28th the crescent Moon will be nearby Saturn (see Sky View).

Southern Deep Sky Olympics (II)

We conclude our 'best of' southern deep sky objects with a look at the three types of nebulae.

Planetary Nebulae

Bronze: NGC 5189 in Musca. This is a faint, but unusual planetary. Photographically it resembles a barred spiral galaxy but visually through 200mm instruments only the central bar is visible, an oval measuring 1×2 arcminutes.

Silver: The Blue Planetary Nebula, NGC 3918, in Centaurus. Its blue colour is quite striking and noticeable even in a 60mm telescope, although it takes a bit of power (80×) to see this 10 arcsecond diameter planetary as a circular ball against its pretty star field. The nebula has a sharp edge and the resemblance to Neptune is obvious.

Gold: NGC 3132 (the Eight Burst Nebula) in Vela. This brilliant planetary is visible through any size telescope but a 150mm instrument shows a prominent two arcminute elliptical ring with a 10th magnitude central star. NGC 3132's interior appears mottled.

Bright Nebulae

Like with the Globulars, the choices for silver and gold shouldn't be surprising to even the moderately experienced amateur.

Bronze: The Homunculus Nebula in Carina. Under low power (50×) the 5th magnitude star Eta Carinae looks fuzzy. A 200mm instrument, under high power (200×) and good seeing, shows its two lobes of gas. This is one object well worth going after with larger instruments. The authors have seen the Homunculus through a 600mm and the detail was amazing, looking just like professional images!

Silver: NGC 2070 (Tarantula Nebula) in Dorado. The smallest binoculars show this enormous star-forming region in the LMC as a large bright knot above the eastern end of the bar. Only a 150mm telescope is needed to reveal this complex area of nebulae and star clusters which extends for approximately 1°. A magnification of 100× shows incredible detail in the loops radiating from the central body — the legs of this arachnid.

Gold: The famous Eta Carinae Nebula (NGC 3372) in Carina. It is awash with star clusters and nebulae. This massive star-forming region can be seen with the naked-eye roughly half way between the Southern Cross and False Cross. Even 7×50 binoculars show this 2° diameter bright nebula with its prominent backward 'L' shaped dark lane dissecting it.

... continued next page.

***The Eta Carinae Nebula Region**. Talk about a busy field! We have three medalists on display. Firstly the massive nebula itself, the red star Eta Carinae (slightly below and left of centre), unfortunately the image scale is too small to see the Homunculus, and finally the dark Keyhole Nebula, just to the left of Eta. Image by Peter Ward.*

Uranus is moving slowly through Pisces as it nears the beginning of its retrograde loop. The planet remains within 0.6° of 20 Piscium, a very wide double star of 5.5 and 10th magnitude suns. Uranus is still a morning object, rising around 12am mid-month.

Neptune rises around 9:30pm mid-month in the eastern evening sky. As the planet is situated near the eastern end of Jupiter's retrograde loop, Neptune finds itself near the giant planet for some considerable time. This month the maximum distance between the pair is 0.8° when Jupiter is stationary on the 16th.

Pluto is at opposition on the 23rd, and above the horizon the entire night. This distant world is presently 4,585,593,000km (30.6528 AU) from Earth, with its light taking four hours and fifteen minutes to reach us.

MINOR PLANETS. Three of the brighter minor planets reach opposition this month in Ophiuchus. They are: 22 Kalliope on the 9th at magnitude 10.8, 471 Papagena on the 11th at magnitude 11.2 and 107 Camilla on the 18th at magnitude 12.4. Others reaching opposition include, 372 Palma on the 13th at magnitude 13.1 in Ara, 31 Euphrosyne on the 17th at magnitude 12.5 in Ara and 97 Klotho on the 25th at magnitude 12.4 in Serpens.

In late June, 2 Pallas passes through the head of Hydra. Also 3 Juno spends most of June in the Circlet of Pisces.

COMETS

Comet C/2006 W3 (Christensen) moves westward through Pegasus, right on the border with Lacerta. Visible in the morning sky (rising around 12am mid-month), Christensen should brighten from 12th to 11th magnitude.

Comet C/2007 Q3 (Siding Spring) moves northeast through Monoceros in June. The 11th magnitude comet will be setting early in the evening.

Comet 22P/Kopff moves eastward through Capricornus and Aquarius during June. Rising around 10pm mid-month, the comet should remain around 9th magnitude. On the 2nd Kopff is 2.5° north of Jupiter.

Comet 88P/Howell is moving southeast through Virgo during June. Expected to brighten from 13th to 12th magnitude, Howell is an evening object.

DIARY

1st	3am	(1am WST) Saturn 6°N of Moon
4th	9pm	(7pm WST) m.p. 15 Eunomia 0.1°NE of star Gamma Corvi
5th		m.p. 324 Bamberga 0.7°S of NGC 772 (G) in Aries
6th		Mercury 0.8°SE of m.p. 11 Parthenope
6th		Mars 0.8°NW of NGC 821 (G) in Aries
6th		m.p. 27 Euterpe 1.0°N of star Regulus
6th	7am	(5am WST) Venus greatest elongation west (46°)
7th	am	m.p. 42 Isis 0.9°N of star Delta Aquarii
7th	2pm	(Noon WST) Antares 0.6°S of Moon; Occn.
8th		m.p. 1 Ceres 0.6°NE of NGC 3507 (G) in Leo
8th	4:12am	(2:12am WST) Full Moon
9th		m.p. 88 Thisbe 0.8°NW of star Theta Aquarii
10th		Venus 0.8°S of NGC 821 (G) in Aries
11th	2am	(Midnight WST, prev day) Moon at apogee
13th		Venus at aphelion
13th	10pm	(8pm WST) Mercury greatest elongation west (23°)
14th		Mercury at greatest latitude south
14th	2am	(Midnight WST, prev day) Neptune 3°S of Moon
14th	4am	(2am WST) Jupiter 3°S of Moon
15th		Uranus 0.6°N of star 20 Piscium
16th	6am	(4am WST) Jupiter stationary
16th	8:15am	(6:15am WST) Last Quarter Moon
16th	9am	(7am WST) Juno 0.4°N of Moon; Occn.
16th	4pm	(2pm WST) Uranus 6°S of Moon
17th		m.p. 654 Zelinda 0.8°NE of NGC 3115 (G) in Sextans
19th	Midnight	(10pm WST) Venus 2°S of Mars
20th		m.p. 1 Ceres 0.2°N of star Theta Leonis
20th	3am	(1am WST) Mars 6°S of Moon
20th	3am	(1am WST) Venus 8°S of Moon
21st		m.p. 18 Melpomene 0.4°SE of m.p. 20 Massalia
21st	4pm	(2pm WST) Solstice
21st	7pm	(5pm WST) Mercury 7°S of Moon
22nd	Midnight	(10pm WST) Mercury 3°N of Aldebaran
22nd		Mercury 0.6°NE of star Epsilon Tauri
22nd		Pluto 0.5°S of star HR 6769
22nd	10pm	(8pm WST) Vesta in conjunction with Sun
23rd	5:35am	(3:35am WST) New Moon
23rd	6pm	(4pm WST) Pluto at opposition
23rd	9pm	(7pm WST) Moon at perigee
24th		Mercury 1.2°N of NGC 1647 (OC) in Taurus
24th	7pm	(5pm WST) m.p. 2 Pallas 0.1°S of star Delta Hydrae
26th		m.p. 1 Ceres 1.0°N of NGC 3628 (G) in Leo
28th		m.p. 2 Pallas 0.8°S of star Epsilon Hydrae
28th	Noon	(10am WST) Saturn 7°N of Moon
29th	9:28pm	(7:28pm WST) First Quarter Moon

... continued from previous page

Dark Nebulae

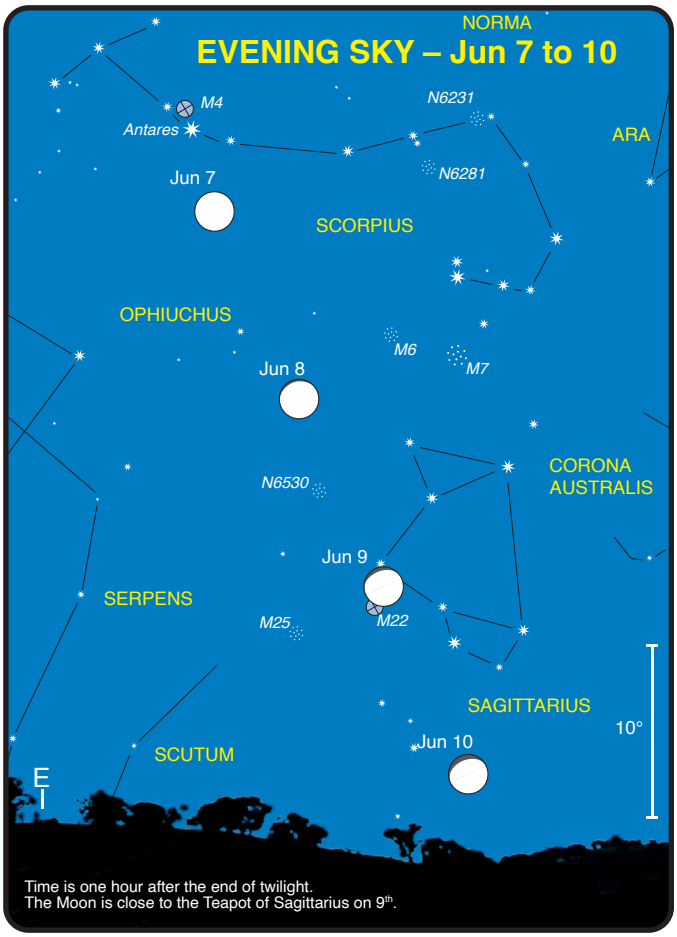
Bronze: The Keyhole Nebula in Carina. Once again we are drawn back to the area around Eta Carinae, with this distinctive bar shaped dark nebula, only two arcminutes southwest of *Eta*.

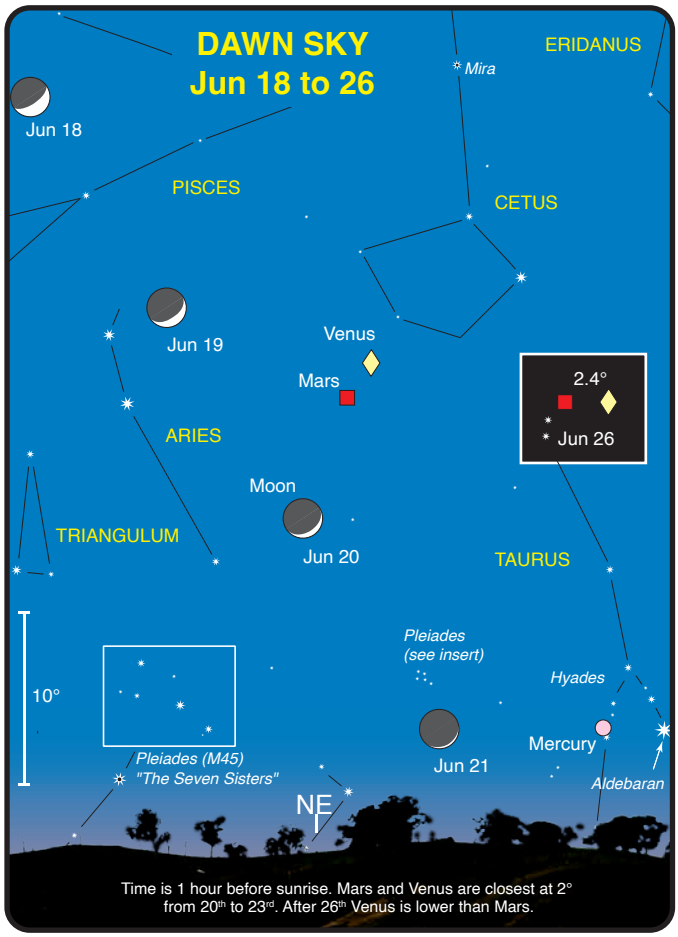
Silver: The Dark Doodad in Musca (what else do you call something you don't have a name for?). This is a remarkable dark nebula, which is 3° long and quite narrow, around 5 to 7 arcminutes wide. It runs in a north-south direction with its southern extremity 20 arcminutes west of the globular cluster NGC 4372. It can also be found by moving approximately 0.7° west of 4th magnitude Gamma Muscae. The combination of its darkness and sharp edge superimposed on a rich Milky Way star field gives the impression in photographs you are looking at a tear in the fabric of our galaxy. The key to observing the nebula is to use rich field instruments at low power under dark skies — large binoculars are ideal.

Gold: The Coal Sack Nebula in Crux. This 7° irregularly shaped dark gaseous cloud is visible because it is silhouetted against the glow of our galaxy. Best seen with the unaided eye, it is nestled close to Crux, between the cross and Pointers, in a spectacular area of the Milky Way. The Coal Sack also doubles for the head of the Aboriginal constellation of the emu (complete with an eye and beak). Its neck consists of the narrow lanes of dark nebulae, which run down through the Pointers. It then widens out to its body, marking the hub of the Milky Way in Scorpius and Sagittarius.

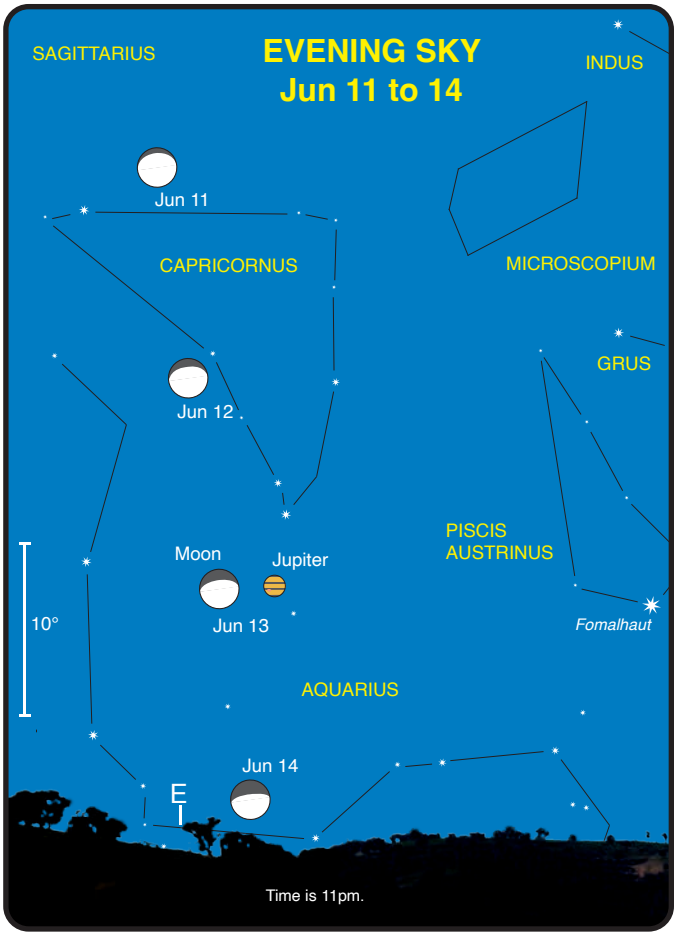
The decision to restrict this list to south of –40° declination was somewhat arbitrary. It was tempting to extend it to south of –35° for this would have drawn some further southern spectaculars into the draw. For example, in Corona Australis there is a complex of reflection (NGC 6726) and dark nebulae around the star R Coronae Australis, with the nearby globular cluster NGC 6723, which is impressive. Other star performers in the galaxy category are the edge-on spiral NGC 55 in Sculptor and face-on barred spiral NGC 1365 in Fornax.

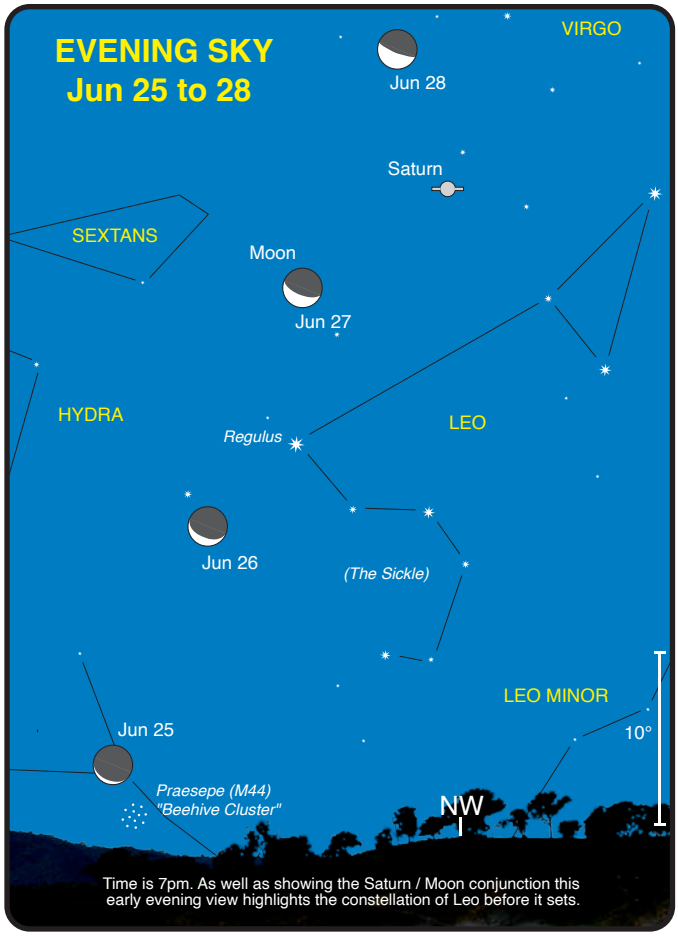
Dark Doodad in Musca *The globular cluster (centre bottom) is NGC 4372. The bright star to its upper left is naked-eye Gamma (g) Muscae. The field is approximately 4.5 degrees wide.*
Image by Albert Van Donkelaar.





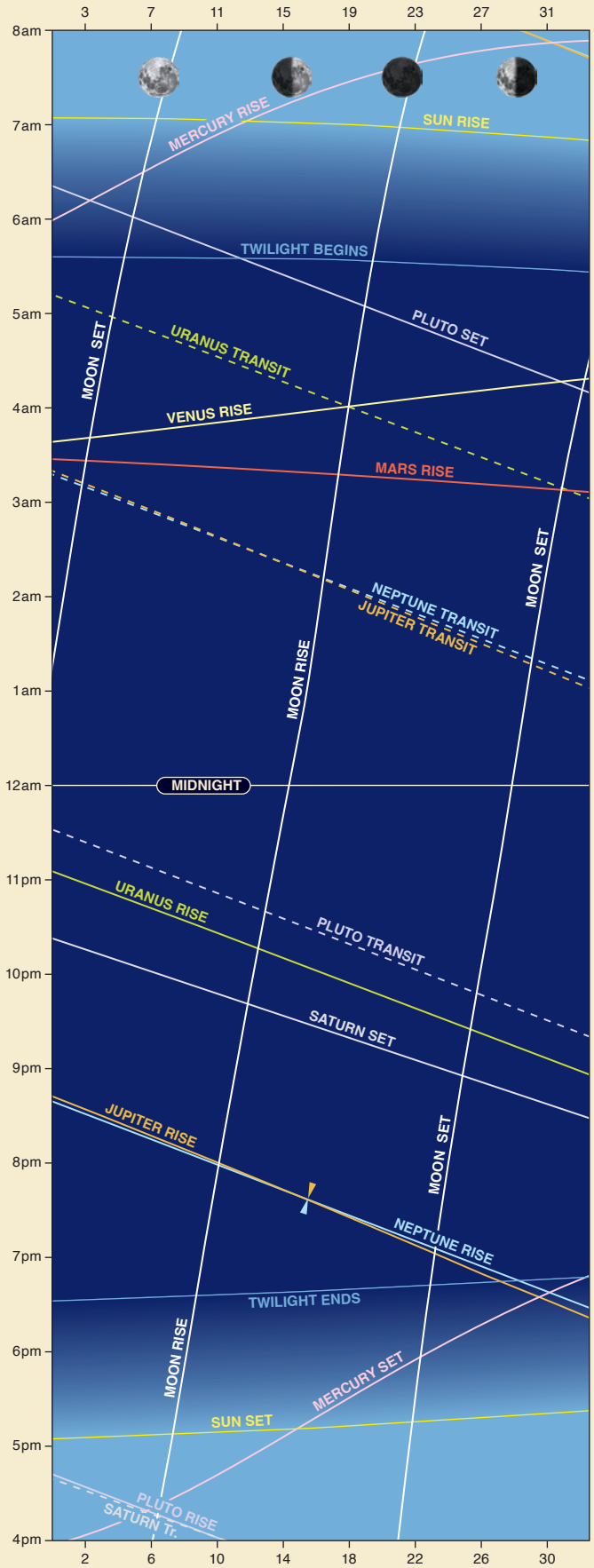
Approximate local standard time.





JULY

RISE–SET CHART



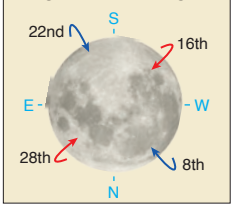
Approximate local standard time.

HIGHLIGHTS

- Venus becomes a member of the Hyades
- Jupiter and Neptune close
- Mars, Aldebaran, Venus and Moon together in the morning
- The Southern delta-Aquarids meteor shower

THE MOON

LUNAR LIBRATION



4th Occultation of Antares by the Moon. Not visible from Australia. However, Antares will be close to the Moon in the early evening eastern sky.

7th Full Moon. Penumbral eclipse technically visible from Australia, however as the immersion into the Earth's penumbral shadow is very shallow there will be little chance of seeing any dimming on our satellite (see Part II for more information).

8th 8am (6am WST). Moon at apogee (furthest from Earth at 406,232km).

8th 3pm (1pm WST). Minimum Libration (0.9°), Full Moon, NW limb.

15th Last Quarter.

16th 1am (11pm WST prev. day). Maximum Libration (10.1°), crater Baade and Mare Orientale on bright SW limb.

22nd 6am (4am WST). Moon at perigee (closest to Earth at 357,463km).

22nd New Moon. Total eclipse of the Sun visible across India and China (see Part II for more information).

22nd 7am (5am WST). Minimum Libration (0.5°), unobservable – too close to New Moon.

APPEARANCE of the PLANETS

MERCURY Mercury is in superior conjunction on the 14th

5th Jul
dia 5.4"
mag –1.5

30th Jul
dia 5.4"
mag –0.7

VENUS

15th Jul
dia 16.6"
mag –3.8

MARS

15th Jul
dia 5.1"
mag 1.1

SATURN

15th Jul
dia 16.7"
mag 1.1

JUPITER

15th Jul
dia 47.3"
mag –2.8

URANUS

15th Jul
dia 3.6"
mag 5.8

NEPTUNE

15th Jul
dia 2.3"
mag 7.8

PLUTO

15th Jul
dia 0.1"
mag 13.9

28th 3pm (1pm WST). Maximum Libration (10.3°), craters Rayleigh and Hubble on bright NE limb, Mare Crisium seen to best advantage.

29th First Quarter.

THE PLANETS

Mercury leaves Taurus this month, moving across Gemini and Cancer before ending up in Leo. Departing the morning sky the planet moves toward the Sun and superior conjunction (Mercury and Earth on opposite sides of the Sun) on the 14th. Returning to the early western evening sky late in July, Mercury is visible a few degrees below the 1st magnitude star Alpha (α) Leonis (Regulus).

Venus separates from Mars as it moves across Taurus (The Bull) in the morning sky. On the 13th, the planet will be 0.4° from 4th magnitude Epsilon (ε) Tauri, the star marking the western tip of the V-shape of the Hyades star cluster (the outline of the Bull's Head). The presence of Venus will dominate the cluster, and overshadow the 1st magnitude star Alpha (α) Tauri (Aldebaran) on the eastern tip of the 'V' (see Sky View). Aldebaran, like Venus is not a true member of the cluster, but by chance lies between the Hyades and us. On the 28th, Venus will be 0.4° from the 3rd magnitude star Zeta (ζ) Tauri, the star marking the tip of the western horn of the Bull.

The **Earth** is at aphelion on the 4th, the furthest point in its orbit from the Sun (152,091,069km or 1.016666 AU distant).

Mars spends the first three days of the month in Aries before moving into Taurus in the morning northeastern sky (rising around 3am mid-month). On the 19th, the planet is situated between the Hyades and Pleiades star clusters, equidistant from the 1st magnitude star Aldebaran and the centre of the Pleiades. The 19th is one of those mornings worth setting the alarm clock for. You have: the Pleiades and Hyades of Taurus with the Saucepan of Orion sitting almost parallel to the horizon, a 26-day old earthshine enhanced Moon directly below Mars, and Venus below Aldebaran. Mars, Aldebaran, Venus and the Moon form a rough square (see Sky View).

Jupiter is at opposition next month, and is now very prominent in the mid-evening eastern sky. On the 10th, the 18-day old waning gibbous Moon appears near the planet (see Sky View). Now in retrograde motion, Jupiter's path takes it again past Neptune and towards the 6th magnitude star 45 Capricorni for a neat encounter in August.

Saturn, in Leo, is visible in the western evening sky after twilight. With conjunction approaching in mid-September, this month will be the last chance to see Saturn at a reasonable altitude. On the 25th, the 4-day old crescent Moon will be just south of the planet (see Sky View).

Uranus rises around 10pm mid-month, south of the asterism of seven stars known as the Circlet in Pisces. On the 2nd, the planet appears stationary against the background stars and will thereafter be in retrograde motion until early December.

Neptune rises around 7:30pm mid-month and again is close to Jupiter. From the 1st to the 17th the pair will be less than 0.7° apart. Jupiter then picks up a little speed and distances itself from Neptune, by month end the two will be 1.5° apart. On the evening of the 11th, the 5th magnitude star

astronomy.podcast

One of the greatest tools in amateur astronomy since the Dobsonian revolution has been the Internet. With the Hubble Telescope, we now have access to the most incredible images of the Universe, and our computer screens have become a window to the cosmos. The profusion and scope of astronomy related information available at the keyboard is astonishing.

With the introduction of podcasting in late 2004, scientists and educators were fast to take advantage of the new technology to disseminate information over the Internet in a radio-style format. Simply put, podcasting is a way to receive audio broadcasts via the Internet. You can subscribe to podcasts of your liking and as new content is available, it is automatically downloaded to the podcasting software on your computer.

The first applications for podcasting were developed for the Apple iPod, and the term podcast is a blend of iPod and broadcast. As other products were later to synchronise with podcast feeds, many felt that the name should become a little less brand orientated, but the name stuck and is now common usage.

Podcasting software is freely available for download and Apple's iTunes player seems to be the dominant contender in the field, however, there are many other rival podcatchers like Juice and Doppler. You can listen to a podcast directly from your computer, or transfer the file to a portable media player such as an iPod, iPhone or any other MP3 player.

The best thing about podcasts is that they are free! You can listen to them at your convenience, and in any order. You can skip any boring bits, keep episodes archived for future reference, or just delete them after you are finished. You can listen to them while working on your computer, driving to work or your favourite observing site.

There are scores of science and astronomy related podcasts available. We present here a small selection that we found were fun, informative and covered topical issues, your podcatcher can take you to many other similar broadcasts. A word of warning, podcasts can be addictive, be selective and just subscribe to two or three favourites initially, unless you have countless hours of spare time.

Science@NASA

As you would expect there is plenty of astronomy and spacecraft updates here. Each non-technical and informative episode appears as news comes to hand, and you may receive a download every day or two or maybe once a week. Each episode, usually narrated by Dr. Tony Phillips, is brief, typically three to ten minutes in duration, and covers all that comes under NASA's diverse umbrella. Only podcasts from May 2008 are available on iTunes, you can download earlier episodes from the website dating back to January 2005 if required.

science.nasa.gov/

The Skeptic's Guide to the Universe (Your Escape to Reality)

The SGU has been around since May 2005 and each weekly episode runs from around 55 to 80 minutes in length. Regular guests on the show are James Randi (the Sceptical Magician) and Phil Plait (The Bad Astronomer). You will find lots of astronomy and science stuff here, but be warned it is a sceptics site and they do not take lightly to creation science, ESP, astrology etc. Dr. Steven Novella and his team of 'rouges' make it fun and entertaining without losing sight of the science.

www.theskepticsguide.org/

Astronomy Cast

Astronomy Cast began in September 2006 and each weekly episode runs for around 30 minutes. Dr Pamela Gay and Fraser Cain are your hosts with this very popular astronomy podcast. Astronomy Cast can be a little technical at times with subject material ranging from spaceflight, planets, stars and cosmology. Astronomy Cast is one of our favourites.

www.astronomycast.com/archive/

Slacker Astronomy Podcast
(An irreverent astronomical road-less-travelled)

Unlike most podcasts listed here, the line up of Slacker presenters has changed since its beginnings in February 2005. Their April 2008 podcast 'Whatever the hell is Slacker Astronomy' gives a rundown on the show plus its history. The Slacker podcast can only be described (in the nicest possible way) as offbeat and at times all over the place. Each episode can range from a few minutes to over an hour and can be audio or video. Despite their claims of a weekly show, episodes can appear on consecutive days or one or two weeks apart.

www.slackerastronomy.org/wordpress/podcast/

Bad Astronomy: Q & BA

After just seven episodes in 2007, astronomer Phil Plait announced that this question and answer type show would be discontinued due to his workload. Phil founded the website badastronomy.com which is dedicated to clearing up public misconceptions on space and astronomy

... continued next page.

Mu (μ) Capricorni will be situated directly between Neptune and Jupiter forming a line – an interesting low magnification field.

Pluto, now just past opposition, transits the meridian around 10:30pm mid-month. By month end, Pluto's path brings it within 1° of the small open star cluster NGC 6507 and within 2° of the excellent open cluster M23 (NGC 6494). Pluto continues to close on them up to its stationary point in September.

MINOR PLANETS at opposition this month include: 7 Iris on the 4th at magnitude 8.7 in Sagittarius, 5 Astraea on the 23rd at magnitude 10.9 in Capricornus, 389 Industria on the 26th at magnitude 11.3 in Capricornus and 37 Fides on the 20th at magnitude 11.2 on the Sagittarius/Capricornus border.

On the 24th, 7 Iris is crossing the open star cluster M25 in Sagittarius.

COMETS

Comet C/2006 W3 (Christensen) crosses over from Pegasus into Cygnus early in July, finishing the month in Vulpecula. This 11th magnitude comet is rising late in the evening.

Comet C/2007 Q3 (Siding Spring) moves northeast through Monoceros into Hydra during July. However, with the 11th magnitude comet setting early in the evening, it will be a challenge to observe it. By the end of July C/2007 Q3 is setting before the end of twilight.

Comet 22P/Kopff arcs southward through Aquarius in July. The comet should be around 9th magnitude, and will be rising mid-evening.

Comet 88P/Howell continues to move southeast through Virgo during July, visible in the evening sky. This month sees Howell tour a few of the Virgo cluster of galaxies (see the diary). The comet is expected to brighten from 12th to 11th magnitude during this period. The end of July sees Howell 2° from Spica.

METEOR SHOWERS

The **Piscis Austrinids** are visible from 15th July to 10th August, reaching their peak ZHR of 5 this month on the 28th. The Piscis Austrinids are generally blue, white or yellow in colour, with some leaving trains. This year the Moon will interfere with observations until after midnight.

The **Southern delta-Aquarids** are one of the strongest and consistent of the southern showers, visible late evening until dawn. The range of activity of these medium speed meteors extends from 12th July through to 19th August, with maximum this month on the 28th to 30th, with a zenith hourly rate of 20. The delta-Aquarids are generally faint (bright meteors are the exception), typically white with some blue members, and occasionally leaving trains. Observers this year will have Moon free skies near the peak for the second half of the night.

The **alpha-Capricornids** are noted for their bright, slow meteors with long paths and frequent fireballs. The shower is visible late evening until dawn, from 3rd July through to 15th August. Maximum activity occurs this month on the 30th and 31st, when a zenith hourly rate of 4 can be expected. Low hourly rates over the period are generally made up by the spectacular nature of the alpha-Capricornids.

DIARY

1st		Mercury 0.7°N of Crab Nebula (M1) in Taurus
2nd		m.p. 2 Pallas 0.3°SW of star Zeta Hydrae
2nd	2am	(Midnight WST, prev day) Uranus stationary
2nd	pm	m.p. 7 Iris 0.5°N of NGC 6716 (OC) in Sagittarius
3rd		Mercury at ascending node
3rd	pm	m.p. 6 Hebe 0.7°W of NGC 5668 (G) in Virgo
4th	Noon	(10am WST) Earth at aphelion
4th	8pm	(6pm WST) Antares 0.5°S of Moon; Occn.
4th	9pm	(7pm WST) m.p. 15 Eunomia 0.1°S of star Delta Corvi
4th	pm	m.p. 7 Iris 0.8°N of Collinder 394 (OC) in Sagittarius
6th		Comet 88P/Howell 1°SW of NGC 4691 (G) in Virgo
6th		Venus at greatest latitude south
7th	7:21pm	(5:21pm WST) Full Moon; Penumbral Eclipse
8th		Mercury at perihelion
8th	8am	(6am WST) Moon at apogee
9th		m.p. 11 Parthenope 0.8°S of star Epsilon Tauri
10th		Jupiter 0.3°S of star Mu Capricorni
11th		Comet 88P/Howell 1.0°NE of NGC 4697 (G) in Virgo
11th	8am	(6am WST) Jupiter 4°S of Moon
11th	8am	(6am WST) Neptune 3°S of Moon
12th		m.p. 1 Ceres 0.2°E of NGC 3810 (G) in Leo
12th	pm	m.p. 6 Hebe 0.6°E of NGC 5638 (G) in Virgo
13th	5am	(3am WST) Venus 0.4°W of star Epsilon Tauri
13th	10pm	(8pm WST) Uranus 6°S of Moon
14th	5am	(3am WST) Jupiter 0.6°S of Neptune
14th	Noon	(10am WST) Mercury in superior conjunction with Sun
15th	4am	(2am WST) Venus 3°N of Aldebaran
15th	7:53pm	(5:53pm WST) Last Quarter Moon
17th		Venus 0.9°N of NGC 1647 (OC) in Taurus
17th		Uranus 0.6°N of star 20 Piscium
17th		Neptune 0.3°NW of star Mu Capricorni
18th		Saturn 0.8°NE of m.p. 27 Euterpe
18th		Mercury at greatest latitude north
18th	10pm	(8pm WST) Mars 5°S of Moon
19th		m.p. 11 Parthenope 0.2°S of NGC 1647 (OC) in Taurus
19th	3pm	(1pm WST) Venus 6°S of Moon
20th		Comet 88P/Howell 0.8°S of NGC 4951 (G) in Virgo
22nd		Comet 88P/Howell 0.5°S of NGC 4981 (G) in Virgo
22nd	6am	(4am WST) Moon at perigee
22nd	12:35pm	(10:35am WST) New Moon; Eclipse
23rd		Comet 88P/Howell 0.4°N of NGC 4995 (G) in Virgo
24th	9pm	(7pm WST) m.p. 7 Iris 0.02°S of M25 (OC) in Sagittarius
25th		Comet C/2006 W3 (Christensen) 0.2°NW of star Zeta Cygni
26th	1am	(11pm WST, prev day) Saturn 7°N of Moon
27th		Venus 0.6°S of Crab Nebula (M1) in Taurus
27th		Saturn 0.3°NE of star Sigma Leonis
27th	9pm	(7pm WST) Mars 5°N of Aldebaran
28th		Venus 0.4°N of star Zeta Tauri
28th	pm	Comet C/2006 W3 (Christensen) 0.5°SE of NGC 7013 (G) in Cygnus
29th		m.p. 1 Ceres 0.5°S of star Omicron Virginis
29th	8:00am	(6:00am WST) First Quarter Moon

astronomy.podcast *continued*

and debunking conspiracy theories (Face on Mars, the Moon Landing Hoax etc). All is not lost however as these seven episodes can be found on YouTube, included in a collection of 65 videos (as at July 2008). Phil is a great educator and enthusiastic presenter making difficult concepts in astronomy easy to understand. The videos range from a few seconds to around ten minutes duration and include several with astronomy questions from kids.

www.youtube.com/user/TheBadAstronomer?ob=1

Are We Alone? – SETI Science and Skepticism

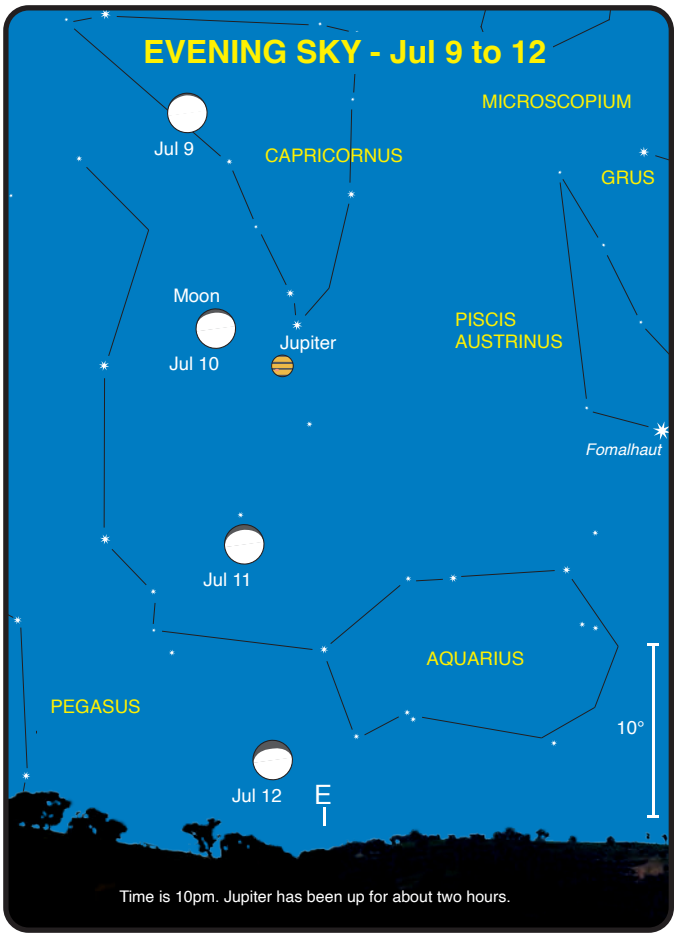
This is the SETI Institute's weekly science radio program hosted by astronomer Seth Shostak. The show has been broadcast over radio stations in the United States since January 2007. Only episodes from March 2008 are available on iTunes, you can download the earlier ones from their website if required. Each 50-minute show has a theme, and once a month they have 'Skeptical Sunday' devoted to separating science from pseudoscience. An excellent show that covers genetics, palaeontology, physics, evolutionary biology, cosmology and astronomy, and astronomer Phil Plait is a regular guest.

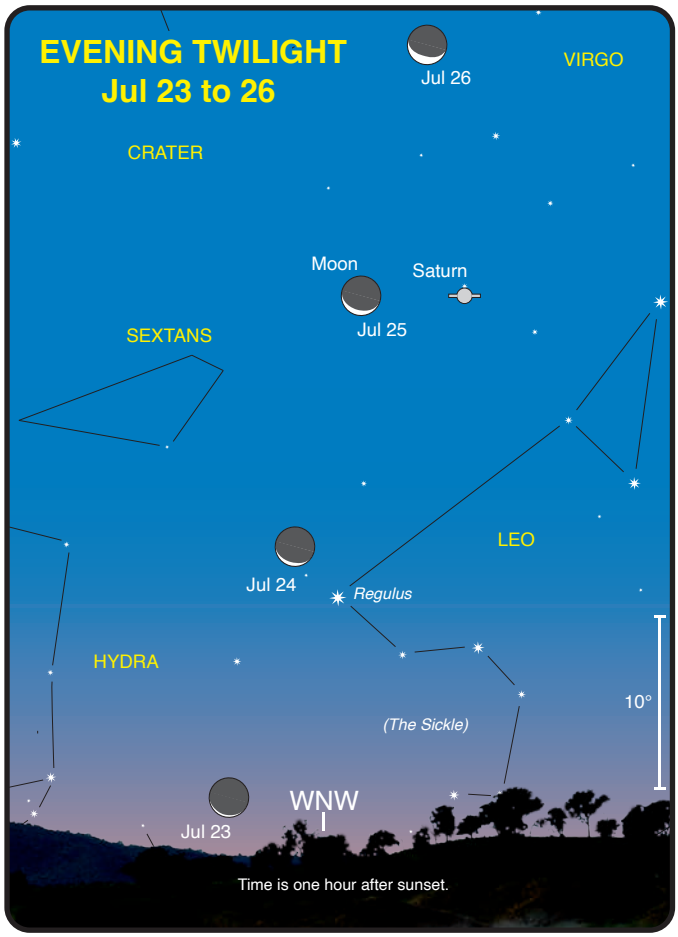
radio.seti.org/

StarStuff

All of the before mentioned programs are American podcasts. StarStuff, is a home-grown product, and was broadcast on ABC radio for nine years, but was axed by Auntie in 2008. This extremely popular half hour weekly show presented by Stuart Gary is now thankfully podcast and continues its tradition of reporting the latest in astronomy, space science and cosmology. If you only have time to listen to one podcast each week make sure you subscribe to StarStuff.

www.abc.net.au/science/podcast/starstuff.xml





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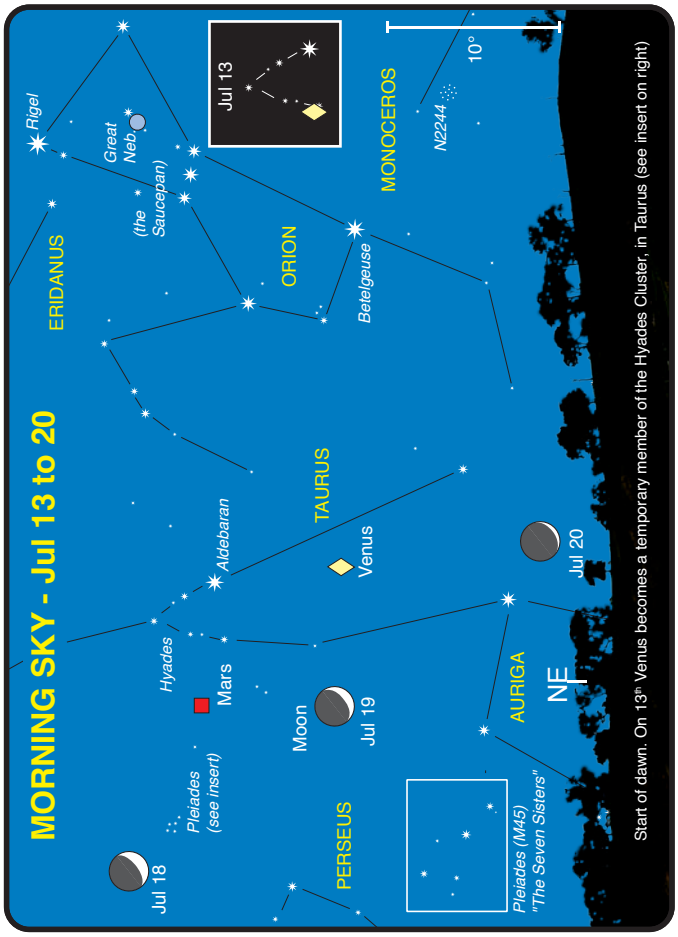
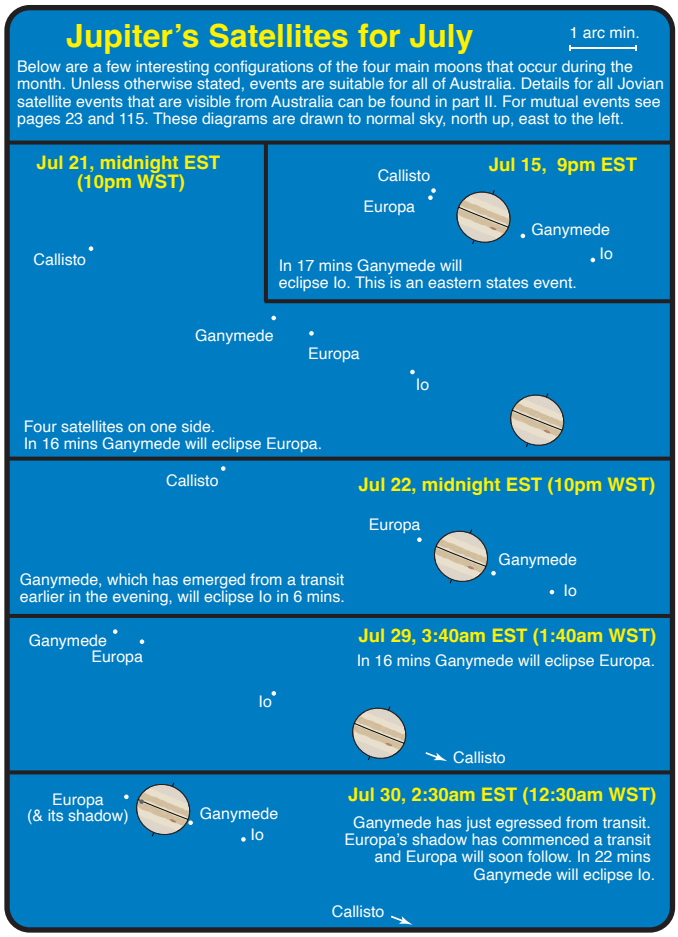
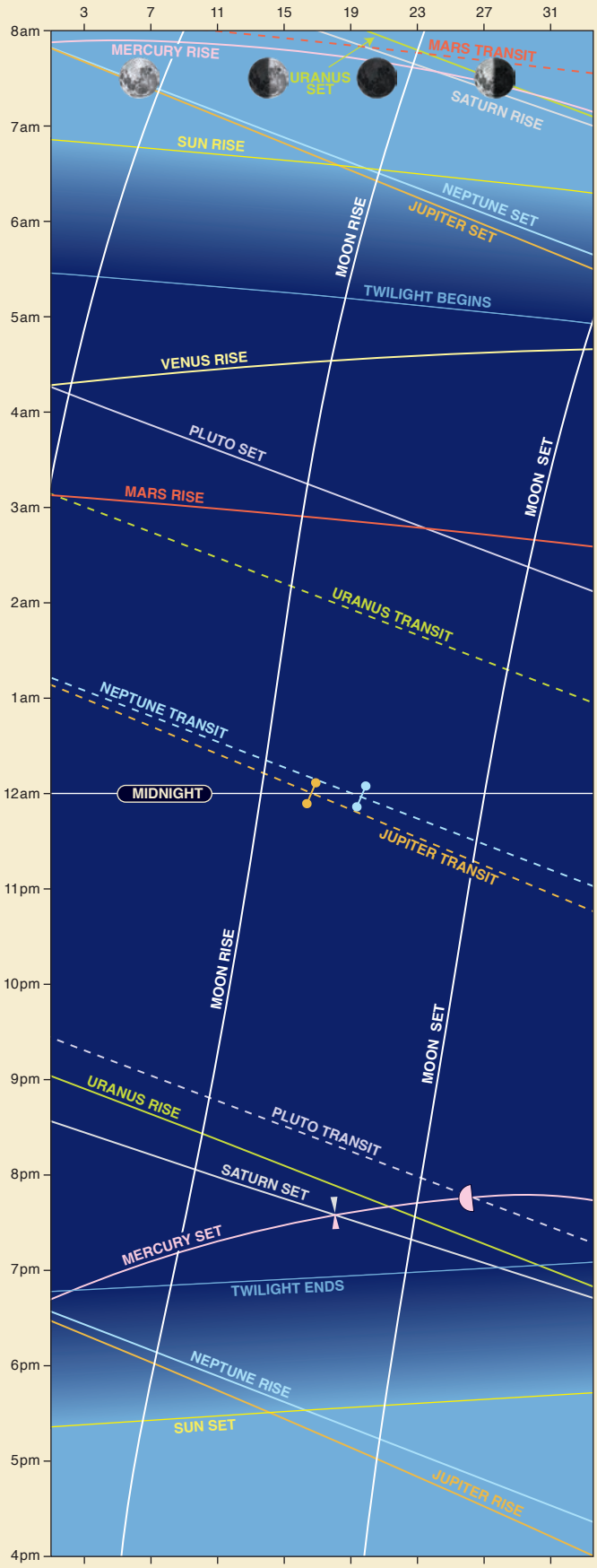




AUGUST

RISE–SET CHART

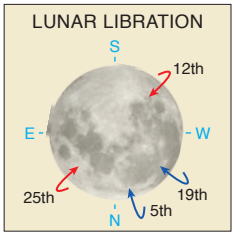


Approximate local standard time.

HIGHLIGHTS

- Moon, Mercury and Saturn together in the evening
- Mercury at its best in evening sky
- Mercury and Saturn close
- Jupiter gains an extra 'moon'
- Jupiter with only one moon – three times!
- Jupiter at opposition
- Saturn's rings invisible!

THE MOON



1st Occultation of Antares by the Moon. Not visible from Australia. However, Antares will be close to the Moon in the early morning western sky before moonset.

4th 11am (9am WST). Moon at apogee (furthest from Earth at 406,028km).

5th 4am (2am WST). Minimum Libration (0.2°), dark NW limb.

6th Full Moon. Penumbral eclipse, not visible from Australia. Like last month's penumbral eclipse the Moon is only slightly immersed in the penumbral shadow.

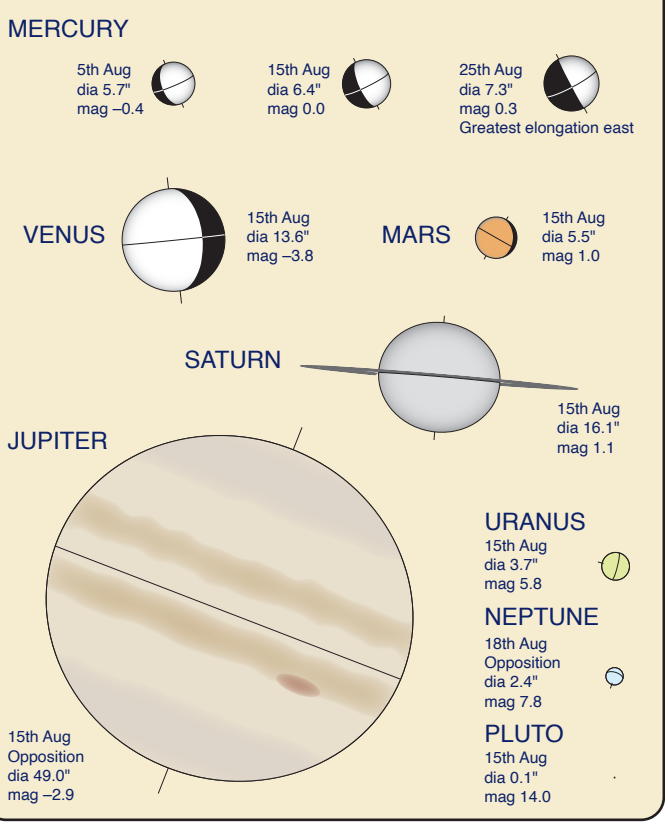
12th 4pm (2pm WST). Maximum Libration (9.5°), crater Baade and Mare Orientale on bright SW limb.

14th Last Quarter.

18th Occultation of minor planet Vesta by the Moon, not visible from Australia.

19th 3pm (1pm WST). Moon at perigee (closest to Earth at 359,639km).

APPEARANCE of the PLANETS



19th 4am (2am WST). Minimum Libration (0.6°), unobservable – too close to New Moon.

20th New Moon.

25th 10am (8am WST). Maximum Libration (10.0°) craters Rayleigh and Hubble on bright NE limb, Mare Crisium seen to best advantage.

27th First Quarter.

28th Occultation of Antares by the Moon. Not visible from Australia.

31st 9pm (7pm WST). Moon at apogee (furthest from Earth at 405,269km).

THE PLANETS

Mercury is at its best for evening viewing from August to early September. On the 2nd and 3rd, the planet will be around 1° from the 1st magnitude star Alpha (α) Leonis (Regulus). As Mercury gains altitude in the western sky it moves from Leo and into Virgo, passing 3° south of Saturn on the 16th and 17th (see Sky View), the ringed planet being the fainter of the pair at this time. On the 22nd, the 2-day old earthshine enhanced Moon appears 3° south of Mercury, with Saturn below and north of the pair (see Sky View).

Venus, in the morning sky, rises around one hour before dawn. It traverses Gemini and crosses over into the inconspicuous constellation of Cancer at month end. On the 18th, the 27-day waning crescent Moon will be around 2.5° from the planet (see Sky View). As a matter of interest, Venus passes within 0.5° of two minor planets this month: Vesta on the 26th and Hygiea on the 28th.

Mars appears in the morning northeastern sky, rising around 3am mid-month, below the Hyades star cluster in the constellation of Taurus (the Bull). On the 17th, the planet will be 1.3° from the Crab Nebula near Zeta (ζ) Tauri, the star marking the tip of the western horn of the Bull. Nearby is the 24-day old waning crescent Moon, which is close to Beta (β) Tauri, the star at the tip of the eastern horn (see Sky View). Late in August the Red Planet slips over the border into Gemini and tours some star clusters, see diary.

Jupiter is at opposition on the 15th, and is prominent in the east after twilight. The equatorial diameter of the planet at this opposition is 49 arcseconds, a size only surpassed by Venus when near inferior

The Unplaneting of Pluto – Was Holst Right All Along?

In the early 1990's, astronomers began to discover a swarm of small icy worlds beyond the orbit of Neptune. This region, known as the Kuiper Belt, extends from around 30 to 55 astronomical units (AU) from the Sun. More than a thousand Kuiper Belt Objects (KBOs) have now been discovered, and it is thought that there maybe tens of thousands of KBOs with diameters larger than 100km, with Pluto the largest known of this family.

From 1996, astronomers began discovering KBOs with highly eccentric and inclined orbits and the term Scattered Disc Objects (SDOs) was adopted to differentiate them from KBOs. The SDOs are located between 40 and 1,000 AU from the Sun. It is thought that SDOs were previously members of the Kuiper Belt that were ejected into scattered orbits due to the gravitational influences of Neptune. Due to its unstable nature, it's very likely that the Scattered Disc is the birthplace of the short-period periodic comets.

The Kuiper Belt and the Scattered Disc objects are collectively known as Trans-Neptunian Objects (TNOs), and should not be confused with the Oort Cloud. This hypothetical spherical shell is believed to lie at a distance of around 50,000 AU from the Sun. It is theorised the Oort Cloud is a reservoir where long period comets become unseated to begin their journey sunward.

Since the 1930's, a few astronomers have expressed reservations about Pluto's planetary status. After its discovery, Pluto defied all efforts to resolve it into a planetary disc. It became clear that Pluto was very small, and in the late 1980's, astronomers studying eclipses of Pluto and its moon Charon confirmed this. Pluto was around 2,300km in diameter, embarrassingly small for a planet; indeed seven of the Solar System's moons are larger.

The Solar System was becoming messy, countless worlds in orbit and no real classification on what constitutes a planet. The discovery of Eris in 2003 (a SDO) complicated things even further. It turns out that Eris was about 2,500km in diameter and 27% more massive than Pluto; this was the trigger that influenced the International Astronomical Union (IAU) to come up with a definitive definition of a planet.

On 24th August 2006, the IAU decided on a set of rules to establish what a planet should be. This highly controversial resolution reclassified Pluto under a new category of dwarf planet along with Eris and Ceres (the largest of the minor planets). Pluto was then listed in the Minor Planet Catalogue (MPC) as number 134340 Pluto. This decision created dissension among astronomers and the public, how could a mere handful of scientists at a conference take away Pluto's planethood? Just as Ceres lost its planetary status a couple of centuries ago after the discovery of many other minor planets, Pluto would be relegated merely as a dwarf planet, a TNO or KBO with a large forgettable number in a catalogue; even Ceres had the distinction of appearing first in the MPC.

Had Pluto been included in the MPC at the time of discovery in 1930, it would have been designated 1164 Pluto. During the interval from discovery to demotion, over 133,000 other minor planets had been numbered!

Almost two years after the introduction of the dwarf planet class, the IAU decided on the term plutoid to cover transneptunian dwarfs similar to Pluto. This term will not apply to the dwarf planet Ceres because of its location within the asteroid belt, and now this body is presently in a class of its own. To add to the confusion, the IAU has set a minimum brightness limit on plutoids. This strange definition means that two bodies can be exactly the same size, but if one is less reflective than the other it may not be a plutoid.

One wonders if the term plutoid was just a shameful attempt at redemption to appease the 'reinstate Pluto crowd'. Do we really need the plutoid classification at all? If it makes people feel any better, Pluto could be regarded as a giant Kuiper Belt Object.

Wasn't life much simpler when we just had nine planets?

Hubble image of Pluto and its moons: Charon, Nix, and Hydra. Credit: NASA, ESA, H. Weaver (JHU/APL), A. Stern (SwRI), and the HST Pluto Companion Search Team.

The British composer Gustav Holst wrote the orchestral suite 'The Planets' prior to the discovery of Pluto, hence its omission. The piece was inspired by astrology rather than astronomical reasons.

conjunction. Even the smallest of telescopes will show plenty of detail on this gas giant and the fascinating Galilean satellites as they shuttle back and forth. Jupiter's motion takes it directly towards the 6th magnitude star 45 Capricorni, and from the 2nd to the 6th the star will be in the satellite plane. This event is reminiscent of last April when nearby 44 Capricorni became an extra 'moon'. On the 3rd, 45 Cap will be close to Europa to the west of Jupiter, the moon the brighter of the pair. On the evening of the 4th, the star will be between Io and Ganymede, with all five 'moons' to the east of the planet. On the 5th, at 8pm EST, 45 Cap will be so close to Callisto, that they will appear like a neat double star almost matched in brightness. On the 6th, the Full Moon will be near the planet (see Sky View).

There are a couple of interesting satellite events this month. The first is best suited for the eastern states when in the twilight of the 18th we see Europa reappear from eclipse at 5:58pm EST, followed by Io reappearing 14 minutes later. A similar double reappearance from eclipse is seen just before dawn on the 22nd from Western Australia, but this time Io leads Europa back into sunlight. The times are 5:09am and 5:17am WST respectively (see part II).

Three times this month Callisto is the only moon of Jupiter's visible (excluding transits). See page 113 for the details. The times are:

16th commencing at 9:23pm EST (7:23pm WST)
ending at 10:15pm EST (8:15pm WST).

23rd commencing at 11:06pm EST (9:06pm WST)
ending at 1:28am EST (11:28pm WST).

31st commencing at 1:00am (11:00pm WST on 30th)
ending at 3:32am EST (1:32am WST)

Saturn is low in the western evening twilight and by month end will be swallowed up in the bright twilight sky. High magnification views early in the month will show the planet's rings very nearly edge on. As Saturn slowly sinks in the west, Mercury races up from below and passes within 3° south of the planet on the 16th and 17th (see Sky View).

On the 10th the Sun passes through the ring plane rendering the rings invisible from Earth until after our ring passage next month (4th). If you wish to observe this rare event don't delay. On the 10th Saturn isn't setting until 2.5 hours after sunset – at month's end this is down to 70 minutes.

Uranus in Pisces rises around 8pm mid-month.

Neptune transits the meridian (is due north) around 12am mid-month. The planet is at opposition on the 18th, and visible the entire night. Even at opposition, this 7.8 magnitude outer world only appears as a small bright blue dot in amateur telescopes. After several months of companionship Jupiter begins to speed away, leaving Neptune again in isolation (until December).

Pluto transits the meridian around 8:30pm mid-month. By the end of August, its path brings it within 0.7° of the small open star cluster NGC 6507 and within 1.5° of the fine open cluster M23 (NGC 6494).

MINOR PLANETS. Two of the brighter minor planets reaching opposition this month are 16 Psyche on the 6th at magnitude 9.3 in Capricornus and 88 Thisbe on the 24th at magnitude 9.8 in Aquarius.

This month, 11th magnitude 324 Bamberga tours some deep sky objects in Auriga and 1 Ceres visits the southern regions of the Virgo cluster of galaxies.

COMETS

Comet C/2006 W3 (Christensen) is moving southwest through Vulpecula as August opens. The comet should remain around 11th magnitude throughout the month. Mid-August sees Christensen enter Sagitta before ending the month in Aquila. Throughout August, the comet is visible until the early hours of the morning.

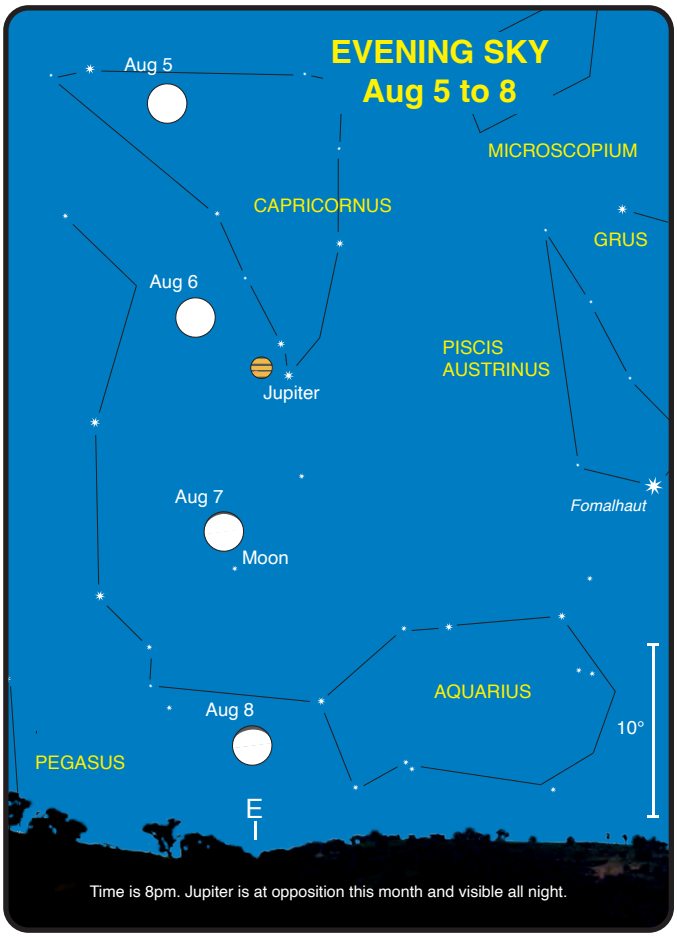
Comet P/2001 MD$_7$ (LINEAR) is moving eastward through Cetus as August begins, rising around 11pm. The comet brightens from 13th to 12th magnitude during the month. During August 6-7, LINEAR is within 1° of the famous variable star Mira (Omicron Ceti). By mid-August, LINEAR has crossed into Eridanus.

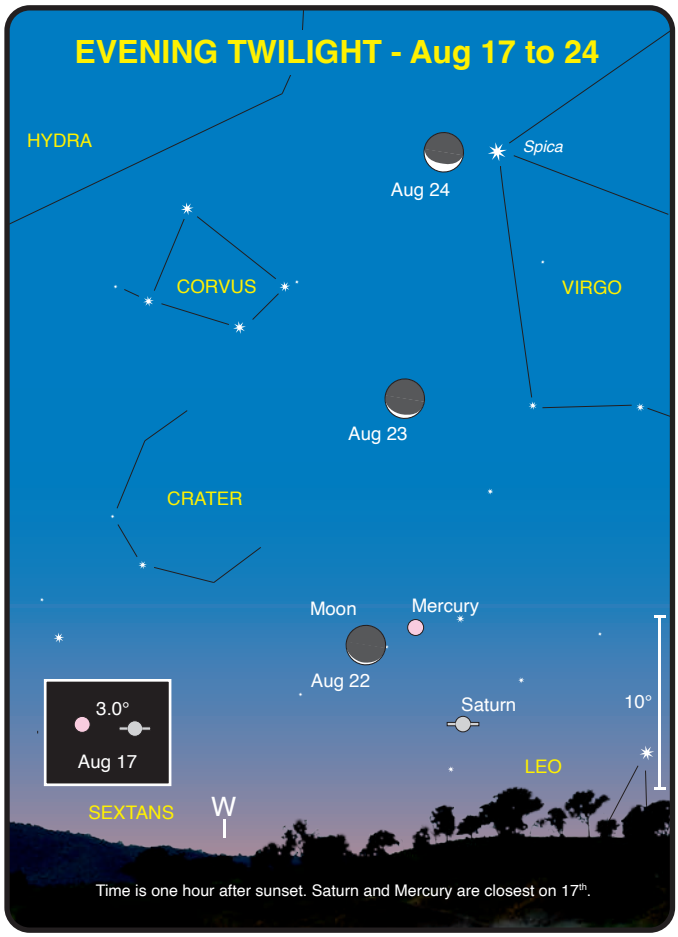
Comet 22P/Kopff moves southwest through Aquarius during August. The comet will be rising early in the evening, and is expected to fade from 9th to 10th magnitude during the month.

DIARY

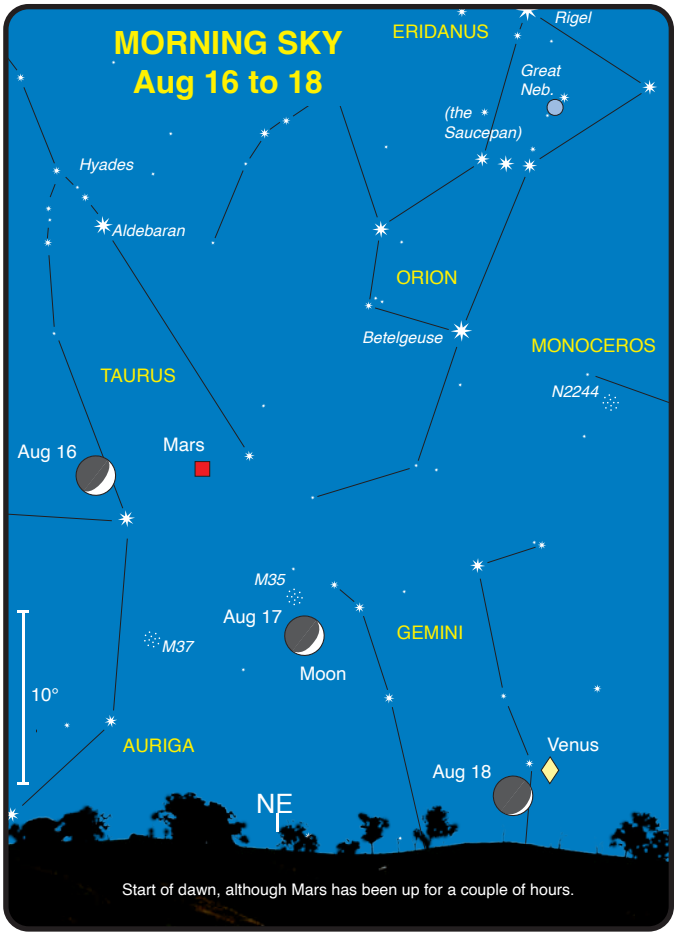
1st	2am	(Midnight WST, prev day) Antares 0.5°S of Moon; Occn.
3rd		m.p. 6 Hebe 0.7°NE of NGC 5713 (G) in Virgo
3rd	5am	(3am WST) Mercury 0.6°N of Regulus
4th	4am	(2am WST) Jupiter 0.03°E of star 45 Capricorni
4th	11am	(9am WST) Moon at apogee
5th		Venus 0.9°SE of star Eta Geminorum
6th		Venus 0.5°S of star Mu Geminorum
6th	10:55am	(8:55am WST) Full Moon; Penumbral Eclipse
7th		Mars 1.0°S of NGC 1746 (OC) in Taurus
7th		m.p. 6 Hebe 0.2°W of NGC 5750 (G) in Virgo
7th		m.p. 40 Harmonia 0.6°S of M95 (SG) in Leo
7th	8am	(6am WST) Jupiter 3°S of Moon
7th	Noon	(10am WST) Neptune 3°S of Moon
8th		m.p. 27 Euterpe 0.5°N of star Beta Virginis
8th		m.p. 40 Harmonia 0.8°S of M96 (G) in Leo
8th	am	m.p. 18 Melpomene 1.0°SW of NGC 474 (G) in Pisces
9th		m.p. 1 Ceres 0.3°N of NGC 4261 (G) in Virgo
10th		m.p. 1 Ceres 0.6°NE of NGC 4281 (G) in Virgo
10th	3am	(1am WST) Uranus 6°S of Moon
11th		m.p. 1 Ceres 0.4°SW of NGC 4339 (G) in Virgo
11th		Mercury at descending node
12th		m.p. 29 Amphitrite 0.1°N of NGC 4699 (G) in Virgo
13th		m.p. 1 Ceres 1.2°NE of M61 (G) in Virgo
14th	4:55am	(2:55am WST) Last Quarter Moon
15th	4am	(2am WST) Jupiter at opposition
15th	pm	m.p. 18 Melpomene 0.3°N of NGC 533 (G) in Cetus
16th		Mercury 0.2°NW of NGC 3640 (G) in Leo
16th		m.p. 29 Amphitrite 0.9°SW of NGC 4818 (G) in Virgo
16th		m.p. 324 Bamberga 0.5°SE of star Iota Aurigae
16th	4am	(2am WST) Juno stationary
16th	1pm	(11am WST) Mars 3°S of Moon
17th		Venus 0.7°SW of star Delta Geminorum
17th		m.p. 1 Ceres 0.6°N of NGC 4496 (G) in Virgo
18th	7am	(5am WST) Neptune at opposition
18th	7am	(5am WST) Venus 1.7°S of Moon
18th	5pm	(3pm WST) Vesta 0.4°S of Moon; Occn.
19th		Venus 0.4°NW of Eskimo Nebula (NGC 2392) in Gemini
19th	7am	(5am WST) Mercury 3°S of Saturn
19th	3pm	(1pm WST) Moon at perigee
19th	pm	Comet C/2006 W3 (Christensen) 0.2°N of NGC 6886 (PN) in Sagitta
20th		Mars at ascending node
20th	8:02pm	(6:02pm WST) New Moon
21st		Mercury at aphelion
22nd	2pm	(Noon WST) Venus 7°S of Pollux
22nd	4pm	(2pm WST) Saturn 7°N of Moon
22nd	10pm	(8pm WST) Mercury 3°N of Moon
23rd		m.p. 29 Amphitrite 0.2°NW of NGC 4939 (G) in Virgo
23rd		m.p. 654 Zelinda 0.6°SW of star Delta Corvi
24th		m.p. 324 Bamberga 0.7°S of IC 405 (Flaming Star Neb.) in Auriga
25th		m.p. 1 Ceres 0.3°NE of NGC 4636 (G) in Virgo
25th	2am	(Midnight WST, prev day) Mercury greatest elongation east (27°)
26th		Venus 0.5°S of m.p. 4 Vesta
26th		Mars 0.4°NW of NGC 2129 (OC) in Gemini
26th		m.p. 1 Ceres 0.3°S of NGC 4665 (G) in Virgo
27th		m.p. 324 Bamberga 0.5°N of NGC 1893 (OC) in Auriga
27th	9:42pm	(7:42pm WST) First Quarter Moon
28th		Mars 0.5°S of IC 2157 (OC) in Gemini
28th	8am	(6am WST) Antares 0.6°S of Moon; Occn.
29th		Mars 0.6°S of NGC 2158 (OC) in Gemini
29th		Mars 0.8°S of M35 (OC) in Gemini
30th		m.p. 324 Bamberga 0.2°SW of NGC 1931 (N) in Auriga
31st		m.p. 1 Ceres 0.5°SW of NGC 4772 (G) in Virgo
31st		Venus at ascending node
31st	9pm	(7pm WST) Moon at apogee

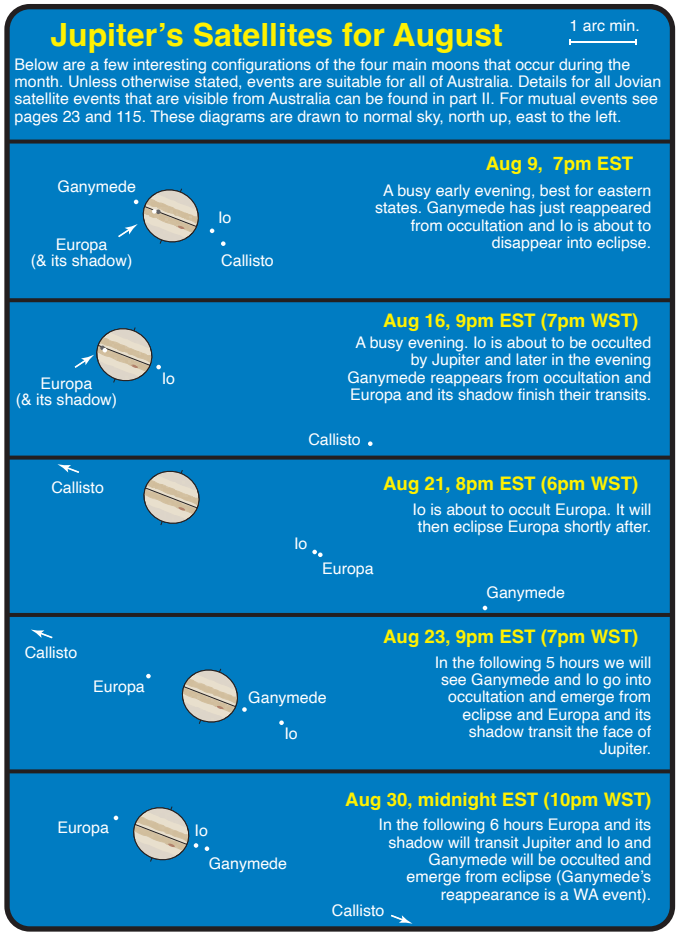
Comet 88P/Howell begins August 2° north of Spica, in Virgo. Moving southeast, the 11th magnitude comet is setting late in the evening. The end of August sees Howell move into Libra.





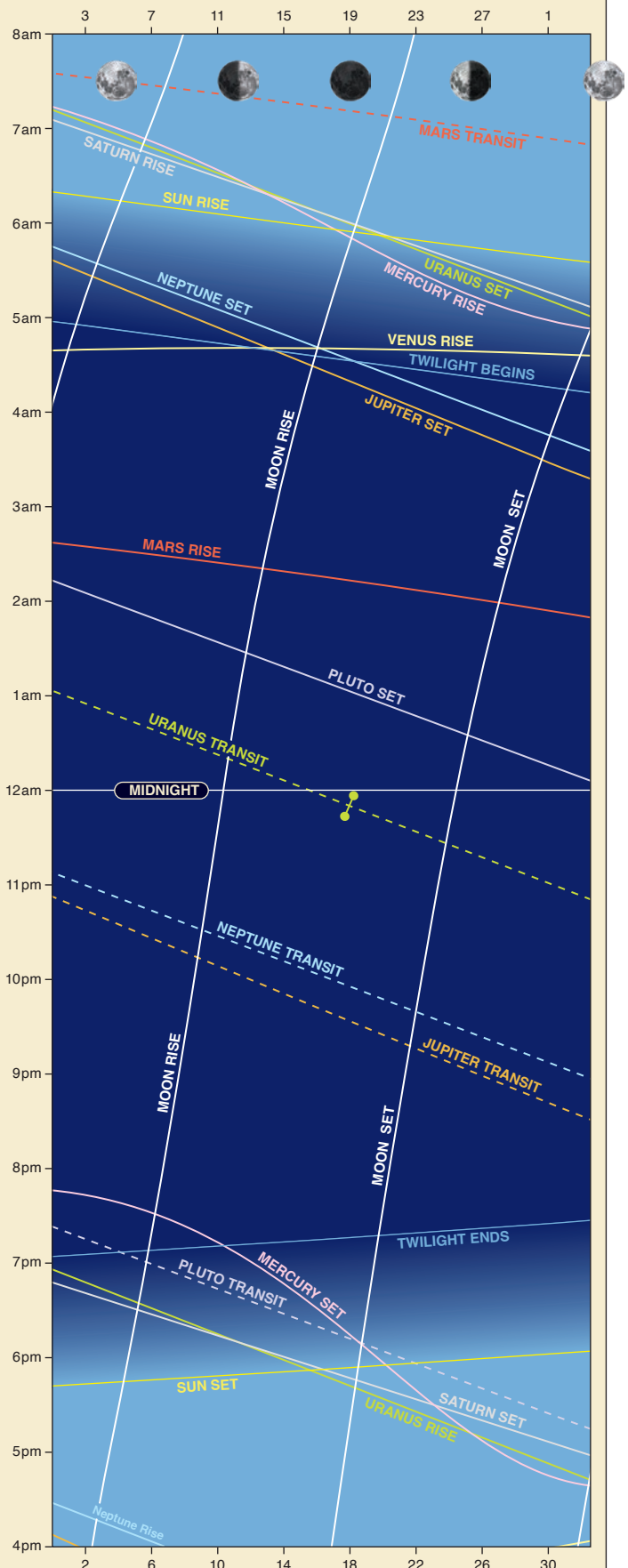
Approximate local standard time.





SEPTEMBER

RISE–SET CHART

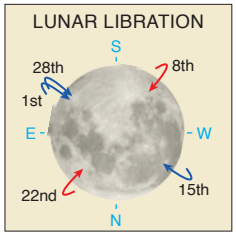


Approximate local standard time.

HIGHLIGHTS

- Venus, crescent Moon and Regulus close.
- Saturn's rings edge-on.
- Jupiter with only one moon

THE MOON



1st 4pm (2pm WST). Minimum Libration (0.3°), bright SE limb.

5th Full Moon.

8th 8pm (6pm WST). Maximum Libration (8.6°), crater Hausen and Mare Orientale on bright SW limb.

12th Last Quarter.

14th Occultation of Mars by the Moon, not visible from Australia.

15th 3pm (1pm WST). Minimum Libration (1.1°), bright NW limb.

16th 6pm (4pm WST). Moon at perigee (closest to Earth at 364,053km).

19th New Moon.

22nd 2am (midnight WST, prev. day) Maximum Libration (9.2°), Mare Humboldtianum on bright NE limb, Mare Crisium seen to best advantage.

24th Occultation of Antares by the Moon. Not visible from Australia.

26th First Quarter.

28th 2pm (noon WST). Moon at apogee (furthest from Earth at 404,432km).

28th 11pm (9pm WST). Minimum Libration (0.6°), bright SE limb.

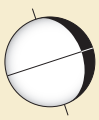
APPEARANCE of the PLANETS

MERCURY Mercury is in inferior conjunction on the 20th

5th Sep dia 8.9" mag 0.6

30th Sep dia 8.4" mag 0.4

VENUS

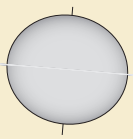


15th Sep dia 11.9" mag –3.8

MARS

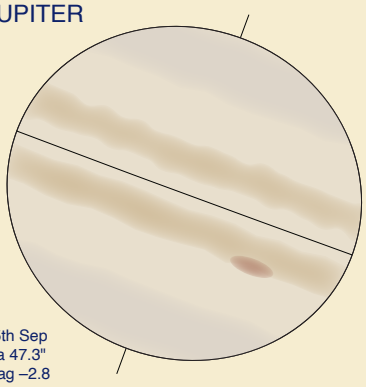
15th Sep dia 6.2" mag 0.9

1st Sep dia 16.0" mag 1.1 Conjunction on the 18th



SATURN

JUPITER



15th Sep dia 47.3" mag –2.8

URANUS 17th Sep Opposition dia 3.7" mag 5.7

NEPTUNE 15th Sep dia 2.3" mag 7.8

PLUTO 15th Sep dia 0.1" mag 14.0

THE PLANETS

Mercury, in Virgo, is visible due west in the early evening sky for the first half of the month. The planet then heads back to the Sun and inferior conjunction (between the Earth and the Sun) on the 20th. Moving west of the Sun, Mercury returns to the morning sky for a poor apparition in October.

Venus, in the morning sky, rises around the start of dawn. It spends the first half of the month crossing Cancer before entering Leo. On the 2nd, the planet passes less than 1° from the Beehive Cluster. Known since antiquity, the Beehive (M44 in Messier's catalogue) is visible to the unaided eye under dark skies. Interestingly, M44 is brighter (integrated 3rd magnitude) than the 4th magnitude stars that form the constellation of Cancer, the most inconspicuous of the zodiacal constellations. On the 17th, in the dawn sky near the horizon, the 27-day old slender crescent Moon can be seen forming the apex of a triangle with Venus and the 1st magnitude star Regulus (see Sky View). On the 20th and 21st Venus will be within 1° of Regulus.

The **Earth** is at its vernal (spring) equinox on the 23rd. An observer on the equator will see the Sun rise due east and set due west. At this location, day and night are equal.

Mars, in Gemini, is visible in the morning northeastern sky near Castor's left foot early in the month. On the mornings of the 1st and 2nd Mars will be crossing the loosely scattered star cluster Collinder 89. On the 14th, the 24-day old waning crescent Moon will be 2.5° below the planet (see Sky View). As Mars moves across the constellation it comes within 1° of Delta (δ) Geminorum, a neat double of 3rd and 8th magnitude suns with interesting colour contrast. Delta Gem is historically significant in that it was the guide star that Clyde Tombaugh centred his telescope on 79 years ago, when exposing the discovery plates of Pluto.

Jupiter transits the meridian (is due north) around 10pm mid-month. Now just past opposition, the planet is ideally located high in the northern evening sky for observation. On the 2nd and 3rd, the nearly full Moon will be close to the planet (see Sky View). Around the 21st, Jupiter will be 0.3° from the 4th magnitude star Iota (ι) Capricorni. On the 29th and 30th our waning gibbous satellite again pays Jupiter a visit (see Sky View).

For a brief period on the morning of the 7th, Callisto will be the only moon of Jupiter's visible (excluding transits). This is better suited for Western Australia, commencing at 4:20am EST (2:20am WST) and ending at 5:27am EST (3:27am WST). See page 113 for details.

Saturn is in conjunction with the Sun on the 18th, remaining unobservable until its return to the eastern dawn sky in October. Early in the month Saturn moves from Leo, its home since late 2006, into Virgo where it meanders until December 2012. On the 4th, Saturn's rings will be edge-on as the Earth passes through the ring plane. When the next opportunity comes to view Saturn though a telescope, earth bound observers will gaze upon the north side of the rings for the first time since 1996. From the 10th of last month to the 4th September the rings will be effectively invisible (see discussion in August monthly text and page 23).

Spotless

At the time of writing (October 2008), many of our readers who regularly observe the Sun would have noticed a protracted three-year period of solar minimum. Weeks and months seem to pass without any activity, and those expensive solar filters are in storage awaiting the kick-start of the next cycle.

In January 2008, a small high-latitude reversed polarity sunspot appeared indicating the beginning of Solar Cycle 24. Since then the Sun has remained strangely quiet, leading some to speculate that we are heading for another prolonged spotless period like the Maunder Minimum of 1645 – 1715. As if to support this claim, the August and September 2008 monthly mean sunspot numbers (both 0.5) were at their lowest since 1954.

Is this unusual? In the three-year period up until 30th June 2008, the Sun experienced 362 spotless days (considering a sunspot can last for weeks or months, it shows just how low the numbers are). However, looking at the past ten solar minima there are four that have exceeded this cycle's drought, so statistically there is nothing overly unusual.

If we go back to the 17th century, we find a very unusual period in the Sun's recent history. Sunspots had first been observed telescopically by Galileo and his contemporaries from 1610. The Sun then went into a seventy-year period of inactivity from 1645 to 1715, when very few sunspots were observed. This same period corresponded to the worst of the 'Little Ice Age' in Europe and North America (possibly the world) when normally ice-free rivers froze, sea-ice increased and snow remained at low altitude all year round.

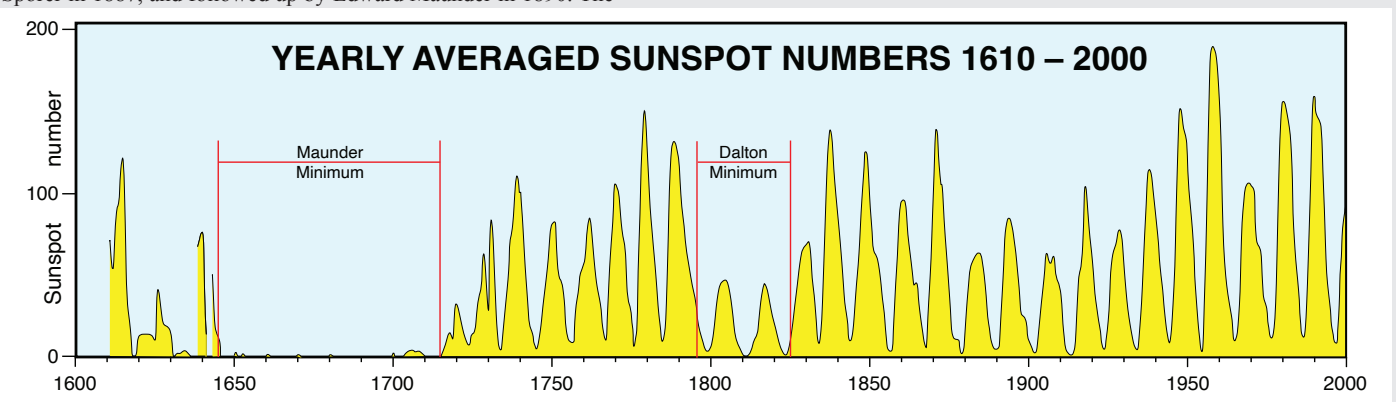
The virtual seventy-year absence of sunspots was first noted by Gustav Sporer in 1887, and followed up by Edward Maunder in 1890. The term Maunder Minimum was coined by J. A. Eddy in 1976. It was not a consequence of a flagging interest in the Sun that brought about the shortfall in sunspots, in fact the opposite was the case. There were many diligent observers at the time, and the Paris observatory had a systematic solar observing programme underway over the entire period. A further indicator of reduced solar activity at the time was a simultaneous decrease in auroral activity (a sign of less magnetic storms on the Sun).

In one 27-year period during the Maunder Minimum (1672 – 1699), astronomers of the day recorded only 50 sunspots. In any similar period over the past hundred years there would have been between 40,000 and 50,000 spots. In addition, from 1645 – 1705 only one sunspot group was noted. Direct and indirect studies have detected other long minima over the past millennium: the Dalton (1795 – 1825), Sporer (1420 – 1530), Wolf (1280 – 1340) and Oort (1010 – 1050) minima.

The sunspot cycle we observe today may not be as 'normal' as we once thought, and gaps in the long-term record do cast some doubt on the regularity of the 11-year cycle. From modern observations, the 11-year cycle appears to have a longer-term pattern of different strengths – an 80-year strong period, followed by a slightly weaker one.

With only four hundred years of observation behind us, it is difficult to typify the Sun's workings. Does the Sun's erratic behaviour suggest a longer-term variability that can influence life on Earth? The times of low sunspot activity seem to correspond with lower Earth temperatures, although it goes beyond this short article to discuss climate change, man made or otherwise.

... continued next page.



Uranus is at opposition on the 17th and is visible the entire evening. Residing close to the Pisces/Aquarius border, the planet will be 5.7 magnitude at this time, just 0.2 of a magnitude brighter than when near conjunction. Even at this time of closest approach to Earth, the planet only appears as a small bright green disc in telescopes – but still worth a few moments at the eyepiece.

Neptune, in Capricornus, is now past opposition and transits the meridian around 10pm mid-month.

Pluto appears stationary against the starry background on the 12th, ending six months of retrograde motion. This reversal of direction now takes Pluto away from the open star clusters NGC 6507 and M23. The plutoid transits the meridian around 6:30pm and sets just after 1am mid-month.

MINOR PLANETS. Four of the brighter minor planets reach opposition this month in Aquarius. They are: 44 Nysa on the 6th at magnitude 10.3, 65 Cybele on the 7th at magnitude 11.2, 42 Isis on the 8th at magnitude 9.4 and 23 Thalia on the 11th at magnitude 11.3. There are three in Pisces: 41 Daphne on the 14th at magnitude 11.3, 3 Juno on the 21st at magnitude 7.6 and 20 Massalia on the 24th at magnitude 9.2. Also reaching opposition in September are 433 Eros on the 1st at magnitude 11.9 in Pegasus and 28 Bellona on the 23rd at magnitude 11.3 in Cetus.

Shortly before dawn on the 16th 4 Vesta can be seen on the southern edge of M44, the Beehive Cluster. On the 25th, retrograde motion sees 7 Iris make its second visit this year to M25, the open cluster in Sagittarius.

COMETS

Comet C/2006 W3 (Christensen) resides in Aquila throughout September. Setting after midnight, the comet is moving southwest and should remain around 11th magnitude. At the end of September, Christensen will be within 2° of the globular cluster NGC 6760.

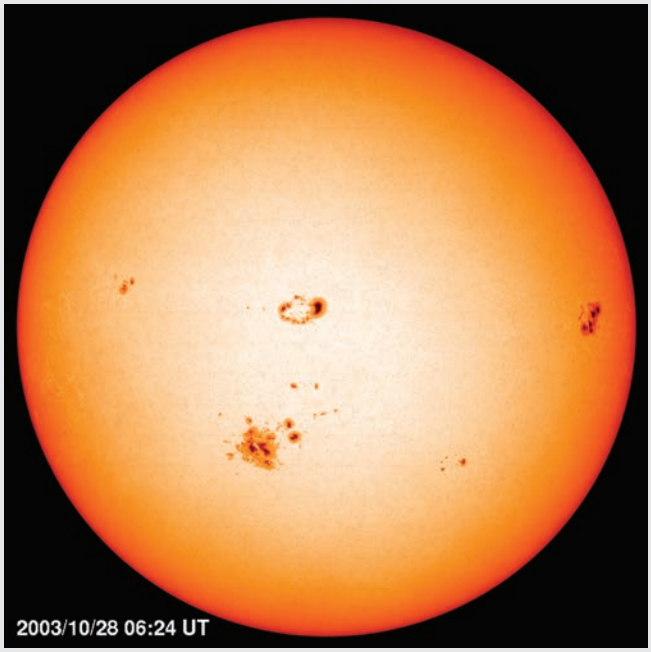
Comet P/2001 MD_7 (LINEAR) is rising around 11pm in Eridanus at the start of September. Expected to remain around 12th magnitude in brightness throughout the month, LINEAR moves into Orion mid-month. During September 25-29, the comet will be within 2° of M42 (the Great Orion Nebula). On the morning of September 27, P/2001 MD_7 passes across the open star cluster NGC 1981. At this time the comet will be only 1° north of the Great Nebula.

Comet 22P/Kopff is moving southwest through Aquarius. The 10th magnitude comet is visible throughout the night.

Comet 88P/Howell moves southeast through Libra into Scorpius this month. The comet remains at 11th magnitude through September and is setting late in the evening.

Spotless continued

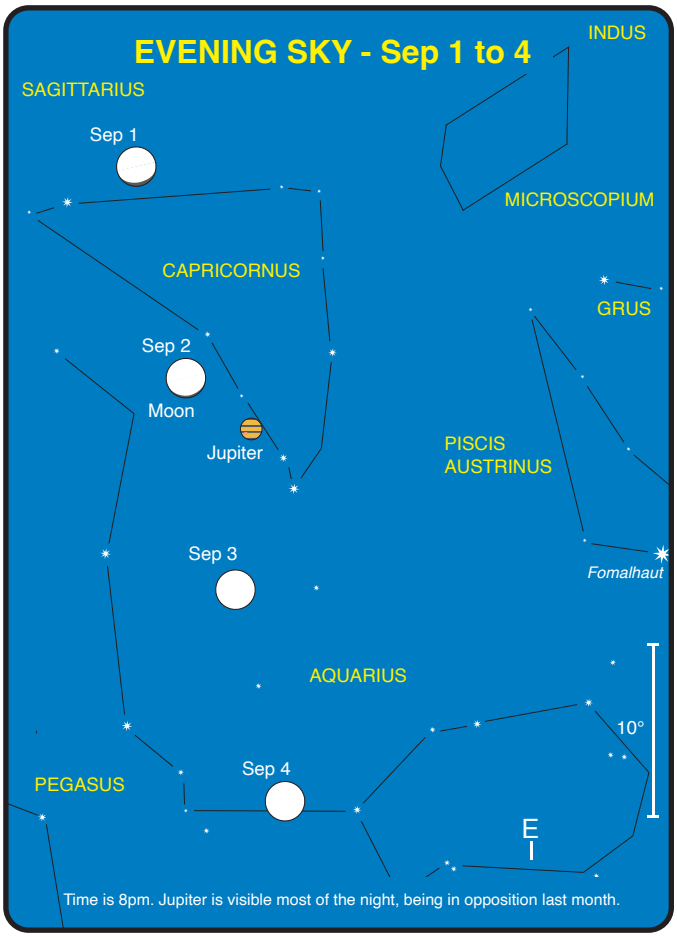
By the time you read this, the next cycle may be well underway, with current predictions of a return to maximum in 2012. Although not advocating armchair astronomy, a simple check may be made on the state of the Sun at sohowww.nascom.nasa.gov/. This will eliminate the need to set up a telescope if there is little to look at. The site provides images of the Sun taken at different wavelengths with various instruments aboard the Solar and Heliospheric Observatory (SOHO). The daily white light image gives a good representation of the Sun, as it would appear through a small Earth based telescope equipped with a solar filter. The SOHO spacecraft was launched in December 1995 and is located at the First Lagrangian Point (L1) moving around the Sun in step with the Earth. SOHO was designed for a nominal two-year mission, but with extensions, it is still in operation.

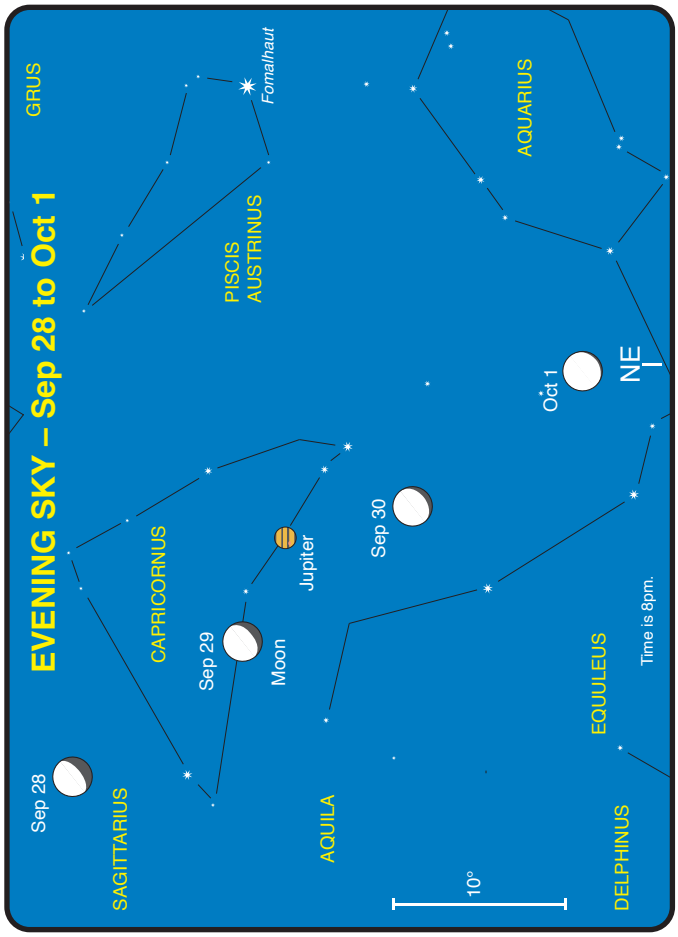


The largest sunspot ever seen by SOHO on 28th October 2003

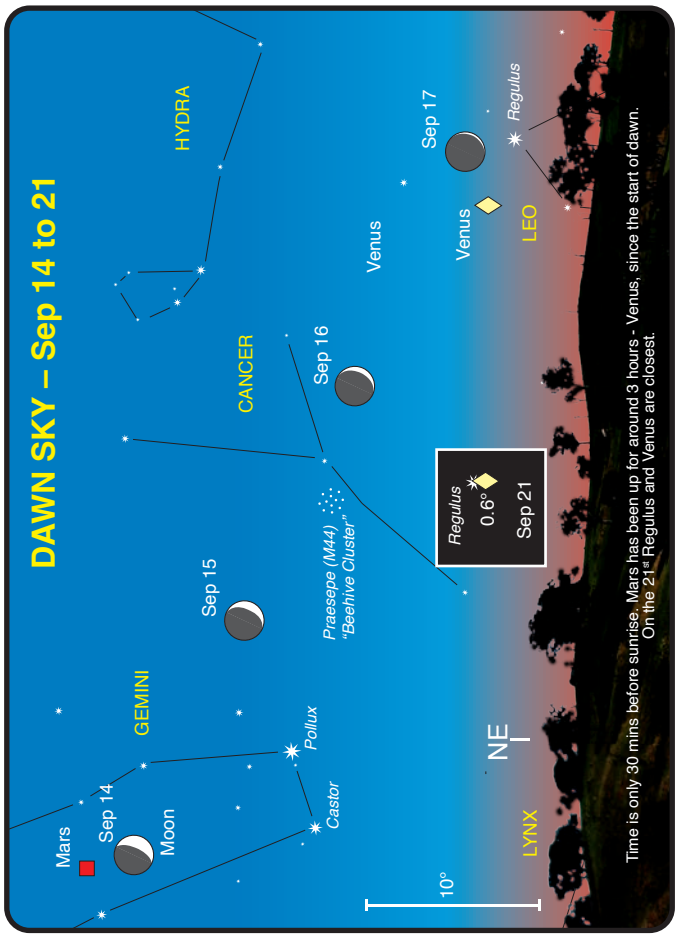
DIARY

2nd		Venus 1.0°S of Beehive Cluster (M44) in Cancer
2nd		Mars 0.2°SE of Collinder 89 (OC) in Gemini
2nd		m.p. 324 Bamberga 0.3°NE of NGC 1960 (OC) in Auriga
2nd		Comet 88P/Howell 0.3°S of NGC 5728 (G) in Libra
3rd		Mars 1.0°N of star Mu Geminorum
3rd		m.p. 1 Ceres 0.5°SW of NGC 4845 (G) in Virgo
3rd	7am	(5am WST) Jupiter 3°S of Moon
3rd	5pm	(3pm WST) Neptune 3°S of Moon
4th		m.p. 29 Amphitrite 0.7°N of NGC 5077 (G) in Virgo
5th	2:03am	(12:03am WST) Full Moon
5th	pm	Comet C/2006 W3 (Christensen) 1.5°NW of star Gamma Aquilae
6th	7am	(5am WST) Uranus 6°S of Moon
7th	6am	(4am WST) Mercury stationary
10th		Pluto 0.7°SE of NGC 6507 (C) in Sagittarius
10th		Mercury at greatest latitude south
11th		m.p. 11 Parthenope 0.9°S of NGC 2175 (OC) in Orion
12th	2am	(Midnight WST, prev day) Pluto stationary
12th	12:16pm	(10:16am WST) Last Quarter Moon
13th		m.p. 654 Zelinda 0.7°S of NGC 5018 (G) in Virgo
13th	10am	(8am WST) Pallas in conjunction with Sun
14th		Comet 88P/Howell 0.5°N of NGC 5897 (GC) in Libra
14th	2am	(Midnight WST, prev day) Mars 1.1°S of Moon; Occn.
14th	am	Comet P/2001 MD_7 (LINEAR) 1.0°N of NGC 1700 (G) in Eridanus
16th		m.p. 4 Vesta 0.5°S of Beehive Cluster (M44) in Cancer
16th		m.p. 654 Zelinda 0.1°W of NGC 5087 (G) in Virgo
16th		m.p. 654 Zelinda 0.5°NE of NGC 5068 (G) in Virgo
16th	6pm	(4pm WST) Moon at perigee
17th	am	Comet P/2001 MD_7 (LINEAR) 1.0°N of star Beta Eridani
17th	4am	(2am WST) Venus 3°N of Moon
17th	8pm	(6pm WST) Uranus at opposition
18th	4am	(2am WST) Saturn in conjunction with Sun
18th	pm	m.p. 89 Julia 0.6°NE of star Delta Andromedae
19th		m.p. 4 Vesta 0.7°N of star Delta Cancri
19th		m.p. 654 Zelinda 0.3°E of NGC 5134 (G) in Virgo
19th	4:44am	(2:44am WST) New Moon
20th	8pm	(6pm WST) Mercury in inferior conjunction with Sun
20th	8pm	(6pm WST) Venus 0.5°N of Regulus
21st	6pm	(4pm WST) Juno at opposition
22nd	pm	Comet C/2006 W3 (Christensen) 1.0°NW of Delta Aquilae
23rd	7am	(5am WST) Equinox
24th	4pm	(2pm WST) Antares 0.8°S of Moon; Occn.
24th	pm	Jupiter 0.3°NW of star Iota Capricorni
25th	pm	m.p. 7 Iris 0.5°N of M25 (OC) in Sagittarius
26th		Mars 0.8°N of star Delta Geminorum
26th	2:50pm	(12:50pm WST) First Quarter Moon
27th		Comet 88P/Howell 0.6°S of star Delta Scorpii
27th	1am	(11pm WST, prev day) Comet P/2001 MD_7 (LINEAR) 0.05°N of NGC 1981 (OC) in Orion
27th	am	Comet P/2001 MD_7 (LINEAR) 1.0°N of M42 (Great Nebula) in Orion
28th	2pm	(Noon WST) Moon at apogee
29th		Mercury at ascending node
29th	4am	(2am WST) Mercury stationary
30th	10am	(8am WST) Jupiter 3°S of Moon
30th	11pm	(9pm WST) Neptune 3°S of Moon





Approximate local standard time.



Jupiter's Satellites for September

1 arc min.

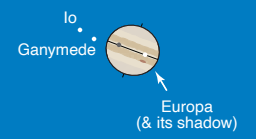
Below are a few interesting configurations of the four main moons that occur during the month. Unless otherwise stated, events are suitable for all of Australia. Details for all Jovian satellite events that are visible from Australia can be found in part II. For mutual events see pages 23 and 115. These diagrams are drawn to normal sky, north up, east to the left.

Sep 10, 7pm EST

The double transit is an eastern states twilight event. Over the next 7 hours Europa, Ganymede and their shadows will complete their transits.

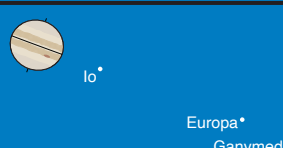
Sep 12, 8pm EST (6pm WST)

Over the next 3 hours Europa will appear to merge with Io leading to an occultation of Europa. Europa then overtakes Io and is eclipsed by Io's shadow.



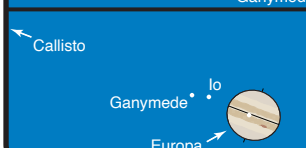
Sep 17, 9pm EST (7pm WST)

During the next 30 mins Europa will complete its transit, just in time for Ganymede to commence its transit.



Sep 18, 10:30pm EST (8:30pm WST)

All four satellites are on the same side. It will be interesting to watch the dance of these moons as they pass each other during the night.

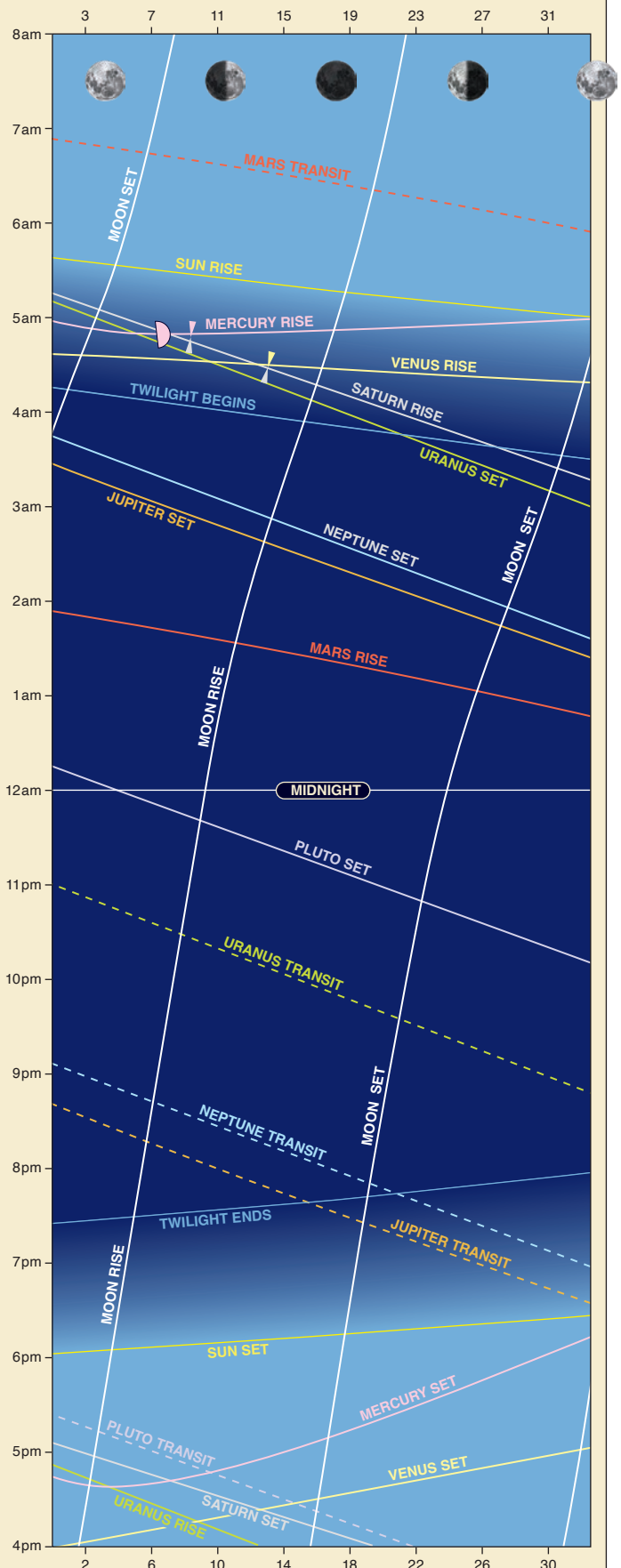


Sep 24, 10:30pm EST (8:30pm WST)

Io and Ganymede pass each other over the next hour. During the night Europa and Ganymede will transit the disc of Jupiter.

OCTOBER

RISE–SET CHART



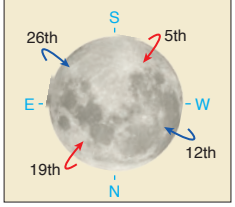
Approximate local standard time, for daylight saving add 1 hour.

HIGHLIGHT

- Mercury and Saturn close
- Venus and Saturn close
- Mars close to the Beehive
- The Orionids meteor shower

THE MOON

LUNAR LIBRATION



4th Full Moon.

5th 4pm (2pm WST). Maximum Libration (8.1°), crater Hausen bright SW limb.

11th Last Quarter.

12th Occultation of Mars by the Moon, not visible from Australia.

12th 1pm (11am WST). Minimum Libration (0.7°), bright NW limb.

13th 10pm (8pm WST). Moon at perigee (closest to Earth at 369,067km).

18th New Moon.

19th 10am (8am WST). Maximum Libration (8.4°), unobservable – too close to New Moon.

22nd Occultation of Antares by the Moon. Not visible from Australia.

26th 9am (7am WST). Moon at apogee (furthest from Earth at 404,166km).

26th 3am (1am WST). Minimum Libration (0.7°), bright SE limb.

26th First Quarter.

APPEARANCE of the PLANETS

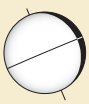
MERCURY

6th Oct
dia 7.0"
mag –0.5
Greatest elongation west

15th Oct
dia 5.6"
mag –1.1

25th Oct
dia 5.0"
mag –1.3

VENUS

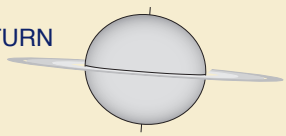


15th Oct
dia 10.8"
mag –3.8

MARS

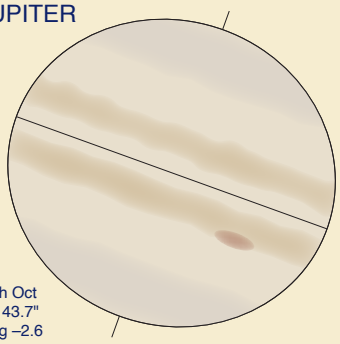
15th Oct
dia 7.1"
mag 0.7

SATURN



15th Oct
dia 16.0"
mag 1.1

JUPITER



15th Oct
dia 43.7"
mag –2.6

URANUS

15th Oct
dia 3.7"
mag 5.7

NEPTUNE

15th Oct
dia 2.3"
mag 7.9

PLUTO

15th Oct
dia 0.1"
mag 14.0

THE PLANETS

Mercury reaches its greatest western elongation from the Sun (18°) on the 6th. This is a poor morning apparition for Mercury with the planet hugging the horizon during the month. Mercury comes within 0.6° of Saturn on the 9th, with Venus about 5° from the pair. This will be a difficult observation low to the horizon in the brightening dawn sky, and binoculars will assist in seeing the trio (see Sky View). By month end Mercury is just a few degrees from the Sun as it moves toward superior conjunction early in November.

Venus, on its journey back toward the Sun, moves from Leo into Virgo early in the month joining Mercury and Saturn. A close encounter with Saturn (0.6°) on the 14th will be rendered difficult in the brightening dawn sky; binoculars will assist in this observation. Venus' spell as the Morning Star is coming to a close for this year, with the planet nearing the Sun and superior conjunction (Venus and Earth on opposite sides of the Sun) early next January.

Mars is visible in the morning eastern sky in Gemini, above the stars Castor and Pollux, Alpha (α) and Beta (β) Geminorum respectively. The planet remains in Gemini during the first half of the month before crossing over into Cancer. On the 12th, the Last Quarter Moon will be around 4° from Mars (see Sky View). At month end the Red Planet will be located on the outer fringes of M44 (Beehive Cluster), an open star cluster visible to the unaided eye from dark skies. The cluster is large and covers an area of more than 1°. Known since antiquity as a 'cloudy patch' its true nature was not discovered until 1610 when Galileo first turned his humble telescope upon it.

Jupiter can be seen high in the northern sky soon after sunset. The planet appears stationary against the stellar backdrop on the 13th, ending four months of retrograde motion. Heading towards the west Jupiter again passes 0.4° from the 4th magnitude star Iota (ι) Capricorni on the 31st. On the 27th, the 9-day old waxing gibbous Moon will be close to Jupiter (see Sky View).

Saturn returns to the morning sky this month after its solar conjunction. It will still be too close to the Sun to be seen until late October, when it appears close to the eastern horizon in the dawn sky (see Sky View).

Uranus, now past opposition, transits the meridian (is due north) around 10pm mid-month. It is located just above the Circlet of Pisces at this time, slipping across the border into Aquarius mid-month, where it will remain for the rest of the year.

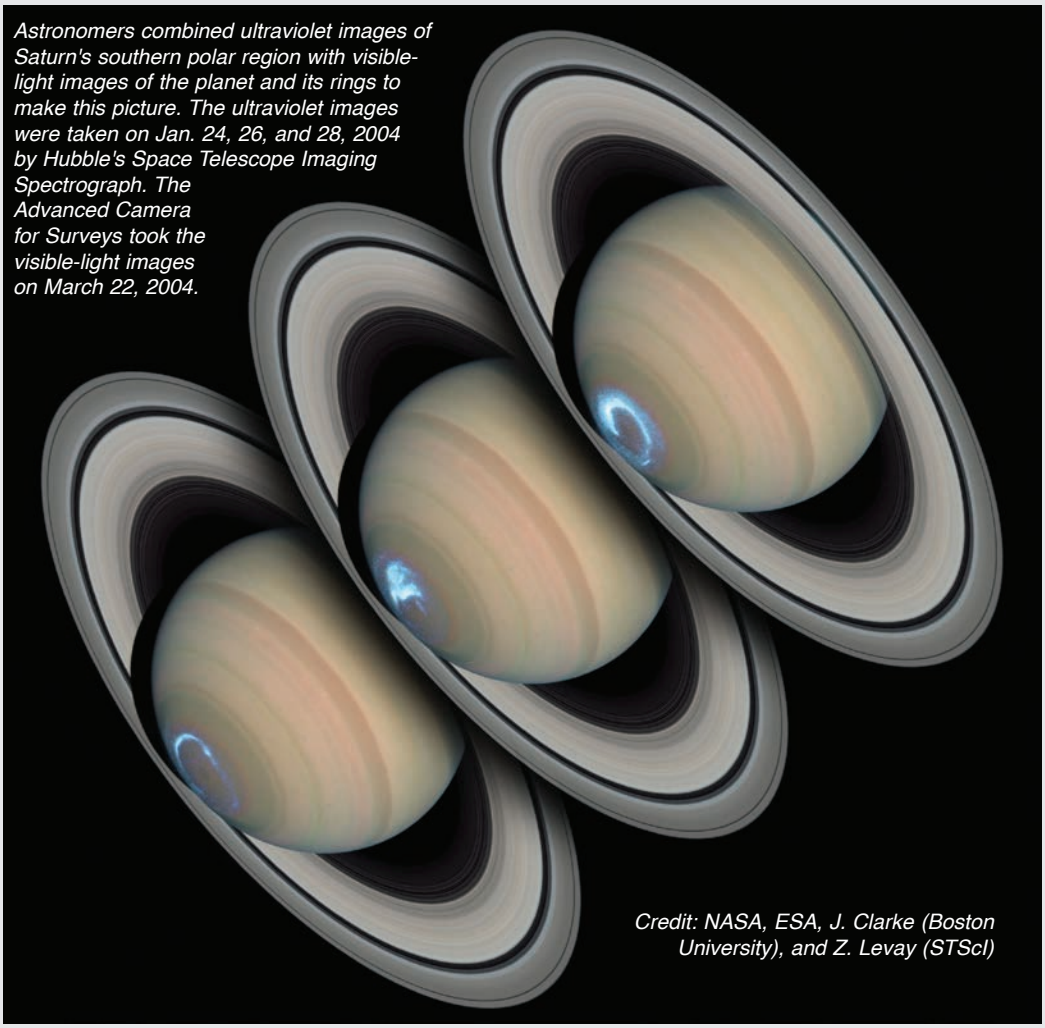
Neptune transits the meridian around 8pm mid-month. At the end of the month the planet will be 0.4° from the 6th magnitude star 44 Capricorni.

Pluto in Sagittarius sets around 11pm mid-month.

MINOR PLANETS reaching opposition this month include, 387 Aquitania on the 7th at magnitude 11.2 in Cetus, 89 Julia on the 10th at magnitude 9.3 in Andromeda and 18 Melpomene on the 10th at magnitude 7.9 in Cetus. On the 22nd 19 Fortuna has a close approach to the Crab Nebula (M1) in Taurus.

COVER STORY – Saturn and Aurora

This year we celebrate the 400th anniversary of Galileo Galilei's first astronomical observations with a telescope. For the first time in history, people became aware that the Earth was not isolated in space but surrounded by other worlds and celestial bodies. Our cover image this year was chosen as a tribute to Galileo and his observations that changed the world forever.



Astronomers combined ultraviolet images of Saturn's southern polar region with visible-light images of the planet and its rings to make this picture. The ultraviolet images were taken on Jan. 24, 26, and 28, 2004 by Hubble's Space Telescope Imaging Spectrograph. The Advanced Camera for Surveys took the visible-light images on March 22, 2004.

Credit: NASA, ESA, J. Clarke (Boston University), and Z. Levay (STScI)

In July 1610, Galileo first observed Saturn in the evening sky as it approached opposition and noted that it appeared to be three-bodied. *"The star of Saturn is not a single star, but is a composite of three, which almost touch each other, never change or move relative to each other, and are arranged in a row along the zodiac, the middle one being three times larger than the lateral ones."* At the time of the observations, the rings were midway between edge-on and fully opened.

Others were turning the newly invented telescope to the heavens and some noted that Saturn appeared oval, but Galileo argued that this was due to inferior instruments. In a letter dated December 1612, Galileo wrote that the planet's appendages had disappeared, *"Has Saturn devoured his children?"* he lamented. The passage of the Earth through the ring-plane of Saturn occurred in February 1613, and observers of the day would be denied ring views for some considerable time in their small instruments. Ironically, this celebration of Galileo's astronomical observations coincides with this year's edge-on appearance of the Saturnian ring system.

In 1616, Galileo presented a drawing of Saturn without commentary showing the planet atop of wide-open oval rings. There was a plethora of sketches by later observers showing the

... continued next page.

COMETS

Comet C/2006 W3 (Christensen) arcs southward through Aquila during October. Setting around midnight, Christensen is expected to fade from 11th to 12th magnitude.

Comet C/2007 Q3 (Siding Spring) is rising around the start of dawn in Leo. The comet is expected to be 10th magnitude in brightness.

Comet P/2001 MD$_7$ (LINEAR) opens the month in Orion, rising around 11pm, at about 12th magnitude. After the first week, LINEAR crosses into Monoceros, where it remains for the rest of October. By month's end, LINEAR is expected to have faded to 13th magnitude.

Comet 22P/Kopff is moving northeast through Aquarius during October. The comet is expected to fade from 11th to 12th magnitude, and will be setting before dawn.

Comet 88P/Howell, at 11th magnitude, moves through Scorpius and Ophiuchus during most of October before ending the month in Sagittarius. Throughout the month Howell is setting late in the evening. On the evening of October 4, the comet presents a good photo opportunity being 1° south of the Rho Ophiuchi Nebula. October 6-7 sees Howell come within 2° of Antares. It then goes on to tour some deep sky objects in Ophiuchus and Sagittarius (see diary).

METEOR SHOWERS

The **epsilon-Geminids** are a weak minor shower that is active from 14th to 27th with maximum on the 18th, a low hourly rate of two can be expected. As this shower is nearby the Orionids that are active at the same time, it may be difficult to distinguish them.

The **Orionids** are best seen from late evening until dawn and are visible from 2nd October through to 7th November. Maximum activity is on the 21st, but with many sub-maxima, good rates can be observed on several consecutive nights around this date. The Orionids provide a prominent display that has, over the past twenty years produced rates of 14 to 31 meteors per hour. Both 2006 and 2007 produced very strong rates, with ZHRs better than the normal peak seen on two or three consecutive nights, at best up to 50 – 70. Strong rates are predicted for 2008 (still to come when this was penned), 2009 and 2010. The Orionids are typically very swift and often bright, with some leaving trains. The shower was first recorded by Chinese observers in 288 AD, and is associated with Halley's Comet.

DIARY

3rd		Mars 0.8°N of NGC 2420 (OC) in Gemini
3rd	Noon	(10am WST) Uranus 6°S of Moon
4th		Comet 88P/Howell 1.0°S of IC 4604 (Rho Oph Neb) in Ophiuchus
4th		Mercury at perihelion
4th		Venus at perihelion
4th	4:10pm	(2:10pm WST) Full Moon
4th	pm	m.p. 18 Melpomene 0.4°E of NGC 596 (G) in Cetus
5th	pm	m.p. 18 Melpomene 0.4°W of NGC 615 (G) in Cetus
6th	8am	(6am WST) Mars 6°S of Pollux
6th	Noon	(10am WST) Mercury greatest elongation west (18°)
8th	7pm	(5pm WST) Mercury 0.3°S of Saturn
11th		Mercury 0.5°SE of NGC 4073 (G) in Virgo
11th	6:56pm	(4:56pm WST) Last Quarter Moon
12th		Mercury 0.6°SW of NGC 4179 (G) in Virgo
12th	11am	(9am WST) Mars 1.2°N of Moon; Occn.
13th		Mercury 0.5°W of m.p. 2 Pallas
13th	7pm	(5pm WST) Jupiter stationary
13th	10pm	(8pm WST) Moon at perigee
14th		Comet 88P/Howell 0.5°NW of M19 (GC) in Ophiuchus
14th		Mercury at greatest latitude north
14th	2am	(Midnight WST, prev day) Venus 0.6°S of Saturn
16th		Comet 88P/Howell 0.6°NW of NGC 6293 (GC) in Ophiuchus
16th		Comet C/2006 W3 (Christensen) 1.0°E of star Lambda Aquilae
16th	11pm	(9pm WST) Saturn 7°N of Moon
17th	5am	(3am WST) Venus 7°N of Moon
18th	3:33pm	(1:33pm WST) New Moon
21st		Venus 0.5°N of NGC 4454 (G) in Virgo
22nd	1am	(11pm WST, prev day) Antares 1.0°S of Moon; Occn.
22nd	am	m.p. 19 Fortuna 0.1°N of Crab Nebula (M1) in Taurus
25th		Venus 0.3°W of NGC 4691 (G) in Virgo
25th		Venus at greatest latitude north
26th	9am	(7am WST) Moon at apogee
26th	10:42am	(8:42am WST) First Quarter Moon
27th	7pm	(5pm WST) Jupiter 3°S of Moon
28th	7am	(5am WST) Neptune 3°S of Moon
29th		Venus 0.4°NE of NGC 4941 (G) in Virgo
30th		Saturn 0.05°S of NGC 4045 (G) in Virgo
30th		Comet 88P/Howell 1.0°N of NGC 6520 (OC) in Sagittarius
30th	7pm	(5pm WST) Uranus 6°S of Moon
31st		Jupiter 0.4°NW of star Iota Capricorni
31st		m.p. 2 Pallas 0.5°N of NGC 4753 (G) in Virgo
31st	8pm	(6pm WST) Juno stationary

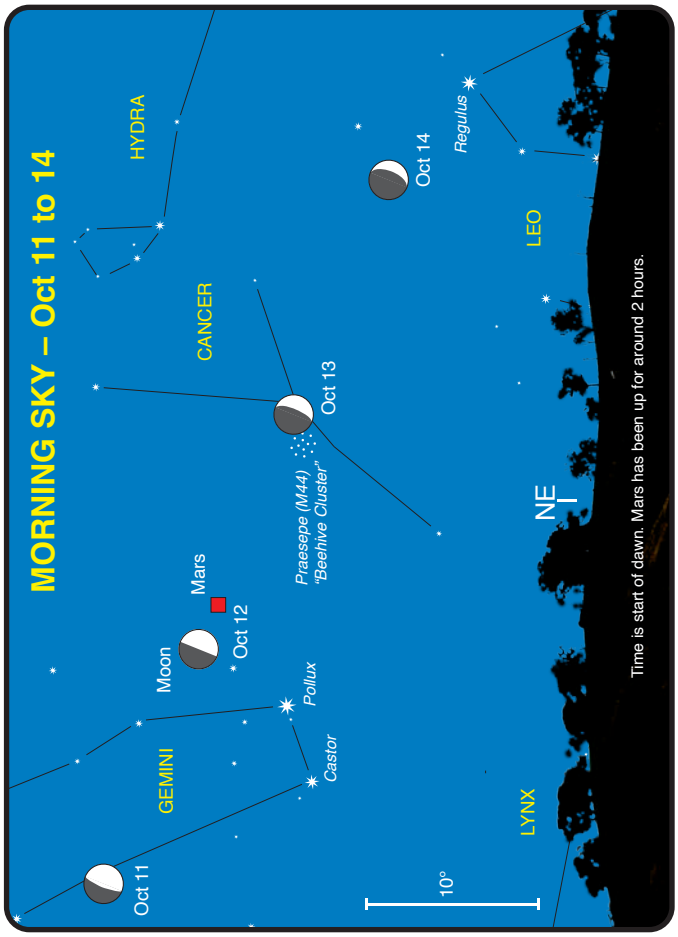
COVER STORY – Saturn and Aurora *continued*

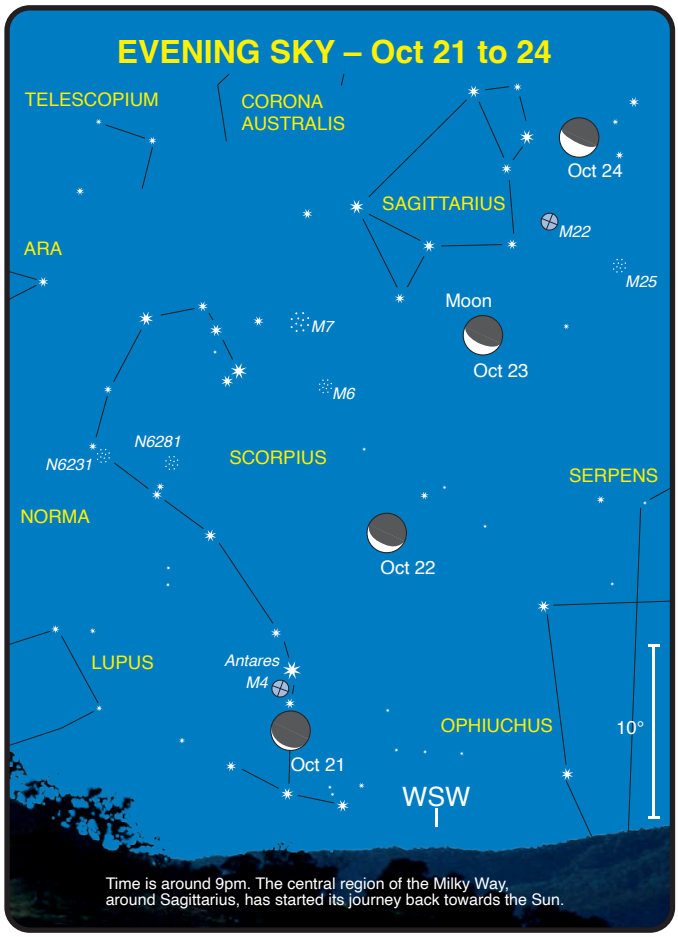
rings attached, detached, sometimes as three bodies, and other odd configurations. In 1659, Christian Huygens (discoverer of Saturn's satellite Titan) presented to the world his theory that the planet was surrounded by a flat ring that nowhere touched it. Huygens incorrectly thought the ring to be a solid structure, that had substantial thickness, but he was close to the mark.

Our cover image is a composite of Hubble Space Telescope (HST) images. The blue aurora at the planet's south polar region was taken in ultraviolet with the HST's Imaging Spectrograph in January 2004. These were then superimposed on visible wavelength images of the planet and rings taken by the HST's Advanced Camera for Surveys in March 2004. The blue colour of the aurora is misleading as the ultraviolet images were transferred to the nearest visible colour to show its geometry.

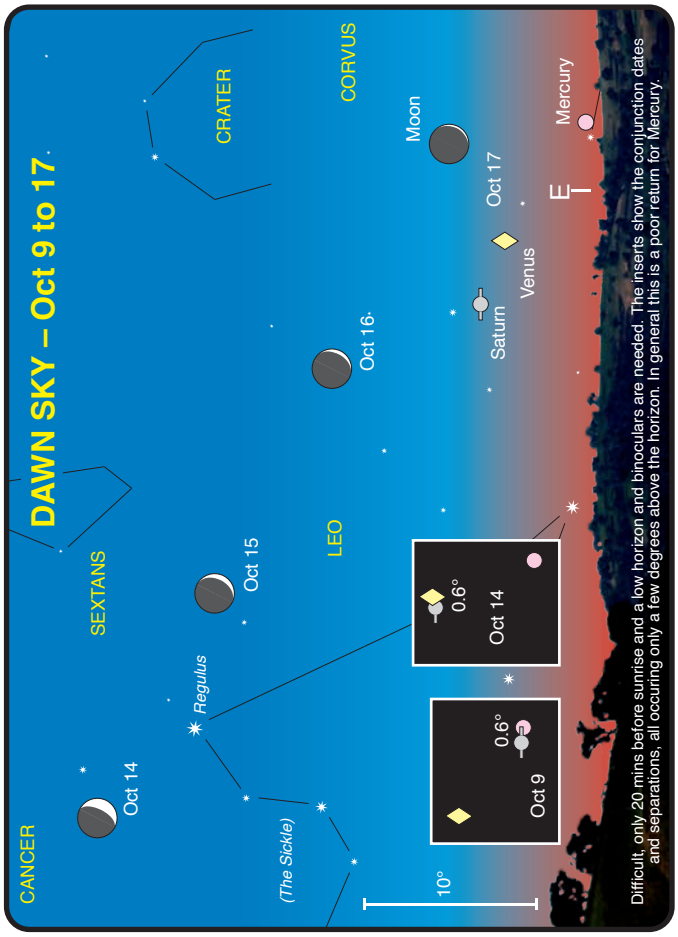
When Galileo first turned his telescope to the heavens, could he ever have imagined that in just four hundred years we would send probes to the planets? Could he ever have conceived that an orbiting observatory would beam images of Saturn back to Earth? Probably not, but we think he would be very impressed with the cover image.

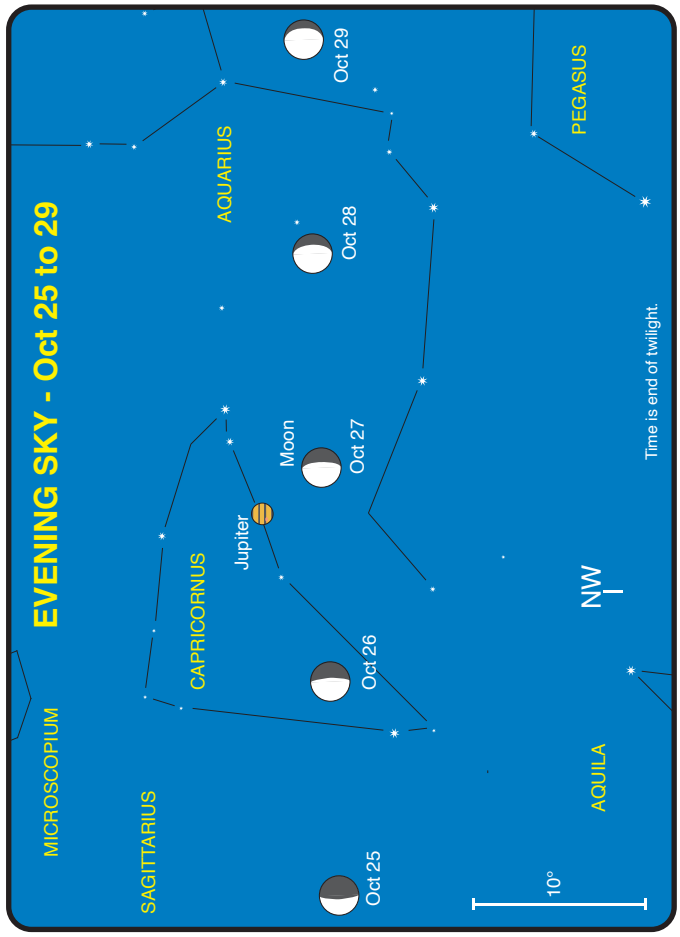
Right is Galileo, a portrait by Leoni in 1624. Left is a sketch of Saturn by Galileo in 1616.





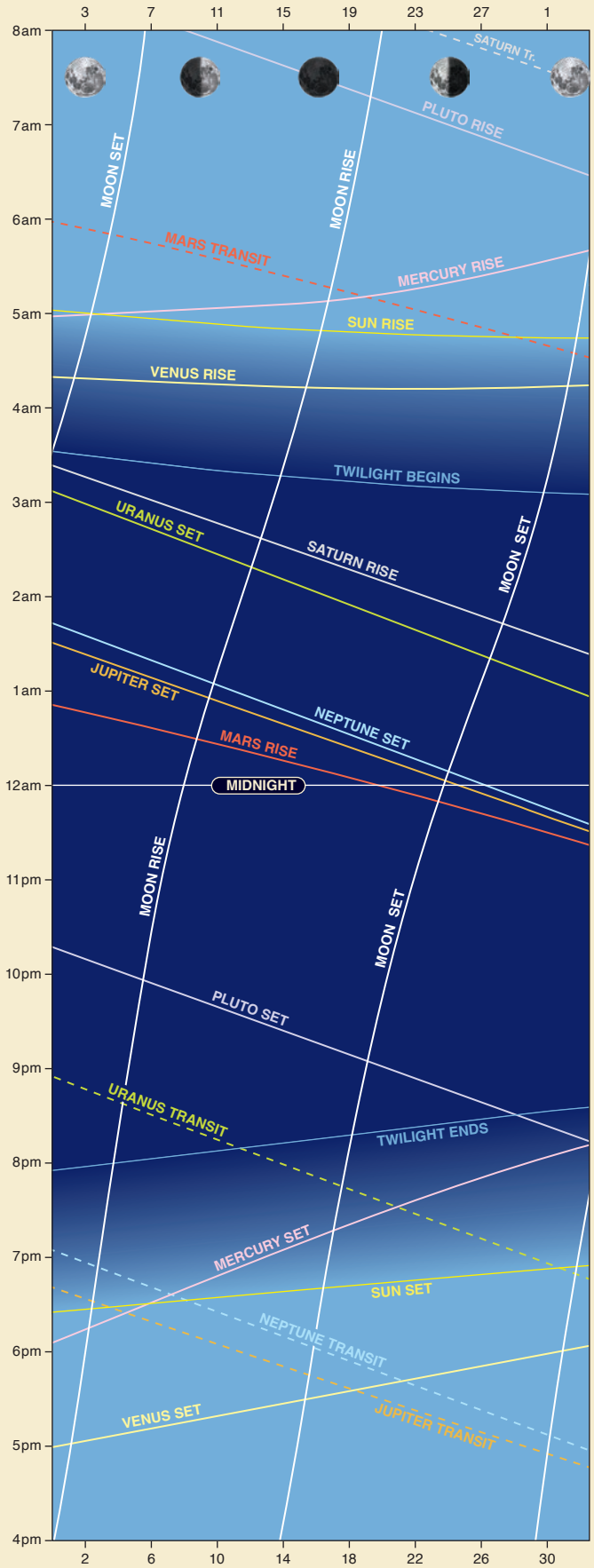
Approximate local standard time, for daylight saving add one hour.





NOVEMBER

RISE–SET CHART

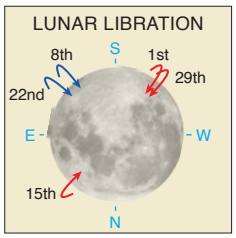


Approximate local standard time, for daylight saving add 1 hour.

HIGHLIGHTS

- Mars crosses the Beehive
- Jupiter and Neptune close
- The Taurids, Leonids and alpha-Monocerotids meteor showers

THE MOON



1st 4pm (2pm WST). Maximum Libration (8.3°), Full Moon, crater Hausen on SW limb.

3rd Full Moon.

7th 5pm (3pm WST). Moon at perigee (closest to Earth at 368,903km).

8th 7am (5am WST). Minimum Libration (0.3°), dark SE limb.

10th (9th WST) Last Quarter.

15th 7am (5am WST). Maximum Libration (8.3°), unobservable – too close to New Moon.

17th New Moon.

17th Occultation of Antares by the Moon. Too close to the Sun to be visible.

22nd 7am (5am WST). Minimum Libration (0.7°), bright SE limb.

23rd 6am (4am WST). Moon at apogee (furthest from Earth at 404,733km).

25th First Quarter.

29th 3am (1am WST). Maximum Libration (9.1°), dark SW limb.

APPEARANCE of the PLANETS

MERCURY Mercury is in superior conjunction on the 5th

15th Nov dia 4.7" mag –1.0

25th Nov dia 4.9" mag –1.8

VENUS 15th Nov dia 10.2" mag –3.8

MARS 15th Nov dia 8.7" mag 0.2

SATURN 15th Nov dia 16.5" mag 1.0

JUPITER 15th Nov dia 39.6" mag –2.4

URANUS 15th Nov dia 3.6" mag 5.8

NEPTUNE 15th Nov dia 2.3" mag 7.9

PLUTO 15th Nov dia 0.1" mag 14.1

THE PLANETS

Mercury is in superior conjunction on the 5th (Mercury and Earth on opposite sides of the Sun), the planet then moves east of the Sun and into the evening sky. Unobservable but of interest is the fact that Mercury is occulted by the Sun's disc at this conjunction, the first time since May 2007 with the next such occurrence in May 2013. Late in the month the planet will be seen moving through the Milky Way region of Ophiuchus.

Venus in the dawn sky becomes too close to the Sun for observation this month and will not be visible until late February when it reappears in the evening twilight.

Mars rises around midnight mid-month in Cancer, and spends all of November moving over the eastern half of the constellation. On the 1st and 2nd the planet can be seen crossing the large open star cluster M44, known commonly as the Beehive or Praesepe cluster (see Sky View). M44 is a cluster of about 200 stars, 80 or so of the brightest are visible in small telescopes. At 3rd magnitude the cluster is easily visible to the unaided eye from dark skies. In fact, it is collectively brighter than the stars that make up the entire constellation of Cancer!

Jupiter can be seen high in the north-western evening sky after the end of evening twilight. On the 1st, the planet will be 0.4° from the 4th magnitude star Iota (ι) Capricorni. Jupiter then moves toward Neptune for a second

Windows to the Heart

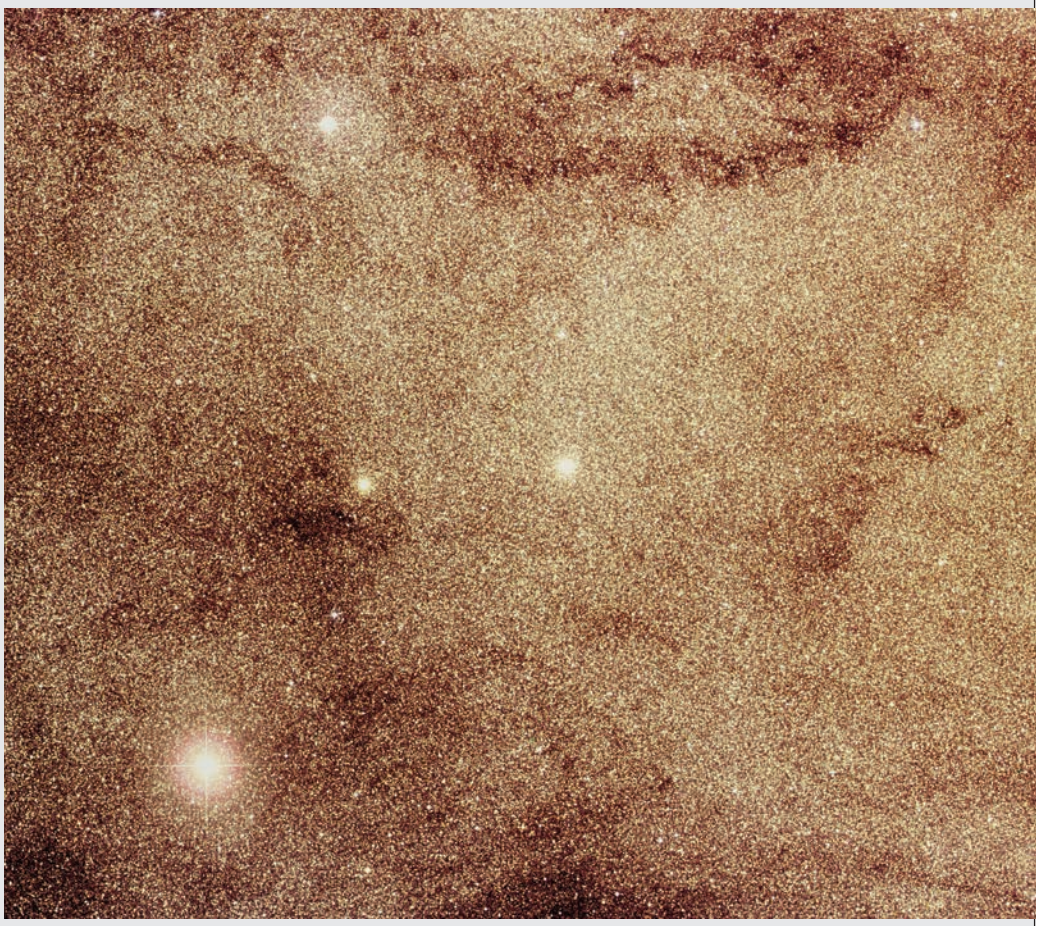
This is not a romance story. The heart refers to the centre of our galaxy. The word window implies you first need a wall and there is one, often called the interstellar medium. This consists of massive clouds of dust and unilluminated Hydrogen and Helium gas, which lie in the plane of the Milky Way. The closer to the centre the denser the wall becomes. This is how our Emu (p. 44) got his dark broad body, composed of a complex of intertwined dark lanes, which lie across Scorpius and Sagittarius.

If it wasn't for this interstellar extinction, Mankind would have long ago discovered that the Milky Way is in fact a barred-spiral galaxy, with two dominant arms extending from the ends of the central bar, which is pretty typical of barred-spirals we see elsewhere in the Universe. It has only been in recent years we have been able to penetrate this veil with imaging in the infrared region of the spectrum. Because atmospheric water moisture absorbs much of this radiation we have needed the Spitzer Telescope, which is in orbit, to give us a more complete view of the Milky Way's structure.

However, the Milky Way does give us some tantalising glimpses into the hub of our galaxy and here are two examples, both easily observable by the amateur.

The 24th object in the famous Messier catalogue of non-stellar objects (M24) is referred to as the Sagittarius Star Cloud. It is a naked-eye, 2° long, oval-shaped region 3° north of the 4th magnitude star Mu Sagittarii (just south of M17, the Omega Nebula). See All Sky Map No. 8. Messier described it as a "large nebulosity containing many stars". It is not a single enormous cluster of stars or star-forming region, like the Orion Nebula, it is really just a clear region in the interstellar medium, giving us a glimpse of the galaxy beyond. In fact M24 contains a number of deep sky objects including the open clusters of NGC 6603, Collinder 469 and Turner 2, 3 and 4. The inky black, dark nebulae of Barnard 92 and 93, side by side in the northern part of M24, are a stark contrast to the rest of the *cloud*. Even this impressive star region only takes us about 10,000 light years towards the hub, about a third of the distance and still 13° from the galactic centre. To get us much closer took the skills of one of the most accomplished astrophysicists of the Twentieth Century, Walter Baade.

While studying the Andromeda Galaxy, M31, Baade was the first to make a distinction between the hot luminous Population I stars, typical of spiral arms, and the redder, cooler Population II stars which prevail in the central cores of galaxies like our Milky Way. As part of this work, Baade discovered that the interstellar medium was not homogeneous and showed some surprising thinning in Sagittarius not far from the Galactic Centre. Hence, he discovered the region now known as Baade's Window. The area is easy to find, its edge is very close to the teapot's naked-eye (3rd magnitude) spout star of Gamma (γ_2) Sagittarii (Nash). Approximately 0.5° northwest lies the 10th magnitude globular cluster, NGC 6522. This cluster is considered to be in the centre of the window and lies at a distance of 25,400 light years. Although this *hole* is about 4° from the galactic centre, it appears to penetrate to a comparable distance, getting us to within 1,800 light years of the core. This is quite an achievement when you consider the Earth is a distant 30,000 light years from the centre. Most of what we know of the Milky Way's population II stars has been learned through Baade's Window.



Baade's Window. *The bright star (bottom left) is Gamma Sagittarii with the globular cluster NGC 6522 in the centre. To the east (left) 16 arcminutes away is the globular of NGC 6528. North is to the top with the height of the image approximately one degree. Photo taken by David Malin, AAO.*

encounter in December. On the 23rd, the 6-day old crescent Moon will be south of the planet and on the 24th, the First Quarter Moon will be just north (see Sky View).

Saturn, in Virgo, appears in the eastern pre-dawn sky. On the 13th, the 25-day old waning crescent Moon will be above and south of the planet (see Sky View). Saturn's rings are slowly opening up and will be at their widest for this year in December. Telescope users this month will look upon the north side of the planet's rings for the first time since February 1996. This northern aspect will continue until March 2025 when the Earth next passes through the ring plane.

Uranus is in the northern evening sky, transiting the meridian around 8pm mid-month, in Aquarius. It is moving slowly against the stellar background as it nears the end of its retrograde period.

Neptune, in Capricornus, is in the north-western evening sky at the end of astronomical twilight. For the second time this year the planet is visited by Jupiter. The pair is 3° apart at the end of the month and closer in December. Neptune has been in retrograde motion since late May and after the 5th it will return to a west to east motion against the heavens.

Pluto, moving into conjunction with the Sun in December is now setting around 9pm mid-month.

MINOR PLANETS. Four of the brighter minor planets reach opposition this month in Taurus. They are: 51 Nemausa on the 15th at magnitude 10.6, 17 Thetis on the 20th at magnitude 11.5, 423 Diotima on the 24th at magnitude 11.6 and 346 Hermentaria on the 29th at magnitude 10.5.

COMETS

Comet C/2007 Q3 (Siding Spring) moves northeast through Leo, Virgo, and Coma Berenices in November. The 10th magnitude comet is rising before dawn (3am mid-month). This month sees C/2007 Q3 tour the Virgo cluster of galaxies, including being 1° northwest of Markrian's chain of galaxies from the 18th to 20th. Unfortunately with the comet rising so close to dawn these conjunctions may be difficult to see against the brightening sky, so only a few of the brighter events have been listed in the diary.

Comet 81P/Wild 2 should brighten to 12th magnitude during November. Moving southeast through Leo, Wild 2 spends the first half of the month within 5° of Regulus, rising around 1am.

Comet 88P/Howell moves eastward through Sagittarius in November. Its path sees the comets pass through the Teapot asterism during the first two weeks. On the evening of the 11th, it has a close conjunction with Sigma Sagittarii. Howell is slowly fading but it should remain around 11th magnitude during November. It sets late in the evening.

Comet 118P/Shoemaker-Levy 4 resides in Orion throughout November. Rising mid-evening, Shoemaker-Levy 4 should brighten from 13th to 12th magnitude. It ends November just over 3° from Betelgeuse.

Comet 169P/NEAT moves from Ophiuchus into Sagittarius early in November, touring a number of deep sky objects along the way (see diary). While NEAT may brighten from 14th to 11th magnitude it is setting around 10pm, so observations should be attempted as soon as possible. During November 17-22, NEAT will be within 2° of the globular cluster M22. November 30 sees NEAT at perihelion (0.6 AU from the Sun). At the end of November the comet enters the Teapot asterism, like Comet 88P/Howell did earlier in the month.

METEOR SHOWERS

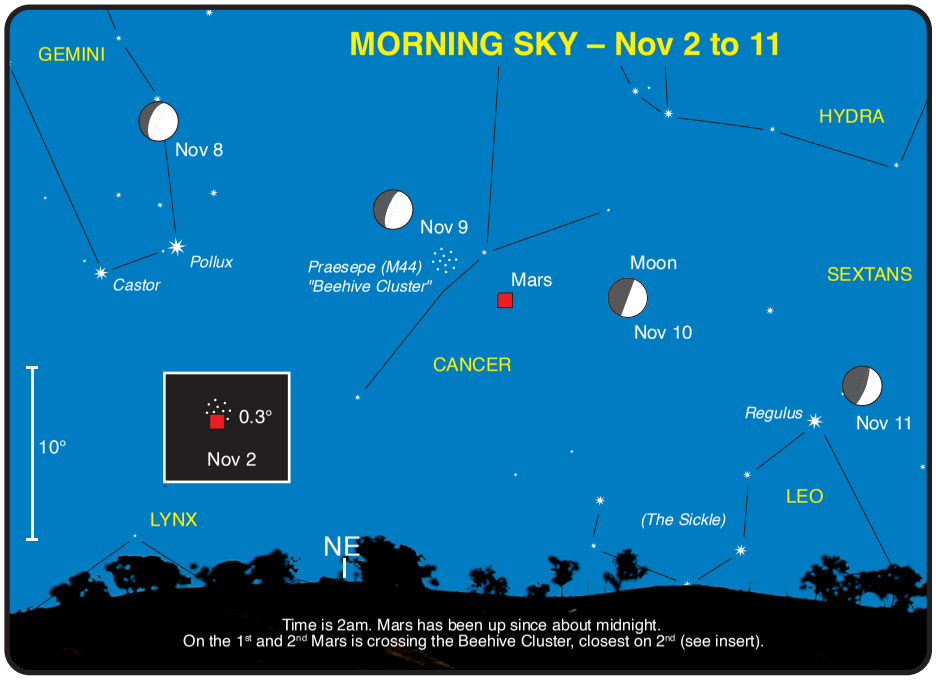
The **Taurids (North and South)** are associated with Comet 2P/Encke, and can be seen from late evening to early morning. The shower is composed of a main double radiant which is visible from 25th September through to 25th November. The Taurids do not have a well-defined sharp peak in activity, but rather plateau for about ten days in early November. Maxima occur on the 5th for the Taurids South (ZHR of 5) and on the 12th for the Taurids North (ZHR of 5). Both maxima last for about a week and provide nearly constant rates. The Taurids are frequently bright, slow moving, and noted for producing colourful fireballs (although not in every year). Their relative slowness and brightness makes them an ideal target for astrophotography.

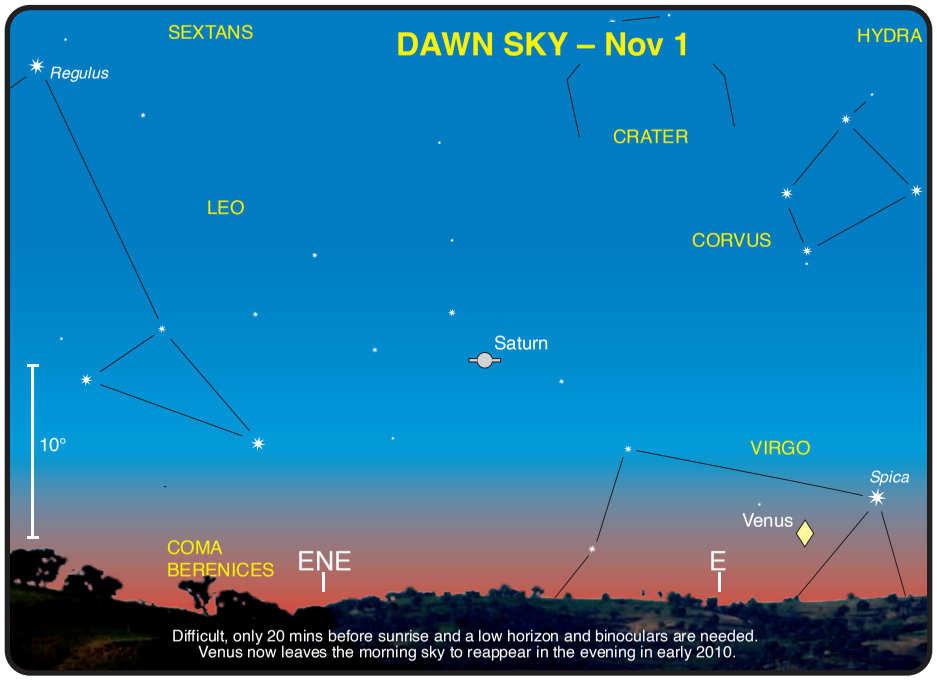
The **Leonids**, after a storm of unbelievable intensity in 1833, were responsible for the change in scientists' attitudes that meteors were not purely an atmospheric event. The shower is associated with the periodic comet 55P/Tempel-Tuttle and is best about every 33 years when the comet returns to perihelion. The Leonids are active from 10th to 21st, with maximum on the 18th. Between 1998 and 2002, the Leonids put on spectacular displays, and since then activity has been variable from year to year. Early predictions for 2009 seem encouraging with some models predicting ZHRs over 100 to storm proportions! We would encourage observers to be on the lookout for updates (www.imo.net is a good place to start) nearer the time of the shower, as this is not one to be missed if active. The sight of those amazing fireballs coming from near the horizon and passing overhead is something else!

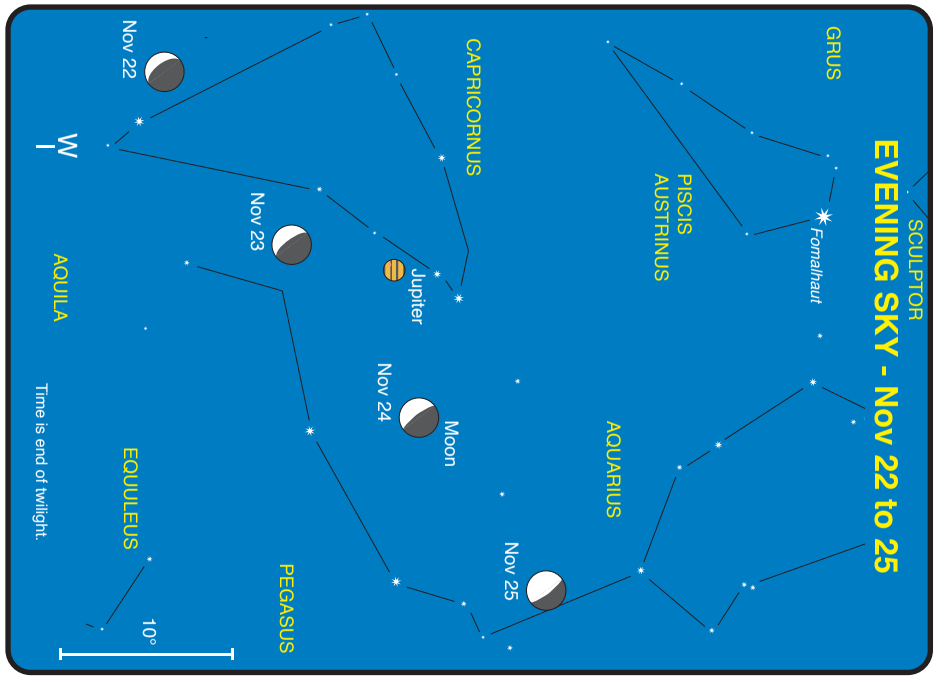
The **alpha-Monocerotids** is a minor shower, with unusual short-lived outbursts. Active from 15th to 25th, they peak on the 21st and are best seen after midnight. While the zenith hourly rate is normally around 5, high rates were seen in the years 1925, 1935, 1985 and 1995. The 1995 rate reached an estimated 420, and lasted just 5 minutes, the entire shower was over in 30 minutes. There is some speculation of a 10-year cycle (although nothing unusual took place during the moonlit shower of 2005). The unpredictability of the alpha-Monocerotids could produce a surprise at any return and reward the patient observer. Australia is favoured for this shower and since the 21st is a Saturday evening, it is an ideal time to head for your favourite deep sky-observing site (you could take a couple of days off work to include the Leonids). Predictions for maximum are for November 21st 15h 25m UT, but a watch should be kept an hour or two on either side.

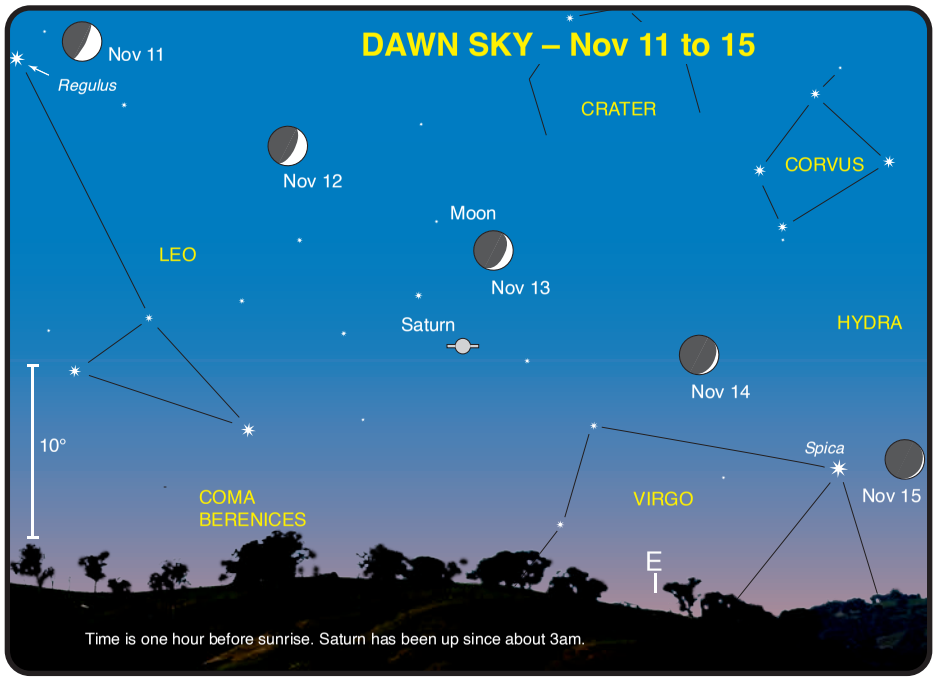
DIARY

1st		Mars 0.4°NW of Beehive Cluster (M44) in Cancer
1st		Comet 88P/Howell 1.0°SE of NGC 6553 (GC) in Sagittarius
1st	1am	(11pm WST, prev day) Ceres in conjunction with Sun
2nd	Noon	(10am WST) Venus 4°N of Spica
3rd		Saturn 0.1°S of NGC 4073 (G) in Virgo
3rd		Comet 169P/NEAT 0.5°N of NGC 6440 (GC) in Sagittarius
3rd	5:14am	(3:14am WST) Full Moon
4th		Neptune 0.6°E of star BY Capricorni
5th		Comet 88P/Howell 1.2°S of star Lambda Sagittarii
5th	5am	(3am WST) Neptune stationary
5th	6pm	(4pm WST) Mercury in superior conjunction with Sun
7th		Mars 0.4°N of NGC 2672 (G) in Cancer
7th		Mercury at descending node
7th	5pm	(3pm WST) Moon at perigee
9th	4pm	(2pm WST) Mars 3°N of Moon
10th		Comet 169P/NEAT 1.0°NE of M21 (OC) in Sagittarius
10th		Comet 88P/Howell 0.6°N of star Phi Sagittarii
10th	1:56am	(11:56pm WST, prev day) Last Quarter Moon
12th		Comet 169P/NEAT 0.7°S of NGC 6568 (OC) in Sagittarius
12th	10pm	(8pm WST) Comet 88P/Howell 0.1°W of star Sigma Sagittarii
13th		Comet 169P/NEAT 0.5°S of NGC 6583 (OC) in Sagittarius
13th	11am	(9am WST) Saturn 8°N of Moon
15th	3am	(1am WST) Comet C/2007 Q3 (Siding Spring) 0.05°W of NGC 4216 (G) in Virgo
17th		Mars 0.5°N of NGC 2749 (G) in Cancer
17th		Comet 169P/NEAT 1.2°NE of M28 (GC) in Sagittarius
17th		Mercury at aphelion
17th	5:14am	(3:14am WST) New Moon
18th		Comet 169P/NEAT 0.8°S of NGC 6642 (GC) in Sagittarius
18th		Comet C/2007 Q3 (Siding Spring) 1.0°SE of M99 (G) in Virgo
19th		Comet 169P/NEAT 1°SW of M22 (GC) in Sagittarius
23rd		Comet C/2007 Q3 (Siding Spring) 0.3°NW of M88 (G) in Virgo
23rd	6am	(4am WST) Moon at apogee
24th		Saturn 0.4°SW of NGC 4179 (G) in Virgo
24th		Comet 169P/NEAT 0.3°NE of star Phi Sagittarii
24th		Comet C/2007 Q3 (Siding Spring) 0.7°NW of M91 (G) in Virgo
24th	8am	(6am WST) Jupiter 4°S of Moon
24th	4pm	(2pm WST) Neptune 3°S of Moon
25th	7:39am	(5:39am WST) First Quarter Moon
27th	4am	(2am WST) Uranus 6°S of Moon
30th		Comet 169P/NEAT 0.6°W of star Zeta Sagittarii





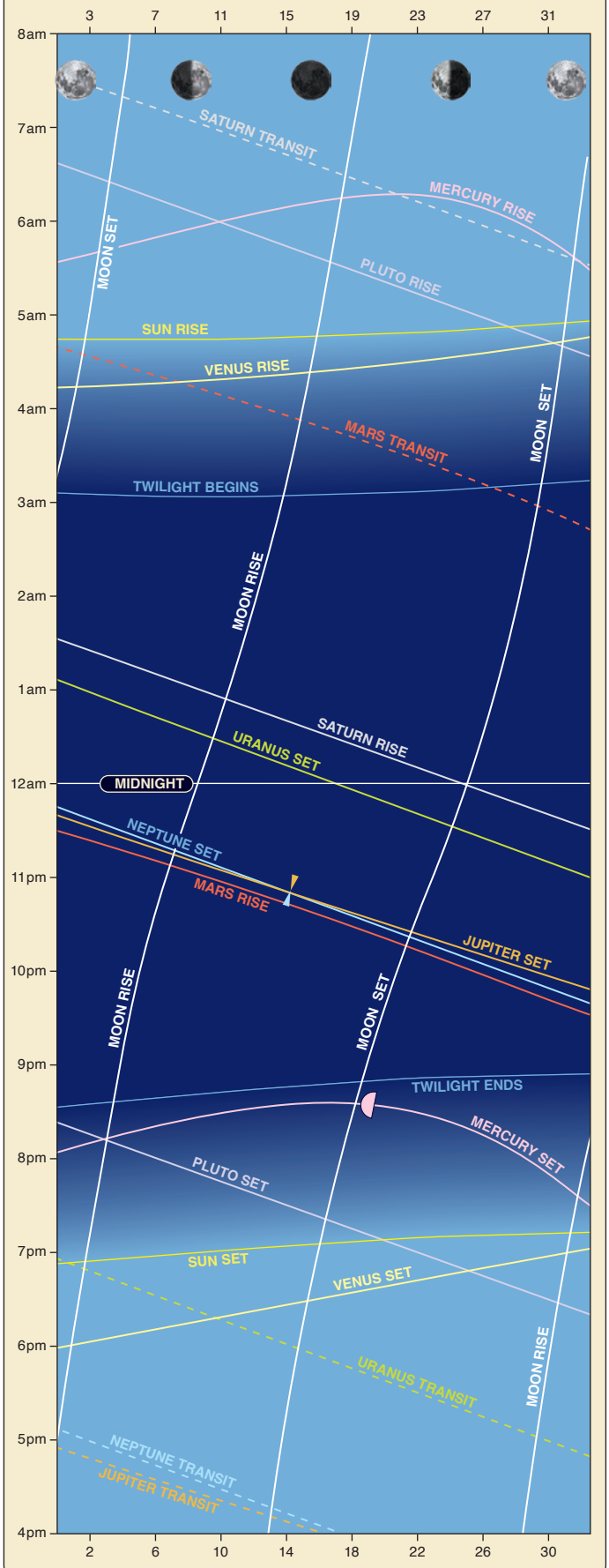




Approximate local standard time, for daylight saving add one hour.

DECEMBER

RISE–SET CHART



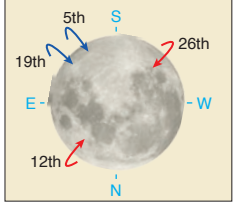
Approximate local standard time, for daylight saving add 1 hour.

HIGHLIGHTS

- Jupiter and Neptune close
- Saturn's rings at their widest for 2009
- The Geminids meteor shower

THE MOON

LUNAR LIBRATION



2nd Full Moon.

5th 12am (4th, 10pm WST). Moon at perigee (closest to Earth at 363,479km).

5th 9am (7am WST). Minimum Libration (0.4°), dark SE limb.

9th Last Quarter.

12th 4am (2am WST). Maximum Libration (9.0°), dark NE limb.

15th Occultation of Antares by the Moon. Too close to the Sun to be visible.

16th New Moon.

19th 2pm (12pm WST). Minimum Libration (0.9°), bright SE limb.

21st 1am (20th, 11pm WST). Moon at apogee (furthest from Earth at 405,731km).

25th First Quarter.

26th 10pm (8pm WST). Maximum Libration (9.9°), dark SW limb.

APPEARANCE of the PLANETS

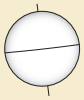
MERCURY

10th Dec
dia 5.7"
mag –0.7

19th Dec
dia 6.8"
mag –0.5
Greatest elongation east

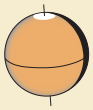
30th Dec
dia 9.2"
mag 1.8

VENUS



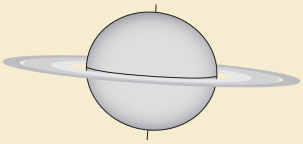
15th Dec
dia 9.9"
mag –3.8

MARS



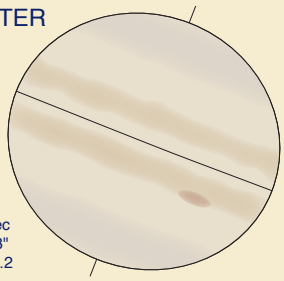
15th Dec
dia 11.1"
mag –0.4

SATURN



15th Dec
dia 17.3"
mag 1.0

JUPITER



15th Dec
dia 36.3"
mag –2.2

URANUS
15th Dec
dia 3.5"
mag 5.8

NEPTUNE
15th Dec
dia 2.2"
mag 7.9

PLUTO
15th Dec
dia 0.1"
mag 14.1
Conjunction on the 25th

THE PLANETS

Mercury begins December in the western twilight sky in Ophiuchus before crossing over into Sagittarius. The planet is at its greatest elongation east of the Sun (20°) on the 19th, and will be observable for most of the month. On the 10th, Mercury will be situated just 0.4° from 3rd magnitude Lambda (λ) Sagittarii, the star marking the lid of the Teapot asterism. On the 18th, the 2-day old slender crescent Moon appears just 2° from the slightly gibbous planet (see Sky View). Mercury passes some well-known objects as it traverses the Sagittarius Star Cloud near the galactic centre, but the low altitude and twilight will render these gems virtually unobservable.

Venus is too close to the Sun for observation this month. The planet will be in superior conjunction (Venus and Earth on opposite sides of the Sun) on 11th January, and thereafter Venus will grace our skies as the Evening Star.

The **Earth** is at Solstice on the 22nd when the days are longest. On this day the Sun is at its most southerly position with a declination of –23.5°.

Mars moves from Cancer into Leo this month; the planet traces a small arc and heads back into Cancer in early January. This arc marks the end of Mars' west to east motion against the star field and from the 22nd the planet will be in retrograde motion until mid-March 2010. This orbital loop occurs when an outer planet is nearest the Earth, and Mars will be at opposition late in January. The coming approach of Mars and Earth is

More Beginner 101 – Coping with Northern Bias

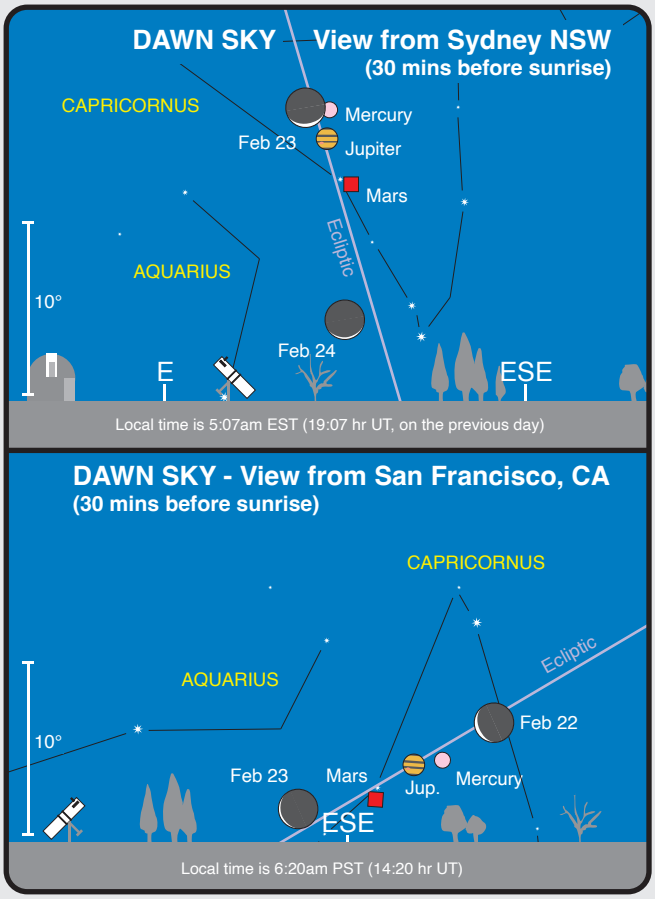
There is no doubt magazines and the Internet are invaluable sources of the latest astronomy news and discoveries, however when it comes to observational articles they can be confusing for the beginner. Take a northern hemisphere based magazine. Even if it has a section for southern hemisphere observers the bulk of the publication is designed to meet the needs of the majority of its readers, who are in the north. Even the treatment of the sky common to both hemispheres, such as around the ecliptic, can be challenging. South of the Tropic of Capricorn, around the latitude of Rockhampton, the ecliptic (the region where the Sun, Moon and planets roam) is mostly in the northern half of the sky. North of the Tropic of Cancer (latitude 23° 26' N), where the majority of the northern hemisphere observers reside, the ecliptic favours their southern sky. That's why recognizing the constellations on or near the ecliptic (such as the signs of the Zodiac) is an even greater challenge for us – we see them upside down. What looks like a crouching Lion, or Leo, to the north is a sickle shaped asterism followed by a handful of 2nd/3rd magnitude stars to us. We see the sword of Orion hanging from his belt pointing up. But, here's an interesting anomaly, we see the flying horse of Pegasus and the maiden Andromeda, the right way up? How about that!

In the past there has been an understandable reluctance by the magazines to admit how brilliant our southern skies are. There was a time when you heard little about Carina, Centaurus or the Magellanic Clouds, but fortunately this situation has changed with more northern amateurs going into print praising the *south*, or expressing an interest in heading down under.

Just because the ecliptic is common to both hemispheres, doesn't mean understanding diagrams of western evening (or eastern morning) views of planetary configurations, drawn for the north, doesn't present its challenges. These diagrams are typically designed for latitudes of around 40° north. The Sky Views presented in this publication are drawn for mid-latitude Australia, or about 32° south. Our view, from say 32° south, will be tilted by the difference in latitude – in this case 72°. This shift can mean the difference between a good return (elongation) of Mercury verses a poor (see diagram this page). The extreme case would be a North Pole vs. a South Pole view – a rotation of 180 degrees!

The Internet can also be a trap for newbies. There are observing podcasts (see page 47) where it is often not stated which hemisphere they have been designed for and even looking at the source may not make it any clearer.

Whether or not a comet or a meteor shower is visible is latitude dependent. Knowing the constellation can help. For example the north has had some spectacular Perseids meteor displays over the years. In this case the name tells us the constellation in which the radiant occurs – Perseus. The radiant is the point in the sky where they appear to originate. Page 134 tells you the Perseids' radiant has a declination of +58° degrees, which from Brisbane (27° south) gets to a maximum altitude of 5° – and that's only if it is due north at the time you are observing. The Zenith Hourly Rate (ZHR) gives the theoretical maximum number of meteors possible if the radiant was overhead, under perfect dark skies. As you move away from the zenith the number drops off by the *sine* of the altitude. That means at an altitude of 30° the Perseids maximum of 100 is reduced to half or 50 observable. Brisbane drops to less than 10% — further south even fewer. That's why we highlight southern showers in this book, even if little is known of them.



This February morning diagram illustrates how dramatically the appearance of the planets can vary between the hemispheres. Notice how steep the ecliptic is to the horizon in the south, compared to the north, making it easier to observe planets close to the Sun or looking for young (near new) Moons. This situation is seasonal; the roles are reversed six months later, with the north favouring the mornings in September. The same situation exists when comparing the morning and evening views – in this case they are opposite. For example, February/March returns of Mercury to the southern hemisphere are poor in the evenings but good in the mornings, as shown here. Also conjunctions involving the Moon can vary greatly with longitude. In this example, America doesn't see the nice Moon/Mercury/Jupiter triangle we do in Australia. Between the two diagrams, the San Francisco view occurred 5 hours before Sydney, during this time the Moon has moved some 3° closer to Mercury.

a poor aphelic opposition, with the planet only reaching 14 arcseconds in diameter. The Martian oppositions over the coming years will also be disappointing, with the next good perihelic opposition not due until July 2018.

Jupiter is visible in the early western evening sky, setting mid-month around 11pm. On the 16th, Jupiter will be 0.1° from the 6th magnitude star 45 Capricorni; this event will not be as spectacular as the August approach to this star as it will be away from the satellite plane. From the 20th to 22nd, the giant planet will be 0.5° from Neptune, not quite as close as their meeting last May. On the 21st, the 4-day old crescent Moon will be close to Jupiter (see Sky View). The planet will remain observable low in the western evening sky throughout January, before coming too close to the Sun in February.

Saturn, in Virgo, rises a little after midnight above and north of Alpha (α) Virginis (Spica), both objects are 1st magnitude. At the end of the month Saturn will be situated 1° from the 4th magnitude star Eta (η) Virginis. The fact that Saturn is near this star is not of any great significance; however as a matter of interest Eta and the 3rd magnitude star Zeta (ζ) Virginis very closely marks the line of the celestial equator (the projection of Earth's equator onto the celestial sphere). This month Saturn's rings are widest for the year, and they will continue to open up until their next maximum in 2016.

Uranus appears stationary on the 2nd, and thereafter returns to a west to east direction across the sky, having being in retrograde motion for the past five months. The planet is very close to the Aquarius/Pisces border, and early next year it leaves Aquarius for the last time (well, until 2086) and moves into Pisces.

Neptune in the western evening sky sets around 10:30pm mid-month. Jupiter again closes in on the planet and from the 20th to the 22nd the pair will be half a degree apart and visible in a low power field.

Pluto is in conjunction with the Sun on Christmas Day and will effectively be lost from view until its return to the morning skies in February.

MINOR PLANETS. Five of the brighter minor planets reach opposition this month in Taurus. They are: 67 Asia on the 1st at magnitude 11.7, 121 Hermione on the 8th at magnitude 11.6, 19 Fortuna on the 9th at magnitude 9.3, 52 Europa on the 18th at magnitude 10.1 and 128 Nemesis on the 18th at magnitude 10.7. There are two reaching opposition in Orion and two in Auriga. The Orion minor planets are 287 Nephthys on the 22nd at magnitude 11.4 and 11 Parthenope on the 26th at magnitude 9.9. The Auriga ones are 324 Bamberga on the 27th at magnitude 9.8 and 71 Niobe on the 30th at magnitude 11.6.

COMETS

Comet C/2007 Q3 (Siding Spring) moves northeast through Coma Berenices before ending the year in Bootes. The comet should remain at 10th magnitude and is rising in the early hours of the morning.

Comet 81P/Wild 2 opens December at 12th magnitude in Leo and is rising around midnight. The middle of December sees Wild 2 cross into Virgo, by which time it should be 11th magnitude. On December 23, Wild 2 will be quite close to 4th magnitude Beta Virginis.

Comet 88P/Howell moves northeast from Sagittarius into Capricornus. Fading to 12th magnitude, Howell is setting mid-evening and ends the year near Delta Capricorni.

Comet 118P/Shoemaker-Levy 4 moves westward through Orion during December and is visible throughout the night. Remaining at 12th magnitude (it reaches perihelion in early January), Shoemaker-Levy 4 will be within 1.5° of Betelgeuse around mid-December.

Comet 169P/NEAT begins December within 1° of 3rd magnitude Zeta Sagittarii, setting around 10pm. As the comet nears Earth (0.23 AU by the end of the month) and at 11th magnitude, NEAT plunges south through the sky, passing through Sagittarius, Corona Australis, Telescopium, and Pavo, before ending December in Ara – where it will be circumpolar, low in the south, and best placed in the southeast pre-dawn sky.

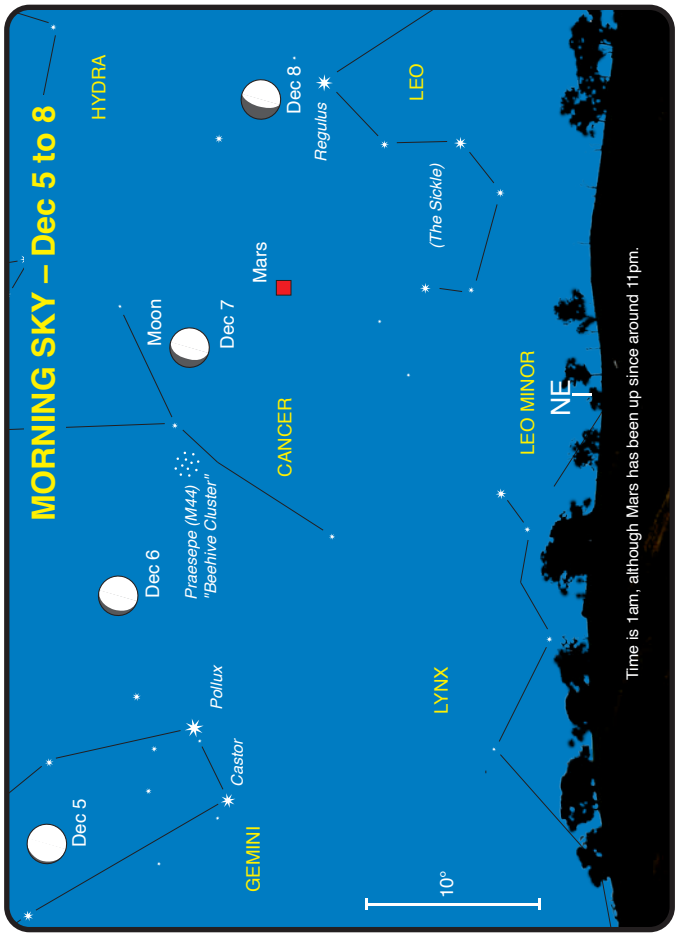
METEOR SHOWERS

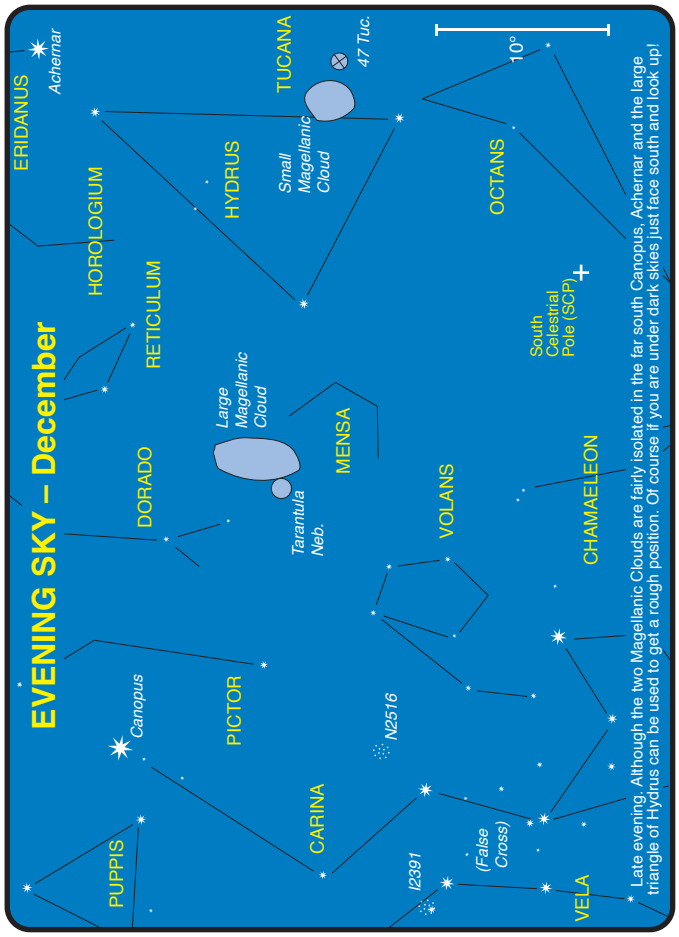
The **Phoenicids** are a southern shower that was first seen in 1956, when a zenith hourly rate of around 100 plus was observed. There have been three minor bursts in activity since then, but in recent years the shower seems nonexistent. There is a possibility that this may be a periodic shower, so observations should still be carried out in case of a return. The period of activity appears to be 28th November through 9th December, with the 6th of this month being the maximum. The Phoenicids' radiant culminates at dusk and a watch for any activity should be keep until around 23 hours local time when the waning gibbous Moon begins to interfere. The very low velocity of the Phoenicids will help in identifying them from the sporadics.

The **Geminids** are one of the finest and most reliable of the major annual showers observable, but for some southern observers the radiant is below or low to the horizon until late evening. Visible from the 7th to 17th, with maximum on the 14th, the Geminids often produce bright, medium-speed meteors. The zenith hourly rate is variable but around 120 is possible. Even though our northern counterparts will see the best of the Geminids, they can still provide a spectacular display for us 'down under'.

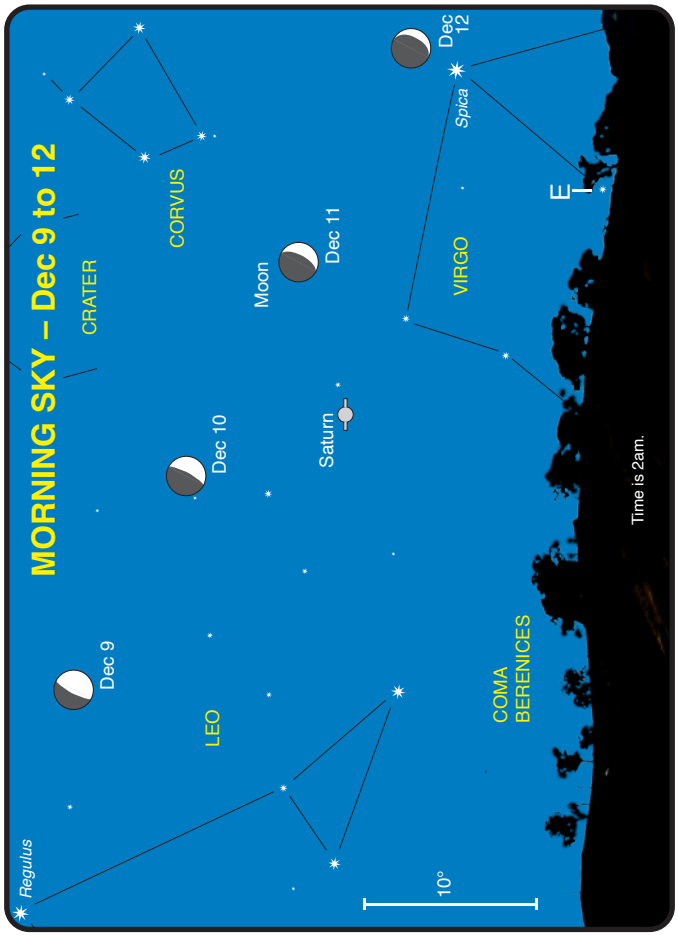
DIARY

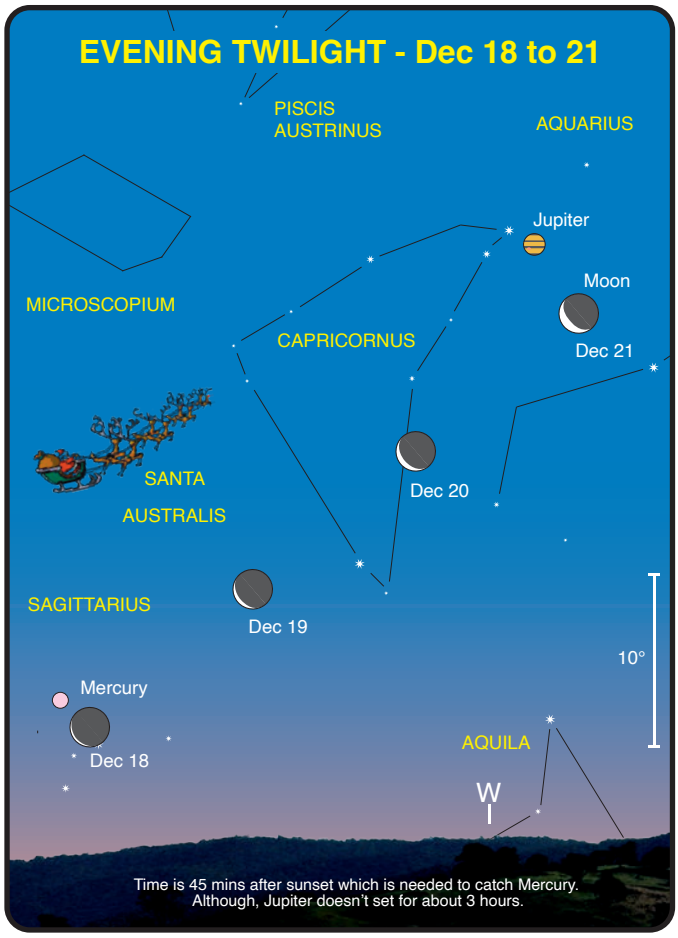
1st	3am	(1am WST) m.p. 4 Vesta 0.1°NW of PGC 30378 (G) in Leo
1st	9pm	(7pm WST) m.p. 42 Isis 0.025°SE of NGC 7723 (G) in Aquarius
2nd	3pm	(1pm WST) Uranus stationary
2nd	5:30pm	(3:30pm WST) Full Moon
3rd		Jupiter 0.4°S of m.p. 16 Psyche
3rd	pm	m.p. 42 Isis 0.4°SE of NGC 7727 (G) in Aquarius
4th	Midnight	(10pm WST) Moon at perigee
7th		Mercury 0.4°NE of NGC 6553 (GC) in Sagittarius
7th		Mercury at greatest latitude south
7th	1pm	(11am WST) Mars 6°N of Moon
8th		m.p. 7 Iris 0.6°S of star Beta Capricorni
9th		Mercury 0.8°S of M28 (GC) in Sagittarius
9th	10:13am	(8:13am WST) Last Quarter Moon
10th		Mercury 0.4°SE of star Lambda Sagittarii
10th		Mercury 0.3°W of NGC NGC 6638 (GC) in Sagittarius
10th	5am	(3am WST) m.p. 1 Ceres 0.1°E of star Gamma Librae
10th	9pm	(7pm WST) Saturn 8°N of Moon
11th		Neptune 0.3°NW of m.p. 16 Psyche
11th	pm	m.p. 18 Melpomene 0.4°NW of star Theta Ceti
14th		Mercury 1.4°N of star Sigma Sagittarii
16th		Jupiter 0.3°SE of star 44 Capricorni
16th		Jupiter 0.1°NW of star 45 Capricorni
16th	10:02pm	(8:02pm WST) New Moon
18th	6pm	(4pm WST) Mercury 1.4°S of Moon
19th	3am	(1am WST) Mercury greatest elongation east (20°)
19th	pm	m.p. 18 Melpomene 0.6°NW of NGC 584 (G) in Cetus
20th		Venus at descending node
20th	3pm	(1pm WST) Jupiter 0.6°S of Neptune
21st		Comet 118P/Shoemaker-Levy 4 1.2°N of star Betelgeuse
21st	1am	(11pm WST, prev day) Moon at apogee
22nd	1am	(11pm WST, prev day) Jupiter 4°S of Moon
22nd	1am	(11pm WST, prev day) Neptune 4°S of Moon
22nd	2am	(Midnight WST, prev day) Mars stationary
22nd	4am	(2am WST) Solstice
23rd		m.p. 3 Juno 0.4°N of star Iota Ceti
23rd	3am	(1am WST) Comet 81P/Wild 2 0.2°SW of star Beta Virginis
24th		m.p. 7 Iris 1.0°S of M72 (GC) in Aquarius
24th	Noon	(10am WST) Uranus 6°S of Moon
25th	3:36am	(1:36am WST) First Quarter Moon
25th	4am	(2am WST) Pluto in conjunction with Sun
26th		Comet 118P/Shoemaker-Levy 4 2.8°NE of Comet P/2001 MD_7 (LINEAR)
26th		Mercury at ascending node
26th	7pm	(5pm WST) Mercury stationary
27th		m.p. 7 Iris 0.6°S of M73 (OC) in Aquarius
30th		Jupiter 0.3°SE of star Mu Capricorni
31st		Saturn 1.0°N of star Eta Virginis
31st		m.p. 7 Iris 0.4°SE of NGC 7010 (G) in Aquarius
31st		m.p. 15 Eunomia 1.0°S of star Tau Scorpii
31st		Comet 88P/Howell 0.6°SW of star Delta Capricorni
31st		Mercury at perihelion
31st	am	m.p. 4 Vesta 0.4°NW of NGC 3338 (G) in Leo
1st	5:13am	(3:13am WST) Full Moon; Eclipse





Approximate local standard time, for daylight saving add one hour.





ALL SKY MAPS

Introduction

These maps have been created to show you the entire night sky at any time of the year from anywhere in Australia. It is probably more accurate to say they are useful for anywhere in the southern hemisphere with latitudes similar to Australia. This includes most of New Zealand, South Africa and parts of South America.

Who can use them?

Anyone, and you don't even need binoculars or a telescope to become completely at ease finding your way around the sky and recognising all of the constellations.

The limiting magnitude of the stars is 5.5. If you live in a suburban area, you will not see the fainter stars marked on the maps. Some of the obscure constellations may not be visible at all; a pair of binoculars will help. Under dark, country skies, where you can see the Milky Way, you will be able to see numerous fainter stars that are not included on the maps.

How Do I Use Them?

There are nine maps. Map 1 *Looking South* covers the far southern sky. Then there are four pairs of maps, one pair for each season i.e., a Centre and a North map.

To use the Looking South map, face south and rotate the chart to get the correct orientation. Use a distinctive star pattern like the Pointers and Southern Cross to help. From mid-Australian latitudes, and further south, Crux is circumpolar and never sets.

The rest of the maps are used as follows. Turn to the relevant season and rotate the book onto its side so the right hand North page is on the bottom and look towards the north. The northern sky, directly above the horizon, is represented on the North map and as you progress up the sky towards the overhead point (or zenith) you will cross over onto the Centre map.

The seasonal views are a little arbitrary. As you will see in the Notes section on the maps, an evening view around the relevant time of the year was chosen. However, if you are willing to stay up all night there is only a small part of the entire sky not available to you. For example, suppose it is around mid to late June. At 9pm the sky will look like the Winter pair. By 3am the sky will be showing the Spring view. Around dawn, the Earth will have rotated further, where the sky is now half Spring (to the left or towards the west) and half Summer (towards the right or east). A planisphere illustrates this quite well.

What does the fine black grid represent?

These are the right ascension (RA) and declination (Dec.) lines. The RA line, which starts on the due north point (N on the North charts) and runs vertically up the page, crossing through the point directly overhead and heading down to the southern horizon, is called the local central meridian. When objects cross this meridian they are said to be culminating and they have reached their highest point in the sky. Looking at the Spring (North) chart, the RA of the central meridian at 11pm on August 20 is approximately 21 hours (as an aside this is also the definition of the local sidereal time, see page 135). The constellation of Cygnus is transiting the meridian. In a couple of hours (around 1am) the star Alpha (α) Pegasi (Markab), with an RA close to 23 hours, will culminate.

The declination indicates which areas of the charts will pass directly overhead. This is when an object has the same declination as your latitude. For example, the latitude of Hobart is nearly 43° S. Looking at the Autumn (Centre) map on March 20 at 9pm the star Suhail, with a declination close to –43°, will be very close to the overhead point (or zenith) as seen from Hobart.

What do the dashed lines, labelled with city names, on the 'North' maps mean?

Australia is a large country and your latitude dictates how far north in the sky you can see. These lines represent the declination furthest north you can see from each of the cities. If a star is very close, but still above your dashed line, it may only be above the northern horizon briefly. To see all the sky, as depicted in the North maps, you would need to be at a latitude similar to Darwin.

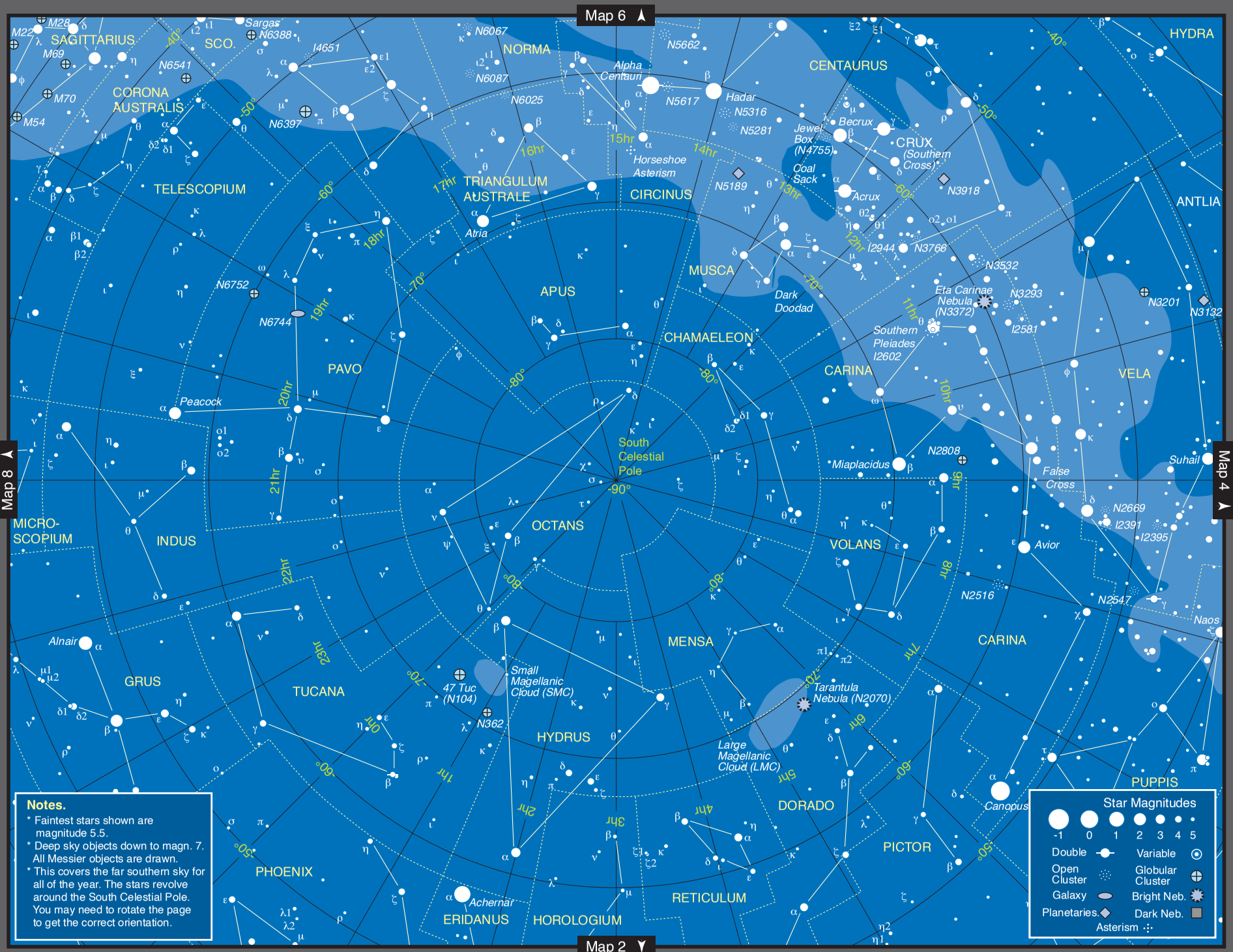
What are the planet lines?

Lines are shown to indicate the approximate path in the sky for **Mars**, **Jupiter, Saturn, Uranus, Neptune and Pluto** for the year. With the exception of Mars, once you have found the general area you can go to the relevant finder chart. The path for **Mars** has the position marked for each month and thus replaces a separate finder chart. The Moon, Mercury and Venus are not shown. The Sky View diagrams (see Part I) show the location and optimum time to observe these objects.

What else is shown on the maps?

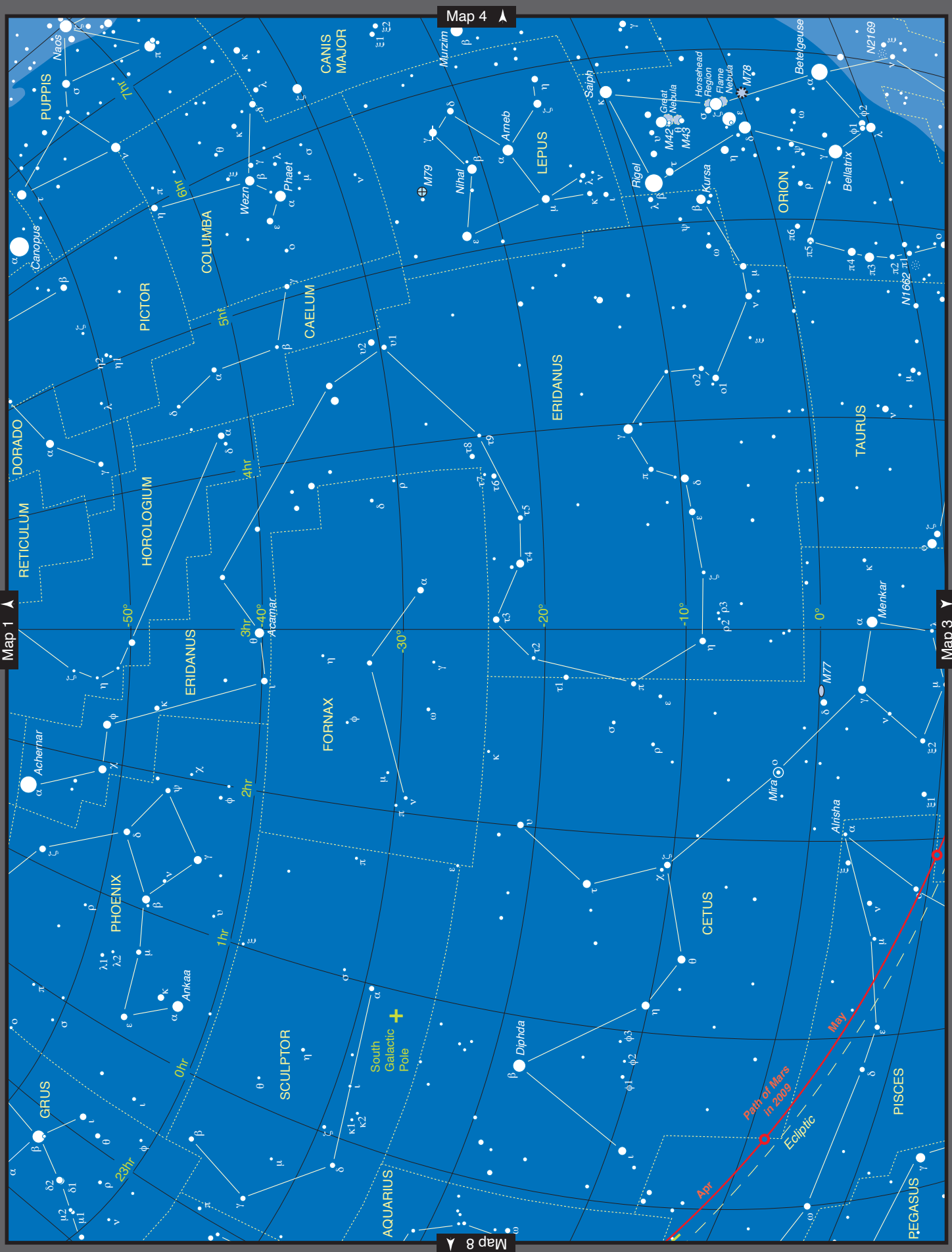
- **Deep sky objects** down to magnitude 7 and all of the Messier objects (see the legend). Most of these objects are identified by their common names (such as asterisms), Messier number (M), NGC (N) or IC (I) catalogue numbers. Most of the star clusters should be visible through a pair of binoculars. The galaxies, planetary and diffuse nebulae may need a small telescope. There are occasionally fainter objects included when referred to elsewhere in the book.
- **Constellation lines**. The yellow dotted lines are the boundaries and the solid lines join some of the brighter stars to help in recognising the constellation's pattern. This pattern has been kept the same as that used in the Sky Views.
- A few of the brighter **Double Stars and Variables**.
- A light blue shading shows the **Milky Way and Magellanic Clouds**.

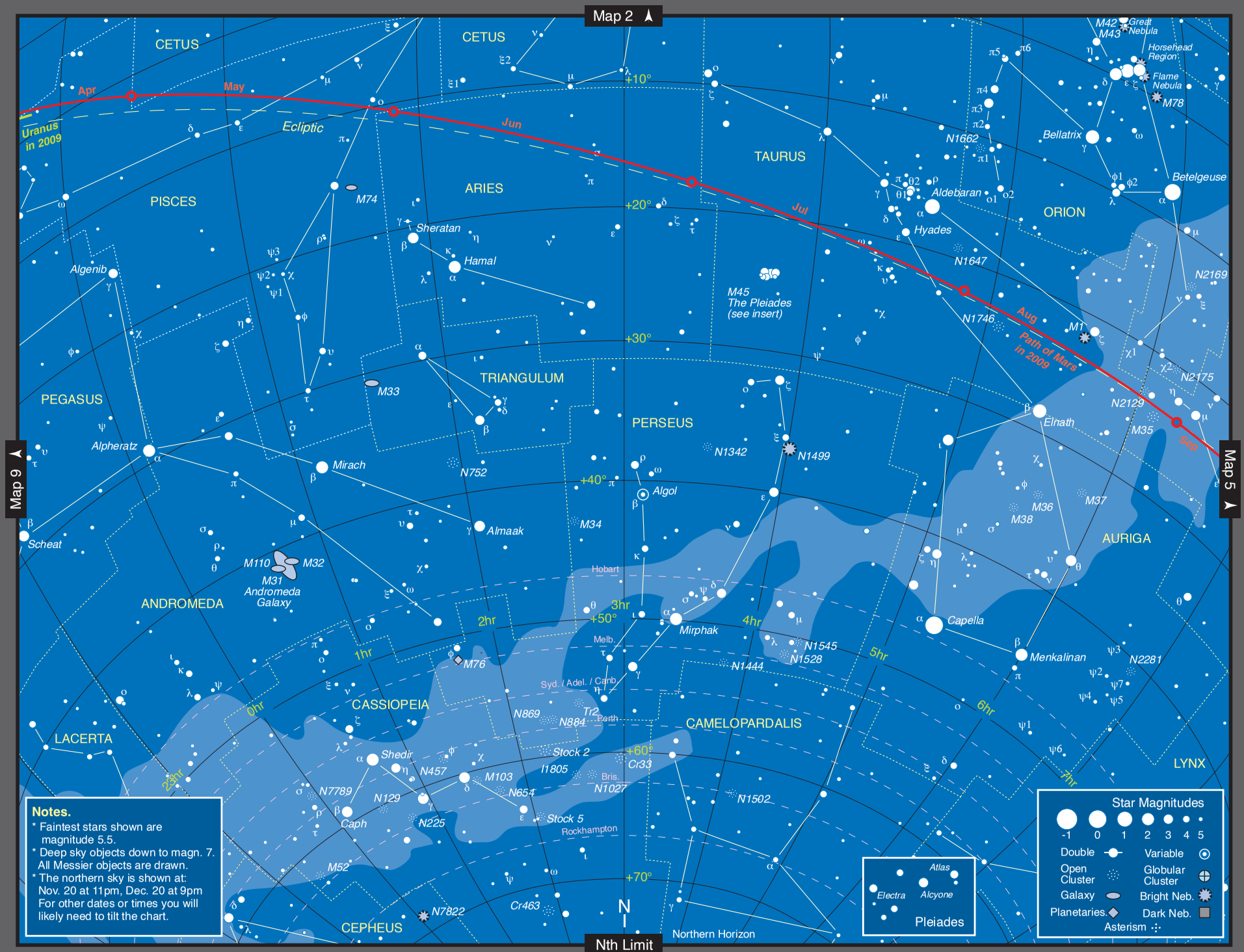
Southern Milky Way showing clearly the 'emu' with the two Magellanic Clouds low on the horizon. Image by Shevill Mathers



Map 1 - Looking South

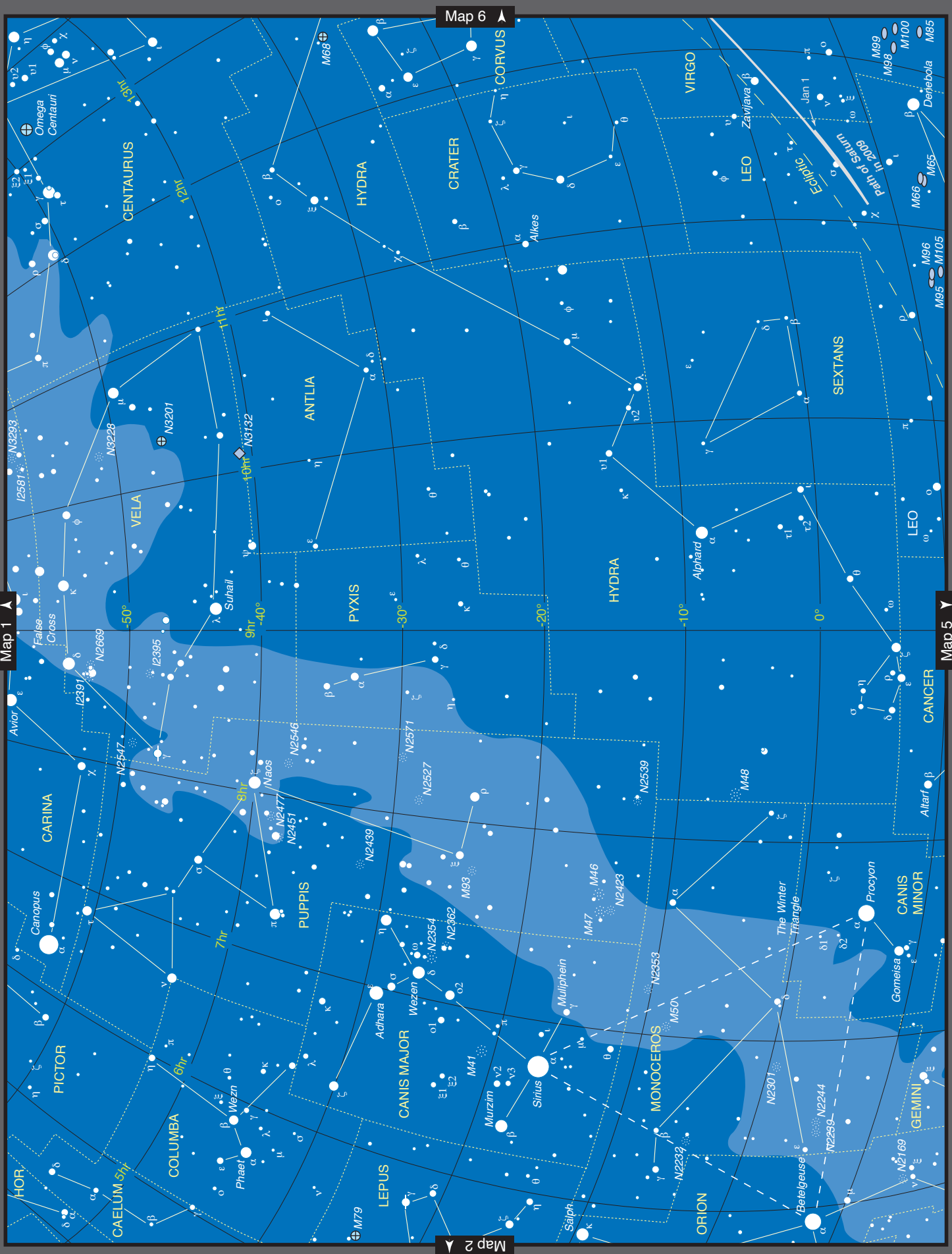
Map 2 - Summer (Centre)



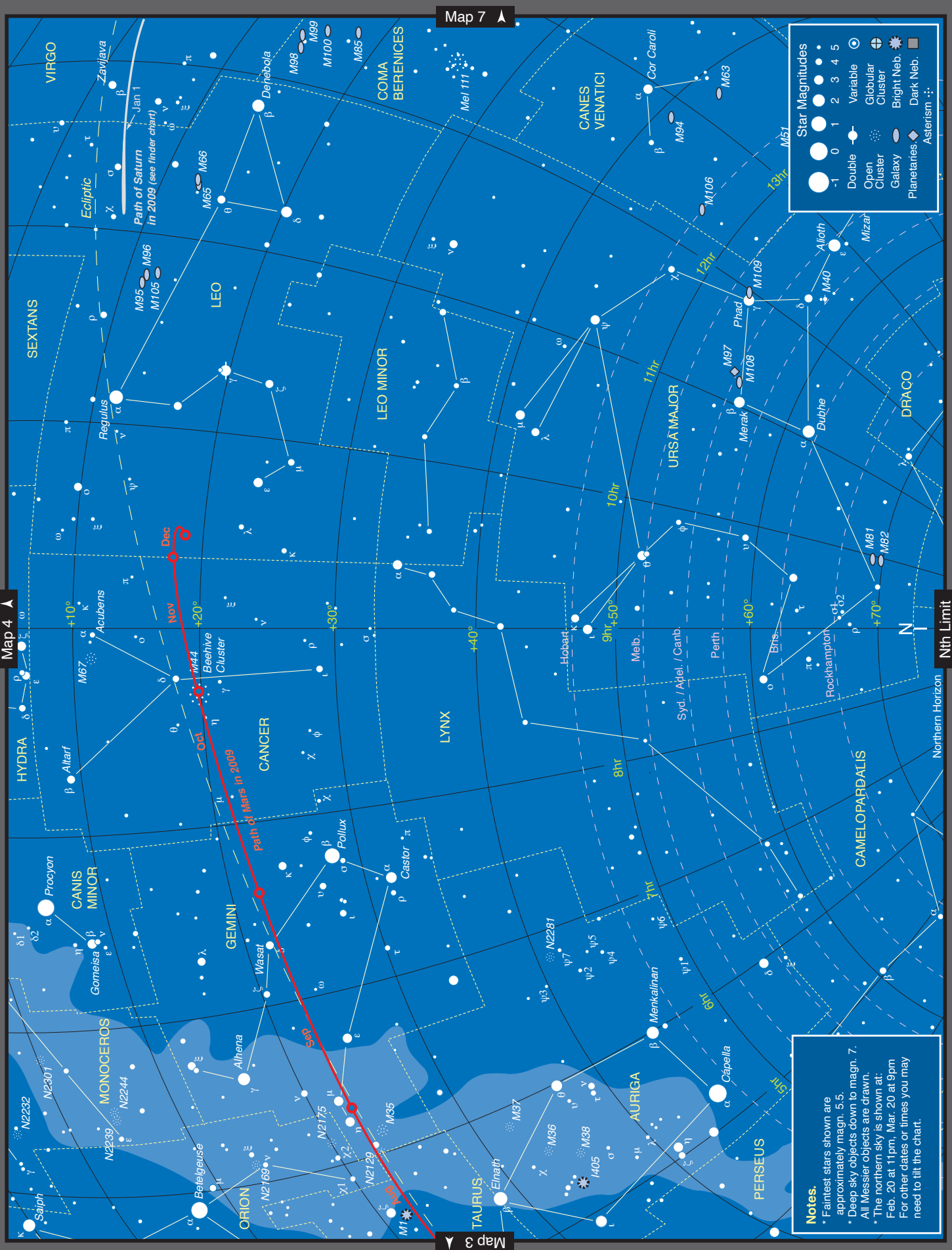


Map 3 - Summer (North)

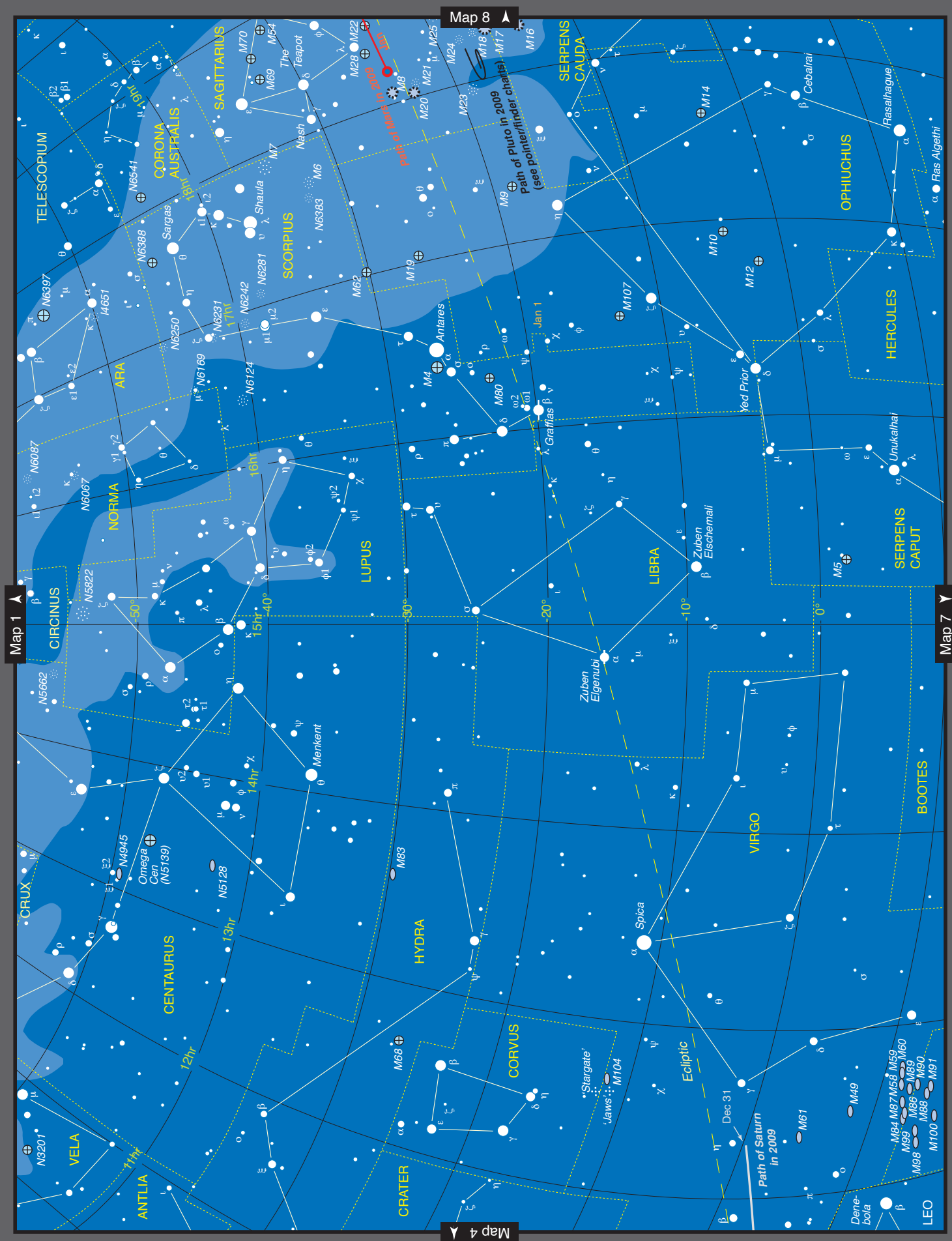
Map 4 - Autumn (Centre)

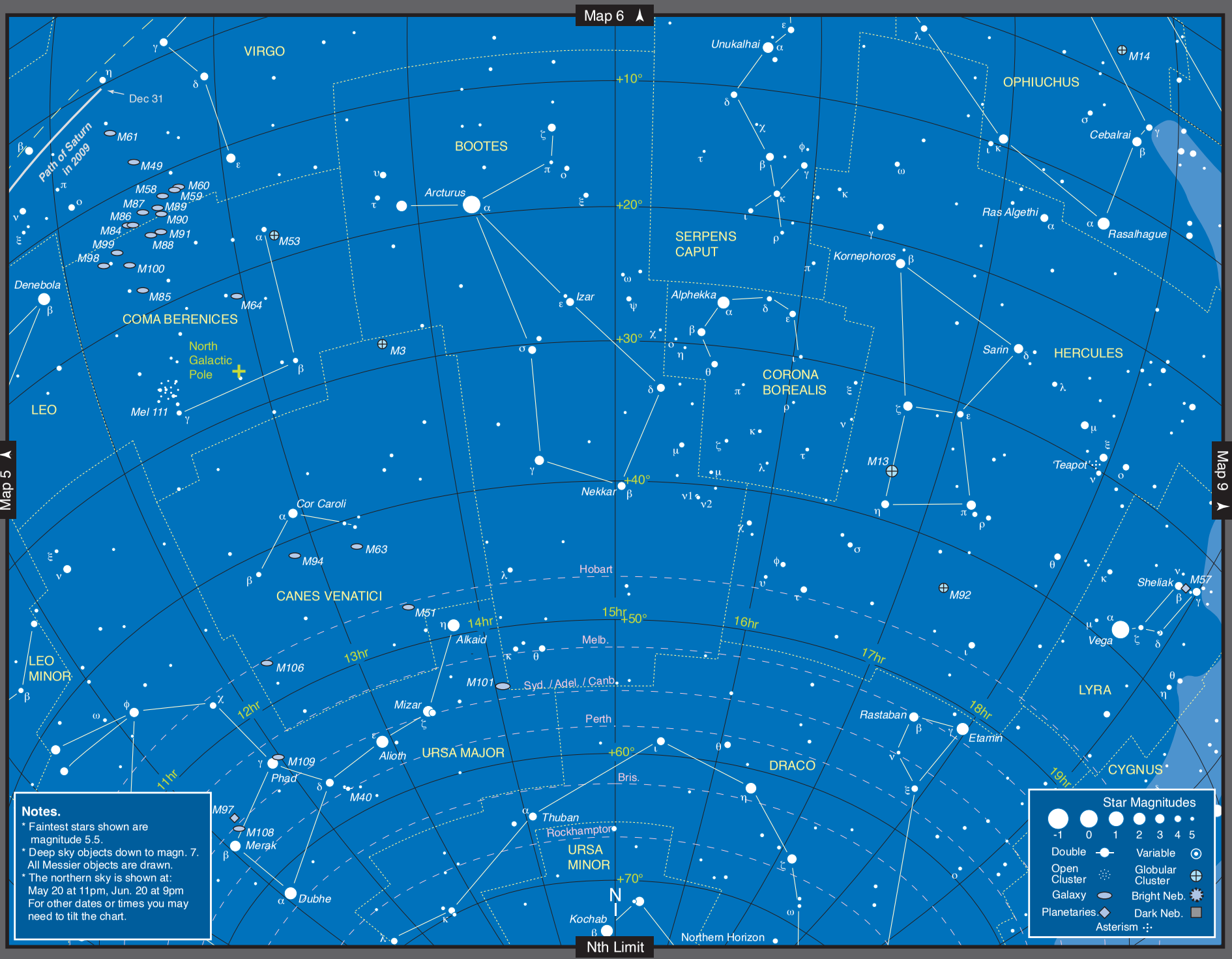


Map 5 - Autumn (North)



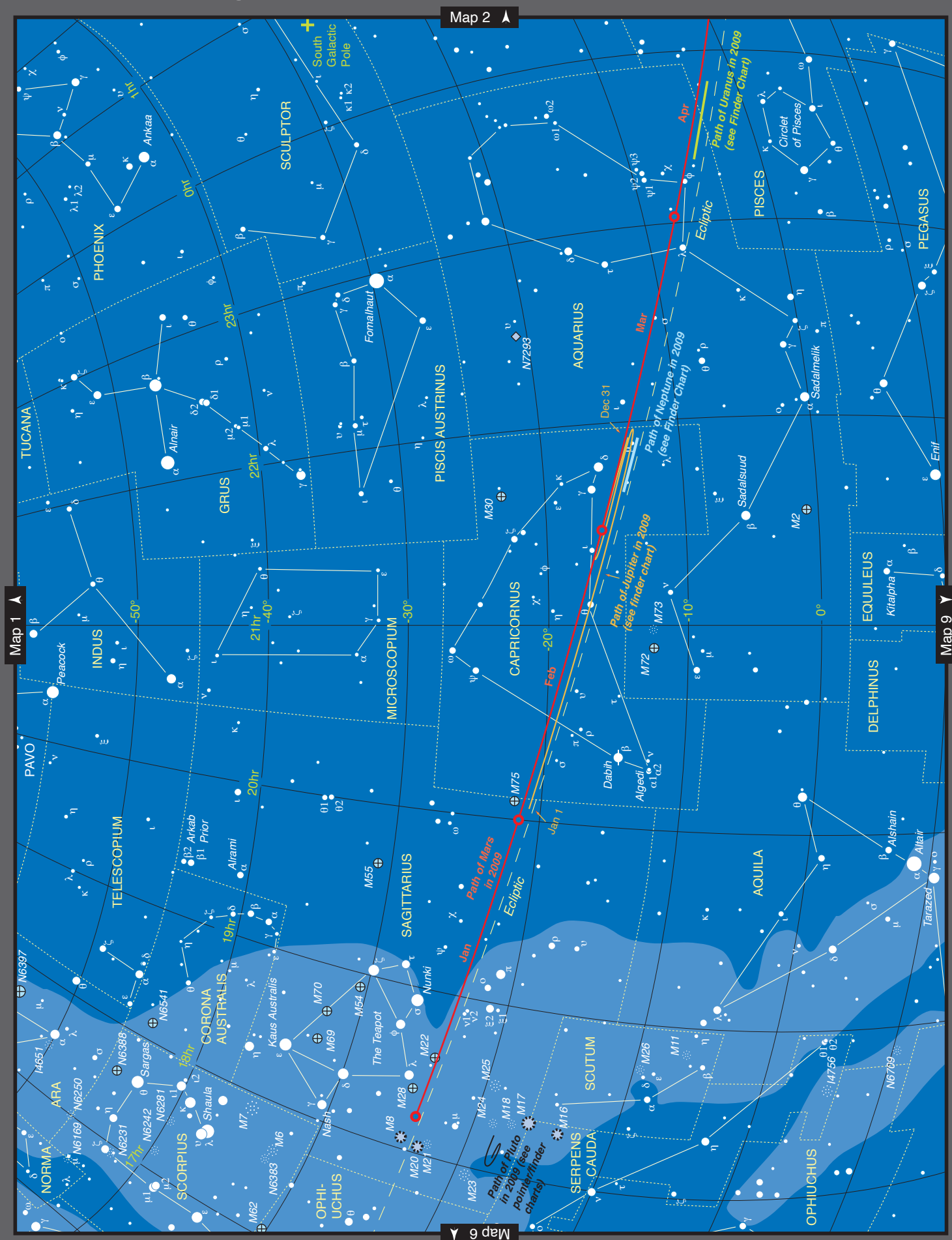
Map 6 - Winter (Centre)



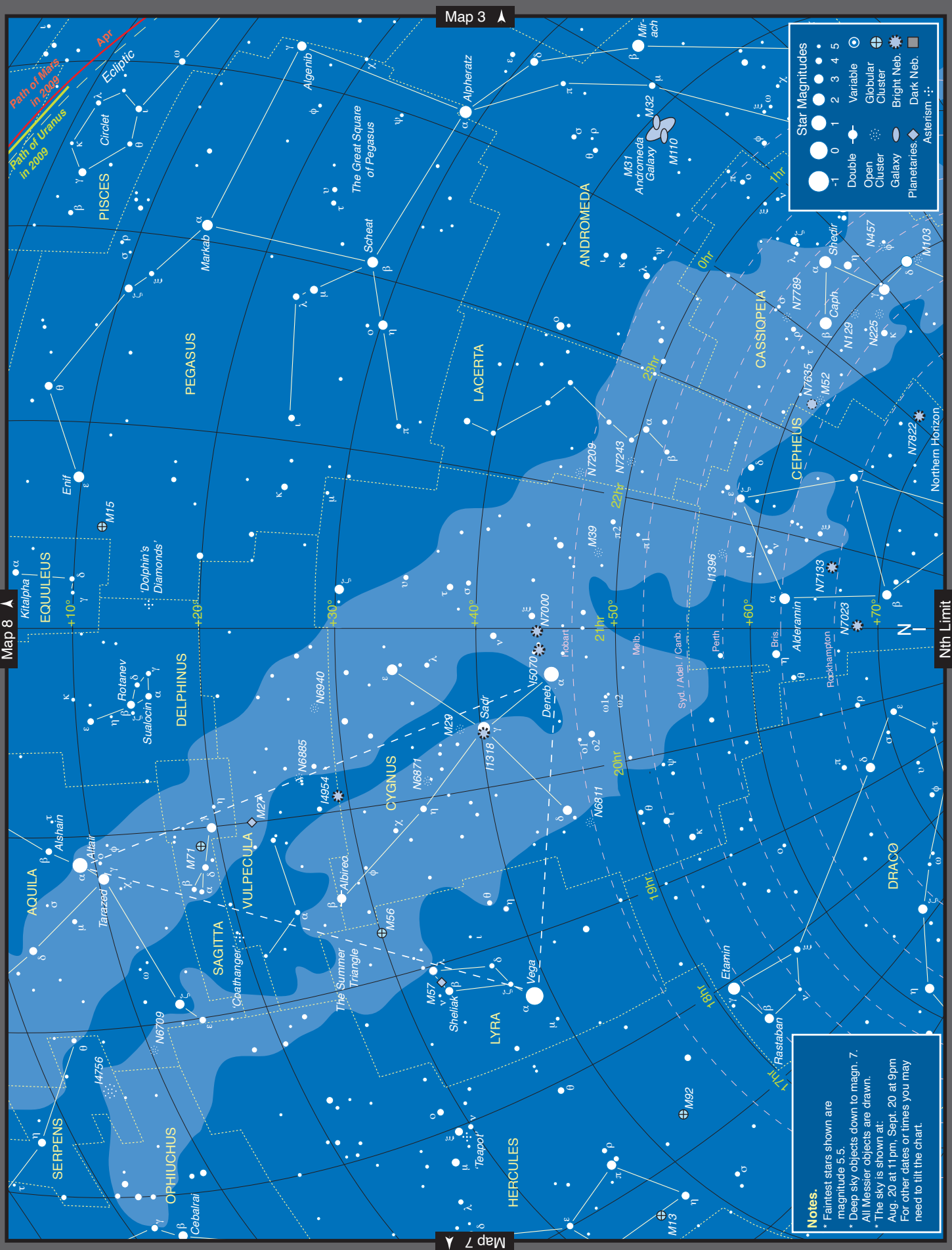


Map 7 - Winter (North)

Map 8 - Spring (Centre)



Map 9 - Spring (North)



Notes.
* Faintest stars shown are magnitude 5.5.
* Deep sky objects down to magn. 7. All Messier objects are drawn.
* The sky is shown at: Aug. 20 at 11pm, Sept. 20 at 9pm For other dates or times you may need to tilt the chart.

This introduction is only brief, as many specific explanations are located in the relevant sections.

Time. There are four zones used in Part II. They are: Eastern Standard Time (EST), Central Standard Time (CST), Western Standard Time (WST) and Universal Time (UT).

Time Zones. The local Australian standard zones are used wherever they involve location specific data, such as rise and set times of the Sun, Moon and planets and lunar occultation tables. As in Part I, no allowance has been made for Daylight Saving Time. When in force you need to add one hour to the times given here.

Universal Time, or UT, is the mean time for the meridian of Greenwich, England, reckoned from midnight. EST is 10 hours ahead of UT, CST is 9.5 hours ahead and WST is 8 hours ahead. For example, midnight UT, or 0 hr, is equal to 10:00hr (10:00am) EST, 9:30hr (9:30am) CST and 8:00hr (8:00am) WST.

The 24 hr clock is often used in astronomy e.g., 16:00 hr is the same as 4:00pm. This avoids having to distinguish between 'am' and 'pm'. The 24hr approach is frequently used in Part II of this book e.g., for rise/set times.

The satellite data for Mars, Saturn, Uranus and Neptune use decimal days. There are worked examples on these pages to further explain this.

Locations. Rise and set times and lunar occultation data are given for specific cities. The latitudes and longitudes used are:

Adelaide	34° 54' S	138° 36' E	Brisbane	27° 30' S	153° 01' E
Canberra	35° 15' S	149° 08' E	Darwin	12° 23' S	130° 44' E
Hobart	42° 48' S	147° 13' E	Melbourne	37° 50' S	145° 00' E
Perth	31° 57' S	115° 51' E	Sydney	33° 54' S	151° 15' E

Astronomical Coordinates or Positions. The astronomical positions are given in equatorial coordinates. These are Right Ascension (RA) and Declination (Dec) which are analogous to longitude and latitude on Earth. RA is the longitude component but, unlike its terrestrial counterpart, it is not measured in degrees, but in hours. The 360 degrees, for once around the sky, are divided into 24 one-hour divisions. Each hour is further divided, like a clock, into minutes and seconds. Declination is the counterpart to latitude but does not use north or south. Instead, objects north of the celestial equator have positive (+) declinations, those south have negative (–). The Right Ascension and Declination grid has been marked on the All Sky Maps (see previous pages). The RA has a line for each hour and the Declination has a line every 10°.

The Earth's daily rotation on its polar axis causes the stars to appear to rotate around a point in the sky. From southern latitudes, including Australia, this point is called the South Celestial Pole and is at declination –90° (see Map 1 in the All Sky Maps). The North Celestial Pole, not visible from the southern hemisphere, is at +90°. The celestial equator and poles can be described as projections on the sky of their terrestrial counterparts.

Position Tables. Right Ascension and Declination have been calculated for 0 hr UT on the date listed (Epoch 2000.0). All positions are geocentric. This means they have been calculated for a position at the centre of the Earth. There is no allowance for the parallax effect of the observer being on the surface of the Earth. Except for the Moon, this slight shift is insignificant. Positions for the outer planets are given in weekly intervals and correspond to Saturdays; those for the Sun, Moon, Venus and Mercury are daily.

Rise and Set Times. Those given are when the upper limb of the object is coincident with the theoretical horizon. The times are adjusted for atmospheric refraction. The intervals used for rise/sets are weekly. They correspond to Saturdays. The exception is the Moon, which is presented for each day. Also see note on time zones (above).

Use of Star Atlases. As the Earth orbits the Sun, the polar axis remains fixed relative to the stars. The points, around which the stars appear to rotate (the celestial poles), appear to never change no matter what time of the year one is observing. However, the positions of the celestial poles do slowly move against the star field. This is called precession and is caused by the Earth's axis slowly wobbling, like a spinning top, over thousands of years. 'Epoch 2000.0' refers to an object's position relative to where the celestial poles (+ /-90° in declination) were in the year 2000. The All Sky Maps are Epoch 2000.0.

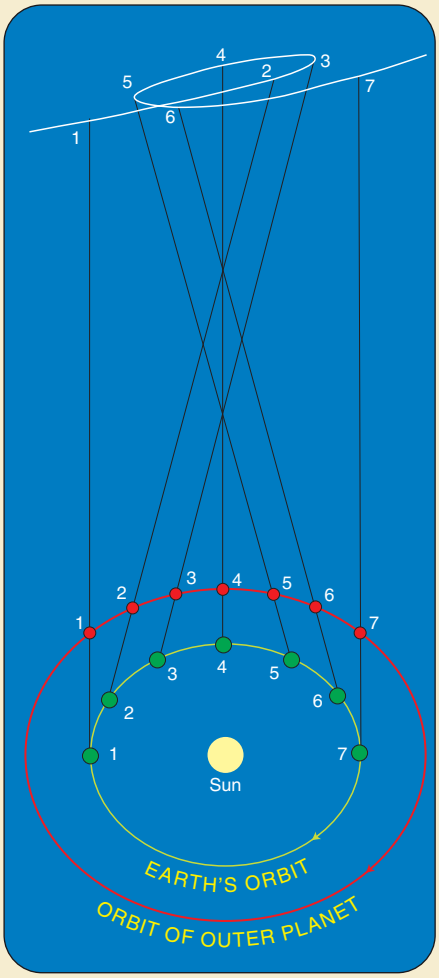
Field of View in a Telescope. All the satellite diagrams and finder charts in this book are drawn to correct or normal sky orientation, i.e., east to the left, and north to the top (in the sky, east and west are opposite to what is seen on terrestrial maps). Telescope systems that use an odd number of mirrors will reverse the image. The common use of star diagonals in Schmidt-Cassegrains or traditional refractors causes this reversal. Binoculars or straight Newtonians show 'normal' sky images (the Newtonian image will be upside down).

Finder Charts. No finder charts are presented for the Moon, Mercury, Venus or Mars. Their rapid motion during the year causes them to cover a very large section of the sky which is difficult to cater for adequately in the space available. Considering how bright these objects are, the Sky View diagrams (see Part I) should be sufficient to act as finders. With regard to Mars, the All Sky Maps give adequate detail to easily find the red planet, so its traditional finder has been included on these maps. Although there are separate finder charts for Jupiter, Saturn, Uranus, Neptune and Pluto, the approximate track for each is also shown on the All Sky Maps. This acts as a pointer to help you find the smaller field of the finder charts.

RETROGRADE MOTION

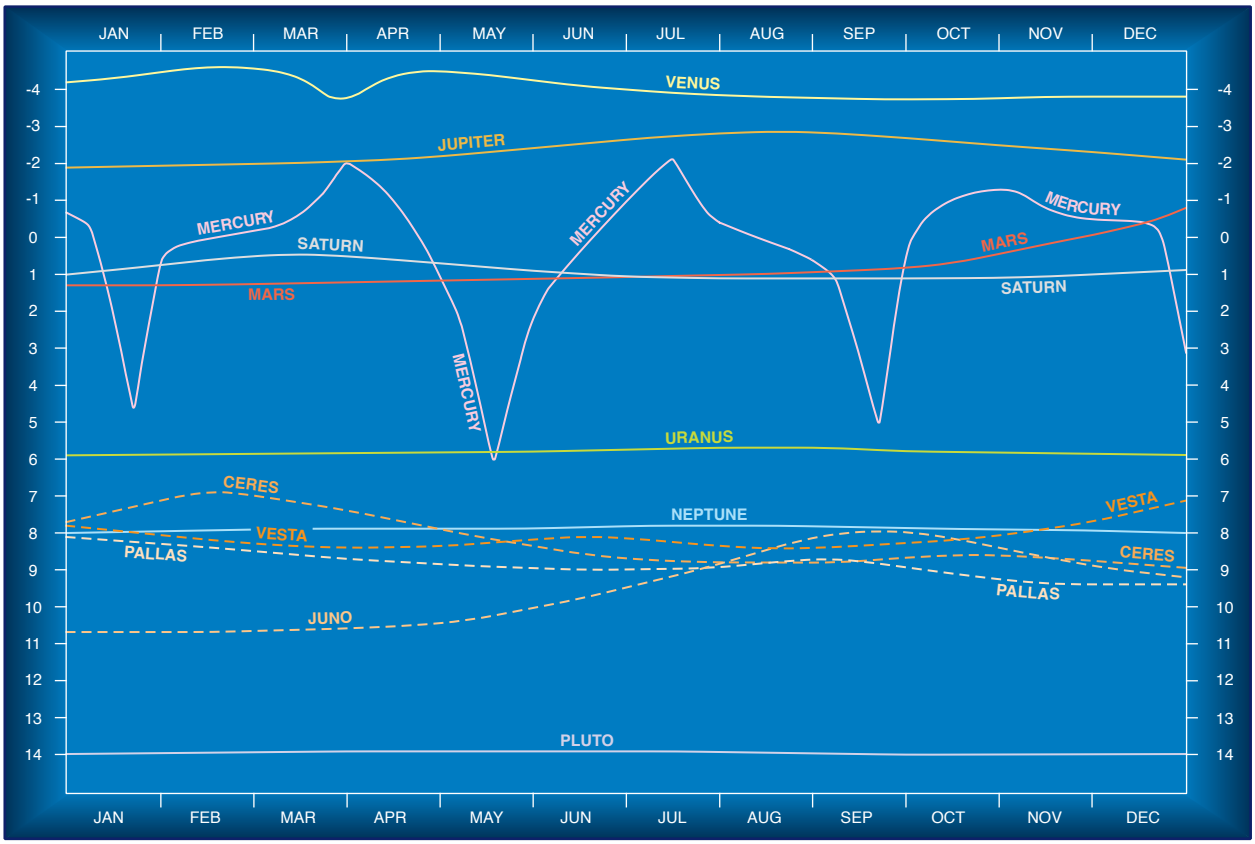
The finder charts for the outer planets have one thing in common — an apparent motion with a loop or 'S' shape. This only applies to the period during opposition. See the All Sky Maps or the Finder Charts for examples. The diagram below illustrates the combined effects of the orbital motions of Earth and an outer planet to explain this loop.

In the diagram, the top section represents the path of an outer planet against the celestial sphere viewed from the south (below the ecliptic). As the Earth moves around the Sun, faster than this outer planet (let's call it Uranus), our home planet overtakes it. The result is this loop in the apparent path against the celestial sphere. This apparent reversal in the planet's movement is known as retrograde motion, and at this time the planet appears to move from east to west, instead of west to east. At positions 1 and 2, Uranus continues its west to east path and begins to slow to position 3 as the Earth catches up. Between 3 and 5, Uranus is in retrograde motion (i.e., moving east to west) and it is at opposition (in line with the Earth and the Sun) at 4. At points 3 and 5, the planet is said to be stationary. After 5, as the Earth passes the slower planet, Uranus continues its west to east direction.

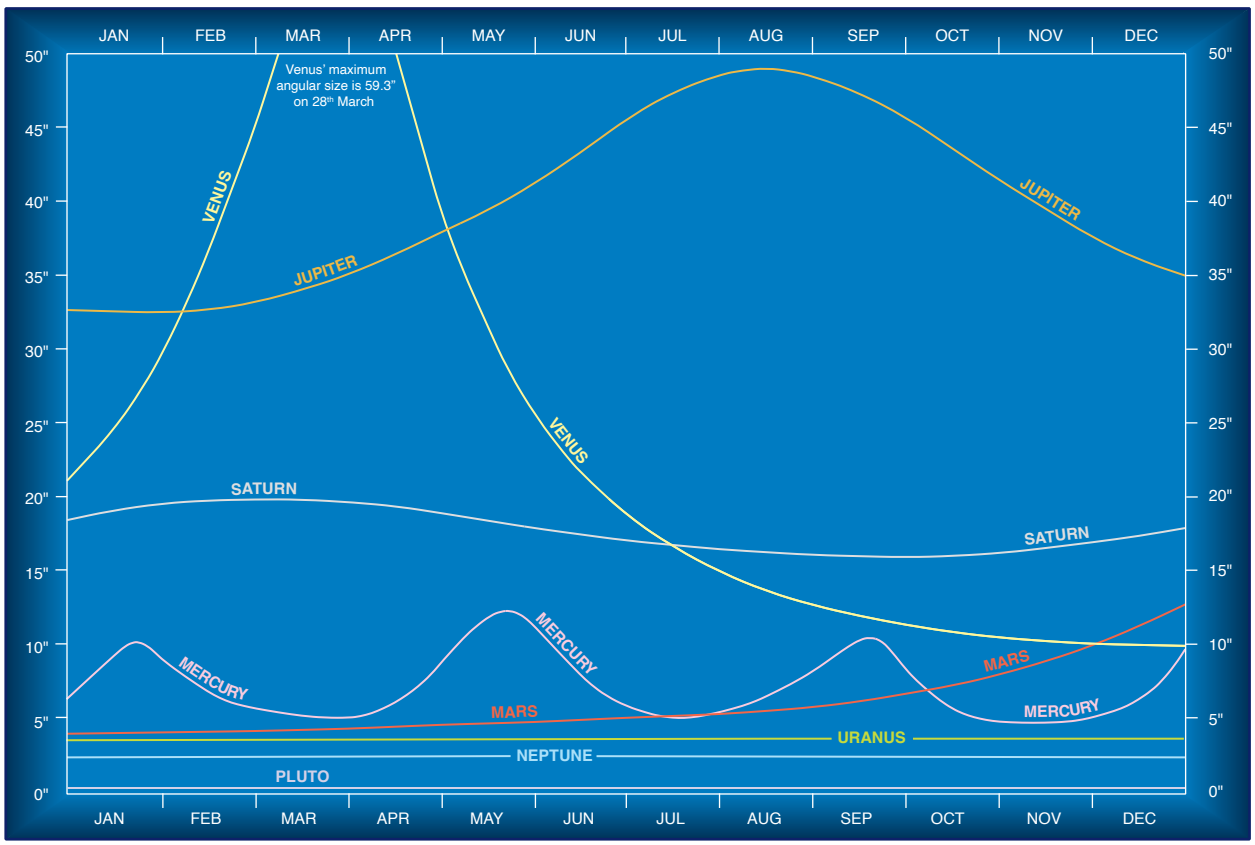


Because the orbits of the outer planets are inclined to that of the Earth's, the path can never be a straight line. It will always be a loop or an S-bend.

MAGNITUDES of the PLANETS and MAJOR ASTEROIDS



PLANETARY ANGULAR SIZE



GEOCENTRIC PHENOMENA (UT)

Planet	Greatest Elongation East	Greatest Illuminated Extent	Stationary	Inferior Conjunction	Stationary	Greatest Illuminated Extent	Greatest Elongation West	Superior Conjunction
Mercury	4 Jan, 14h (19°) 26 Apr, 8h (20°) 24 Aug, 16h (27°) 18 Dec, 17h (20°)		11 Jan, 7h 7 May, 16h 6 Sep, 20h 26 Dec, 9h	20 Jan, 16h 18 May, 10h 20 Sep, 10h	1 Feb, 2h 30 May, 16h 28 Sep, 18h		13 Feb, 21h (26°) 13 Jun, 12h (23°) 6 Oct, 2h (18°)	31 Mar, 3h 14 Jul, 2h 5 Nov, 8h
Venus	14 Jan, 21h (47°)	19 Feb, 15h	5 Mar, 1h	27 Mar, 19h	15 Apr, 8h	2 May, 15h	5 Jun, 21h (46°)	

Planet	Conjunction	Stationary	Opposition	Stationary	Conjunction	Stationary	EARTH	
Mars						21 Dec, 16h	Perihelion	4 Jan, 15h
Jupiter	24 Jan, 6h	15 Jun, 20h	14 Aug, 18h	13 Oct, 9h			Equinox	20 Mar, 12h
Saturn		1 Jan, 20h	8 Mar, 20h	17 May, 19h	17 Sep, 18h		Solstice	21 Jun, 6h
Uranus	13 Mar, 1h	1 Jul, 16h	17 Sep, 10h	2 Dec, 5h			Aphelion	4 Jul, 2h
Neptune	12 Feb, 13h	29 May, 11h	17 Aug, 21h	4 Nov, 19h			Equinox	22 Sep, 21h
Pluto		4 Apr, 16h	23 Jun, 8h	11 Sep, 16h	24 Dec, 18h		Solstice	21 Dec, 18h

HELIOCENTRIC PHENOMENA (UT)

Planet	Ascending Node	Perihelion	Greatest Latitude North	Descending Node	Aphelion	Greatest Latitude South
Mercury	8 Jan 6 Apr 3 Jul 29 Sep 26 Dec	13 Jan 11 Apr 8 Jul 4 Oct 31 Dec	23 Jan 21 Apr 18 Jul 14 Oct	16 Feb 15 May 11 Aug 7 Nov	26 Feb 25 May 21 Aug 17 Nov	18 Mar 14 Jun 10 Sep 7 Dec
Venus	18 Jan 31 Aug	21 Feb 4 Oct	15 Mar 25 Oct	10 May 20 Dec	13 Jun	6 Jul
Mars	20 Aug	21 Apr				26 Mar
Uranus					27 Feb	

Jupiter, Saturn, Neptune and Pluto have no events in 2009

SOLAR SYSTEM DATA – SUN, MOON AND THE PLANETS

NAME	MEAN DISTANCE FROM SUN ($\times 10^3$ km)	(Earth = 1)	MAG at OPP	EQUATORIAL DIAMETER (km).	FLATTENING [1]	No of MOONS	MASS ($\times 10^{24}$ kg)	(Earth = 1)
Sun	-		-26.8	1392530	0	-	1989085	332946
Moon	-		-12.74 [11]	3475	0	-	0.073483	0.0123
Mercury	57856	0.387	0.16 [12]	4879	0	0	0.33022	0.055
Venus	108132	0.723	-4.07 [12]	12104	0	0	4.8690	0.816
Earth	149492	1.000	-3.5 [13]	12756	0.00335364	1	5.9742	1.000
Mars	227780	1.524	-2.01	6794	0.006476	2	0.64191	0.107
Jupiter	777776	5.203	-2.70	142984	0.064874	63	1898.8	317.900
Saturn	1425983	9.540	0.67	120536	0.097962	60	568.50	95.200
Uranus	2867760	19.180	5.52	51118	0.022927	27	86.625	14.500
Neptune	4492800	30.700	7.84	49528	0.017081	13	102.78	17.400
Pluto	5745000	39.670	13.7	2302	0	3	0.015	0.003

NAME	VOLUME (Earth = 1)	SIDEREAL PERIOD [2]	SYNODIC PERIOD (days) [3]	AXIAL ROTATION (days) [4]	ALBEDO [5]	ECCEN-TRICITY [6]	INCLINATION [7]	OBLIQUITY [8]
Sun	1300000	-	-	25.38 [9]	-	-	-	7° 15' [10]
Moon	0.02	27.32 d	29.4	27.32166	0.12	0.0549	5° 08' 40"	6° 41'
Mercury	0.06	87.97 d	115.8	58.6462	0.106	0.20562	7° 00' 00"	0° 00'
Venus	0.86	224.7 d	583.9	-243.0187	0.65	0.00681	3° 23' 38"	92° 00'
Earth	1	365.256 d	-	0.99726968	0.367	0.01681	0° 00' 00"	23° 26'
Mars	0.15	687 d	779.8	1.02595675	0.150	0.09333	1° 51' 01"	25° 10'
Jupiter	1323	11.86 y	398.8	0.41354 [14]	0.52	0.04837	1° 18' 28"	3° 07'
Saturn	752	29.46 y	378.0	0.44401 [14]	0.47	0.05582	2° 29' 29"	26° 45'
Uranus	64	84.01 y	369.7	-0.71833	0.51	0.0471	0° 46' 22"	98° 00'
Neptune	54	164.8 y	367.5	0.67125	0.41	0.00855	1° 46' 38"	29° 00'
Pluto	0.007	249.9 y	366.7	-6.3872	0.30	0.2486	17° 09' 00"	118° 00'

Notes:

1 The ratio of the difference of equatorial and polar radii to equatorial radius.
2 The planet's year.
3 The period of the planet's orbit with respect to the Earth.
4 The planet's day. A negative sign indicates the rotation is retrograde with respect to the north pole.
5 The ratio of the sunlight reflected to that received.
6 The measure of how long or thin the ellipse of the planet's orbit is.
7 The angle of the planet's orbit from the plane of the ecliptic.
8 The degree of inclination of the planet's equator to its orbit
9 Equatorial region (the polar areas of the Sun rotate in a period of 29 to 30 days).
10 To the ecliptic.
11 From the Earth.
12 At mean greatest elongation.
13 As seen from the Sun.
14 Based on System III rotation. Similar to systems I or II except a radio source within the planet is used as the reference point.

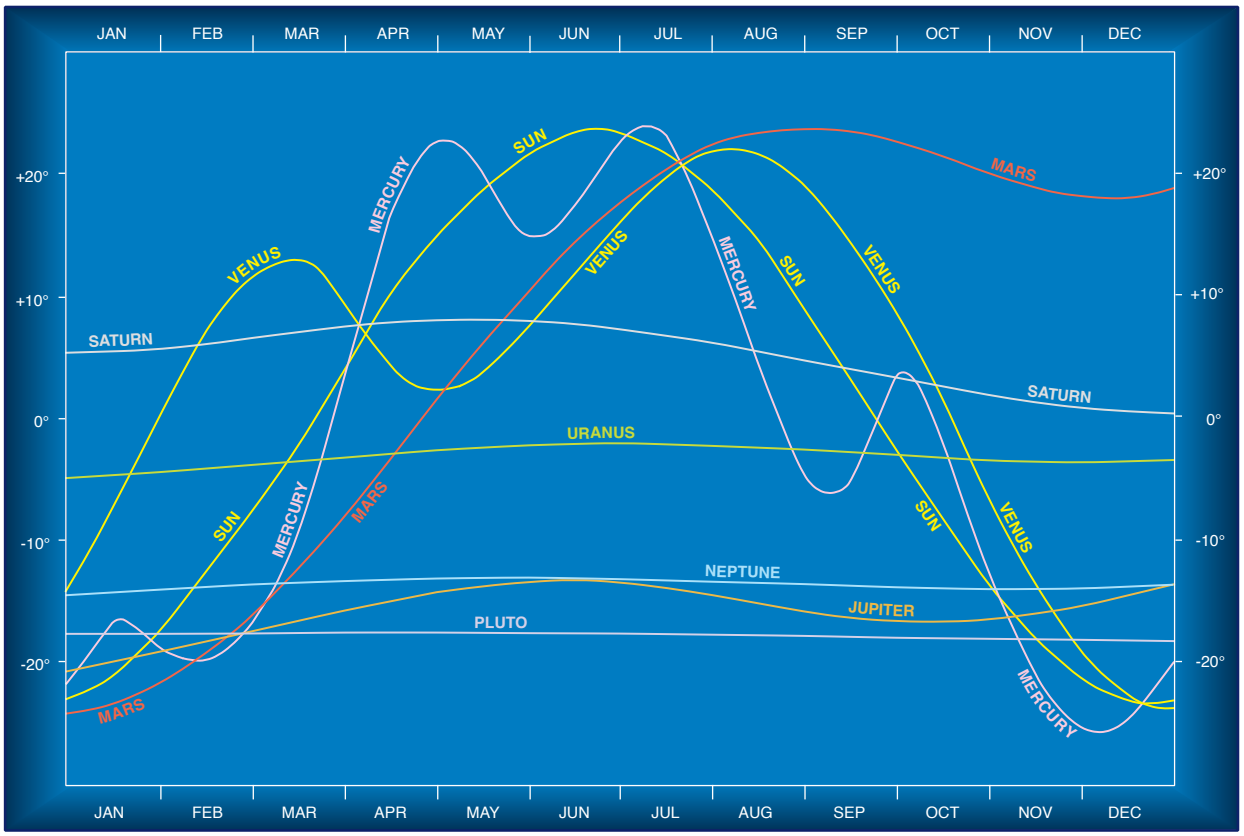
SOLAR SYSTEM DATA — SATELLITES

PLANET	SATELLITE	ORBITAL PERIOD (days)	MAX. ELONG AT MEAN OPPOSITION	SEMIMAJOR AXIS ($x10^3$ km)	DIAMETER (km)	MAGN AT OPP
Earth	Moon	27.321661		388.4	3,475	-12.74
Mars	Phobos	0.31891023	25"	9.376	26.8×21×18.4	11.4
	Deimos	1.2624407	01' 02"	23.458	15.0×12×10.4	12.45
Jupiter	Metis	0.295	42"	128.0	43	17.5
	Adrastea	0.298	42"	129.0	16	18.7
	Amalthea	0.498	01' 00"	181.4	166	14.1
	Thebe	0.675	01' 13"	221.9	98	16
	Io	1.769	02' 18"	421.8	3,643	5.02
	Europa	3.551	03' 40"	671.1	3,122	5.29
	Ganymede	7.155	05' 51"	1,070.40	5,262	5.61
	Callisto	16.69	10' 18"	1,882.70	4,820	5.65
	Themisto	130.02	39' 49"	7,284.00	8	21
	Leda	240.92	1° 01' 02"	11,165.00	20	19.5
	Himalia	250.56	1° 02' 39"	11,461.00	170	14.62
	Lysithea	259.20	1° 04' 03"	11,717.00	36	18.25
	Elara	259.64	1° 04' 11"	11,741.00	86	16.32
	S/2000 J11	287		12,555.00	4	16.1R
	Carpo	456.30	1° 33' 15"	17,058.00	3	23.0R
	S/2003 J3	583.88		20,224.00	2	23.4R
	S/2003 J12	489.72		17,833.00	1	23.9R
	Euporie	550.74	1° 45' 31"	19,304.00	2	23.1R
	S/2003 J18	596.58		20,426.00	2	23.4R
	Orthosie	622.56	1° 53' 15"	20,720.00	2	23.1R
	Euanthe	620.49	1° 53' 40"	20,797.00	3	22.8R
	Thyone	627.21	1° 54' 27"	20,939.00	4	22.3R
	S/2003 J16	616.33		20,956.00	2	23.3R
	Mneme	620.04	1° 54' 58"	21,035.00	2	23.3R
	Harpalyke	623.32	1° 54' 00"	20,858.00	4.4	22.2
	Hermippe	633.90	1° 55' 29"	21,131.00	4	22.1R
	Praxidike	625.39	1° 54' 16"	20,908.00	6.8	21.2
	Thelxinoe	628.09	1° 55' 40"	21,164.00	2	23.5R
	Helike	626.32	1° 55' 09"	21,069.00	4	22.6R
	Iocaste	631.60	1° 55' 06"	21,060.00	5.2	21.8
	Ananke	629.77	1° 56' 17"	21,276.00	28	18.75
	S/2003 J15	689.77		22,630.00	2	23.5R
	S/2003 J17	714.51		22,983.00	2	23.4R
	S/2003 J9	733.30		23,388.00	1	23.7R
	S/2003 J19	740.43		23,535.00	2	23.7R
	Eurydome	717.33	2° 04' 58"	22,865.00	3	22.7R
	Arche	731.95	2° 07' 38"	23,355.00	3	22.8R
	Autonoe	760.95	2° 11' 24"	24,046.00	4	22.0R
	Pasithee	719.44	2° 05' 43"	23,004.00	2	23.2R
	Chaldene	723.72	2° 06' 15"	23,100.00	3.8	22.5
	Isonoe	726.23	2° 06' 33"	23,155.00	3.8	22.5
	Kale	729.47	2° 06' 53"	23,217.00	2	23.0R
	Aitne	730.18	2° 06' 57"	23,229.00	3	22.7R
	S/2003 J4	755.26		23,933.00	2	23.0R
	Erinome	728.46	2° 06' 46"	23,196.00	3.2	22.8
	Taygete	732.41	2° 07' 14"	23,280.00	5	21.9
	Carme	734.17	2° 07' 54"	23,404.00	46	17.55
	Sponde	748.34	2° 08' 21"	23,487.00	2	23.0R
	Kalyke	742.06	2° 08' 20"	23,483.00	5.2	21.8
	Pasiphae	743.63	2° 09' 06"	23,624.00	60	17
	Eukelade	730.47	2° 07' 29"	23,328.00	4	22.6R
	Megaclite	752.86	2° 08' 23"	23,493.00	5.4	21.7
	Sinope	758.90	2° 10' 49"	23,939.00	38	18.05
	Hegemone	739.88	2° 08' 51"	23,577.00	3	22.9R
Jupiter	Aoede	761.50	2° 11' 03"	23,980.00	4	22.5R
	Kallichore	728.73	2° 07' 16"	23,288.00	2	23.7R
	S/2003 J23	732.45		23,566.00	2	23.6R
	S/2003 J5	738.74		23,498.00	4	22.4R
	Callirrhoe	758.77	2° 11' 43"	24,103.00	8.6	20.73
	S/2003 J10	716.25		23,044.00	2	23.6R
	Cyllene	752.00	2° 10' 07"	23,809.00	2	23.2R
	Kore	779.17	2° 14' 07"	24,543.00	2	23.6R
	S/2003 J2	981.55		28,455.00	2	23.2R
Saturn	Pan	0.575	31"	133.58	25.6	19.4
	Daphnis	0.594	09' 35"	136.50	7	24R
	Atlas	0.602	48"	137.67	20	19
	Prometheus	0.613	55' 51"	139.38	93.6	15.8
	Pandora	0.629	34"	141.72	81.2	16.4
	Epimetheus	0.694	24"	151.41	116.6	15.6
	Janus	0.695	29' 57"	151.46	180.8	14.4
	Mimas	0.942	41' 50"	185.54	397.6	12.8
	Methone	1.01	43' 33"	194.44	3	25
	Anthe	1.04		197.70	1	26R
	Pallene	1.154	51' 10"	212.28	4	23
	Enceladus	1.37	24"	238.04	504.6	11.8
	Calypso	1.888	04' 02"	294.71	19	18.7
	Telesto	1.888		294.71	24	18.5
	Tethys	1.888		294.67	1,073	10.2
	Dione	2.737	34' 51"	377.42	1,125	10.4
	Helene	2.737	23"	377.42	32	18.4
	Polydeuces	2.737	22"	377.20	4	25R
	Rhea	4.518	46' 05"	527.07	1,529	9.6
	Titan	15.95		1,221.87	5,151	8.4
	Hyperion	21.28	22"	1,500.88	266	14.4
	Iapetus	79.33	40' 55"	3,560.84	1,469	11
	Kiviuq	449.22	30' 35"	11,110.00	16	22.0R
	Ijiraq	451.42	46' 24"	11,124.00	12	22.6R
	Phoebe	550.31	01' 01"	12,947.78	213	16.4
	Paaliaq	686.95	54' 41"	15,200.00	22	21.3R
	Skathi	728.20		15,540.00	8	23.6R
	Albiorix	783.45	38"	16,182.00	32	20.5R
	S/2007 S2	808.08	47' 33"	16,725.00	6	24.4R
	Bebhionn	834.84	01' 01"	17,119.00	6	24.1R
	Erriapo	871.19	01' 01"	17,343.00	10	23.0R
	Siarnaq	895.53		17,531.00	40	20.1R
	Skoll	878.29		17,665.00	6	24.5R
	Tarqeq	895		17,920.00	7	23.9R
	Tarvos	926.23		17,983.00	15	22.1R
	Greip	905		18,105.00	6	24.4R
	Hyrrokkin	931.86	1° 02' 01"	18,437.00	8	23.5R
	S/2004 S13	933.48	54' 21"	18,404.00	6	24.5R
	Jarnsaxa	942		18,600.00	6	24.7R
	S/2004 S17	1014.70	54' 51"	19,447.00	4	25.2R
	Mundilfari	952.77	46' 41"	18,628.00	7	23.8R
	S/2006 S1	963.37	1° 07' 41"	18,790.00	6	24.6R
	Narvi	1003.86	47' 11"	19,007.00	7	23.8R
	Bergelmir	1005.74	01' 25"	19,336.00	6	24.2R
	Suttungr	1016.67		19,459.00	7	23.9R
	S/2004 S12	1046.19	52' 03"	19,878.00	5	24.8R
	S/2004 S7	1140.24	1° 00' 26"	20,999.00	6	24.5R
	Hati	1038.61	23"	19,846.00	6	24.4R
Saturn	Bestla	1088.72	03' 17"	20,192.00	7	23.8R
	Farbauti	1085.55	48"	20,377.00	5	24.7R
	Thrymr	1094.11		20,314.00	7	23.9R
	S/2007 S3	977.80	1° 01' 06"	18,975.00	5	24.9R
	Aegir	1117.52	30"	20,751.00	6	24.4R
	S/2006 S3	1227.21	53' 25"	22,096.00	6	24.6R
	Kari	1230.97	52' 24"	22,089.00	7	23.9R
	Fenrir	1260.35	48"	22,454.00	4	25.0R
	Surtur	1297.36		22,704.00	6	24.8R
	Ymir	1315.14		23,040.00	18	21.7R
	Loge	1311.36	50' 24"	23,058.00	6	24.6R
	Fornjot	1494.20	22"	25,146.00	6	24.6R
Uranus	Cordelia	0.335	04"	49.8	40	23.62
	Ophelia	0.376	04"	53.8	43	23.26
	Bianca	0.435	04"	59.2	51	22.52
	Cressida	0.464	05"	61.8	80	21.58
	Desdemona	0.474	05"	62.7	64	21.99
	Juliet	0.493	05"	64.4	94	21.12
	Portia	0.513	05"	66.1	135	20.42
	Rosalind	0.558	05"	69.9	72	21.79
	Cupid	0.613	06"	74.392	10	26
	Belinda	0.624	06"	75.3	81	21.47
	Perdita	0.638	06"	76.417	20	24
	Puck	0.762	07"	86.0	162	19.75
	Mab	0.923	07"	97.736	10	26
	Miranda	1.413	10"	129.9	471.6	15.79
	Ariel	2.52	14"	190.9	1,158	13.7
	Umbriel	4.144	20"	266.0	1,169	14.47
	Titania	8.706	33"	436.3	1,578	13.49
	Oberon	13.46	44"	583.5	1,523	13.7
	Francisco	266.56	05' 24"	4,276	12	25.0R
	Caliban	579.73	09' 08"	7,231	98	22.42
	Stephano	677.36	10' 07"	8,004	20	24.1
	Trinculo	749.24	10' 45"	8,504	10	25.4R
	Sycorax	1288.30	15' 23"	12,179	190	20.82
	Margaret	1687.01	18' 07"	14,345	11	25.2R
	Prospero	1978.29	20' 32"	16,256	30	23.2
	Setebos	2225.21	22' 00"	17,418	30	23.3
	Ferdinand	2887.21	26' 24"	20,901	12	25.1R
Neptune	Naiad	0.294	02"	48.227	66	23.91
	Thalassa	0.311	02"	50.074	82	23.32
	Despina	0.335	02"	52.526	150	22
	Galatea	0.429	03"	61.953	176	21.85
	Larissa	0.555	03"	73.548	194	21.49
	Proteus	1.122	06"	117.647	420	19.75
	Triton	5.877	17"	354.759	2,706.8	13.472
	Nereid	360.13	04' 22"	5,513.787	340	19.7
	Halimede	1879.08	12' 26"	16,611	62	19.2R
	Sao	2912.72	17' 43"	22,228	44	24.5R
	Laomedeia	3171.33	18' 38"	23,567	42	25.5R
	Psamathe	9074.30	36' 55"	48,096	40	25.5R
	Neso	9740.73	38' 15"	49,285	60	24.6R
Pluto	Charon	6.387	01"	17.536	1,186	17.26
	Nix	24.86	02"	48.708		
	Hydra	38.20	02"	64.749		

The table covers the currently known satellites (as of September 2008). Some are recent discoveries and not yet named. Instead they have a preliminary designation such as S/2007 S3. Magnitudes marked R are red magnitudes.

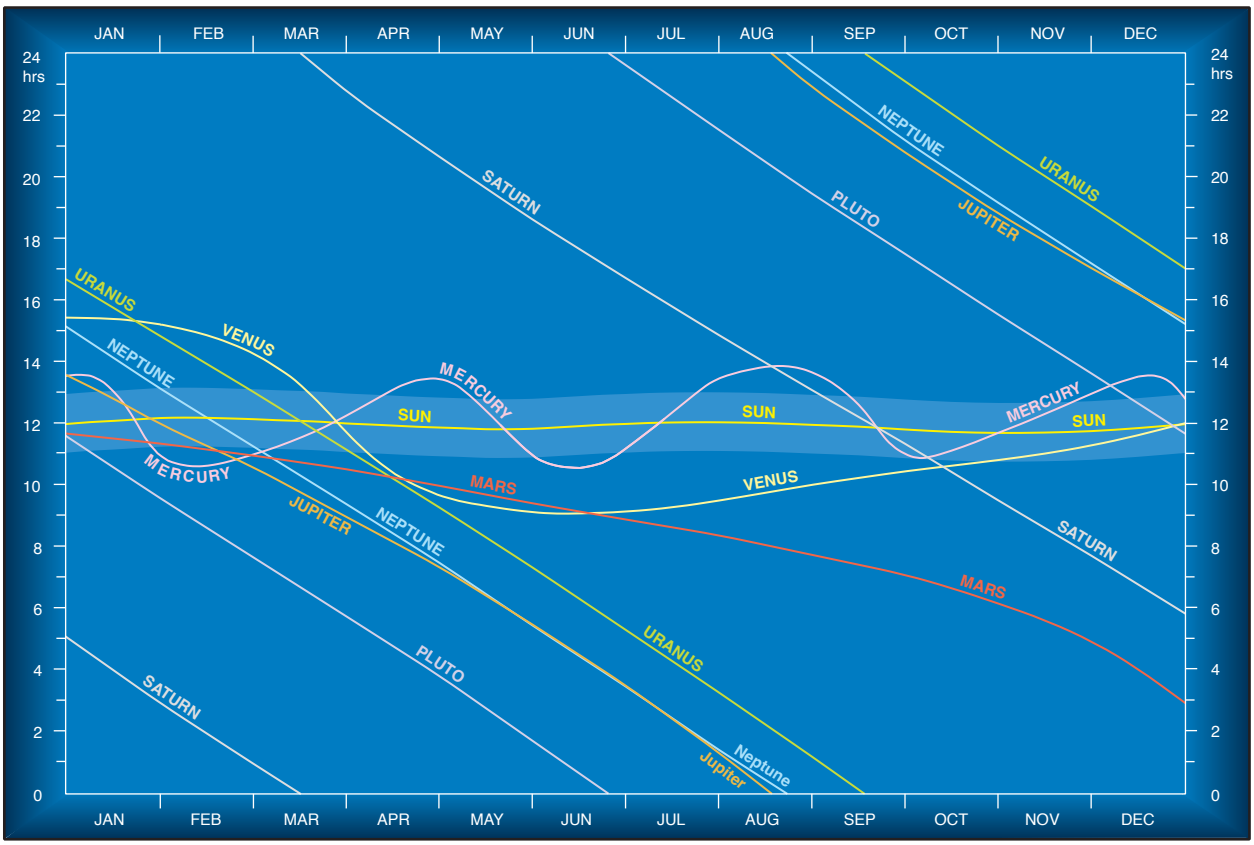
DECLINATIONS of the SUN and PLANETS

In general, the further south a planet is (negative declination), the higher in the northern sky it is, as seen from most of Australia. The higher in the sky, the less atmosphere you have to look through and the more stable the image is (less prone to turbulence). This can be particularly relevant when trying to observe a planet under high magnification.



MERIDIAN PASSAGE of the SUN and PLANETS

The time of meridian passage for a planet is when it is due north and at its highest point in the sky. For the outer planets this is certainly looked upon as the best time to observe when you are looking through the least amount of atmosphere. The time for the Sun is close to midday (12hrs). When a planet crosses from the bottom of the diagram (0 hours) to the top (24 hours) it is at opposition and visible the whole night.



SUN

GEOCENTRIC POSITION

(0hr UT, Epoch 2000.0)

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	R.A.	Dec.	R.A.	Dec	R.A.	Dec	R.A.	Dec	R.A.	Dec	R.A.	Dec
	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "
1	18 46 01	- 23 01 01	20 58 23	- 17 09 21	22 47 40	- 07 39 48	00 41 28	+ 04 27 38	02 32 52	+ 15 00 46	04 35 40	+ 22 01 25
2	18 50 26	- 22 55 56	21 02 27	- 16 52 11	22 51 25	- 07 16 58	00 45 07	+ 04 50 46	02 36 41	+ 15 18 51	04 39 46	+ 22 09 27
3	18 54 50	- 22 50 23	21 06 31	- 16 34 44	22 55 10	- 06 54 02	00 48 45	+ 05 13 48	02 40 31	+ 15 36 40	04 43 52	+ 22 17 06
4	18 59 14	- 22 44 24	21 10 34	- 16 16 59	22 58 53	- 06 31 01	00 52 24	+ 05 36 45	02 44 22	+ 15 54 14	04 47 59	+ 22 24 22
5	19 03 38	- 22 37 57	21 14 36	- 15 58 58	23 02 37	- 06 07 53	00 56 04	+ 05 59 36	02 48 13	+ 16 11 32	04 52 06	+ 22 31 14
6	19 08 01	- 22 31 04	21 18 37	- 15 40 40	23 06 20	- 05 44 41	00 59 43	+ 06 22 20	02 52 04	+ 16 28 34	04 56 13	+ 22 37 42
7	19 12 24	- 22 23 44	21 22 37	- 15 22 07	23 10 02	- 05 21 25	01 03 22	+ 06 44 58	02 55 56	+ 16 45 19	05 00 20	+ 22 43 46
8	19 16 46	- 22 15 57	21 26 37	- 15 03 18	23 13 44	- 04 58 04	01 07 02	+ 07 07 29	02 59 49	+ 17 01 47	05 04 28	+ 22 49 27
9	19 21 08	- 22 07 45	21 30 35	- 14 44 13	23 17 26	- 04 34 40	01 10 42	+ 07 29 52	03 03 42	+ 17 17 59	05 08 36	+ 22 54 44
10	19 25 29	- 21 59 06	21 34 33	- 14 24 54	23 21 07	- 04 11 12	01 14 22	+ 07 52 08	03 07 36	+ 17 33 53	05 12 44	+ 22 59 36
11	19 29 49	- 21 50 02	21 38 30	- 14 05 21	23 24 48	- 03 47 40	01 18 02	+ 08 14 16	03 11 30	+ 17 49 29	05 16 53	+ 23 04 04
12	19 34 09	- 21 40 32	21 42 27	- 13 45 33	23 28 29	- 03 24 07	01 21 43	+ 08 36 16	03 15 25	+ 18 04 48	05 21 01	+ 23 08 08
13	19 38 29	- 21 30 37	21 46 22	- 13 25 32	23 32 09	- 03 00 30	01 25 24	+ 08 58 07	03 19 21	+ 18 19 48	05 25 10	+ 23 11 48
14	19 42 48	- 21 20 18	21 50 17	- 13 05 17	23 35 49	- 02 36 52	01 29 05	+ 09 19 50	03 23 17	+ 18 34 30	05 29 19	+ 23 15 03
15	19 47 06	- 21 09 33	21 54 11	- 12 44 50	23 39 29	- 02 13 12	01 32 47	+ 09 41 23	03 27 14	+ 18 48 54	05 33 28	+ 23 17 53
16	19 51 23	- 20 58 24	21 58 05	- 12 24 10	23 43 09	- 01 49 30	01 36 29	+ 10 02 47	03 31 11	+ 19 02 58	05 37 38	+ 23 20 19
17	19 55 40	- 20 46 51	22 01 57	- 12 03 18	23 46 48	- 01 25 48	01 40 11	+ 10 24 01	03 35 09	+ 19 16 43	05 41 47	+ 23 22 20
18	19 59 56	- 20 34 55	22 05 49	- 11 42 14	23 50 27	- 01 02 05	01 43 54	+ 10 45 04	03 39 07	+ 19 30 09	05 45 57	+ 23 23 56
19	20 04 12	- 20 22 34	22 09 41	- 11 20 59	23 54 06	- 00 38 21	01 47 37	+ 11 05 58	03 43 06	+ 19 43 14	05 50 07	+ 23 25 07
20	20 08 26	- 20 09 51	22 13 31	- 10 59 34	23 57 45	- 00 14 38	01 51 21	+ 11 26 40	03 47 06	+ 19 56 00	05 54 16	+ 23 25 54
21	20 12 40	- 19 56 45	22 17 22	- 10 37 58	00 01 24	+ 00 09 05	01 55 05	+ 11 47 11	03 51 06	+ 20 08 25	05 58 26	+ 23 26 16
22	20 16 54	- 19 43 16	22 21 11	- 10 16 12	00 05 03	+ 00 32 47	01 58 50	+ 12 07 30	03 55 07	+ 20 20 30	06 02 36	+ 23 26 12
23	20 21 06	- 19 29 25	22 25 00	- 09 54 17	00 08 41	+ 00 56 28	02 02 35	+ 12 27 38	03 59 08	+ 20 32 13	06 06 45	+ 23 25 44
24	20 25 18	- 19 15 13	22 28 48	- 09 32 12	00 12 20	+ 01 20 07	02 06 20	+ 12 47 33	04 03 09	+ 20 43 36	06 10 55	+ 23 24 52
25	20 29 29	- 19 00 39	22 32 36	- 09 09 59	00 15 58	+ 01 43 44	02 10 06	+ 13 07 16	04 07 12	+ 20 54 37	06 15 04	+ 23 23 34
26	20 33 39	- 18 45 45	22 36 23	- 08 47 38	00 19 37	+ 02 07 19	02 13 52	+ 13 26 45	04 11 14	+ 21 05 16	06 19 14	+ 23 21 52
27	20 37 48	- 18 30 30	22 40 09	- 08 25 09	00 23 15	+ 02 30 51	02 17 39	+ 13 46 02	04 15 18	+ 21 15 33	06 23 23	+ 23 19 45
28	20 41 57	- 18 14 54	22 43 55	- 08 02 32	00 26 54	+ 02 54 20	02 21 27	+ 14 05 04	04 19 21	+ 21 25 29	06 27 32	+ 23 17 13
29	20 46 05	- 17 59 00			00 30 32	+ 03 17 46	02 25 15	+ 14 23 53	04 23 26	+ 21 35 02	06 31 41	+ 23 14 17
30	20 50 12	- 17 42 45			00 34 11	+ 03 41 08	02 29 03	+ 14 42 27	04 27 30	+ 21 44 12	06 35 49	+ 23 10 57
31	20 54 18	- 17 26 12			00 37 49	+ 04 04 25			04 31 35	+ 21 53 00		
	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	06 39 58	+ 23 07 12	08 44 46	+ 18 04 04	10 40 47	+ 08 21 21	12 28 44	- 03 06 10	14 24 45	- 14 21 25	16 28 16	- 21 45 53
2	06 44 06	+ 23 03 03	08 48 39	+ 17 48 53	10 44 25	+ 07 59 34	12 32 21	- 03 29 25	14 28 40	- 14 40 33	16 32 35	- 21 55 06
3	06 48 13	+ 22 58 30	08 52 31	+ 17 33 25	10 48 02	+ 07 37 40	12 35 59	- 03 52 38	14 32 36	- 14 59 28	16 36 55	- 22 03 53
4	06 52 21	+ 22 53 33	08 56 23	+ 17 17 40	10 51 39	+ 07 15 38	12 39 36	- 04 15 48	14 36 32	- 15 18 08	16 41 15	- 22 12 15
5	06 56 28	+ 22 48 13	09 00 13	+ 17 01 38	10 55 15	+ 06 53 29	12 43 15	- 04 38 55	14 40 30	- 15 36 32	16 45 35	- 22 20 12
6	07 00 35	+ 22 42 28	09 04 04	+ 16 45 20	10 58 52	+ 06 31 13	12 46 53	- 05 01 58	14 44 28	- 15 54 42	16 49 57	- 22 27 42
7	07 04 41	+ 22 36 20	09 07 53	+ 16 28 45	11 02 28	+ 06 08 50	12 50 32	- 05 24 58	14 48 27	- 16 12 35	16 54 19	- 22 34 46
8	07 08 47	+ 22 29 48	09 11 42	+ 16 11 55	11 06 04	+ 05 46 22	12 54 11	- 05 47 54	14 52 27	- 16 30 13	16 58 41	- 22 41 24
9	07 12 53	+ 22 22 53	09 15 31	+ 15 54 49	11 09 40	+ 05 23 48	12 57 51	- 06 10 45	14 56 28	- 16 47 34	17 03 04	- 22 47 35
10	07 16 58	+ 22 15 35	09 19 19	+ 15 37 27	11 13 15	+ 05 01 08	13 01 31	- 06 33 32	15 00 29	- 17 04 38	17 07 27	- 22 53 20
11	07 21 03	+ 22 07 54	09 23 06	+ 15 19 51	11 16 51	+ 04 38 23	13 05 12	- 06 56 14	15 04 32	- 17 21 24	17 11 51	- 22 58 37
12	07 25 07	+ 21 59 50	09 26 53	+ 15 02 00	11 20 26	+ 04 15 33	13 08 53	- 07 18 50	15 08 35	- 17 37 53	17 16 16	- 23 03 27
13	07 29 11	+ 21 51 23	09 30 39	+ 14 43 54	11 24 02	+ 03 52 38	13 12 35	- 07 41 20	15 12 40	- 17 54 04	17 20 40	- 23 07 49
14	07 33 15	+ 21 42 34	09 34 25	+ 14 25 34	11 27 37	+ 03 29 39	13 16 17	- 08 03 44	15 16 45	- 18 09 55	17 25 05	- 23 11 44
15	07 37 18	+ 21 33 22	09 38 10	+ 14 07 00	11 31 12	+ 03 06 36	13 20 00	- 08 26 01	15 20 51	- 18 25 28	17 29 30	- 23 15 11
16	07 41 21	+ 21 23 49	09 41 55	+ 13 48 12	11 34 47	+ 02 43 30	13 23 43	- 08 48 12	15 24 58	- 18 40 42	17 33 56	- 23 18 10
17	07 45 23	+ 21 13 53	09 45 39	+ 13 29 12	11 38 23	+ 02 20 20	13 27 27	- 09 10 14	15 29 06	- 18 55 35	17 38 22	- 23 20 41
18	07 49 24	+ 21 03 36	09 49 23	+ 13 09 58	11 41 58	+ 01 57 08	13 31 12	- 09 32 09	15 33 14	- 19 10 08	17 42 48	- 23 22 45
19	07 53 25	+ 20 52 58	09 53 06	+ 12 50 32	11 45 33	+ 01 33 53	13 34 57	- 09 53 56	15 37 23	- 19 24 21	17 47 14	- 23 24 20
20	07 57 26	+ 20 41 58	09 56 49	+ 12 30 53	11 49 08	+ 01 10 36	13 38 43	- 10 15 34	15 41 34	- 19 38 13	17 51 40	- 23 25 27
21	08 01 26	+ 20 30 37	10 00 31	+ 12 11 03	11 52 44	+ 00 47 17	13 42 29	- 10 37 03	15 45 45	- 19 51 43	17 56 07	- 23 26 06
22	08 05 25	+ 20 18 55	10 04 13	+ 11 51 01	11 56 19	+ 00 23 57	13 46 16	- 10 58 22	15 49 56	- 20 04 51	18 00 33	- 23 26 16
23	08 09 24	+ 20 06 54	10 07 54	+ 11 30 48	11 59 55	+ 00 00 35	13 50 04	- 11 19 32	15 54 09	- 20 17 38	18 04 59	- 23 25 58
24	08 13 22	+ 19 54 31	10 11 35	+ 11 10 24	12 03 30	- 00 22 47	13 53 52	- 11 40 31	15 58 22	- 20 30 02	18 09 26	- 23 25 12
25	08 17 20	+ 19 41 50	10 15 15	+ 10 49 49	12 07 06	- 00 46 09	13 57 41	- 12 01 19	16 02 37	- 20 42 03	18 13 52	- 23 23 58
26	08 21 17	+ 19 28 48	10 18 55	+ 10 29 05	12 10 42	- 01 09 31	14 01 31	- 12 21 56	16 06 51	- 20 53 41	18 18 18	- 23 22 16
27	08 25 13	+ 19 15 27	10 22 35	+ 10 08 10	12 14 18	- 01 32 53	14 05 21	- 12 42 22	16 11 07	- 21 04 55	18 22 45	- 23 20 06
28	08 29 09	+ 19 01 47	10 26 14	+ 09 47 06	12 17 54	- 01 56 14	14 09 13	- 13 02 36	16 15 23	- 21 15 46	18 27 11	- 23 17 27
29	08 33 04	+ 18 47 49	10 29 53	+ 09 25 53	12 21 30	- 02 19 34	14 13 04	- 13 22 38	16 19 40	- 21 26 13	18 31 36	- 23 14 21
30	08 36 59	+ 18 33 32	10 33 31	+ 09 04 31	12 25 07	- 02 42 53	14 16 57	- 13 42 26	16 23 58	- 21 36 15	18 36 02	- 23 10 46
31	08 40 53	+ 18 18 57	10 37 09	+ 08 43 00			14 20 51	- 14 02 02			18 40 27	- 23 06 44

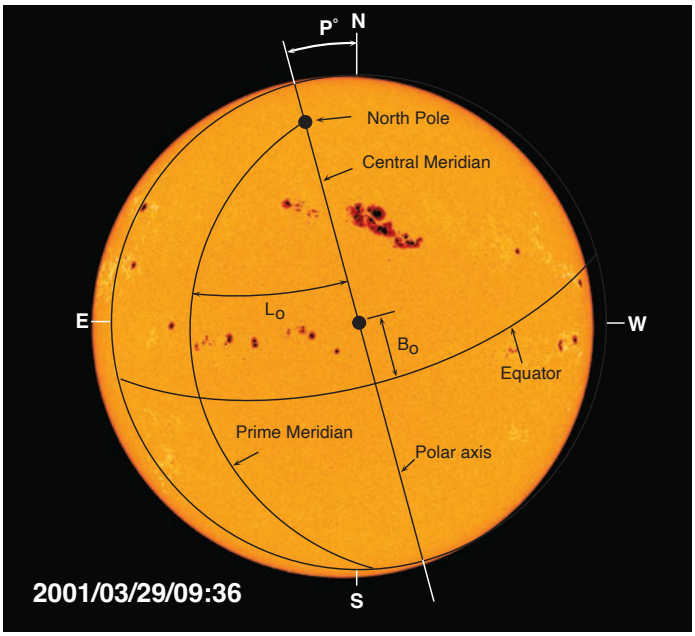
SUN RISE, SUN SET and ASTRONOMICAL TWILIGHT

	ADELAIDE (CST)				BRISBANE (EST)				CANBERRA (EST)				DARWIN (CST)				
	Twilight	Sun		Twilight	Twilight	Sun		Twilight	Twilight	Sun		Twilight	Twilight	Sun		Twilight	
	Begin	Rise	Set	End	Begin	Rise	Set	End	Begin	Rise	Set	End	Begin	Rise	Set	End	
Jan 3	3:21	5:07	19:33	21:18	3:25	4:57	18:47	20:19	3:07	4:54	19:22	21:08	5:08	6:26	19:17	20:35	Jan 3
10	3:29	5:13	19:33	21:17	3:32	5:03	18:48	20:19	3:15	5:00	19:22	21:06	5:13	6:30	19:19	20:36	10
17	3:38	5:20	19:31	21:13	3:39	5:08	18:48	20:17	3:24	5:07	19:20	21:02	5:17	6:34	19:20	20:37	17
24	3:47	5:27	19:28	21:07	3:46	5:14	18:46	20:13	3:34	5:14	19:17	20:56	5:22	6:38	19:20	20:36	24
31	3:57	5:34	19:24	21:00	3:54	5:20	18:43	20:09	3:44	5:21	19:12	20:49	5:26	6:41	19:20	20:35	31
Feb 7	4:07	5:41	19:18	20:51	4:01	5:25	18:39	20:03	3:54	5:28	19:06	20:41	5:30	6:44	19:18	20:32	Feb 7
14	4:16	5:48	19:11	20:42	4:08	5:30	18:33	19:56	4:03	5:36	18:59	20:31	5:33	6:46	19:16	20:29	14
21	4:25	5:55	19:03	20:32	4:14	5:35	18:27	19:49	4:12	5:42	18:51	20:21	5:36	6:48	19:13	20:26	21
28	4:34	6:01	18:54	20:22	4:20	5:40	18:21	19:41	4:21	5:49	18:43	20:10	5:38	6:49	19:10	20:21	28
Mar 7	4:41	6:08	18:45	20:11	4:25	5:44	18:14	19:32	4:28	5:55	18:33	20:00	5:39	6:50	19:06	20:17	Mar 7
14	4:48	6:14	18:36	20:01	4:30	5:48	18:06	19:24	4:36	6:01	18:24	19:49	5:40	6:51	19:02	20:12	14
21	4:55	6:19	18:26	19:50	4:34	5:52	17:58	19:16	4:42	6:07	18:14	19:38	5:41	6:51	18:57	20:08	21
28	5:01	6:25	18:16	19:40	4:38	5:55	17:50	19:08	4:48	6:13	18:04	19:28	5:41	6:51	18:53	20:03	28
Apr 4	5:06	6:30	18:06	19:30	4:41	5:59	17:43	19:00	4:54	6:18	17:54	19:18	5:41	6:52	18:48	19:59	Apr 4
11	5:12	6:36	17:57	19:21	4:45	6:03	17:35	18:53	5:00	6:24	17:45	19:09	5:41	6:52	18:44	19:55	11
18	5:17	6:41	17:48	19:13	4:48	6:06	17:28	18:46	5:05	6:30	17:36	19:00	5:41	6:53	18:40	19:51	18
25	5:22	6:47	17:40	19:05	4:51	6:10	17:22	18:40	5:10	6:35	17:27	18:53	5:42	6:53	18:37	19:48	25
May 2	5:27	6:52	17:32	18:58	4:54	6:14	17:16	18:35	5:15	6:41	17:20	18:46	5:42	6:54	18:34	19:46	May 2
9	5:31	6:58	17:26	18:53	4:58	6:18	17:11	18:31	5:19	6:46	17:13	18:40	5:43	6:56	18:31	19:44	9
16	5:36	7:03	17:20	18:48	5:01	6:22	17:07	18:28	5:24	6:52	17:07	18:35	5:43	6:57	18:30	19:43	16
23	5:40	7:08	17:16	18:45	5:04	6:26	17:04	18:25	5:28	6:57	17:03	18:32	5:45	6:59	18:28	19:43	23
30	5:44	7:13	17:13	18:42	5:07	6:29	17:01	18:24	5:32	7:02	17:00	18:30	5:46	7:01	18:28	19:43	30
Jun 6	5:47	7:17	17:11	18:41	5:10	6:33	17:00	18:23	5:36	7:06	16:58	18:28	5:47	7:03	18:28	19:44	Jun 6
13	5:50	7:21	17:11	18:41	5:12	6:35	17:01	18:24	5:38	7:09	16:58	18:28	5:49	7:05	18:29	19:45	13
20	5:52	7:23	17:11	18:42	5:14	6:37	17:01	18:25	5:41	7:12	16:58	18:29	5:51	7:07	18:30	19:46	20
27	5:53	7:24	17:13	18:44	5:15	6:39	17:03	18:27	5:42	7:13	17:00	18:31	5:52	7:08	18:32	19:48	27
Jul 4	5:54	7:24	17:16	18:46	5:16	6:39	17:06	18:29	5:42	7:13	17:03	18:34	5:53	7:09	18:34	19:50	Jul 4
11	5:53	7:22	17:20	18:50	5:16	6:38	17:09	18:31	5:41	7:11	17:07	18:37	5:54	7:09	18:36	19:51	11
18	5:51	7:20	17:24	18:53	5:14	6:36	17:12	18:34	5:39	7:08	17:11	18:41	5:54	7:09	18:38	19:52	18
25	5:48	7:16	17:29	18:57	5:12	6:33	17:16	18:37	5:36	7:04	17:16	18:45	5:54	7:08	18:39	19:53	25
Aug 1	5:43	7:10	17:34	19:01	5:09	6:29	17:19	18:40	5:31	6:59	17:21	18:49	5:53	7:06	18:41	19:54	Aug 1
8	5:38	7:04	17:39	19:05	5:05	6:25	17:23	18:43	5:26	6:52	17:26	18:53	5:51	7:04	18:42	19:54	8
15	5:31	6:56	17:44	19:10	5:00	6:19	17:27	18:45	5:19	6:45	17:32	18:57	5:49	7:01	18:43	19:55	15
22	5:23	6:48	17:49	19:14	4:54	6:12	17:30	18:48	5:11	6:36	17:37	19:02	5:46	6:57	18:43	19:54	22
29	5:15	6:39	17:55	19:19	4:47	6:05	17:33	18:51	5:03	6:27	17:42	19:07	5:42	6:53	18:43	19:54	29
Sep 5	5:06	6:30	18:00	19:24	4:40	5:57	17:36	18:54	4:54	6:18	17:47	19:11	5:38	6:49	18:43	19:54	Sep 5
12	4:56	6:20	18:05	19:29	4:32	5:50	17:39	18:57	4:44	6:08	17:52	19:17	5:33	6:44	18:43	19:54	12
19	4:46	6:10	18:10	19:34	4:24	5:41	17:43	19:00	4:33	5:58	17:57	19:22	5:29	6:39	18:43	19:53	19
26	4:35	6:00	18:15	19:40	4:15	5:33	17:46	19:04	4:23	5:48	18:03	19:28	5:24	6:34	18:43	19:53	26
Oct 3	4:24	5:50	18:20	19:46	4:07	5:25	17:49	19:08	4:12	5:38	18:08	19:34	5:19	6:29	18:43	19:54	Oct 3
10	4:13	5:40	18:26	19:53	3:58	5:18	17:53	19:12	4:01	5:28	18:14	19:41	5:14	6:25	18:43	19:55	10
17	4:03	5:31	18:32	20:00	3:50	5:10	17:57	19:17	3:50	5:19	18:20	19:49	5:09	6:21	18:44	19:56	17
24	3:52	5:23	18:38	20:08	3:42	5:04	18:01	19:23	3:39	5:10	18:26	19:57	5:05	6:17	18:45	19:58	24
31	3:42	5:15	18:44	20:17	3:35	4:58	18:06	19:29	3:29	5:02	18:33	20:06	5:01	6:15	18:47	20:01	31
Nov 7	3:33	5:08	18:51	20:26	3:28	4:53	18:11	19:36	3:20	4:55	18:39	20:15	4:58	6:13	18:49	20:04	Nov 7
14	3:25	5:03	18:58	20:36	3:22	4:49	18:16	19:43	3:12	4:50	18:46	20:25	4:56	6:11	18:52	20:07	14
21	3:18	4:59	19:05	20:45	3:18	4:46	18:22	19:50	3:05	4:46	18:53	20:34	4:55	6:11	18:55	20:11	21
28	3:13	4:56	19:11	20:54	3:15	4:45	18:27	19:57	3:00	4:43	19:00	20:44	4:54	6:12	18:58	20:16	28
Dec 5	3:10	4:55	19:18	21:02	3:14	4:45	18:32	20:04	2:56	4:42	19:06	20:52	4:55	6:13	19:02	20:20	Dec 5
12	3:09	4:55	19:23	21:09	3:14	4:46	18:37	20:09	2:55	4:42	19:12	20:59	4:57	6:15	19:06	20:25	12
19	3:11	4:57	19:28	21:15	3:16	4:48	18:41	20:14	2:57	4:44	19:17	21:04	5:00	6:18	19:10	20:29	19
26	3:14	5:01	19:31	21:18	3:19	4:52	18:45	20:17	3:00	4:48	19:20	21:07	5:03	6:22	19:13	20:32	26

SUN RISE, SUN SET and ASTRONOMICAL TWILIGHT

	HOBART (EST)				MELBOURNE (EST)				PERTH (WST)				SYDNEY (EST)				
	Twilight	Sun		Twilight	Twilight	Sun		Twilight	Twilight	Sun		Twilight	Twilight	Sun		Twilight	
	Begin	Rise	Set	End	Begin	Rise	Set	End	Begin	Rise	Set	End	Begin	Rise	Set	End	
Jan 3	2:24	4:38	19:53	22:07	3:09	5:03	19:46	21:39	3:36	5:16	19:26	21:05	3:06	4:49	19:10	20:53	Jan 3
10	2:35	4:45	19:51	22:01	3:18	5:09	19:45	21:36	3:43	5:21	19:27	21:04	3:13	4:55	19:10	20:51	10
17	2:48	4:53	19:48	21:54	3:28	5:17	19:43	21:31	3:51	5:27	19:26	21:01	3:22	5:01	19:08	20:48	17
24	3:02	5:02	19:43	21:43	3:39	5:24	19:39	21:24	4:00	5:34	19:23	20:57	3:31	5:08	19:05	20:42	24
31	3:16	5:12	19:37	21:32	3:50	5:32	19:34	21:16	4:09	5:41	19:19	20:51	3:40	5:15	19:01	20:36	31
Feb 7	3:30	5:21	19:28	21:19	4:01	5:40	19:27	21:06	4:17	5:47	19:14	20:43	3:50	5:22	18:56	20:28	Feb 7
14	3:44	5:31	19:19	21:06	4:12	5:48	19:20	20:56	4:26	5:53	19:08	20:35	3:59	5:29	18:49	20:19	14
21	3:56	5:40	19:09	20:52	4:22	5:56	19:11	20:45	4:34	5:59	19:01	20:26	4:07	5:36	18:41	20:09	21
28	4:08	5:49	18:58	20:38	4:31	6:03	19:01	20:33	4:41	6:05	18:53	20:17	4:15	5:42	18:33	19:59	28
Mar 7	4:20	5:58	18:46	20:24	4:40	6:10	18:51	20:21	4:47	6:10	18:44	20:07	4:22	5:48	18:24	19:49	Mar 7
14	4:30	6:06	18:34	20:10	4:48	6:17	18:41	20:10	4:53	6:16	18:36	19:58	4:29	5:53	18:15	19:39	14
21	4:39	6:14	18:22	19:56	4:56	6:24	18:30	19:58	4:59	6:20	18:27	19:48	4:35	5:59	18:05	19:29	21
28	4:48	6:23	18:09	19:43	5:03	6:30	18:20	19:47	5:04	6:25	18:18	19:39	4:41	6:04	17:56	19:19	28
Apr 4	4:57	6:31	17:57	19:31	5:09	6:36	18:09	19:36	5:09	6:30	18:09	19:30	4:46	6:09	17:46	19:09	Apr 4
11	5:04	6:39	17:45	19:19	5:15	6:43	17:59	19:26	5:13	6:35	18:00	19:22	4:51	6:14	17:37	19:00	11
18	5:12	6:46	17:34	19:08	5:21	6:49	17:49	19:17	5:18	6:39	17:52	19:14	4:56	6:20	17:29	18:52	18
25	5:19	6:54	17:23	18:59	5:27	6:55	17:40	19:08	5:22	6:44	17:45	19:07	5:01	6:25	17:21	18:45	25
May 2	5:26	7:02	17:14	18:50	5:33	7:02	17:32	19:01	5:26	6:49	17:38	19:01	5:05	6:30	17:13	18:38	May 2
9	5:32	7:10	17:05	18:42	5:38	7:08	17:25	18:55	5:30	6:54	17:32	18:56	5:10	6:36	17:07	18:33	9
16	5:39	7:17	16:57	18:36	5:43	7:14	17:18	18:50	5:34	6:59	17:27	18:52	5:14	6:41	17:02	18:28	16
23	5:44	7:24	16:51	18:31	5:48	7:20	17:13	18:46	5:38	7:03	17:23	18:49	5:18	6:46	16:58	18:25	23
30	5:49	7:30	16:47	18:28	5:52	7:25	17:10	18:43	5:41	7:07	17:21	18:47	5:22	6:50	16:55	18:23	30
Jun 6	5:54	7:35	16:44	18:26	5:56	7:29	17:08	18:42	5:44	7:11	17:19	18:46	5:25	6:54	16:53	18:22	Jun 6
13	5:57	7:39	16:43	18:25	5:59	7:33	17:07	18:41	5:47	7:14	17:19	18:46	5:28	6:57	16:53	18:22	13
20	5:59	7:42	16:43	18:26	6:01	7:35	17:08	18:42	5:49	7:16	17:20	18:47	5:30	7:00	16:53	18:23	20
27	6:01	7:43	16:45	18:28	6:02	7:36	17:10	18:44	5:50	7:18	17:22	18:49	5:31	7:01	16:55	18:25	27
Jul 4	6:00	7:42	16:49	18:31	6:02	7:36	17:13	18:47	5:51	7:18	17:24	18:51	5:32	7:01	16:58	18:27	Jul 4
11	5:59	7:40	16:54	18:35	6:01	7:34	17:17	18:50	5:50	7:16	17:28	18:54	5:31	6:59	17:02	18:30	11
18	5:56	7:36	16:59	18:39	5:59	7:31	17:22	18:54	5:48	7:14	17:32	18:58	5:29	6:57	17:06	18:34	18
25	5:51	7:30	17:06	18:45	5:55	7:26	17:27	18:58	5:45	7:10	17:36	19:01	5:26	6:53	17:10	18:37	25
Aug 1	5:45	7:23	17:13	18:50	5:50	7:21	17:33	19:03	5:42	7:06	17:41	19:05	5:22	6:48	17:15	18:41	Aug 1
8	5:38	7:14	17:20	18:56	5:44	7:13	17:38	19:08	5:37	7:00	17:45	19:08	5:16	6:42	17:20	18:45	8
15	5:29	7:05	17:27	19:03	5:37	7:05	17:44	19:13	5:31	6:53	17:50	19:12	5:10	6:34	17:25	18:50	15
22	5:20	6:54	17:35	19:09	5:28	6:56	17:50	19:18	5:24	6:46	17:54	19:16	5:03	6:26	17:30	18:54	22
29	5:09	6:43	17:42	19:16	5:19	6:46	17:56	19:24	5:16	6:37	17:58	19:20	4:55	6:18	17:35	18:58	29
Sep 5	4:57	6:31	17:49	19:23	5:09	6:36	18:02	19:29	5:08	6:29	18:02	19:24	4:46	6:08	17:40	19:03	Sep 5
12	4:45	6:19	17:57	19:31	4:58	6:26	18:08	19:35	4:59	6:20	18:07	19:28	4:36	5:59	17:44	19:07	12
19	4:32	6:06	18:04	19:39	4:47	6:15	18:14	19:41	4:49	6:10	18:11	19:32	4:26	5:49	17:49	19:12	19
26	4:18	5:54	18:12	19:48	4:36	6:04	18:20	19:48	4:40	6:01	18:15	19:37	4:16	5:39	17:54	19:18	26
Oct 3	4:05	5:41	18:20	19:57	4:24	5:53	18:26	19:55	4:30	5:52	18:20	19:42	4:05	5:30	17:59	19:24	Oct 3
10	3:50	5:29	18:28	20:07	4:12	5:42	18:32	20:03	4:20	5:43	18:25	19:48	3:55	5:20	18:04	19:30	10
17	3:36	5:18	18:36	20:18	4:00	5:32	18:39	20:12	4:10	5:35	18:30	19:55	3:44	5:12	18:10	19:37	17
24	3:22	5:07	18:45	20:30	3:48	5:23	18:46	20:21	4:01	5:27	18:35	20:02	3:34	5:03	18:16	19:45	24
31	3:08	4:57	18:54	20:43	3:37	5:15	18:53	20:31	3:52	5:20	18:41	20:09	3:25	4:56	18:22	19:53	31
Nov 7	2:55	4:48	19:03	20:56	3:27	5:07	19:01	20:42	3:44	5:14	18:47	20:17	3:16	4:49	18:28	20:02	Nov 7
14	2:42	4:40	19:12	21:10	3:17	5:01	19:09	20:53	3:37	5:09	18:53	20:26	3:08	4:44	18:35	20:11	14
21	2:31	4:34	19:21	21:24	3:09	4:56	19:16	21:03	3:31	5:06	18:59	20:34	3:02	4:40	18:42	20:20	21
28	2:22	4:29	19:29	21:37	3:03	4:53	19:23	21:14	3:27	5:04	19:05	20:42	2:57	4:38	18:48	20:29	28
Dec 5	2:15	4:27	19:37	21:49	2:59	4:51	19:30	21:23	3:25	5:03	19:11	20:50	2:55	4:37	18:54	20:37	Dec 5
12	2:11	4:26	19:43	21:59	2:57	4:51	19:36	21:30	3:24	5:04	19:17	20:56	2:54	4:37	19:00	20:44	12
19	2:11	4:28	19:48	22:06	2:58	4:53	19:41	21:36	3:26	5:06	19:21	21:01	2:55	4:40	19:04	20:49	19
26	2:14	4:32	19:51	22:08	3:02	4:57	19:44	21:39	3:30	5:10	19:24	21:04	2:59	4:43	19:08	20:52	26

ORIENTATION OF THE SUN



P ° Position angle of Polar Axis. (+ when pole east of north point, – if west)

B_o° Heliocentric Latitude of centre of Sun

L_o° Heliocentric Longitude of centre of Sun

At the date of commencement of each synodic rotation period the value of L_o is zero; that is, the prime meridian passes through the central point of the disc.

The rotation period of the Sun depends on latitude. The sidereal period of rotation at the equator is 25.38 days. The mean synodic period is 27.28 days.

Example for Calculating Heliocentric Longitude

You wish to calculate the L_o value for Aug 19 at 2pm WST.

2pm WST is 6 hours UT (0 hr UT is 8am WST). To get the value for Aug 19 (0 hr UT) start with the value from the main table for Aug 15 (66.4°) plus 4 days which from the daily variation table is –52.7°. Then you add the value for 6 hours, which is –3.3°. The calculation becomes:

66.4° + (–52.7°) + (–3.3°) = 10.4° (If result negative, add 360°)

SYNODIC ROTATION NUMBERS (UT)

Rotation	Month	d.dd
2079	Jan	13.94
2080	Feb	10.28
2081	Mar	9.62
2082	Apr	5.92
2083	May	3.18
2084	May	30.4
2085	Jun	26.59
2086	Jul	23.8
2087	Aug	20.02
2088	Sep	16.28
2089	Oct	13.56
2090	Nov	9.86
2091	Dec	7.17

Active region 9393 as seen by MDI hosted a large sunspot group. On 30 March 2001, the sunspot area within the group spanned an area more than 13 times the entire surface of the Earth! It was the source of numerous flares and coronal mass ejections, including the largest flare recorded (at the time) in 25 years on 2 April 2001. Caused by intense magnetic fields emerging from the interior, a sunspot appears to be dark only when contrasted against the rest of the solar surface, because it is slightly cooler than the unmarked regions. Courtesy of SOHO/[MDI] consortium. SOHO is a project of international cooperation between ESA and NASA.

VARIATION OF L_o	
DAILY	
1	– 13.2
2	– 26.4
3	– 39.6
4	– 52.7
5	– 65.9
6	– 79.1
HOURLY	
1	– 0.6
2	– 1.1
3	– 1.7
4	– 2.2
5	– 2.8
6	– 3.3
7	– 3.8
8	– 4.4
9	– 4.9
10	– 5.5
11	– 6.0
12	– 6.6
13	– 7.1
14	– 7.7
15	– 8.2
16	– 8.8
17	– 9.3
18	– 9.9
19	– 10.4
20	– 11.0
21	– 11.5
22	– 12.1
23	– 12.6
24	– 13.2

Date	P°	B_o°	L_o°
Jan 3	+ 1.0	- 3.3	144.1
10	- 2.4	- 4.1	051.9
17	- 5.7	- 4.8	319.7
24	- 8.8	- 5.4	227.5
31	- 11.8	- 6.0	135.4
Feb 7	- 14.6	- 6.4	043.2
14	- 17.1	- 6.8	311.0
21	- 19.4	- 7.1	218.9
28	- 21.3	- 7.2	126.7
Mar 7	- 23.0	- 7.3	034.5
14	- 24.3	- 7.2	302.2
21	- 25.3	- 7.0	209.9
28	- 25.9	- 6.7	117.6
Apr 4	- 26.3	- 6.4	025.3
11	- 26.2	- 5.9	292.9
18	- 25.8	- 5.4	200.5
25	- 25.1	- 4.8	108.0
May 2	- 23.9	- 4.1	015.5
9	- 22.5	- 3.3	283.0
16	- 20.7	- 2.6	190.4
23	- 18.5	- 1.7	097.8
30	- 16.1	- 0.9	005.2
Jun 6	- 13.5	- 0.1	272.6
13	- 10.6	+ 0.8	179.9
20	- 7.6	+ 1.6	087.3
27	- 4.5	+ 2.4	354.6
Jul 4	- 1.3	+ 3.2	261.9
11	+ 1.9	+ 3.9	169.3
18	+ 5.0	+ 4.6	076.7
25	+ 8.0	+ 5.2	344.1
Aug 1	+ 10.9	+ 5.8	251.5
8	+ 13.5	+ 6.3	158.9
15	+ 16.0	+ 6.6	066.4
22	+ 18.3	+ 6.9	333.8
29	+ 20.3	+ 7.1	241.3
Sep 5	+ 22.1	+ 7.2	148.9
12	+ 23.5	+ 7.2	056.4
19	+ 24.7	+ 7.1	324.0
26	+ 25.6	+ 6.9	231.6
Oct 3	+ 26.1	+ 6.6	139.3
10	+ 26.3	+ 6.2	046.9
17	+ 26.1	+ 5.7	314.6
24	+ 25.6	+ 5.1	222.2
31	+ 24.6	+ 4.5	129.9
Nov 7	+ 23.3	+ 3.8	037.6
14	+ 21.7	+ 3.0	305.3
21	+ 19.6	+ 2.1	213.1
28	+ 17.2	+ 1.3	120.8
Dec 5	+ 14.5	+ 0.4	028.5
12	+ 11.5	- 0.5	296.3
19	+ 8.3	- 1.4	204.1
26	+ 5.0	- 2.3	111.9

SOLAR AND LUNAR ECLIPSES

During 2009, there are six eclipses, two of the Sun and four of the Moon. One solar eclipse is annular and the other total, of the lunar eclipses three are penumbral and one is partial. To cater for all observers we use three time zones in the eclipse section, UT, EST and WST and no account is made for daylight saving time. Carefully check the data you are using before planning your observing.

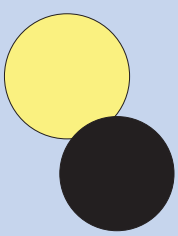
Magnitudes for lunar eclipses relate to the percentage of the lunar diameter immersed in the Earth's umbral shadow (total and partial eclipses), or the penumbral shadow (penumbral eclipse). It is not a measure of brightness.

January 26th — Annular eclipse of the Sun

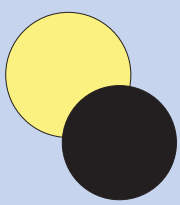
The first eclipse of the year is an annular eclipse of the Sun. The path of annularity is primarily across water, from the South Atlantic to the Indian Ocean. Landfall occurs in Indonesia as the path crosses southern Sumatra and the volcano Krakatoa. Leaving Sumatra the path again passes over water to land in Borneo for a sunset eclipse. Greatest eclipse of close to eight minutes occurs over the Indian Ocean about half way between Australia and Madagascar, and those on land in Sumatra will enjoy around six minutes of annularity.

ANNULAR SOLAR ECLIPSE 26th January 2009

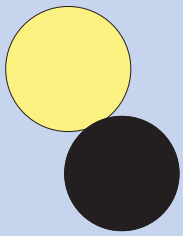
The diagrams below show the view at maximum partial eclipse as seen from various Australian locations. The approximate local time for each stage of the eclipse is given, followed by the Sun's altitude. No account has been made for daylight saving time. P1 = first contact (beginning of partial eclipse), Max = maximum eclipse, P2 = second contact (end of partial eclipse), Obsc = the percentage of the solar disk obscured by the Moon at maximum eclipse.



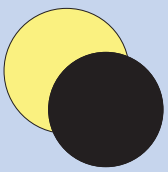
ADELAIDE
P1 6:01 pm (16°)
Max 6:30 (10°)
P2 6:58 (5°)
Obsc 3.4%



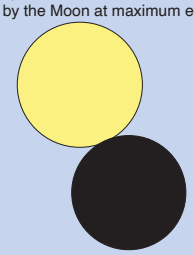
ALICE SPRINGS
P1 6:00 pm (18°)
Max 6:48 (7°)
P2 Below horizon
Obsc 17.9%



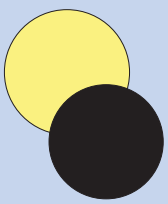
CANBERRA
P1 6:42 pm (5.5°)
Max 6:58 (2.5°)
P2 Below horizon
Obsc 0.6%



DARWIN
P1 6:04 pm (17°)
Max 7:04 (3°)
P2 Below horizon
Obsc 41.6%



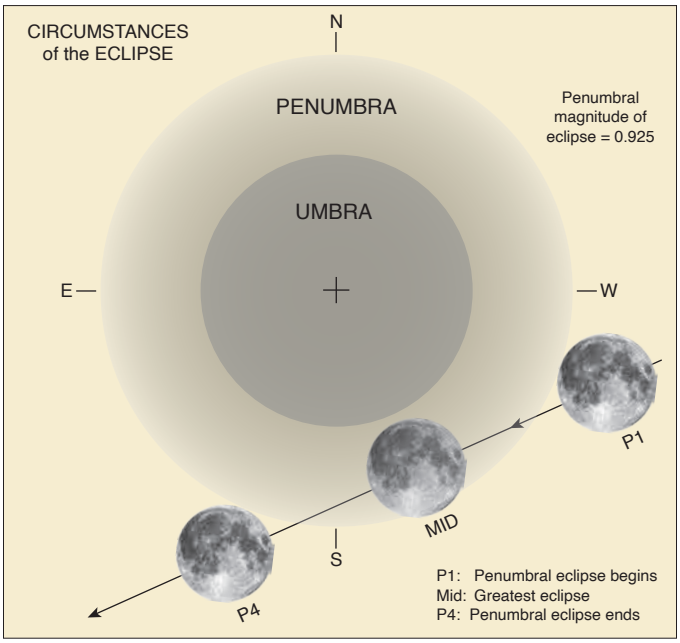
MELBOURNE
P1 6:41 pm (10°)
Max 6:55 (7°)
P2 7:08 (5°)
Obsc 0.4%



PERTH
P1 4:01 pm (41°)
Max 5:02 (28°)
P2 5:56 (16°)
Obsc 22.2%

Most parts of Australia will witness some degree of partiality (except Tasmania), although the Sun may be low to or below the horizon at maximum eclipse, especially from the eastern mainland states. From Brisbane maximum eclipse occurs with the Sun below the horizon, and from Sydney the Sun will be on the horizon at this instant.

February 9th/10th — Penumbral eclipse of the Moon



The first lunar eclipse of the year is visible from eastern Asia, Australia, New Zealand, eastern Europe, and Alaska. Generally, penumbral lunar eclipses are of little interest to the casual observer as they often provide little evidence that an eclipse is happening at all! At this eclipse, however the penumbral magnitude is 0.925, placing the Moon deep within the penumbral shadow. Observers will note a subtle darkening across the northern half of the Moon, best seen around the time of maximum eclipse.

	UT (9th)	EST (9/10th)	WST (9/10th)
Penumbral eclipse begins (P1)	12h 36.8m	10:36.8pm	8:36.8pm
Greatest eclipse (MID)	14h 38.2m	00:38.2am	10:38.2pm
Penumbral eclipse ends (P4)	16h 39.6m	02:39.6am	00:39.6am

July 7th — Penumbral eclipse of the Moon

The second penumbral lunar eclipse of the year is technically visible from Australia, however the passage of the Moon's limb through the penumbral shadow is very shallow. Unlike the February eclipse when the Moon passed deep into the shadow it is very likely that this event will go unnoticed. Any penumbral eclipse with a magnitude of 0.7 or less is generally considered difficult to observe, and with a magnitude of only 0.182, this one will be near impossible. From Western Australia the Moon rises at mid-eclipse in a twilight sky.

	UT	EST	WST
Penumbral eclipse begins (P1)	08h 32.8m	6:32.8pm	4:32.8pm
Greatest eclipse (MID)	09h 38.6m	7:38.6pm	5:38.2pm
Penumbral eclipse ends (P4)	10h 44.4m	8:44.4pm	6:44.4pm

July 21st/22nd — Total eclipse of the Sun

This total solar eclipse belongs to a family of eclipses (Saros 136) that is noted for producing the longest lasting total eclipses of last century (e.g., June 30th 1973 and July 11th 1991). The maximum duration of 6 minutes and 39 seconds occurs over the Pacific Ocean, however land based observers in eastern China can expect around five minutes of darkness. It is interesting to note that there are only four total solar eclipses that exceed six minutes in length this century. The next two in 2027 and 2045 are from the same Saros 136, and the last in 2096 belongs to Saros 139.

The path of totality begins on the west coast of the Indian subcontinent, travels northeast fleetingly touching Nepal's eastern border, the northern section of Bangladesh, and most of Bhutan, before crossing over China. The path leaves land near Shanghai passing below Japan and across the Pacific Ocean; the only other landfall along this watery journey will be some members of the Marshall and Gilbert Island groups.

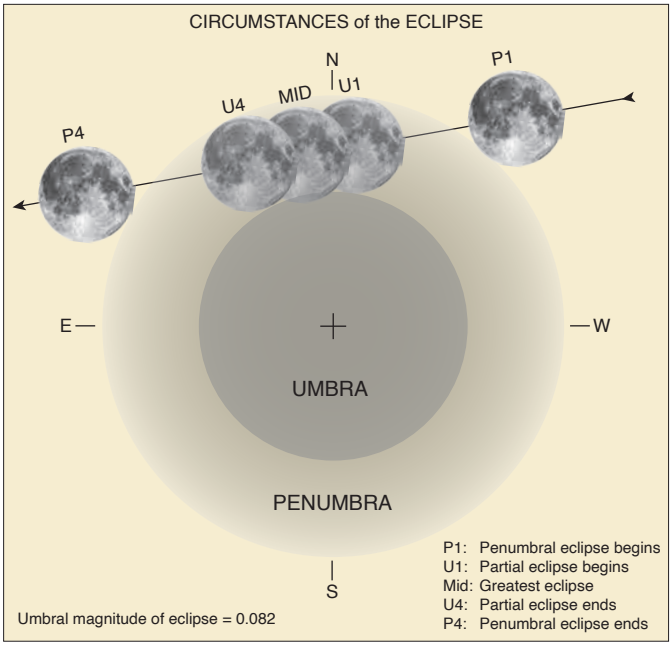
As luck would have it, the weather prospects are not very favourable for this long duration eclipse. Monsoons, thunderstorms, typhoons, cyclones and general cloudiness along the path of totality will make the choice of observing site difficult. India is probably the worst place to be, with the eastern side of China around the cities of Wuhan or Shanghai showing some promise. An excellent resource for site information and weather analysis can be found at home.cc.umanitoba.ca/~jander/.

	UT	Longitude	Latitude
Eclipse begins:	21d 23h 58.3m	+84°43.1'	+19°02.9'
Central eclipse at local apparent noon:	22d 02h 33.0m	+143°21.6'	+24°36.7'
Eclipse ends:	22d 05h 12.4m	-171°50.9'	-14°13.8'

August 5th/6th — Penumbral eclipse of the Moon

Another shallow penumbral eclipse (magnitude 0.428) that will go unnoticed by all except an experienced observer. This eclipse is visible from Europe, Africa and South America.

January 1st 2010 — Partial eclipse of the Moon



The last eclipse of the year (if reckoned using UT) actually occurs in the morning hours of the 1st January 2010 for Western Australian observers. From the eastern states, the eclipse begins in the dawn sky and the Moon sets before mid-eclipse. Central Australian observers fair a little better with the beginning to mid-eclipse occurring in the dawn sky just before moonset.

From Perth, observers will be able to follow the eclipse right up to mid-eclipse before the onset of dawn. The immersion of the Moon into the Earth's umbral shadow is very shallow at just 0.082 magnitude, observers will see a small-defined bite taken out of the southern lunar limb by the umbra. The rest of the Moon will be bathed in the penumbral shadow gradually fading towards the northern limb.

	UT (31st)	WST (1st)
Penumbral eclipse begins:	17h 15.3m	1:15.3am
Partial eclipse begins:	18h 51.6m	2:51.6am
Mid-eclipse:	19h 22.7m	3:22.7am
Partial eclipse ends:	19h 53.8m	Dawn
Penumbral eclipse ends:	21h 30.1m	Set

ADELAIDE (CST) MOON RISE AND SET BRISBANE (EST)

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	09:09	22:18	11:05	22:10	10:03	20:46	12:25	22:02
2	10:08	22:44	12:11	22:44	11:11	21:25	13:23	23:10
3	11:08	23:10	13:19	23:25	12:20	22:10	14:12	DNS
4	12:09	23:37	14:29	DNS	13:28	23:05	14:54	00:20
5	13:14	DNS	15:38	00:14	14:31	DNS	15:29	01:31
6	14:22	00:09	16:41	01:14	15:27	00:09	16:01	02:40
7	15:34	00:46	17:36	02:22	16:15	01:18	16:30	03:47
8	16:47	01:31	18:22	03:37	16:55	02:31	16:58	04:52
9	17:56	02:27	19:00	04:52	17:30	03:44	17:27	05:57
10	18:58	03:34	19:34	06:06	18:01	04:54	17:58	07:01
11	19:49	04:48	20:04	07:16	18:30	06:02	18:32	08:04
12	20:32	06:05	20:32	08:23	18:59	07:08	19:10	09:07
13	21:07	07:21	21:01	09:29	19:28	08:13	19:54	10:08
14	21:38	08:32	21:30	10:32	20:00	09:18	20:42	11:05
15	22:06	09:39	22:03	11:35	20:35	10:21	21:36	11:56
16	22:34	10:44	22:39	12:37	21:15	11:23	22:32	12:41
17	23:02	11:46	23:21	13:37	22:01	12:21	23:30	13:20
18	23:31	12:48	DNR	14:33	22:51	13:16	DNR	13:55
19	DNR	13:48	00:08	15:24	23:46	14:04	00:29	14:25
20	00:05	14:48	01:00	16:10	DNR	14:47	01:28	14:53
21	00:42	15:46	01:56	16:51	00:43	15:24	02:27	15:19
22	01:25	16:40	02:54	17:26	01:42	15:57	03:27	15:46
23	02:14	17:30	03:54	17:57	02:42	16:26	04:29	16:14
24	03:08	18:14	04:54	18:26	03:41	16:53	05:34	16:45
25	04:05	18:52	05:54	18:52	04:42	17:20	06:42	17:21
26	05:04	19:26	06:54	19:18	05:43	17:47	07:53	18:03
27	06:04	19:56	07:55	19:45	06:46	18:15	09:05	18:54
28	07:03	20:23	08:58	20:14	07:52	18:47	10:14	19:54
29	08:02	20:48			09:00	19:25	11:16	21:01
30	09:02	21:14			10:10	20:09	12:09	22:12
31	10:02	21:41			11:19	21:01		

	MAY		JUNE		JULY		AUGUST	
1	12:54	23:23	13:04	00:37	12:34	01:39	13:13	03:32
2	13:31	DNS	13:32	01:41	13:07	02:41	14:04	04:25
3	14:03	00:32	14:00	02:43	13:45	03:42	14:59	05:12
4	14:32	01:39	14:32	03:45	14:28	04:41	15:57	05:53
5	15:00	02:43	15:06	04:47	15:16	05:37	16:55	06:29
6	15:28	03:47	15:46	05:48	16:09	06:28	17:53	07:00
7	15:58	04:49	16:31	06:47	17:06	07:13	18:51	07:28
8	16:30	05:52	17:21	07:42	18:04	07:53	19:48	07:55
9	17:07	06:55	18:15	08:31	19:02	08:27	20:45	08:20
10	17:48	07:56	19:12	09:15	19:59	08:57	21:44	08:45
11	18:35	08:55	20:10	09:52	20:56	09:24	22:45	09:12
12	19:27	09:48	21:08	10:25	21:53	09:50	23:49	09:42
13	20:23	10:36	22:05	10:54	22:51	10:15	DNR	10:17
14	21:20	11:17	23:03	11:21	23:51	10:41	00:55	10:58
15	22:18	11:53	DNR	11:46	DNR	11:09	02:02	11:49
16	23:16	12:24	00:01	12:12	00:54	11:41	03:08	12:48
17	DNR	12:53	01:00	12:39	02:00	12:19	04:09	13:57
18	00:14	13:19	02:03	13:09	03:09	13:05	05:02	15:11
19	01:13	13:45	03:09	13:45	04:18	14:01	05:47	16:27
20	02:13	14:12	04:19	14:27	05:25	15:07	06:26	17:41
21	03:15	14:41	05:30	15:19	06:24	16:21	07:00	18:53
22	04:21	15:14	06:41	16:22	07:14	17:38	07:32	20:02
23	05:30	15:53	07:45	17:34	07:56	18:54	08:02	21:10
24	06:43	16:41	08:39	18:49	08:33	20:07	08:33	22:16
25	07:55	17:38	09:25	20:05	09:05	21:16	09:06	23:21
26	09:02	18:45	10:03	21:17	09:35	22:23	09:42	DNS
27	10:01	19:58	10:36	22:26	10:04	23:28	10:23	00:24
28	10:50	21:11	11:06	23:32	10:35	DNS	11:08	01:24
29	11:31	22:23	11:34	DNS	11:08	00:32	11:58	02:19
30	12:05	23:32	12:03	00:36	11:45	01:34	12:53	03:08
31	12:35	DNS			12:26	02:35	13:49	03:52

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	14:47	04:29	15:31	04:00	17:17	03:47	18:19	03:28
2	15:46	05:02	16:29	04:26	18:23	04:19	19:28	04:16
3	16:43	05:31	17:28	04:52	19:31	04:55	20:31	05:14
4	17:41	05:58	18:29	05:19	20:39	05:38	21:28	06:20
5	18:39	06:24	19:32	05:48	21:45	06:29	22:15	07:32
6	19:38	06:50	20:38	06:21	22:44	07:29	22:56	08:45
7	20:39	07:17	21:45	06:58	23:35	08:36	23:30	09:57
8	21:42	07:46	22:51	07:43	DNR	09:46	DNR	11:06
9	22:47	08:19	23:53	08:36	00:18	10:57	00:02	12:12
10	23:53	08:58	DNR	09:37	00:56	12:06	00:32	13:17
11	DNR	09:45	00:49	10:44	01:29	13:13	01:01	14:22
12	00:58	10:40	01:37	11:54	01:59	14:19	01:32	15:26
13	01:59	11:43	02:18	13:04	02:29	15:24	02:06	16:29
14	02:53	12:53	02:54	14:14	02:59	16:29	02:45	17:31
15	03:40	14:05	03:27	15:22	03:31	17:34	03:28	18:30
16	04:21	15:18	03:58	16:30	04:07	18:39	04:16	19:24
17	04:56	16:30	04:28	17:37	04:47	19:41	05:10	20:12
18	05:28	17:40	04:59	18:43	05:33	20:39	06:06	20:53
19	05:59	18:48	05:33	19:50	06:24	21:31	07:04	21:29
20	06:30	19:56	06:11	20:54	07:19	22:17	08:02	22:00
21	07:03	21:03	06:54	21:55	08:16	22:56	08:59	22:28
22	07:38	22:08	07:42	22:51	09:14	23:30	09:55	22:54
23	08:17	23:11	08:34	23:40	10:12	00:00	10:51	23:19
24	09:02	DNS	09:30	DNS	11:08	DNS	11:47	23:45
25	09:51	00:09	10:27	00:22	12:05	00:27	12:45	DNS
26	10:44	01:01	11:25	00:59	13:01	00:53	13:45	00:12
27	11:40	01:47	12:22	01:31	13:59	01:18	14:49	00:43
28	12:38	02:27	13:19	02:00	15:00	01:45	15:55	01:18
29	13:36	03:02	14:17	02:27	16:03	02:14	17:04	02:02
30	14:34	03:32	15:15	02:53	17:10	02:48	18:10	02:54
31			16:15	03:19			19:11	03:56

Note: DNR or DNS means Moon does not rise/set on that day. The reason for this lies in the Moon's rapid daily motion from west to east. Consecutive days show the Moon to rise (or set) more than 24 hours later. Hence, if the Moon rises just before midnight on the 1st of the month, it may not rise again until after midnight on the 2nd. Therefore it becomes an event for the 3rd of the month with no event on the 2nd.

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	08:47	21:44	10:26	21:52	09:21	20:31	11:32	21:55
2	09:41	22:14	11:27	22:30	10:24	21:13	12:31	23:00
3	10:36	22:44	12:31	23:14	11:29	22:02	13:24	DNS
4	11:33	23:16	13:38	DNS	12:35	22:58	14:10	00:07
5	12:33	23:52	14:45	00:06	13:38	DNS	14:50	01:14
6	13:37	DNS	15:48	01:06	14:36	00:01	15:26	02:18
7	14:45	00:33	16:46	02:14	15:27	01:08	16:00	03:20
8	15:54	01:22	17:36	03:25	16:12	02:17	16:33	04:21
9	17:03	02:20	18:20	04:36	16:52	03:25	17:06	05:21
10	18:06	03:26	18:58	05:45	17:28	04:30	17:41	06:20
11	19:02	04:38	19:33	06:50	18:02	05:33	18:18	07:20
12	19:49	05:51	20:06	07:53	18:35	06:35	19:00	08:19
13	20:29	07:02	20:39	08:53	19:09	07:35	19:45	09:18
14	21:05	08:08	21:13	09:52	19:45	08:35	20:35	10:13
15	21:38	09:11	21:50	10:51	20:24	09:35	21:27	11:05
16	22:10	10:11	22:29	11:49	21:06	10:33	22:22	11:51
17	22:42	11:09	23:13	12:46	21:53	11:30	23:17	12:33
18	23:16	12:06	DNR	13:41	22:44	12:24	DNR	13:11
19	23:53	13:03	00:01	14:32	23:37	13:13	00:12	13:45
20	DNR	13:59	00:52	15:20	DNR	13:58	01:07	14:17
21	00:33	14:55	01:46	16:03	00:32	14:38	02:02	14:48
22	01:18	15:48	02:42	16:41	01:28	15:14	02:58	15:19
23	02:07	16:38	03:38	17:16	02:24	15:48	03:56	15:51
24	03:00	17:24	04:34	17:49	03:19	16:19	04:56	16:26
25	03:55	18:05	05:30	18:20	04:15	16:50	05:59	17:06
26	04:51	18:43	06:26	18:50	05:12	17:21	07:06	17:52
27	05:47	19:16	07:22	19:21	06:10	17:54	08:14	18:45
28	06:42	19:47	08:20	19:54	07:11	18:30	09:22	19:46
29	07:37	20:17			08:15	19:12	10:24	20:52
30	08:32	20:47			09:21	19:59	11:20	22:00
31	09:28	21:18			10:28	20:53		

	MAY		JUNE		JULY		AUGUST	
1	12:08	23:07	12:36	00:09	12:17	00:58	13:05	02:41
2	12:50	DNS	13:08	01:07	12:54	01:56	13:56	03:34
3	13:27	00:12	13:41	02:05	13:35	02:54	14:50	04:22
4	14:01	01:14	14:16	03:03	14:19	03:51	15:45	05:05
5	14:33	02:14	14:54	04:01	15:09	04:46	16:40	05:44
6	15:06	03:12	15:36	04:59	16:01	05:37	17:34	06:19
7	15:39	04:11	16:22	05:56	16:55	06:24	18:27	06:51
8	16:16	05:09	17:13	06:50	17:50	07:06	19:21	07:21
9	16:55	06:08	18:06	07:40	18:45	07:43	20:14	07:51
10	17:39	07:07	19:01	08:26	19:39	08:17	21:09	08:20
11	18:27	08:03	19:56	09:06	20:32	08:48	22:05	08:51
12	19:19	08:57	20:50	09:43	21:25	09:18	23:04	09:25
13	20:13	09:45	21:44	10:15	22:18	09:47	DNR	10:03
14	21:08	10:29	22:37	10:46	23:14	10:17	00:07	10:48
15	22:03	11:08	23:31	11:16	DNR	10:49	01:11	11:40
16	22:57	11:43	DNR	11:45	00:12	11:25	02:16	12:40
17	23:51	12:15	00:26	12:16	01:14	12:06	03:17	13:47
18	DNR	12:46	01:24	12:51	02:19	12:55	04:13	14:58
19	00:46	13:16	02:25	13:30	03:26	13:53	05:03	16:09
20	01:41	13:47	03:31	14:16	04:32	14:59	05:47	17:19
21	02:39	14:20	04:39	15:11	05:33	16:10	06:26	18:25
22	03:40	14:57	05:48	16:14	06:28	17:23	07:02	19:30
23	04:45	15:40	06:53	17:24	07:15	18:34	07:38	20:33
24	05:53	16:31	07:51	18:36	07:56	19:42	08:13	21:35
25	07:03	17:30	08:41	19:47	08:33	20:46	08:50	22:36
26	08:10	18:36	09:24	20:55	09:08	21:48	09:30	23:36
27	09:11	19:47	10:02	21:59	09:42	22:49	10:13	DNS
28	10:03	20:56	10:36	23:00	10:16	23:48	11:00	00:33
29	10:48	22:04	11:09	00:00	10:53	DNS	11:50	01:28
30	11:28	23:08	11:42	DNS	11:33	00:47	12:44	02:18
31	12:03	DNS			12:17	01:45	13:38	03:03

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	14:33	03:43	15:07	03:24	16:38	03:26	17:29	03:16
2	15:28	04:20	16:01	03:54	17:39	04:01	18:36	04:07
3	16:22	04:53	16:56	04:24	18:43	04:41	19:40	05:05
4	17:15	05:24	17:52	04:55	19:49	05:27	20:38	06:11
5	18:09	05:54	18:51	05:28	20:53	06:20	21:30	07:20
6	19:04	06:23	19:52	06:04	21:53	07:21	22:15	08:29
7	20:00	06:54	20:56	06:46	22:47	08:26	22:54	09:36
8	20:59	07:27	22:00	07:33	23:34	09:33	23:30	10:41
9	22:00	08:04	23:02	08:27	DNR	10:39	DNR	11:43
10	23:03	08:47	23:59	09:28	00:16	11:44	00:04	12:43
11	DNR	09:35	DNR	10:33	00:53	12:47	00:38	13:43
12	00:06	10:32	00:50	11:40	01:28	13:48	01:14	14:43
13	01:07	11:34	01:36	12:46	02:03	14:49	01:51	15:43
14	02:04	12:41	02:16	13:51	02:37	15:49	02:33	16:42
15	02:54	13:50	02:53	14:55	03:13	16:50	03:18	17:40
16	03:39	14:58	03:28	15:57	03:53	17:51	04:08	18:33
17	04:19	16:05	04:03	16:59	04:36	18:51	05:01	19:23
18	04:56	17:10	04:39	18:02	05:24	19:48	05:56	20:06
19	05:32	18:13	05:17	19:04	06:16	20:41	06:51	20:45
20	06:08	19:17	05:59	20:05	07:10	21:28	07:46	21:20
21	06:45	20:19	06:44	21:04	08:05	22:10	08:39	21:52
22	07:24	21:21	07:33	22:00	09:00	22:47	09:31	22:21
23	08:06	22:21	08:26	22:50	09:54	23:21	10:23	22:50
24	08:53	23:18	09:20	23:35	10:47	23:52	11:15	23:20
25	09:43	DNS	10:15	DNS	11:39	DNS	12:09	23:51
26	10:36	00:10	11:10	00:14	12:32	00:21	13:05	DNS
27	11:30	00:58	12:04	00:50	13:26	00:51	14:04	00:25
28	12:25	01:40	12:57	01:22	14:22	01:22	15:07	01:05
29	13:19	02:18	13:50	01:53	15:21	01:55	16:13	01:51
30	14:13	02:52	14:44	02:23	16:24	02:32	17:18	02:45
31			15:40	02:53			18:21	03:47

CANBERRA (EST) MOON RISE AND SET DARWIN (CST)

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	08:55	22:06	10:52	21:57	09:50	20:33	12:12	21:47
2	09:54	22:31	11:57	22:30	10:57	21:10	13:10	22:55
3	10:54	22:57	13:06	23:10	12:07	21:56	14:00	DNS
4	11:55	23:24	14:16	23:59	13:15	22:50	14:41	00:05
5	13:00	23:55	15:25	DNS	14:18	23:53	15:17	01:16
6	14:09	DNS	16:28	00:58	15:14	DNS	15:48	02:25
7	15:21	00:32	17:23	02:07	16:02	01:03	16:17	03:33
8	16:34	01:17	18:09	03:21	16:43	02:16	16:45	04:38
9	17:43	02:12	18:48	04:37	17:17	03:29	17:14	05:43
10	18:45	03:19	19:21	05:51	17:48	04:39	17:44	06:47
11	19:37	04:33	19:51	07:02	18:17	05:48	18:18	07:51
12	20:19	05:50	20:19	08:09	18:45	06:54	18:56	08:54
13	20:54	07:06	20:47	09:15	19:15	08:00	19:39	09:55
14	21:25	08:17	21:17	10:19	19:46	09:04	20:28	10:52
15	21:53	09:25	21:49	11:22	20:21	10:08	21:21	11:44
16	22:20	10:30	22:25	12:24	21:01	11:10	22:17	12:29
17	22:48	11:33	23:06	13:24	21:46	12:09	23:15	13:08
18	23:18	12:34	23:53	14:20	22:36	13:03	DNR	13:42
19	23:51	13:35	DNR	15:12	23:31	13:52	00:14	14:13
20	DNR	14:35	00:45	15:58	DNR	14:35	01:13	14:40
21	00:28	15:33	01:41	16:39	00:28	15:12	02:13	15:07
22	01:11	16:28	02:40	17:14	01:27	15:44	03:13	15:33
23	01:59	17:18	03:39	17:45	02:27	16:14	04:16	16:01
24	02:53	18:02	04:40	18:13	03:27	16:41	05:21	16:31
25	03:50	18:40	05:40	18:39	04:28	17:07	06:29	17:07
26	04:49	19:13	06:40	19:05	05:29	17:34	07:40	17:49
27	05:49	19:43	07:41	19:32	06:32	18:02	08:52	18:39
28	06:49	20:10	08:44	20:00	07:38	18:34	10:01	19:39
29	07:48	20:36			08:47	19:10	11:04	20:46
30	08:48	21:01			09:57	19:54	11:57	21:57
31	09:49	21:28			11:06	20:46		

	MAY		JUNE		JULY		AUGUST	
1	12:41	23:08	12:51	00:23	12:20	01:25	12:58	03:20
2	13:18	DNS	13:18	01:27	12:53	02:28	13:49	04:13
3	13:50	00:18	13:47	02:29	13:31	03:29	14:45	05:00
4	14:20	01:25	14:18	03:32	14:13	04:29	15:42	05:41
5	14:47	02:29	14:52	04:34	15:02	05:25	16:41	06:17
6	15:15	03:33	15:31	05:35	15:55	06:16	17:39	06:48
7	15:44	04:36	16:16	06:34	16:51	07:01	18:36	07:16
8	16:17	05:39	17:06	07:29	17:49	07:41	19:34	07:42
9	16:53	06:42	18:00	08:19	18:47	08:15	20:32	08:07
10	17:34	07:43	18:57	09:02	19:45	08:45	21:31	08:32
11	18:21	08:42	19:56	09:40	20:42	09:12	22:32	08:59
12	19:12	09:36	20:54	10:13	21:39	09:37	23:36	09:29
13	20:08	10:23	21:51	10:42	22:37	10:02	DNR	10:03
14	21:05	11:05	22:49	11:08	23:37	10:28	00:42	10:44
15	22:04	11:41	23:47	11:34	DNR	10:56	01:49	11:34
16	23:02	12:12	DNR	11:59	00:40	11:27	02:55	12:33
17	DNR	12:40	00:46	12:26	01:46	12:04	03:56	13:42
18	00:00	13:06	01:49	12:56	02:56	12:50	04:49	14:56
19	00:59	13:32	02:55	13:30	04:05	13:46	05:35	16:12
20	01:59	13:59	04:05	14:13	05:12	14:52	06:14	17:26
21	03:01	14:28	05:17	15:04	06:11	16:06	06:48	18:38
22	04:07	15:00	06:28	16:07	07:02	17:23	07:19	19:48
23	05:17	15:39	07:32	17:18	07:44	18:39	07:49	20:56
24	06:30	16:26	08:27	18:34	08:20	19:52	08:20	22:03
25	07:42	17:23	09:12	19:50	08:52	21:02	08:52	23:08
26	08:49	18:30	09:50	21:03	09:22	22:09	09:28	DNS
27	09:48	19:42	10:23	22:12	09:51	23:14	10:08	00:11
28	10:37	20:56	10:53	23:18	10:21	DNS	10:54	01:11
29	11:18	22:08	11:21	DNS	10:54	00:18	11:44	02:07
30	11:52	23:17	11:50	00:22	11:30	01:21	12:38	02:56
31	12:23	DNS			12:11	02:22	13:35	03:39

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	14:33	04:17	15:17	03:48	17:04	03:34	18:06	03:14
2	15:31	04:50	16:15	04:14	18:10	04:05	19:15	04:02
3	16:29	05:19	17:15	04:40	19:18	04:41	20:19	04:59
4	17:27	05:46	18:16	05:06	20:26	05:24	21:15	06:05
5	18:25	06:11	19:19	05:35	21:32	06:15	22:03	07:17
6	19:24	06:37	20:25	06:07	22:31	07:14	22:43	08:30
7	20:25	07:03	21:32	06:44	23:22	08:21	23:18	09:42
8	21:28	07:32	22:38	07:29	DNR	09:31	23:49	10:51
9	22:34	08:05	23:41	08:21	00:06	10:42	DNR	11:58
10	23:40	08:44	DNR	09:22	00:43	11:51	00:18	13:03
11	DNR	09:30	00:36	10:29	01:16	12:59	00:48	14:08
12	00:45	10:25	01:25	11:39	01:46	14:05	01:19	15:12
13	01:46	11:28	02:06	12:50	02:15	15:10	01:52	16:16
14	02:41	12:38	02:42	13:59	02:45	16:16	02:30	17:19
15	03:28	13:50	03:14	15:08	03:17	17:21	03:13	18:18
16	04:08	15:03	03:45	16:16	03:53	18:26	04:02	19:12
17	04:43	16:15	04:15	17:23	04:33	19:28	04:55	20:00
18	05:15	17:25	04:46	18:30	05:19	20:27	05:52	20:41
19	05:46	18:34	05:20	19:36	06:09	21:19	06:50	21:17
20	06:17	19:42	05:57	20:41	07:04	22:04	07:48	21:48
21	06:49	20:49	06:40	21:42	08:01	22:44	08:45	22:16
22	07:24	21:55	07:27	22:38	08:59	23:17	09:41	22:41
23	08:03	22:58	08:19	23:28	09:57	23:47	10:37	23:06
24	08:47	23:56	09:15	DNS	10:54	DNS	11:33	23:32
25	09:36	DNS	10:12	00:10	11:51	00:14	12:31	23:59
26	10:29	00:49	11:10	00:47	12:47	00:40	13:32	DNS
27	11:26	01:35	12:08	01:19	13:45	01:05	14:35	00:29
28	12:23	02:15	13:05	01:47	14:46	01:32	15:42	01:04
29	13:21	02:49	14:03	02:14	15:50	02:01	16:51	01:47
30	14:19	03:20	15:01	02:40	16:57	02:34	17:57	02:39
31			16:01	03:06			18:59	03:41

Note: DNR or DNS means Moon does not rise/set on that day. The reason for this lies in the Moon's rapid daily motion from west to east. Consecutive days show the Moon to rise (or set) more than 24 hours later. Hence, if the Moon rises just before midnight on the 1st of the month, it may not rise again until after midnight on the 2nd. Therefore it becomes an event for the 3rd of the month with no event on the 2nd.

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	10:02	22:37	11:14	23:12	10:04	21:56	11:58	23:34
2	10:49	23:14	12:07	23:57	11:00	22:45	12:58	DNS
3	11:37	23:51	13:05	DNS	11:59	23:39	13:55	00:37
4	12:26	DNS	14:06	00:48	13:01	DNS	14:47	01:39
5	13:18	00:31	15:10	01:45	14:04	00:38	15:34	02:39
6	14:15	01:14	16:14	02:47	15:04	01:41	16:18	03:35
7	15:16	02:03	17:15	03:53	16:00	02:44	16:59	04:29
8	16:22	02:58	18:12	04:59	16:52	03:47	17:40	05:22
9	17:29	04:00	19:02	06:03	17:39	04:47	18:21	06:13
10	18:34	05:07	19:49	07:03	18:23	05:44	19:03	07:06
11	19:34	06:15	20:32	08:00	19:04	06:39	19:47	07:58
12	20:28	07:22	21:13	08:54	19:46	07:32	20:34	08:52
13	21:16	08:24	21:54	09:46	20:27	08:25	21:23	09:46
14	22:00	09:22	22:35	10:38	21:10	09:17	22:14	10:39
15	22:41	10:16	23:18	11:30	21:55	10:10	23:05	11:31
16	23:20	11:08	DNR	12:22	22:42	11:04	23:57	12:19
17	00:00	11:58	00:03	13:14	23:32	11:57	DNR	13:05
18	DNR	12:48	00:50	14:06	DNR	12:49	00:48	13:48
19	00:40	13:39	01:40	14:58	00:23	13:39	01:37	14:28
20	01:23	14:30	02:31	15:47	01:14	14:27	02:25	15:06
21	02:08	15:22	03:23	16:33	02:06	15:11	03:13	15:44
22	02:56	16:13	04:14	17:17	02:56	15:53	04:02	16:22
23	03:46	17:04	05:05	17:58	03:46	16:33	04:52	17:02
24	04:38	17:52	05:54	18:37	04:35	17:11	05:44	17:45
25	05:30	18:37	06:42	19:15	05:23	17:49	06:40	18:32
26	06:21	19:20	07:31	19:52	06:12	18:28	07:40	19:25
27	07:10	20:00	08:20	20:31	07:03	19:09	08:44	20:23
28	07:59	20:38	09:10	21:12	07:57	19:53	09:48	21:26
29	08:47	21:15			08:53	20:41	10:51	22:30
30	09:34	21:52			09:53	21:34	11:50	23:34
31	10:23	22:31			10:55	22:33		

	MAY		JUNE		JULY		AUGUST	
1	12:44	DNS	13:38	01:14	13:39	01:43	14:43	03:08
2	13:32	00:34	14:18	02:05	14:22	02:34	15:34	04:00
3	14:17	01:31	14:58	02:55	15:08	03:27	16:26	04:49
4	14:58	02:25	15:40	03:46	15:57	04:20	17:17	05:36
5	15:38	03:17	16:24	04:38	16:47	05:12	18:06	06:19
6	16:18	04:08	17:11	05:31	17:39	06:03	18:54	07:00
7	16:59	04:59	18:00	06:24	18:30	06:52	19:41	07:38
8	17:42	05:50	18:51	07:17	19:20	07:38	20:27	08:15
9	18:27	06:43	19:43	08:07	20:09	08:20	21:14	08:51
10	19:15	07:37	20:34	08:55	20:57	09:00	22:01	09:27
11	20:06	08:30	21:24	09:40	21:43	09:37	22:51	10:05
12	20:57	09:23	22:13	10:21	22:29	10:13	23:44	10:46
13	21:49	10:13	23:00	11:00	23:16	10:49	DNR	11:32
14	22:40	10:59	23:46	11:37	DNR	11:26	00:40	12:22
15	23:30	11:43	DNR	12:13	00:04	12:06	01:40	13:18
16	DNR	12:23	00:33	12:50	00:55	12:49	02:42	14:20
17	00:18	13:02	01:21	13:29	01:51	13:37	03:45	15:25
18	01:05	13:39	02:12	14:10	02:50	14:31	04:45	16:30
19	01:52	14:16	03:06	14:57	03:54	15:32	05:40	17:34
20	02:41	14:55	04:05	15:50	04:59	16:38	06:31	18:35
21	03:31	15:35	05:09	16:49	06:02	17:46	07:19	19:33
22	04:25	16:20	06:15	17:54	07:02	18:52	08:03	20:29
23	05:23	17:11	07:20	19:02	07:56	19:55	08:47	21:24
24	06:25	18:07	08:22	20:09	08:45	20:54	09:30	22:18
25	07:31	19:10	09:18	21:12	09:30	21:50	10:14	23:13
26	08:36	20:16	10:09	22:12	10:12	22:43	11:00	DNS
27	09:39	21:22	10:54	23:07	10:54	23:36	11:48	00:07
28	10:37	22:26	11:36	DNS	11:36	DNS	12:38	01:01
29	11:29	23:25	12:17	00:00	12:20	00:29	13:29	01:54
30	12:15	DNS	12:58	00:52	13:05	01:22	14:20	02:44
31	12:58	00:21			13:53	02:15	15:12	03:32

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	16:02	04:17	16:19	04:13	17:24	04:39	18:01	04:47
2	16:50	04:58	17:06	04:50	18:19	05:22	19:04	05:43
3	17:38	05:37	17:53	05:27	19:17	06:09	20:08	06:44
4	18:24	06:15	18:43	06:05	20:18	07:01	21:09	07:48
5	19:11	06:51	19:35	06:45	21:20	07:58	22:05	08:53
6	19:59	07:28	20:30	07:28	22:21	08:59	22:57	09:56
7	20:48	08:06	21:28	08:16	23:19	10:02	23:43	10:56
8	21:40	08:46	22:28	09:09	DNR	11:04	DNR	11:52
9	22:35	09:30	23:29	10:06	00:12	12:04	00:27	12:46
10	23:33	10:19	DNR	11:06	01:00	13:01	01:09	13:39
11	DNR	11:12	00:28	12:08	01:45	13:56	01:50	14:31
12	00:33	12:11	01:23	13:10	02:27	14:49	02:33	15:24
13	01:34	13:12	02:14	14:09	03:09	15:42	03:17	16:18
14	02:33	14:16	03:02	15:06	03:51	16:36	04:04	17:13
15	03:29	15:18	03:47	16:02	04:35	17:30	04:53	18:08
16	04:20	16:19	04:30	16:56	05:21	18:25	05:45	19:01
17	05:08	17:17	05:13	17:50	06:09	19:21	06:38	19:51
18	05:53	18:13	05:56	18:45	07:00	20:16	07:30	20:38
19	06:37	19:09	06:41	19:41	07:53	21:09	08:22	21:22
20	07:21	20:04	07:29	20:37	08:46	21:58	09:11	22:02
21	08:05	20:59	08:19	21:33	09:38	22:43	09:58	22:39
22	08:51	21:55	09:11	22:27	10:28	23:25	10:44	23:16
23	09:39	22:50	10:03	23:18	11:17	DNS	11:29	23:51
24	10:29	23:45	10:56	DNS	12:04	00:05	12:14	DNS
25	11:21	DNS	11:47	00:05	12:50	00:42	13:01	00:27
26	12:13	00:37	12:36	00:49	13:35	01:18	13:51	01:05
27	13:04	01:26	13:24	01:30	14:22	01:54	14:44	01:47
28	13:55	02:12	14:11	02:09	15:11	02:32	15:41	02:32
29	14:44	02:55	14:58	02:46	16:04	03:12	16:42	03:24
30	15:32	03:35	15:45	03:22	17:00	03:57	17:46	04:22
31			16:33	04:00			18:50	05:26

HOBART (EST) MOON RISE AND SET MELBOURNE (EST)

HOBART (EST)

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	08:54	22:20	11:11	21:51	10:13	20:23	12:49	21:26
2	09:58	22:40	12:22	22:19	11:26	20:56	13:46	22:36
3	11:03	23:00	13:36	22:54	12:40	21:37	14:31	23:51
4	12:11	23:22	14:51	23:39	13:52	22:29	15:08	DNS
5	13:21	23:48	16:02	DNS	14:56	23:32	15:38	01:08
6	14:36	DNS	17:05	00:37	15:49	DNS	16:03	02:23
7	15:53	00:19	17:56	01:47	16:33	00:45	16:26	03:36
8	17:10	00:59	18:37	03:05	17:07	02:03	16:49	04:48
9	18:21	01:51	19:10	04:27	17:36	03:22	17:12	05:58
10	19:21	02:57	19:37	05:47	18:01	04:39	17:37	07:08
11	20:07	04:15	20:01	07:04	18:24	05:54	18:06	08:18
12	20:44	05:37	20:23	08:18	18:47	07:06	18:40	09:25
13	21:13	06:59	20:46	09:30	19:10	08:17	19:20	10:30
14	21:38	08:17	21:10	10:40	19:37	09:28	20:07	11:29
15	22:00	09:31	21:37	11:48	20:07	10:37	21:01	12:20
16	22:22	10:42	22:09	12:55	20:43	11:43	22:00	13:03
17	22:44	11:50	22:47	13:58	21:26	12:45	23:02	13:39
18	23:09	12:57	23:32	14:57	22:15	13:40	DNR	14:09
19	23:37	14:03	DNR	15:49	23:11	14:28	00:05	14:34
20	DNR	15:08	00:24	16:33	DNR	15:08	01:10	14:57
21	00:10	16:09	01:22	17:10	00:12	15:41	02:14	15:18
22	00:50	17:05	02:25	17:41	01:15	16:09	03:20	15:39
23	01:38	17:54	03:29	18:08	02:20	16:33	04:28	16:02
24	02:33	18:36	04:35	18:31	03:25	16:55	05:39	16:27
25	03:33	19:10	05:40	18:52	04:31	17:16	06:53	16:56
26	04:36	19:39	06:46	19:12	05:38	17:38	08:10	17:33
27	05:41	20:04	07:53	19:34	06:47	18:00	09:27	18:20
28	06:46	20:26	09:02	19:57	07:59	18:26	10:38	19:18
29	07:51	20:46			09:13	18:58	11:40	20:26
30	08:56	21:06			10:29	19:37	12:30	21:42
31	10:02	21:28			11:42	20:26		

	MAY		JUNE		JULY		AUGUST	
1	13:09	22:58	12:58	00:29	12:13	01:46	12:38	03:56
2	13:41	DNS	13:20	01:38	12:41	02:54	13:29	04:49
3	14:07	00:14	13:43	02:47	13:15	04:00	14:26	05:34
4	14:31	01:26	14:09	03:54	13:54	05:03	15:27	06:12
5	14:53	02:37	14:39	05:01	14:41	06:01	16:30	06:44
6	15:15	03:46	15:14	06:07	15:35	06:52	17:33	07:11
7	15:39	04:55	15:56	07:09	16:34	07:35	18:36	07:34
8	16:06	06:03	16:46	08:06	17:35	08:11	19:38	07:55
9	16:38	07:11	17:41	08:54	18:38	08:41	20:41	08:16
10	17:16	08:17	18:41	09:35	19:41	09:06	21:46	08:36
11	18:01	09:18	19:44	10:09	20:43	09:29	22:52	08:58
12	18:52	10:12	20:46	10:37	21:46	09:49	DNR	09:22
13	19:50	10:58	21:49	11:02	22:49	10:09	00:01	09:51
14	20:51	11:37	22:51	11:23	23:54	10:30	01:13	10:28
15	21:53	12:08	23:55	11:44	DNR	10:52	02:24	11:14
16	22:56	12:35	DNR	12:04	01:03	11:19	03:32	12:12
17	00:00	12:59	01:00	12:26	02:14	11:51	04:32	13:23
18	DNR	13:20	02:08	12:50	03:28	12:32	05:21	14:41
19	01:03	13:41	03:20	13:20	04:42	13:25	06:01	16:03
20	02:09	14:02	04:35	13:57	05:49	14:32	06:34	17:24
21	03:17	14:25	05:52	14:45	06:45	15:49	07:02	18:43
22	04:29	14:53	07:05	15:46	07:31	17:11	07:27	19:59
23	05:44	15:26	08:08	16:59	08:07	18:34	07:52	21:13
24	07:02	16:08	08:59	18:20	08:37	19:53	08:17	22:25
25	08:18	17:03	09:39	19:42	09:03	21:09	08:44	23:36
26	09:26	18:09	10:11	21:01	09:27	22:22	09:15	DNS
27	10:22	19:25	10:38	22:16	09:51	23:34	09:51	00:43
28	11:07	20:44	11:02	23:28	10:16	DNS	10:34	01:46
29	11:42	22:02	11:25	DNS	10:43	00:43	11:23	02:43
30	12:10	23:17	11:48	00:38	11:15	01:51	12:19	03:31
31	12:35	DNS			11:53	02:56	13:19	04:12

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	14:21	04:46	15:18	04:04	17:24	03:33	18:39	03:00
2	15:24	05:14	16:21	04:26	18:35	03:59	19:50	03:44
3	16:27	05:39	17:26	04:47	19:48	04:30	20:54	04:39
4	17:30	06:01	18:32	05:08	21:01	05:08	21:48	05:46
5	18:33	06:22	19:41	05:32	22:08	05:56	22:31	07:01
6	19:38	06:42	20:52	05:59	23:06	06:54	23:06	08:20
7	20:44	07:04	22:04	06:31	23:54	08:03	23:35	09:37
8	21:53	07:27	23:13	07:11	DNR	09:17	DNR	10:53
9	23:03	07:55	DNR	08:01	00:32	10:33	00:00	12:06
10	DNR	08:29	00:17	09:02	01:04	11:48	00:24	13:17
11	00:14	09:11	01:10	10:11	01:31	13:02	00:48	14:27
12	01:22	10:04	01:55	11:26	01:56	14:14	01:14	15:36
13	02:22	11:08	02:31	12:42	02:20	15:25	01:43	16:45
14	03:14	12:21	03:01	13:58	02:44	16:36	02:16	17:51
15	03:57	13:39	03:28	15:13	03:11	17:47	02:56	18:53
16	04:31	14:58	03:53	16:26	03:42	18:56	03:43	19:47
17	05:01	16:16	04:17	17:40	04:18	20:02	04:36	20:33
18	05:27	17:33	04:43	18:52	05:00	21:02	05:35	21:11
19	05:52	18:48	05:11	20:04	05:50	21:54	06:36	21:43
20	06:17	20:02	05:44	21:13	06:46	22:37	07:38	22:10
21	06:43	21:14	06:23	22:17	07:46	23:13	08:40	22:33
22	07:13	22:25	07:08	23:14	08:47	23:42	09:41	22:54
23	07:48	23:32	08:00	DNS	09:50	DNS	10:42	23:14
24	08:29	DNS	08:57	00:02	10:51	00:08	11:43	23:35
25	09:16	00:32	09:58	00:42	11:53	00:30	12:46	23:57
26	10:10	01:24	11:00	01:15	12:54	00:51	13:52	DNS
27	11:09	02:09	12:02	01:42	13:58	01:12	15:01	00:23
28	12:10	02:45	13:04	02:06	15:03	01:33	16:13	00:53
29	13:12	03:16	14:07	02:28	16:13	01:57	17:25	01:31
30	14:15	03:42	15:10	02:49	17:25	02:25	18:33	02:20
31			16:16	03:10			19:33	03:21

Note: DNR or DNS means Moon does not rise/set on that day. The reason for this lies in the Moon's rapid daily motion from west to east. Consecutive days show the Moon to rise (or set) more than 24 hours later. Hence, if the Moon rises just before midnight on the 1st of the month, it may not rise again until after midnight on the 2nd. Therefore it becomes an event for the 3rd of the month with no event on the 2nd.

MELBOURNE (EST)

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	09:09	22:25	11:12	22:09	10:12	20:44	12:38	21:55
2	10:10	22:48	12:20	22:41	11:21	21:20	13:36	23:04
3	11:11	23:12	13:30	23:20	12:32	22:04	14:24	DNS
4	12:15	23:38	14:42	DNS	13:41	22:58	15:04	00:16
5	13:22	DNS	15:51	00:08	14:45	DNS	15:38	01:28
6	14:32	00:07	16:54	01:06	15:40	00:02	16:07	02:39
7	15:46	00:42	17:48	02:15	16:26	01:12	16:34	03:48
8	17:00	01:26	18:32	03:31	17:05	02:27	17:01	04:56
9	18:10	02:20	19:09	04:49	17:38	03:41	17:27	06:02
10	19:11	03:27	19:40	06:05	18:06	04:54	17:56	07:09
11	20:01	04:42	20:08	07:17	18:33	06:04	18:28	08:14
12	20:41	06:01	20:35	08:27	19:00	07:13	19:05	09:19
13	21:15	07:19	21:01	09:34	19:28	08:20	19:48	10:21
14	21:43	08:32	21:29	10:40	19:58	09:26	20:36	11:18
15	22:10	09:42	22:00	11:45	20:31	10:32	21:29	12:10
16	22:35	10:49	22:35	12:48	21:10	11:35	22:27	12:54
17	23:01	11:53	23:15	13:49	21:54	12:35	23:26	13:32
18	23:29	12:56	DNR	14:46	22:44	13:29	DNR	14:05
19	DNR	13:59	00:01	15:38	23:39	14:18	00:26	14:34
20	00:01	15:00	00:53	16:24	DNR	15:00	01:27	15:00
21	00:37	15:59	01:50	17:03	00:38	15:35	02:28	15:25
22	01:19	16:54	02:50	17:37	01:38	16:06	03:30	15:49
23	02:07	17:44	03:51	18:07	02:40	16:34	04:34	16:15
24	03:01	18:27	04:53	18:33	03:41	17:00	05:41	16:44
25	03:59	19:04	05:55	18:58	04:43	17:24	06:51	17:18
26	05:00	19:36	06:57	19:22	05:47	17:49	08:04	17:58
27	06:01	20:04	08:00	19:47	06:52	18:16	09:18	18:48
28	07:03	20:29	09:05	20:14	08:00	18:46	10:28	19:47
29	08:04	20:53			09:10	19:21	11:30	20:55
30	09:05	21:17			10:22	20:03	12:22	22:07
31	10:08	21:42			11:32	20:55		

	MAY		JUNE		JULY		AUGUST	
1	13:04	23:20	13:07	00:40	12:32	01:47	13:06	03:46
2	13:40	DNS	13:33	01:45	13:04	02:51	13:58	04:39
3	14:10	00:31	14:00	02:50	13:40	03:53	14:54	05:25
4	14:37	01:40	14:29	03:54	14:22	04:54	15:52	06:05
5	15:03	02:47	15:02	04:57	15:10	05:51	16:52	06:40
6	15:30	03:52	15:41	06:00	16:03	06:42	17:52	07:10
7	15:57	04:57	16:24	07:00	17:00	07:26	18:51	07:36
8	16:28	06:01	17:14	07:55	17:59	08:05	19:50	08:01
9	17:03	07:06	18:09	08:45	18:59	08:37	20:49	08:24
10	17:43	08:09	19:07	09:27	19:58	09:06	21:50	08:48
11	18:29	09:08	20:06	10:04	20:57	09:31	22:53	09:13
12	19:21	10:02	21:06	10:35	21:56	09:55	23:59	09:41
13	20:17	10:49	22:05	11:02	22:56	10:19	DNR	10:14
14	21:15	11:29	23:04	11:27	23:57	10:43	01:06	10:53
15	22:15	12:04	DNR	11:51	DNR	11:09	02:15	11:42
16	23:15	12:34	00:04	12:15	01:02	11:39	03:22	12:42
17	DNR	13:00	01:05	12:40	02:10	12:15	04:22	13:51
18	00:15	13:25	02:10	13:08	03:21	12:59	05:14	15:06
19	01:15	13:49	03:18	13:42	04:31	13:54	05:58	16:24
20	02:17	14:14	04:30	14:22	05:38	15:00	06:35	17:40
21	03:21	14:41	05:43	15:13	06:37	16:15	07:07	18:55
22	04:29	15:12	06:54	16:15	07:25	17:34	07:36	20:06
23	05:41	15:49	07:58	17:27	08:06	18:52	08:04	21:16
24	06:55	16:35	08:52	18:45	08:40	20:07	08:33	22:25
25	08:08	17:32	09:35	20:02	09:10	21:19	09:04	23:32
26	09:16	18:38	10:11	21:17	09:38	22:28	09:39	DNS
27	10:14	19:52	10:42	22:28	10:05	23:35	10:18	00:36
28	11:01	21:07	11:10	23:36	10:34	DNS	11:02	01:37
29	11:40	22:21	11:37	DNS	11:05	00:41	11:52	02:33
30	12:12	23:32	12:04	00:42	11:40	01:45	12:47	03:22
31	12:41	DNS			12:20	02:47	13:44	04:04

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	14:44	04:41	15:32	04:07	17:25	03:48	18:31	03:24
2	15:43	05:12	16:32	04:32	18:33	04:17	19:40	04:11
3	16:43	05:40	17:33	04:56	19:42	04:52	20:44	05:08
4	17:43	06:05	18:36	05:21	20:52	05:33	21:40	06:14
5	18:42	06:29	19:41	05:48	21:58	06:23	22:26	07:27
6	19:43	06:53	20:48	06:19	22:57	07:23	23:05	08:42
7	20:46	07:18	21:57	06:55	23:47	08:30	23:37	09:55
8	21:51	07:45	23:04	07:38	DNR	09:41	DNR	11:07
9	22:58	08:16	DNR	08:30	00:29	10:54	00:07	12:15
10	DNR	08:54	00:07	09:30	01:04	12:05	00:35	13:22
11	00:06	09:39	01:02	10:38	01:35	13:15	01:02	14:29
12	01:11	10:33	01:49	11:50	02:04	14:22	01:32	15:35
13	02:12	11:37	02:28	13:02	02:31	15:30	02:04	16:40
14	03:06	12:47	03:02	14:14	02:59	16:37	02:40	17:44
15	03:51	14:02	03:33	15:24	03:30	17:44	03:22	18:43
16	04:30	15:17	04:01	16:34	04:04	18:50	04:10	19:37
17	05:03	16:30	04:30	17:43	04:43	19:54	05:04	20:25
18	05:33	17:43	04:59	18:52	05:27	20:52	06:01	21:05
19	06:02	18:53	05:31	20:00	06:18	21:45	07:00	21:39
20	06:31	20:03	06:07	21:06	07:13	22:29	07:59	22:09
21	07:02	21:12	06:49	22:08	08:11	23:07	08:58	22:36
22	07:35	22:19	07:36	23:04	09:10	23:40	09:56	23:00
23	08:13	23:23	08:28	23:53	10:09	DNS	10:53	23:23
24	08:56	DNS	09:24	DNS	11:08	00:08	11:51	23:47
25	09:45	00:22	10:23	00:35	12:06	00:34	12:51	DNS
26	10:38	01:15	11:22	01:10	13:04	00:58	13:53	00:13
27	11:35	02:00	12:21	01:41	14:04	01:22	14:58	00:41
28	12:34	02:39	13:20	02:08	15:06	01:47	16:06	01:15
29	13:33	03:12	14:19	02:33	16:12	02:14	17:16	01:57
30	14:33	03:41	15:19	02:57	17:20	02:46	18:23	02:48
31			16:21	03:22			19:24	03:50

PERTH (WST) MOON RISE AND SET SYDNEY (EST)

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	09:17	22:19	11:06	22:18	10:03	20:56	12:20	22:17
2	10:14	22:46	12:10	22:54	11:09	21:36	13:18	23:24
3	11:12	23:14	13:17	23:37	12:17	22:23	14:08	DNS
4	12:12	23:44	14:26	DNS	13:23	23:19	14:51	00:33
5	13:14	DNS	15:33	00:28	14:26	DNS	15:28	01:42
6	14:21	00:17	16:36	01:28	15:22	00:23	16:01	02:49
7	15:32	00:57	17:31	02:37	16:11	01:32	16:32	03:53
8	16:43	01:44	18:19	03:50	16:53	02:43	17:02	04:57
9	17:52	02:42	18:59	05:04	17:29	03:54	17:33	05:59
10	18:53	03:49	19:34	06:15	18:02	05:02	18:06	07:01
11	19:46	05:03	20:06	07:23	18:33	06:08	18:42	08:03
12	20:29	06:18	20:36	08:28	19:04	07:12	19:22	09:05
13	21:07	07:31	21:07	09:31	19:35	08:15	20:07	10:04
14	21:39	08:40	21:38	10:33	20:09	09:17	20:56	11:00
15	22:09	09:45	22:13	11:34	20:46	10:19	21:49	11:51
16	22:39	10:47	22:51	12:34	21:28	11:19	22:45	12:36
17	23:08	11:48	23:34	13:32	22:14	12:17	23:42	13:16
18	23:40	12:47	DNR	14:28	23:05	13:11	DNR	13:52
19	DNR	13:46	00:21	15:19	23:59	13:59	00:39	14:23
20	00:15	14:45	01:13	16:05	DNR	14:42	01:36	14:53
21	00:54	15:41	02:09	16:46	00:56	15:20	02:34	15:21
22	01:38	16:35	03:06	17:23	01:53	15:54	03:32	15:49
23	02:28	17:25	04:05	17:55	02:51	16:25	04:33	16:19
24	03:21	18:09	05:03	18:25	03:49	16:54	05:36	16:52
25	04:18	18:48	06:01	18:53	04:48	17:22	06:42	17:30
26	05:16	19:23	06:59	19:21	05:47	17:51	07:52	18:15
27	06:14	19:54	07:59	19:50	06:49	18:22	09:02	19:07
28	07:12	20:23	09:00	20:21	07:52	18:56	10:10	20:08
29	08:09	20:50			08:59	19:35	11:12	21:16
30	09:07	21:18			10:07	20:21	12:05	22:25
31	10:05	21:46			11:16	21:15		

	MAY		JUNE		JULY		AUGUST	
1	12:51	23:35	13:07	00:43	12:42	01:39	13:26	03:28
2	13:29	DNS	13:37	01:44	13:17	02:39	14:18	04:20
3	14:03	00:42	14:07	02:45	13:57	03:39	15:13	05:07
4	14:34	01:46	14:40	03:45	14:41	04:37	16:09	05:49
5	15:04	02:48	15:17	04:45	15:30	05:33	17:06	06:25
6	15:34	03:50	15:58	05:45	16:23	06:23	18:02	06:58
7	16:05	04:51	16:44	06:43	17:18	07:09	18:58	07:28
8	16:40	05:52	17:34	07:37	18:15	07:49	19:53	07:55
9	17:18	06:53	18:29	08:26	19:12	08:24	20:49	08:22
10	18:01	07:53	19:25	09:10	20:08	08:55	21:46	08:50
11	18:49	08:50	20:21	09:49	21:03	09:24	22:46	09:18
12	19:41	09:43	21:18	10:22	21:58	09:51	23:48	09:50
13	20:36	10:31	22:13	10:53	22:54	10:18	DNR	10:27
14	21:32	11:13	23:09	11:21	23:53	10:46	00:53	11:10
15	22:29	11:49	DNR	11:48	DNR	11:16	01:59	12:02
16	23:25	12:22	00:05	12:16	00:54	11:50	03:04	13:03
17	DNR	12:52	01:03	12:45	01:58	12:30	04:04	14:11
18	00:22	13:20	02:04	13:17	03:06	13:18	04:58	15:24
19	01:19	13:48	03:08	13:54	04:14	14:15	05:45	16:38
20	02:17	14:16	04:17	14:39	05:20	15:22	06:25	17:50
21	03:17	14:47	05:27	15:33	06:20	16:35	07:01	18:59
22	04:21	15:23	06:37	16:37	07:11	17:50	07:35	20:07
23	05:29	16:04	07:40	17:48	07:55	19:04	08:07	21:12
24	06:40	16:54	08:36	19:03	08:33	20:14	08:40	22:17
25	07:51	17:53	09:23	20:16	09:07	21:21	09:15	23:20
26	08:58	19:00	10:02	21:26	09:38	22:26	09:53	DNS
27	09:57	20:11	10:37	22:33	10:10	23:29	10:35	00:21
28	10:47	21:23	11:09	23:36	10:42	DNS	11:21	01:20
29	11:29	22:33	11:39	DNS	11:17	00:31	12:12	02:14
30	12:05	23:39	12:10	00:38	11:56	01:32	13:06	03:03
31	12:37	DNS			12:38	02:31	14:02	03:47

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	14:59	04:25	15:38	04:00	17:18	03:53	18:16	03:39
2	15:55	04:59	16:34	04:28	18:22	04:27	19:24	04:29
3	16:51	05:30	17:32	04:56	19:29	05:05	20:27	05:28
4	17:47	05:59	18:31	05:24	20:36	05:50	21:24	06:34
5	18:44	06:26	19:33	05:55	21:41	06:43	22:12	07:45
6	19:41	06:54	20:37	06:29	22:40	07:43	22:54	08:57
7	20:40	07:22	21:42	07:09	23:31	08:50	23:31	10:06
8	21:41	07:53	22:47	07:56	DNR	09:59	DNR	11:13
9	22:45	08:29	23:49	08:50	00:16	11:07	00:04	12:18
10	23:50	09:09	DNR	09:51	00:55	12:15	00:35	13:21
11	DNR	09:58	00:45	10:57	01:29	13:20	01:07	14:23
12	00:54	10:54	01:34	12:06	02:01	14:24	01:40	15:25
13	01:55	11:57	02:16	13:15	02:33	15:27	02:16	16:27
14	02:49	13:06	02:54	14:22	03:05	16:30	02:56	17:28
15	03:37	14:17	03:28	15:28	03:39	17:34	03:40	18:26
16	04:19	15:28	04:01	16:34	04:17	18:37	04:30	19:20
17	04:56	16:37	04:33	17:39	04:59	19:38	05:23	20:07
18	05:30	17:45	05:06	18:44	05:46	20:35	06:19	20:49
19	06:03	18:51	05:42	19:48	06:37	21:27	07:16	21:26
20	06:36	19:57	06:22	20:51	07:32	22:12	08:12	21:58
21	07:11	21:02	07:06	21:51	08:29	22:52	09:08	22:28
22	07:48	22:06	07:55	22:46	09:25	23:27	10:02	22:55
23	08:29	23:07	08:48	23:35	10:21	23:58	10:56	23:22
24	09:14	DNS	09:43	DNS	11:16	DNS	11:51	23:49
25	10:04	00:04	10:39	00:18	12:11	00:27	12:47	DNS
26	10:58	00:56	11:36	00:56	13:06	00:54	13:46	00:18
27	11:53	01:43	12:32	01:29	14:02	01:22	14:48	00:51
28	12:50	02:23	13:27	01:59	15:01	01:50	15:53	01:29
29	13:46	02:59	14:23	02:27	16:03	02:22	17:00	02:13
30	14:42	03:31	15:19	02:55	17:08	02:57	18:06	03:07
31			16:17	03:23			19:07	04:10

Note: DNR or DNS means Moon does not rise/set on that day. The reason for this lies in the Moon's rapid daily motion from west to east. Consecutive days show the Moon to rise (or set) more than 24 hours later. Hence, if the Moon rises just before midnight on the 1st of the month, it may not rise again until after midnight on the 2nd. Therefore it becomes an event for the 3rd of the month with no event on the 2nd.

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	08:48	21:56	10:41	21:50	09:38	20:27	11:59	21:43
2	09:46	22:22	11:46	22:24	10:45	21:05	12:57	22:50
3	10:45	22:49	12:53	23:05	11:54	21:51	13:47	00:00
4	11:46	23:17	14:03	23:55	13:01	22:46	14:30	DNS
5	12:49	23:49	15:11	DNS	14:05	23:49	15:06	01:10
6	13:57	DNS	16:15	00:54	15:01	DNS	15:38	02:18
7	15:08	00:26	17:10	02:02	15:50	00:58	16:08	03:25
8	16:21	01:12	17:57	03:16	16:31	02:10	16:37	04:29
9	17:30	02:08	18:37	04:31	17:07	03:22	17:06	05:33
10	18:32	03:14	19:11	05:44	17:39	04:32	17:38	06:36
11	19:24	04:28	19:42	06:54	18:08	05:39	18:12	07:40
12	20:08	05:45	20:11	08:00	18:38	06:45	18:51	08:42
13	20:44	06:59	20:40	09:05	19:08	07:49	19:35	09:42
14	21:16	08:10	21:10	10:08	19:40	08:53	20:23	10:39
15	21:45	09:17	21:43	11:10	20:16	09:56	21:16	11:31
16	22:13	10:21	22:20	12:12	20:56	10:57	22:12	12:16
17	22:41	11:22	23:02	13:11	21:42	11:56	23:10	12:56
18	23:12	12:23	23:49	14:07	22:32	12:50	DNR	13:31
19	23:45	13:23	DNR	14:59	23:26	13:39	00:08	14:02
20	DNR	14:23	00:40	15:45	DNR	14:22	01:07	14:30
21	00:23	15:20	01:36	16:26	00:23	15:00	02:05	14:57
22	01:06	16:15	02:34	17:02	01:22	15:33	03:05	15:25
23	01:55	17:04	03:33	17:34	02:21	16:03	04:06	15:53
24	02:48	17:49	04:33	18:03	03:20	16:31	05:10	16:25
25	03:45	18:28	05:32	18:30	04:19	16:58	06:17	17:01
26	04:44	19:02	06:32	18:57	05:20	17:26	07:28	17:43
27	05:43	19:32	07:32	19:24	06:22	17:55	08:39	18:34
28	06:42	20:00	08:34	19:54	07:27	18:27	09:48	19:34
29	07:40	20:27			08:35	19:05	10:50	20:41
30	08:39	20:53			09:44	19:49	11:44	21:52
31	09:39	21:20			10:53	20:42		

	MAY		JUNE		JULY		AUGUST	
1	12:29	23:02	12:42	00:14	12:14	01:14	12:54	03:07
2	13:07	DNS	13:11	01:17	12:48	02:16	13:45	03:59
3	13:40	00:11	13:40	02:19	13:26	03:17	14:40	04:47
4	14:10	01:17	14:12	03:21	14:09	04:16	15:37	05:28
5	14:39	02:21	14:47	04:22	14:57	05:12	16:35	06:05
6	15:08	03:23	15:27	05:23	15:50	06:03	17:32	06:37
7	15:38	04:25	16:11	06:21	16:46	06:48	18:29	07:06
8	16:11	05:28	17:02	07:16	17:43	07:28	19:26	07:32
9	16:48	06:30	17:56	08:06	18:41	08:03	20:23	07:58
10	17:29	07:31	18:52	08:50	19:38	08:34	21:21	08:24
11	18:16	08:29	19:50	09:28	20:34	09:02	22:21	08:52
12	19:08	09:23	20:47	10:01	21:31	09:28	23:24	09:22
13	20:03	10:10	21:44	10:31	22:28	09:54	DNR	09:57
14	21:00	10:52	22:41	10:58	23:27	10:20	00:29	10:39
15	21:58	11:29	23:38	11:25	DNR	10:49	01:36	11:29
16	22:55	12:01	DNR	11:51	00:29	11:21	02:42	12:29
17	23:53	12:30	00:37	12:18	01:35	11:59	03:43	13:37
18	DNR	12:57	01:38	12:49	02:43	12:45	04:37	14:50
19	00:51	13:24	02:44	13:25	03:52	13:41	05:23	16:05
20	01:50	13:51	03:53	14:08	04:59	14:47	06:03	17:19
21	02:51	14:20	05:04	15:00	05:58	16:01	06:38	18:30
22	03:56	14:54	06:14	16:02	06:49	17:17	07:10	19:39
23	05:05	15:34	07:19	17:13	07:33	18:32	07:41	20:46
24	06:17	16:21	08:14	18:29	08:10	19:44	08:13	21:52
25	07:29	17:19	09:01	19:44	08:43	20:53	08:46	22:56
26	08:36	18:25	09:40	20:56	09:13	21:59	09:23	23:59
27	09:35	19:37	10:14	22:04	09:43	23:04	10:04	DNS
28	10:25	20:50	10:44	23:09	10:15	DNS	10:49	00:58
29	11:07	22:02	11:13	DNS	10:48	00:07	11:39	01:54
30	11:42	23:10	11:43	00:12	11:25	01:09	12:33	02:43
31	12:13	DNS			12:07	02:09	13:30	03:27

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	14:27	04:05	15:09	03:37	16:53	03:27	17:53	03:08
2	15:25	04:38	16:07	04:04	17:58	03:59	19:01	03:57
3	16:22	05:08	17:05	04:31	19:05	04:35	20:06	04:54
4	17:19	05:36	18:05	04:58	20:13	05:19	21:02	06:00
5	18:16	06:02	19:08	05:28	21:19	06:10	21:51	07:11
6	19:15	06:29	20:13	06:01	22:18	07:10	22:32	08:24
7	20:15	06:56	21:19	06:39	23:10	08:16	23:08	09:35
8	21:17	07:26	22:25	07:24	23:54	09:26	23:40	10:44
9	22:22	07:59	23:27	08:16	DNR	10:36	DNR	11:49
10	23:27	08:39	DNR	09:17	00:32	11:44	00:10	12:54
11	DNR	09:25	00:24	10:24	01:06	12:51	00:40	13:58
12	00:32	10:20	01:12	11:33	01:37	13:56	01:12	15:01
13	01:33	11:23	01:55	12:43	02:07	15:00	01:47	16:04
14	02:28	12:32	02:31	13:52	02:38	16:05	02:25	17:06
15	03:16	13:44	03:05	15:00	03:11	17:10	03:08	18:05
16	03:57	14:57	03:36	16:06	03:47	18:14	03:57	18:59
17	04:33	16:07	04:07	17:13	04:28	19:16	04:50	19:47
18	05:06	17:17	04:39	18:19	05:14	20:14	05:47	20:29
19	05:38	18:25	05:13	19:24	06:05	21:06	06:44	21:05
20	06:09	19:32	05:52	20:29	06:59	21:52	07:42	21:37
21	06:42	20:38	06:35	21:30	07:56	22:32	08:38	22:05
22	07:18	21:43	07:23	22:25	08:54	23:06	09:33	22:32
23	07:58	22:45	08:15	23:15	09:51	23:36	10:28	22:58
24	08:43	23:43	09:10	23:58	10:47	DNS	11:24	23:24
25	09:32	DNS	10:07	DNS	11:43	00:04	12:21	23:52
26	10:25	00:36	11:04	00:35	12:39	00:31	13:21	DNS
27	11:21	01:22	12:01	01:08	13:36	00:57	14:24	00:23
28	12:18	02:02	12:58	01:37	14:36	01:24	15:30	00:59
29	13:15	02:38	13:55	02:04	15:38	01:54	16:38	01:42
30	14:12	03:09	14:52	02:31	16:45	02:28	17:44	02:34
31			15:51	02:58			18:46	03:36

LUNAR OCCULTATIONS

INTRODUCTION

An occultation is when a body passes in front of a more distant astronomical object. As viewed from Earth, no Solar System body occults more stars, more often, than our own Moon. The reasons for this are:

1. Its large angular size. Although the Moon is small in comparison to the planets, it appears large (0.5° wide) because of its proximity. The Moon travels along a 0.5° wide path across the sky, as does the Sun.
2. The rapid motion of the Moon across the sky. It completes one orbit about every 28 days.
3. With it moving approximately in the plane of the ecliptic, as do most Solar System bodies, each month the Moon crosses the heavily star populated Milky Way. It also occasionally occults the Sun and the planets. An eclipse of the Sun is indeed the most spectacular lunar occultation!

From month to month the Moon does not occult the same stars. In fact over a number of years it drifts in declination between plus and minus 28°. The brighter stars the Moon occults are listed in the Zodiacal Catalogue (ZC). There are about 3500 stars in the ZC.

The Moon moves from west to east, so it rises and sets later from day to day. From just after New Moon to just before Full Moon, stars being occulted disappear behind part of the dark limb and reappear from the bright limb. The limb is another way of saying the edge of the Moon. After Full Moon a star disappears on the bright limb and reappears on the dark limb. There is no dark limb at Full Moon.

Dark limb events, in particular disappearances, are the easiest to observe. Following a star until it 'winks out' is much easier than scanning the lunar limb, waiting for it to suddenly reappear. The brighter the star, the more spectacular the event. The following tables present the easier to observe occultations for 2009 as predicted for **Adelaide**, **Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth** and **Sydney**. Both events, the disappearance and reappearance, are not necessarily included. An event may not be present because:

1. The Moon is in daylight.
2. The Moon is too close to or below the horizon.
3. For faint stars, events on a bright limb (in particular reappearances) are difficult to observe and have been omitted.

THE TIMING OF OCCULTATIONS.

Besides being a spectacular event, occultations is an area in which the amateur can make a scientific contribution. The exact timing of when a star goes into or out of occultation helps astronomers in refining their knowledge of the Moon's position and the shape of the limb.

TIMING EQUIPMENT. For a single event, such as a normal occultation, a stop-watch and the telephone time signal as a reference are required. For multiple events, the amateur may tape record simultaneously a shortwave radio time signal with his own voice calling out the events (e.g., star gone … now!) The tape would be later played back (often at a slower speed) and the precise times determined. An accuracy within 0.2 seconds is not unusual for the experienced observer. With the demise of time signal services, such as Australia's VNG, beeper boxes are now being used instead of shortwave radios, especially for multiple timing events. The boxes are electronically synchronised to a time standard before the event.

TELESCOPE REQUIREMENTS. These vary greatly with the brightness of the star being observed, the brightness of the Moon (how close to Full Moon) and whether the event is on a bright or dark limb. Disappearances of first magnitude stars on the dark limb can be observed with the naked-eye!

For further information on timing methods for occultations it would be worth contacting your local astronomical society (see Part III) or see the following web link from the RASNZ Occultation Section.

occsec.wellington.net.nz

LUNAR OCCULTATION TABLES

The faintest stars, which have occultation predictions on the following pages, are approximately 6th magnitude. The criteria for selection are complex involving the Sun and Moon altitude, star magnitude and whether it is a bright or dark limb event.

EXPLANATION

EST the date and time of the occultation, hr and min are in EST except Adelaide and Darwin using CST and Perth using WST.

OBJECT n, nn, nnn, nnnn ZC catalogue number
ggg ccc Greek letter and constellation abbreviation
n ccc Flamsteed number and constellation
name of planet, satellite or deep sky object.

PD event, consisting of two letters.
The first letter is the type of Event: 'D' = Disappearance and 'R' = Reappearance. The second letter represents: 'D' = Dark limb, 'B' = a bright limb event. A 'G' indicates a graze at or near the location. An 'M' means a miss with a graze nearby.

Mag magnitude of the star.

Elg elongation or separation of the Moon from the Sun as measured in degrees.

Alt altitude of the Moon during the occultation.

PA position angle is the position the event occurs on the limb of the Moon (measured as degrees east of north).

A coefficient of longitude (see below)

B coefficient of latitude (see below)
NB. For some stars, close to 'grazing', A and B values become useless, and no values are recorded.

CALCULATING EVENT TIME FOR OTHER LOCATIONS

Unless the event is close to a 'graze' (PA is close to 0° or 180°) this method will give a good approximation for any location within about 500km from the city's table you are working from. The formula is:

Predicted Time at your location

= Time from Table + (A × n) + (B × p)

where 'n' and 'p' are the **change** in longitude and latitude respectively (in decimal degrees).

'n' is positive (+) if east, negative (-) if west

'p' is positive (+) if north, negative (-) if south.

The values for A and B are taken from the tables.

It is best to use data for the city which you are closest to.

WORKED EXAMPLE

An observer wishes to calculate a more accurate time for the disappearance of Lam Sgr on April 16th for their location in Albury NSW (146° 55' E, 36° 05' S), see page 135. Canberra is the closest city, therefore we start with the data from its table.

The change in longitude from Canberra (decimal degrees)

= 149.13° – 146.92° = – 2.21° — 'n' (-)

The change in latitude from Canberra (decimal degrees)

= 35.25° – 36.08° = – 0.83° — 'p' (–)

From the Canberra table, the time of the event is 03:42 EST and the values of A and B are + 2.5 and + 3.1 respectively.

Therefore the equation becomes:

03:42 + (2.5 × – 2.21°) + (3.1 × – 0.83°)

= 03:42 + (– 5.5) + (– 2.6)

= 03:42 + (– 8.1) = 03:34

The event will be visible from Albury approximately eight minutes earlier than Canberra, i.e., about 3:34am (EST) on April 16th.

Lunar occultation predictions were calculated using Occult version 4 by D. Herald,

ADELAIDE (34° 54' S, 138° 36' E)

CST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 10 02:09	136 Tau	DD	4.6	158	12	90	1.2	1.0
Jan 12 04:14	Mu Cnc	RD	5.3	172	17	276	1.1	0.8
Jan 15 22:56	Ups Leo	RD	4.3	120	9	276	0.3	-1.3
Feb 02 20:32	15 Ara	DD	5.7	83	22	113	1.6	0.4
Feb 04 22:06	44 Tau	DD	5.4	110	18	166	-0.9	-5.6
Feb 12 00:51	76 Leo	RD	5.9	153	49	18	-1.6	-4.8
Feb 15 00:27	85 Vir	RD	6.2	115	34	302	0.5	-1.9
Feb 18 00:26	Sig Sco	DB	2.9	81	10	97	-0.2	-1.2
Feb 18 01:23	Sig Sco	RD	2.9	81	21	296	-0.1	-1.7
Feb 18 05:26	Antares	DB	1.1	80	69	160	0.7	-5.0
Feb 19 01:57	36 Oph N	RD	5.1	70	19	268	0.2	-1.1
Feb 19 01:57	36 Oph S	RD	5.2	70	19	268	0.2	-1.1
Feb 19 02:21	2482	RD	6.3	70	23	290	0.1	-1.6
Mar 05 21:31	909	DD	6.0	105	21	70	2.1	1.3
Mar 07 22:40	Mu Cnc	DD	5.3	132	31	147	0.9	-1.0
Mar 10 03:14	31 Leo	DD	4.4	161	18	53	2.5	5.2
Mar 14 23:42	2039	RD	5.5	136	43	6	-1.3	-4.5
Mar 15 01:18	2045	RD	6.4	135	61	328	0.8	-2.7
Mar 15 02:08	2051	RD	5.9	135	70	354	0.1	-4.2
Mar 15 23:41	2157	RD	6.1	124	35	318	0.1	-2.3
Mar 16 23:28	2286	RD	5.4	113	24	262	0.5	-1.0
Mar 20 02:35	2719	RD	5.8	79	30	311	0.0	-2.9
Apr 06 01:08	18 Leo	DD	5.7	129	16	174	-0.3	-2.3
Apr 06 22:30	48 Leo	DD	5.1	141	47	55	6.3	4.7
Apr 06 22:51	48 Leo	RD	5.1	141	46	24	-3.2	-6.8
Apr 13 00:08	42 Lib	RD	5.0	144	57	328	0.6	-3.1
Apr 15 01:59	2524	RD	6.0	121	60	319	1.1	-3.5
Apr 15 22:43	2652	RD	6.5	111	11	258	0.0	-0.8
Apr 16 02:46	Lam Sgr	DB	2.8	110	58	40	2.5	2.1
Apr 16 03:51	Lam Sgr	RD	2.8	109	71	311	2.3	-3.6
Apr 20 05:12	Lam Cap	RD	5.6	65	43	261	1.6	-0.7
Apr 21 03:38	3308	RD	6.2	54	13	168	0.5	7.9
May 01 21:10	1276	DD	6.5	84	21	174	-0.5	-2.2
May 08 03:52	83 Vir	DD	5.6	162	22	151	0.9	-1.3
May 09 20:45	2183	RD	5.5	174	41	325	0.2	-2.6
May 10 23:53	2332	RD	6.1	163	70	232	3.3	2.1
May 11 02:58	Sig Sco	DB	2.9	162	68	109	2.3	-0.3
May 11 04:21	Sig Sco	RD	2.9	162	51	255	1.4	1.7
May 18 05:09	The Aqr	DB	4.2	84	54	103	3.0	-1.9
May 18 06:04	The Aqr	RD	4.2	84	61	182	0.2	3.8
May 20 04:05	19 Psc	DB	5.0	61	21	31	0.4	1.0
May 20 05:09	19 Psc	RD	5.0	60	32	260	1.5	-0.7
Jun 06 19:39	2269	DD	5.4	165	44	127	0.6	-2.2
Jun 06 22:39	2286	DD	5.4	166	78	108	2.3	-1.1
Jun 07 02:42	2299	DD	6.2	167	45	25	-0.1	6.2
Jun 11 23:06	Sig Cap	RD	5.3	138	33	279	0.9	-1.7
Jun 12 05:15	Pi Cap	RD	5.1	136	60	284	2.9	0.1
Jun 16 03:17	9 Psc	RD	6.3	91	37	219	1.0	1.0
Jun 16 03:18	Kap Psc	RD	5.0	91	37	254	1.5	-0.4
Jun 18 06:12	75 Psc	RD	6.1	66	38	190	0.2	2.2
Jun 19 05:08	Iot Ari	RD	5.1	54	20	208	0.2	1.0
Jul 02 19:47	2109	DD	6.1	125	75	142	1.5	-2.6
Jul 05 22:29	2524	DD	6.0	160	80	86	2.6	0.0
Jul 07 00:42	Lam Sgr	DD	2.8	171	75	133	3.7	-3.3
Jul 07 01:28	Lam Sgr	RB	2.8	172	66	193	0.1	5.5
Jul 10 01:34	3064	RD	5.9	155	70	176	-0.1	5.7
Jul 16 01:12	Eta Psc	RD	3.8	86	3	210	-0.2	0.8
Jul 28 21:51	83 Vir	DD	5.6	84	30	80	0.8	1.7
Jul 31 21:27	Sig Sco	DD	2.9	119	69	92	2.3	0.5
Jul 31 22:55	Sig Sco	RB	2.9	120	51	271	1.6	1.0
Aug 09 00:05	3370	RD	6.2	151	47	213	1.1	1.5
Aug 13 02:09	15 Ara	DD	5.7	103	22	338	9.9	9.9
Aug 13 02:20	15 Ara	RD	5.7	103	24	319	9.9	9.9
Aug 27 21:29	2299	DD	6.2	89	43	32	0.2	4.7
Sep 01 22:53	Pi Cap	DD	5.1	145	70	38	1.4	2.5
Sep 02 00:41	Rho Cap	DD	4.9	146	51	354	-1.2	4.9
Sep 05 21:30	Kap Psc	RD	5.0	169	32	258	1.4	-0.6
Sep 05 21:30	9 Psc	RD	6.3	169	32	222	0.9	0.8
Sep 07 03:54	41 Psc	RD	5.4	155	36	231	1.5	1.9
Sep 08 01:40	75 Psc	RD	6.1	144	42	184	0.1	2.8
Sep 09 01:39	Iot Ari	RD	5.1	132	34	173	-1.1	3.8
Sep 11 01:46	555	RD	6.4	107	17	230	0.7	0.1
Sep 11 05:13	579	RD	6.4	106	29	292	2.6	-0.5
Sep 23 19:02	42 Lib	DD	5.0	58	47	83	1.3	1.4
Sep 23 20:14	42 Lib	RB	5.0	58	32	285	0.9	0.7
Sep 27 22:20	2822	DD	5.6	104	47	36	0.4	2.7
Sep 28 01:36	50 Sgr	DD	5.6	105	8	19	-0.9	2.5
Oct 06 00:23	105 Psc	RD	6.0	162	38	245	1.9	0.5
Oct 08 02:39	7 Tau	RD	6.0	137	31	246	2.1	0.6
Oct 10 02:15	844	RD	5.8	111	20	304	2.2	-1.8
Oct 11 03:48	Eps Gem	DB	3.1	98	24	153	2.2	-2.8
Oct 11 04:36	Eps Gem	RD	3.1	97	28	224	2.3	1.2
Oct 12 04:01	1167	RD	6.3	84	22	280	1.6	-1.1
Oct 13 04:59	Del Cnc	MB	3.9	71	26	23	9.9	9.9
Oct 27 19:58	18 Aqr	DD	5.5	105	66	130	8.1	-6.5
Oct 27 20:18	18 Aqr	RD	5.5	105	64	156	-4.5	9.8
Oct 28 20:13	3248	DD	6.5	116	63	32	1.3	2.3
Oct 29 23:49	3371	DD	6.4	129	35	24	0.6	2.6
Nov 12 04:18	65 Leo	RD	5.6	62	27	263	1.3	-1.0
Nov 20 20:50	26 Sgr	DD	6.2	41	15	133	1.0	-0.4
Nov 25 23:10	3326	DD	6.4	97	20	101	0.9	1.0
Dec 01 22:28	18 Tau	DD	5.7	169	29	77	2.0	0.0
Dec 02 00:13	555	DD	6.4	169	29	83	2.2	0.5
Dec 05 01:07	Ome Gem	RD	5.2	148	28	283	2.0	-0.8
Dec 13 03:50	2039	RD	5.5	43	19	279	0.2	-1.3
Dec 27 21:56	The Ari	DD	5.6	123	30	94	2.2	0.6

BRISBANE (27° 30' S, 153° 01' E)

EST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 15 23:23	Ups Leo	RD	4.3	120	22	298	0.7	-1.6
Jan 19 00:47	2011	RD	6.3	84	18	311	-0.1	-1.8
Feb 02 21:24	15 Ara	DD	5.7	83	12	92	0.9	0.9
Feb 04 22:38	44 Tau	DD	5.4	110	15	115	0.8	0.1
Feb 15 00:46	85 Vir	RD	6.2	116	45	343	0.0	-3.0
Feb 18 00:54	Sig Sco	DB	2.9	81	19	55	1.1	0.3
Feb 18 01:32	Sig Sco	RD	2.9	81	27	342	-0.9	-3.3
Feb 19 02:17	36 Oph N	RD	5.1	70	26	309	-0.1	-2.1
Feb 19 02:18	36 Oph S	RD	5.2	70	26	308	-0.1	-2.1
Feb 19 02:30	2482	RD	6.3	70	29	339	-0.9	-3.8
Feb 21 03:07	2771	RD	5.6	48	15	225	0.9	0.8
Mar 03 20:30	569	DD	5.3	78	16	130	0.6	-0.5
Mar 05 19:34	136 Tau	RB	4.6	104	34	280	2.4	0.0
Mar 05 22:01	906	DD	6.6	105	19	105	1.2	0.3
Mar 06 19:21	40 Gem	DD	6.4	117	36	71	2.8	0.5
Mar 07 23:26	Mu Cnc	DD	5.3	132	29	101	1.6	0.3
Mar 11 19:56	Ups Leo	RD	4.3	175	24	287	0.8	-1.4
Mar 16 21:42	2269	RD	5.4	114	6	281	-0.3	-1.1
Mar 16 23:54	2286	RD	5.4	113	33	302	0.3	-1.8
Mar 23 04:21	29 Cap	RD	5.3	45	24	222	0.9	1.0
Apr 04 21:29	Del Cnc	DD	3.9	114	38	176	-0.3	-2.8
Apr 04 22:15	Del Cnc	RB	3.9	114	31	252	2.7	1.8
Apr 06 01:32	18 Leo	DD	5.7	129	9	126	0.2	-0.3
Apr 07 18:51	76 Leo	DD	5.9	152	35	64	2.5	0.4
Apr 07 23:13	1649	DD	6.1	154	58	183	-0.2	-3.7
Apr 12 01:03	2108	RD	6.6	155	83	273	2.9	-0.2
Apr 12 01:52	2109	RD	6.1	155	80	267	3.0	0.4
Apr 15 23:03	2652	RD	6.5	111	18	298	-0.2	-1.8
Apr 16 04:32	Lam Sgr	MD	2.8	109	87	348	9.9	9.9
Apr 21 04:37	3308	RD	6.2	53	32	208	0.8	1.7
May 01 21:37	1276	DD	6.5	84	17	121	0.6	-0.1
May 04 21:41	65 Leo	DD	5.6	123	53	192	-1.0	-4.9
May 08 04:26	83 Vir	DD	5.6	162	8	131	0.4	-0.5
May 11 01:09	2332	RD	6.1	163	85	278	2.8	-0.3
May 11 04:00	Sig Sco	DB	2.9	162	49	93	1.7	0.8
May 11 05:17	Sig Sco	RD	2.9	162	32	262	0.7	1.2
May 11 22:55	2458	RD	6.3	152	54	219	3.8	3.3
May 12 05:18	2482	RD	6.3	151	43	205	-0.3	4.2
May 20 04:53	19 Psc	DB	5.0	61	38	23	0.6	1.9
Jun 05 18:04	2134	DD	5.9	153	38	72	1.8	-0.2
Jun 06 20:18	2269	DD	5.4	165	57	81	2.3	-0.4
Jun 06 23:50	2286	DD	5.4	166	76	70	2.8	1.7
Jun 11 23:26	Sig Cap	RD	5.3	138	43	330	9.9	9.9
Jun 13 04:15	3100	RD	6.5	126	74	253	2.6	1.2
Jun 14 00:56	3208	RD	6.5	115	41	242	1.5	0.3
Jun 16 00:56	3444	RD	6.3	93	18	184	0.1	3.2
Jun 16 02:59	Kap Psc	DB	5.0	92	42	28	0.9	1.8
Jun 16 04:14	9 Psc	RD	6.3	91	55	217	1.4	1.7
Jun 16 04:16	Kap Psc	RD	5.0	91	55	252	2.4	0.4
Jun 19 04:52	Iot Ari	DB	5.1	54	26	91	1.7	-1.0
Jun 19 05:52	Iot Ari	RD	5.1	54	36	201	0.4	1.7
Jul 02 20:38	2109	DD	6.1	125	78	97	2.8	-0.1
Jul 05 23:43	2524	DD	6.0	160	73	65	2.3	1.8
Jul 06 19:00	2652	DD	6.5	169	35	98	0.9	-1.3
Jul 07 01:48	Lam Sgr	DD	2.8	171	56	129	3.7	-2.0
Jul 07 02:30	Lam Sgr	RB	2.8	172	47	190	-0.9	4.8
Jul 16 01:48	Eta Psc	RD	3.8	86	18	217	0.3	0.9
Jul 28 22:42	83 Vir	DD	5.6	84	13	56	-0.2	2.7
Jul 29 22:14	2084	DD	6.5	96	31	82	0.8	1.3
Jul 31 22:33	Sig Sco	DD	2.9	119	50	76	1.5	1.5
Jul 31 23:51	Sig Sco	RB	2.9	120	33	278	1.0	0.7
Aug 01 23:33	2482	DD	6.3	131	48	148	4.2	-4.6
Aug 09 01:08	3370	RD	6.2	151	64	207	1.2	2.4
Aug 13 03:29	15 Ara	RD	5.7	103	41	294	4.1	-2.0
Aug 27 18:47	2286	DD	5.4	88	71	69	2.6	1.8
Aug 27 22:27	2299	DD	6.2	90	24	18	-1.7	6.1
Sep 01 23:59	Pi Cap	DD	5.1	145	55	47	1.1	2.3
Sep 02 01:30	Rho Cap	DD	4.9	146	35	10	-0.5	3.3
Sep 02 21:20	3100	DD	6.5	156	72	52	2.2	1.6
Sep 03 02:31	3112	DD	6.4	157	30	10	-0.4	3.1
Sep 05 22:23	Kap Psc	RD	5.0	169	50	259	2.4	-0.2
Sep 05 22:24	9 Psc	RD	6.3	169	51	224	1.4	1.3
Sep 07 04:57	41 Psc	RD	5.4	155	24	232	1.0	2.0
Sep 08 02:30	75 Psc	RD	6.1	144	48	159	-2.9	7.3
Sep 11 00:59	18 Tau	RD	5.7	108	20	250	1.0	-0.2
Sep 11 02:34	555	RD	6.4	107	32	224	1.3	0.9
Sep 23 19:56	42 Lib	DD	5.0	58	28	72	0.5	1.6
Sep 27 23:11	2822	DD	5.6	104	30	44	0.0	2.2
Oct 05 19:43	Eta Psc	RD	3.8	164	10	295	1.3	-2.6
Oct 06 01:30	105 Psc	RD	6.0	162	44	237	2.1	1.4
Oct 08 03:48	7 Tau	RD	6.0	137	34	252	2.3	1.0
Oct 10 03:08	844	RD	5.8	111	34	310	2.7	-1.8
Oct 10 04:21	849	RD	6.5	111	36	243	2.7	1.0
Oct 11 04:34	Eps Gem	DB	3.1	98	37	132	2.3	-1.5
Oct 20 18:42	2183	DD	5.5	26	16	61	-0.2	1.9
Oct 28 21:20	3248	DD	6.5	116	57	45	1.4	2.2
Oct 30 00:45	3371	DD	6.4	129	20	25	0.3	2.6
Nov 21 18:53	50 Sgr	RB	5.6	51	40	258	1.1	1.3
Nov 21 20:24	2851	DD	6.1	52	21	60	0.0	1.7
Dec 01 23:33	18 Tau	DD	5.7	169	37	75	2.4	0.7
Dec 02 01:20	555	DD	6.4	169	27	66	2.0	1.4
Dec 04 02:27	139 Tau	RD	4.8	162	32	238	2.8	1.8
Dec 05 02:01	Ome Gem	RD	5.2	148	38	307	2.0	-1.0
Dec 13 04:12	2039	RD	5.5	43	29	313	0.2	-1.9
Dec 27 23:00	The Ari	DD	5.6	123	23	81	1.5	1.2
Dec 30 02:04	Chi Tau	DD	5.4	150	7	137	0.0	-0.7

LUNAR OCCULTATION TABLE

CANBERRA (35° 15' S, 149° 08' E)

EST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 15 23:32	Ups Leo	RD	4.3	120	19	281	0.7	-1.5
Jan 19 01:00	2011	RD	6.3	84	19	292	0.1	-1.6
Feb 02 21:15	15 Ara	DD	5.7	83	13	112	0.9	0.6
Feb 04 22:38	44 Tau	DD	5.4	110	12	144	0.3	-0.8
Feb 07 20:07	57 Gem	DD	5.0	150	22	49	1.6	0.5
Feb 15 01:04	85 Vir	RD	6.2	115	44	318	0.6	-2.2
Feb 18 00:56	Sig Sco	DB	2.9	81	19	84	0.2	-1.0
Feb 18 01:54	Sig Sco	RD	2.9	81	30	311	0.0	-2.2
Feb 19 02:30	36 Oph N	RD	5.1	70	28	282	0.3	-1.5
Feb 19 02:31	36 Oph S	RD	5.2	70	28	282	0.3	-1.5
Feb 19 02:52	2482	RD	6.3	70	32	304	0.1	-2.2
Mar 05 19:24	136 Tau	RB	4.6	104	27	263	2.3	0.3
Mar 05 22:23	909	DD	6.0	105	13	51	2.3	2.6
Mar 07 23:21	Mu Cnc	DD	5.3	132	25	129	1.0	-0.3
Mar 15 01:55	2045	RD	6.4	136	69	351	0.3	-4.0
Mar 16 00:13	2157	RD	6.1	124	44	337	-0.1	-3.0
Mar 16 21:50	2269	RD	5.4	114	8	260	-0.1	-0.9
Mar 17 00:04	2286	RD	5.4	113	33	277	0.7	-1.4
Mar 20 03:06	2719	RD	5.8	79	39	328	-0.1	-4.8
Apr 06 01:37	18 Leo	DD	5.7	129	8	159	-0.1	-1.3
Apr 07 18:49	76 Leo	DD	5.9	152	29	90	1.3	-1.2
Apr 08 23:24	1759	DD	6.6	166	61	96	2.5	-0.2
Apr 12 00:40	2108	RD	6.6	156	72	227	5.4	4.9
Apr 13 00:42	42 Lib	RD	5.0	144	66	351	-0.1	-5.2
Apr 15 02:44	2524	RD	6.0	121	71	332	1.5	-5.3
Apr 15 23:14	2652	RD	6.5	111	19	271	0.2	-1.2
Apr 16 03:42	Lam Sgr	DB	2.8	110	71	36	2.5	3.1
Apr 16 04:51	Lam Sgr	RD	2.8	109	80	306	3.0	-2.7
Apr 20 06:01	Lam Cap	RD	5.6	65	54	250	2.0	0.1
May 01 21:39	1276	DD	6.5	84	15	152	0.1	-0.9
May 07 02:01	1845	DD	6.5	149	30	69	1.1	2.5
May 08 04:32	83 Vir	DD	5.6	162	12	163	0.8	-2.1
May 09 21:16	2183	RD	5.5	174	50	347	-0.3	-3.8
May 11 00:54	2332	RD	6.1	163	80	246	2.8	1.4
May 11 03:50	Sig Sco	DB	2.9	162	55	116	2.0	-0.2
May 11 05:01	Sig Sco	RD	2.9	162	40	242	0.7	2.2
May 19 04:24	3370	RD	6.2	73	38	295	2.6	-3.4
May 20 04:41	19 Psc	DB	5.0	61	29	44	0.8	0.6
May 20 05:55	19 Psc	RD	5.0	60	42	242	1.5	0.3
Jun 05 18:06	2134	DD	5.9	153	36	99	0.8	-1.4
Jun 06 20:20	2269	DD	5.4	165	54	111	1.3	-1.7
Jun 06 23:35	2286	DD	5.4	166	78	101	2.4	-0.3
Jun 07 03:12	2299	DD	6.2	167	37	46	0.2	3.1
Jun 11 23:49	Sig Cap	RD	5.3	138	44	281	1.5	-1.8
Jun 12 06:07	Pi Cap	RD	5.1	136	47	261	1.5	1.4
Jun 13 03:56	3100	RD	6.5	126	69	239	2.0	1.4
Jun 14 00:46	3208	RD	6.5	115	34	215	1.0	1.2
Jun 16 02:47	Kap Psc	DB	5.0	92	33	49	1.0	0.5
Jun 16 03:56	9 Psc	RD	6.3	92	44	201	0.7	2.0
Jun 16 04:05	Kap Psc	RD	5.0	91	46	236	1.6	0.6
Jun 19 04:58	Iot Ari	DB	5.1	54	20	114	2.2	-2.6
Jun 19 05:37	Iot Ari	RD	5.1	54	25	182	-0.6	2.6
Jul 01 19:17	1993	DD	6.6	113	72	143	1.5	-2.3
Jul 02 20:36	2109	DD	6.1	125	75	128	2.0	-1.7
Jul 05 23:25	2524	DD	6.0	160	77	89	2.5	0.4
Jul 07 01:53	Lam Sgr	MD	2.8	171	59	161	9.9	9.9
Jul 16 01:39	Eta Psc	RD	3.8	86	10	194	-0.3	1.7
Jul 25 18:47	65 Leo	DD	5.6	45	25	64	1.7	3.2
Jul 28 22:27	83 Vir	DD	5.6	84	21	86	0.4	1.4
Jul 29 22:03	2084	DD	6.5	96	37	107	1.2	0.5
Jul 31 22:18	Sig Sco	DD	2.9	119	56	99	1.9	0.5
Jul 31 23:38	Sig Sco	RB	2.9	120	40	259	0.9	1.6
Aug 09 00:44	3370	RD	6.2	151	54	192	0.6	2.8
Aug 13 03:27	15 Ara	RD	5.7	103	32	278	2.6	-1.0
Aug 27 18:31	2286	DD	5.4	88	75	99	2.4	-0.1
Aug 27 22:00	2299	DD	6.2	89	35	51	0.3	2.7
Sep 01 23:37	Pi Cap	DD	5.1	145	60	58	1.5	1.9
Sep 02 01:07	Rho Cap	DD	4.9	146	43	23	0.1	2.9
Sep 02 21:04	3100	DD	6.5	156	62	72	2.2	0.3
Sep 03 02:09	3112	DD	6.4	157	37	22	0.1	2.7
Sep 05 22:09	9 Psc	RD	6.3	169	41	206	0.8	1.6
Sep 05 22:15	Kap Psc	RD	5.0	169	42	242	1.5	0.3
Sep 07 04:36	41 Psc	RD	5.4	155	27	220	1.1	2.2
Sep 11 00:57	18 Tau	RD	5.7	108	12	235	0.5	-0.1
Sep 11 02:23	555	RD	6.4	107	23	210	0.6	1.0
Sep 11 03:57	569	RD	5.3	107	29	308	3.2	-1.8
Sep 23 19:43	42 Lib	DD	5.0	58	36	94	0.9	1.0
Sep 23 20:50	42 Lib	RB	5.0	58	22	272	0.3	1.1
Sep 27 22:54	2822	DD	5.6	104	38	55	0.5	2.1
Oct 05 19:52	Eta Psc	RD	3.8	164	6	267	0.5	-1.1
Oct 06 01:12	105 Psc	RD	6.0	162	38	227	1.7	1.3
Oct 08 03:30	7 Tau	RD	6.0	137	29	238	2.1	1.2
Oct 10 03:09	844	RD	5.8	111	25	294	2.2	-1.1
Oct 10 03:09	X 75950	RD	6.6	111	25	294	2.2	-1.1
Oct 10 04:03	849	RD	6.5	111	28	223	2.2	1.3
Oct 11 04:40	Eps Gem	DB	3.1	98	29	154	1.9	-2.3
Oct 20 19:29	2183	RB	5.5	26	12	287	0.1	0.6
Oct 22 21:03	2469	DD	6.5	50	16	29	-0.9	2.8
Oct 28 00:26	3146	DD	6.6	106	15	348	-1.2	4.6
Oct 28 20:58	3248	DD	6.5	116	58	54	1.7	1.8
Oct 30 00:24	3371	DD	6.4	129	26	37	0.6	2.3
Nov 21 20:11	2851	DD	6.1	52	28	70	0.4	1.6
Dec 01 23:21	18 Tau	DD	5.7	169	30	88	2.2	0.1
Dec 02 01:04	555	DD	6.4	169	24	84	1.9	0.8
Dec 05 01:59	Ome Gem	RD	5.2	148	31	288	2.0	-0.5
Dec 27 22:46	The Ari	DD	5.6	123	22	98	1.6	0.8

DARWIN (12° 23' S, 130° 44' E)

CST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 01 20:59	3285	DD	5.9	54	23	95	1.0	0.3
Jan 05 20:12	Eta Psc	RB	3.8	102	59	182	0.4	4.2
Jan 06 00:47	105 Psc	DD	6.0	103	6	90	0.3	0.4
Jan 12 03:59	Mu Cnc	RD	5.3	172	40	326	0.6	-1.6
Jan 21 04:38	2 Sco	DB	4.5	59	32	148	-0.1	-2.4
Jan 21 05:44	2 Sco	RD	4.5	59	46	263	2.3	-0.1
Feb 02 20:37	15 Ara	DD	5.7	83	41	56	2.1	1.7
Feb 04 21:31	44 Tau	DD	5.4	110	45	93	2.6	0.1
Feb 09 00:27	35 Cnc	DD	6.6	166	58	76	3.8	0.9
Feb 12 05:00	1649	RD	6.1	151	54	320	1.3	-1.7
Feb 14 23:40	85 Vir	RD	6.2	115	14	344	-0.5	-2.6
Feb 18 04:23	Antares	DB	1.1	80	45	97	1.8	-0.7
Feb 18 05:53	Antares	RD	1.1	79	64	303	2.2	-2.0
Feb 21 05:26	2790	RD	6.3	47	26	286	0.7	-1.1
Feb 23 06:01	3041	RD	6.2	24	12	215	0.9	1.8
Mar 03 21:14	579	DD	6.4	79	29	95	1.5	0.2
Mar 05 20:49	906	DD	6.6	105	48	98	2.7	-0.2
Mar 07 22:05	Mu Cnc	DD	5.3	132	56	107	2.7	-0.7
Mar 09 04:10	Pi Cnc	DD	5.4	148	8	133	0.0	-0.9
Mar 31 20:07	701	DD	6.6	61	28	67	2.0	1.3
Apr 04 20:08	Del Cnc	DD	3.9	114	59	190	-0.9	-6.3
Apr 04 20:45	Del Cnc	RB	3.9	114	60	238	6.0	3.4
Apr 06 00:42	18 Leo	DD	5.7	129	38	109	1.4	-0.4
Apr 06 01:25	19 Leo	DD	6.4	129	29	118	0.9	-0.6
Apr 08 21:53	1759	DD	6.6	166	59	75	3.9	0.7
Apr 11 23:25	2108	RD	6.6	155	49	271	2.1	-0.5
Apr 12 00:11	2109	RD	6.1	155	59	272	2.6	-0.5
Apr 30 21:00	1144	DD	6.6	71	31	156	0.0	-2.0
May 01 20:36	1276	DD	6.5	84	48	120	1.7	-0.9
May 08 03:54	83 Vir	DD	5.6	162	26	55	0.7	2.8
May 09 03:23	2084	DD	6.5	172	44	67	1.8	1.9
May 10 23:25	2332	RD	6.1	163	54	299	1.6	-1.6
May 11 21:53	2458	RD	6.3	152	22	235	1.7	1.2
May 12 03:55	36 Oph N	RD	5.1	151	68	288	3.4	-0.9
May 12 03:55	36 Oph S	RD	5.2	151	68	288	3.4	-0.9
May 12 04:33	2482	RD	6.3	150	61	297	3.4	-1.3
May 16 02:30	Ups Cap	RD	5.2	107	41	246	1.8	0.7
May 18 05:18	The Aqr	DB	4.2	84	59	9	0.8	3.9
May 18 06:29	The Aqr	RD	4.2	83	76	271	4.0	-0.2
May 29 21:06	81 Cnc	DD	6.5	68	30	79	1.9	1.1
Jun 06 19:06	2269	DD	5.4	165	24	80	1.0	-0.1
Jun 10 03:14	2719	RD	5.8	158	72	259	3.1	0.8
Jun 15 01:58	3328	RD	6.4	103	30	182	0.4	4.3
Jun 19 04:51	Iot Ari	RD	5.1	54	22	310	3.5	-4.7
Jul 07 00:32	Lam Sgr	DD	2.8	171	76	34	2.4	3.7
Jul 07 01:56	Lam Sgr	RB	2.8	172	63	288	3.6	-0.9
Jul 07 01:58	2678	DD	6.6	172	63	16	0.4	5.0
Jul 10 02:06	3064	RD	5.9	155	82	271	4.0	-0.2
Jul 27 22:09	1852	DD	6.0	72	20	112	0.8	-0.4
Aug 01 21:10	36 Oph N	DD	5.1	130	75	71	3.6	1.2
Aug 01 21:10	36 Oph S	DD	5.2	130	75	71	3.6	1.2
Aug 01 22:00	2482	DD	6.3	131	73	57	3.1	2.3
Aug 03 03:49	2652	DD	6.5	144	12	119	0.9	-0.7
Aug 08 00:55	The Aqr	DB	4.2	162	74	101	4.7	-1.3
Aug 08 01:52	The Aqr	RD	4.2	162	85	173	-0.6	5.1
Aug 10 02:52	19 Psc	RD	5.0	138	73	220	1.8	2.2
Aug 22 19:30	1688	DD	6.4	27	13	70	0.6	1.5
Aug 30 20:22	2719	DD	5.8	123	75	84	3.5	0.3
Sep 07 03:50	41 Psc	RD	5.4	156	57	308	8.0	-6.1
Sep 08 02:01	75 Psc	RD	6.1	144	62	262	3.2	0.3
Sep 09 02:03	Iot Ari	RD	5.1	132	53	259	2.6	0.3
Sep 11 00:11	20 Tau	RD	3.9	108	7	228	-0.2	0.9
Sep 11 00:21	21 Tau	RD	5.8	108	10	265	0.5	-0.3
Sep 22 19:35	2108	DD	6.6	46	31	74	1.0	1.2
Sep 22 20:08	2109	DD	6.1	46	23	98	0.9	0.1
Sep 25 19:41	2524	DD	6.0	81	63	77	2.7	1.0
Sep 26 21:53	Lam Sgr	MD	2.8	93	46	157	9.9	9.9
Sep 26 22:37	2678	DD	6.6	93	36	139	4.8	-4.5
Sep 26 23:01	2678	RD	6.6	93	31	177	-2.9	6.6
Sep 29 21:32	3064	DD	5.9	126	84	99	4.5	-0.6
Oct 06 06:00	4 Ara	RD	5.9	160	19	211	1.3	2.7
Oct 06 21:56	26 Ara	RD	6.1	151	18	218	0.0	1.3
Oct 10 02:51	849	RD	6.5	111	38	295	2.6	-1.4
Oct 11 02:58	Eps Gem	DB	3.1	98	29	83	1.5	-0.2
Oct 11 04:20	Eps Gem	RD	3.1	97	43	285	2.6	-0.9
Oct 27 19:50	18 Aqr	DD	5.5	105	89	30	1.6	3.0
Nov 08 00:52	58 Gem	RD	6.2	116	19	273	1.0	-0.5
Nov 12 03:42	65 Leo	RD	5.6	62	17	310	0.5	-1.6
Nov 20 21:03	26 Sgr	DD	6.2	41	11	56	-0.2	1.3
Nov 25 20:55	Kap Aqr	DD	5.0	96	62	59	2.1	1.7
Nov 25 22:19	Kap Aqr	RB	5.0	96	42	221	1.0	2.2
Nov 25 23:36	3326	DD	6.4	97	24	42	0.5	2.0
Nov 29 21:21	4 Ara	DD	5.9	143	59	78	2.9	0.5
Dec 01 21:51	16 Tau	DD	5.5	169	43	117	3.4	-1.9
Dec 01 22:01	19 Tau	DD	4.3	169	45	84	2.3	-0.1
Dec 01 22:29	21 Tau	DD	5.8	169	48	80	2.5	0.2
Dec 01 22:32	20 Tau	DD	3.9	169	48	122	4.0	-2.3
Dec 01 22:33	22 Tau	DD	6.4	169	48	88	2.7	-0.1
Dec 01 23:27	20 Tau	RB	3.9	169	53	198	1.3	3.8
Dec 04 01:07	139 Tau	RD	4.8	161	50	264	2.8	0.1
Dec 04 01:28	902	RD	6.6	161	51	226	3.0	2.4
Dec 13 04:19	2045	RD	6.4	42	13	283	0.2	-0.8
Dec 13 05:05	2051	RD	5.9	42	24	297	0.4	-1.2
Dec 21 21:37	3169	DD	6.1	54	14	87	0.5	0.6
Dec 27 22:08	The Ari	DD	5.6	123	51	35	2.2	2.6
Dec 30 01:06	Chi Tau	DD	5.4	150	37	120	1.6	-0.9

LUNAR OCCULTATION TABLE

HOBART (42° 48' S, 147° 13' E)

EST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 15 23:42	Ups Leo	RD	4.3	120	18	269	0.7	-1.4
Jan 19 01:12	2011	RD	6.3	84	21	279	0.3	-1.6
Jan 23 02:45	2524	RD	6.0	39	9	320	-0.8	-2.1
Jan 24 03:52	Lam Sgr	DB	2.8	28	11	14	2.3	3.8
Jan 24 04:04	Lam Sgr	RD	2.8	27	13	349	-2.8	-6.5
Feb 02 21:09	15 Ara	DD	5.7	83	10	130	0.9	0.2
Feb 07 20:05	57 Gem	DD	5.0	150	15	64	1.4	-0.5
Feb 12 01:44	76 Leo	RD	5.9	153	46	19	-1.7	-4.7
Feb 15 01:18	85 Vir	RD	6.2	115	43	302	0.8	-1.9
Feb 18 01:06	Sig Sco	DB	2.9	81	21	101	0.0	-1.5
Feb 18 02:08	Sig Sco	RD	2.9	81	32	292	0.3	-1.8
Feb 19 02:40	36 Oph N	RD	5.1	70	30	261	0.6	-1.2
Feb 19 02:40	36 Oph S	RD	5.2	70	30	261	0.6	-1.2
Feb 19 03:06	2482	RD	6.3	70	34	282	0.5	-1.7
Mar 04 20:23	731	DD	6.0	91	14	25	2.6	3.1
Mar 05 22:06	909	DD	6.0	105	10	75	1.5	1.4
Mar 07 23:23	Mu Cnc	DD	5.3	132	20	150	0.5	-0.6
Mar 10 03:34	31 Leo	DD	4.4	161	10	83	0.8	1.7
Mar 11 04:16	58 Leo	DD	4.8	174	16	57	1.3	4.2
Mar 15 00:37	2039	RD	5.5	136	52	2	-0.8	-4.3
Mar 15 02:16	2045	RD	6.4	135	64	322	1.2	-2.3
Mar 15 03:12	2051	RD	5.9	135	66	339	1.0	-3.0
Mar 16 00:32	2157	RD	6.1	124	45	315	0.5	-2.3
Mar 16 21:56	2269	RD	5.4	114	11	242	0.1	-0.7
Mar 17 00:12	2286	RD	5.4	113	34	257	0.9	-1.1
Mar 20 03:29	2719	RD	5.8	79	42	293	0.8	-2.3
Apr 06 23:12	48 Leo	DD	5.1	141	37	65	3.2	2.6
Apr 07 18:58	76 Leo	DD	5.9	152	25	103	1.0	-1.6
Apr 13 01:08	42 Lib	RD	5.0	144	65	317	1.2	-2.5
Apr 15 03:04	2524	RD	6.0	121	69	295	1.9	-1.8
Apr 16 03:27	Lam Sgr	DB	2.8	110	64	69	2.0	0.2
Apr 16 04:56	Lam Sgr	RD	2.8	109	73	275	2.2	-0.3
Apr 20 05:54	Lam Cap	RD	5.6	65	48	227	1.3	0.8
May 08 04:33	85 Vir	DD	6.2	162	14	71	0.0	2.1
May 09 21:38	2183	RD	5.5	174	51	320	0.6	-2.5
May 10 20:10	2311	RD	6.3	165	28	354	-1.3	-4.0
May 11 03:55	Sig Sco	DB	2.9	162	54	149	2.2	-2.5
May 11 04:37	Sig Sco	RD	2.9	162	46	213	0.3	4.5
May 19 04:34	3370	RD	6.2	73	35	263	1.5	-1.0
May 20 04:39	19 Psc	DB	5.0	61	24	67	0.9	-0.5
May 20 05:49	19 Psc	RD	5.0	60	34	223	1.0	0.6
Jun 05 01:41	2045	DD	6.4	144	33	49	0.5	4.0
Jun 05 02:30	2051	DD	5.9	144	25	60	0.2	2.8
Jun 05 18:18	2134	DD	5.9	153	37	117	0.5	-1.9
Jun 06 00:23	2157	DD	6.1	155	57	48	1.9	4.3
Jun 06 20:34	2269	DD	5.4	165	54	134	0.8	-2.5
Jun 06 23:38	2286	DD	5.4	166	71	129	1.9	-1.7
Jun 07 02:52	2299	DD	6.2	167	42	72	0.8	2.0
Jun 11 23:55	Sig Cap	RD	5.3	138	43	253	1.3	-0.6
Jun 12 05:52	Pi Cap	RD	5.1	136	49	248	1.2	1.8
Jun 12 06:54	Rho Cap	RD	4.9	136	38	292	1.7	0.7
Jun 16 02:45	Kap Psc	DB	5.0	92	28	72	1.1	-0.6
Jun 16 03:36	9 Psc	RD	6.3	92	35	172	-0.5	4.0
Jun 16 03:57	Kap Psc	RD	5.0	91	38	217	1.0	0.9
Jun 25 18:12	Del Cnc	MD	3.9	35	12	30	9.9	9.9
Jul 02 20:51	2109	DD	6.1	125	68	160	1.2	-3.5
Jul 03 02:41	2134	DD	5.9	127	12	37	-0.9	3.6
Jul 03 20:59	42 Lib	DD	5.0	136	71	45	3.1	3.9
Jul 05 20:22	2514	DD	6.4	159	56	40	2.5	2.0
Jul 05 23:23	2524	DD	6.0	160	72	117	2.3	-1.1
Jul 25 18:31	65 Leo	DD	5.6	44	26	100	1.0	0.9
Jul 28 22:18	83 Vir	DD	5.6	84	24	111	0.6	0.7
Jul 31 18:21	2332	DD	6.1	118	65	158	0.7	-4.3
Jul 31 22:15	Sig Sco	DD	2.9	119	57	126	1.9	-0.7
Jul 31 23:21	Sig Sco	RB	2.9	120	45	235	0.7	2.7
Aug 13 03:28	15 Ara	RD	5.7	103	25	263	1.8	-0.5
Aug 15 06:23	44 Tau	RD	5.4	76	21	297	2.2	-0.8
Aug 25 21:46	2045	DD	6.4	66	17	47	-0.3	3.5
Aug 25 22:25	2051	DD	5.9	66	11	62	-0.3	2.2
Aug 26 19:55	2157	DD	6.1	77	48	36	1.0	5.9
Aug 27 18:32	2286	DD	5.4	88	70	127	1.9	-1.5
Aug 27 21:42	2299	DD	6.2	89	40	75	0.8	1.9
Sep 01 23:22	Pi Cap	DD	5.1	145	60	73	1.7	1.4
Sep 02 00:46	Rho Cap	DD	4.9	146	46	36	0.5	2.5
Sep 03 01:49	3112	DD	6.4	157	40	33	0.4	2.4
Sep 05 21:52	9 Psc	RD	6.3	169	32	178	-0.1	3.3
Sep 05 22:09	Kap Psc	RD	5.0	169	35	221	0.9	0.7
Sep 07 04:18	41 Psc	RD	5.4	155	26	210	0.9	2.2
Sep 11 02:13	555	RD	6.4	107	14	190	-0.4	1.7
Sep 11 04:01	569	RD	5.3	107	21	292	2.3	-0.9
Sep 23 19:35	42 Lib	DD	5.0	58	39	117	1.1	0.4
Sep 23 20:38	42 Lib	RB	5.0	58	27	251	0.2	1.9
Sep 27 01:13	24 Sgr	DD	5.5	94	8	19	-1.0	2.5
Sep 27 22:37	2822	DD	5.6	104	42	68	0.8	1.9
Sep 28 01:44	50 Sgr	DD	5.6	105	9	45	-0.5	1.8
Oct 06 01:00	105 Psc	RD	6.0	162	31	217	1.2	1.2
Oct 08 03:18	7 Tau	RD	6.0	137	22	226	1.7	1.1
Oct 10 03:12	844	RD	5.8	111	18	282	1.8	-0.8
Oct 11 05:06	Eps Gem	GD	3.1	97	22	192	9.9	9.9
Oct 20 19:21	2183	RB	5.5	26	17	267	0.0	1.4
Oct 30 00:07	3371	DD	6.4	129	28	46	0.7	2.1
Nov 25 23:41	3326	DD	6.4	97	12	129	0.9	0.2
Dec 01 23:17	18 Tau	DD	5.7	169	23	99	2.0	-0.1
Dec 02 00:56	555	DD	6.4	169	19	96	1.7	0.6
Dec 05 01:58	Ome Gem	RD	5.2	148	23	275	1.8	-0.2
Dec 27 22:37	The Ari	DD	5.6	123	18	111	1.6	0.7

MELBOURNE (37° 50' S, 145° 00' E)

EST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 10 02:43	136 Tau	DD	4.6	158	6	87	0.9	1.1
Jan 15 23:33	Ups Leo	RD	4.3	120	16	274	0.6	-1.4
Jan 19 01:04	2011	RD	6.3	84	17	284	0.1	-1.5
Jan 24 03:52	Lam Sgr	MB	2.8	28	7	2	9.9	9.9
Feb 02 21:09	15 Ara	DD	5.7	83	15	119	1.1	0.4
Feb 04 22:43	44 Tau	DD	5.4	110	12	167	-1.7	-5.2
Feb 07 20:00	57 Gem	DD	5.0	150	18	54	1.3	0.0
Feb 15 01:07	85 Vir	RD	6.2	115	41	307	0.7	-2.0
Feb 18 00:59	Sig Sco	DB	2.9	81	17	95	0.0	-1.3
Feb 18 01:59	Sig Sco	RD	2.9	81	28	299	0.1	-1.9
Feb 19 02:32	36 Oph N	RD	5.1	70	26	270	0.4	-1.2
Feb 19 02:33	36 Oph S	RD	5.2	70	26	270	0.4	-1.2
Feb 19 02:57	2482	RD	6.3	70	30	291	0.2	-1.8
Mar 05 22:10	909	DD	6.0	105	15	67	1.9	1.6
Mar 07 23:18	Mu Cnc	DD	5.3	132	25	142	0.8	-0.6
Mar 10 03:43	31 Leo	DD	4.4	161	12	60	1.4	3.6
Mar 15 02:01	2045	RD	6.4	135	66	333	0.9	-2.8
Mar 15 02:51	2051	RD	5.9	135	71	357	0.1	-4.8
Mar 16 00:19	2157	RD	6.1	124	42	322	0.2	-2.5
Mar 16 21:52	2269	RD	5.4	114	6	250	-0.1	-0.7
Mar 17 00:05	2286	RD	5.4	113	31	265	0.7	-1.1
Mar 20 03:15	2719	RD	5.8	79	38	309	0.4	-3.0
Apr 06 01:43	18 Leo	DD	5.7	129	10	179	-0.5	-2.5
Apr 07 18:48	76 Leo	DD	5.9	152	24	98	1.0	-1.5
Apr 13 00:51	42 Lib	RD	5.0	144	63	331	0.8	-3.3
Apr 15 02:48	2524	RD	6.0	121	67	314	1.6	-3.2
Apr 15 23:16	2652	RD	6.5	111	18	258	0.2	-0.9
Apr 16 03:26	Lam Sgr	DB	2.8	110	64	50	2.3	1.5
Apr 16 04:45	Lam Sgr	RD	2.8	109	76	296	2.6	-1.8
Apr 20 05:53	Lam Cap	RD	5.6	65	49	245	1.7	0.1
May 01 21:43	1276	DD	6.5	84	15	171	-0.4	-1.8
May 07 01:51	1845	DD	6.5	149	34	83	1.2	1.7
May 08 04:48	85 Vir	DD	6.2	162	13	43	-0.5	4.2
May 09 21:24	2183	RD	5.5	174	48	330	0.3	-2.8
May 11 00:37	2332	RD	6.1	163	75	228	3.2	2.9
May 11 03:43	Sig Sco	DB	2.9	162	59	123	2.1	-0.7
May 11 04:52	Sig Sco	RD	2.9	162	45	238	0.8	2.5
May 19 04:23	3370	RD	6.2	73	34	287	1.9	-2.6
May 20 04:37	19 Psc	DB	5.0	61	25	48	0.7	0.3
May 20 05:48	19 Psc	RD	5.0	60	36	241	1.3	0.1
Jun 05 18:08	2134	DD	5.9	153	33	110	0.5	-1.7
Jun 06 20:20	2269	DD	5.4	165	51	124	0.9	-2.2
Jun 06 23:27	2286	DD	5.4	166	77	112	2.2	-1.0
Jun 07 03:03	2299	DD	6.2	167	42	52	0.6	2.9
Jun 11 23:47	Sig Cap	RD	5.3	138	40	270	1.3	-1.3
Jun 12 05:57	Pi Cap	RD	5.1	136	52	262	1.7	1.3
Jun 13 03:44	3100	RD	6.5	126	66	239	2.0	1.2
Jun 14 00:38	3208	RD	6.5	115	28	205	0.8	1.6
Jun 16 02:42	Kap Psc	DB	5.0	92	28	53	0.9	0.2
Jun 16 03:49	9 Psc	RD	6.3	92	39	199	0.6	1.9
Jun 16 03:58	Kap Psc	RD	5.0	91	40	235	1.4	0.4
Jun 19 05:33	Iot Ari	RD	5.1	54	21	182	-0.6	2.4
Jul 01 19:19	1993	DD	6.6	113	69	159	0.9	-3.1
Jul 02 20:34	2109	DD	6.1	125	74	143	1.6	-2.5
Jul 05 23:15	2524	DD	6.0	160	78	97	2.4	-0.2
Jul 07 01:43	Lam Sgr	MD	2.8	171	63	162	9.9	9.9
Jul 16 01:36	Eta Psc	RD	3.8	86	5	188	-0.5	2.0
Jul 25 18:35	65 Leo	DD	5.6	44	29	84	1.4	1.5
Jul 28 22:22	83 Vir	DD	5.6	84	25	93	0.6	1.2
Jul 29 21:57	2084	DD	6.5	96	41	114	1.3	0.2
Jul 31 22:09	Sig Sco	DD	2.9	119	61	106	2.0	0.1
Jul 31 23:30	Sig Sco	RB	2.9	120	45	255	1.1	1.8
Aug 09 00:35	3370	RD	6.2	151	49	191	0.5	2.6
Aug 13 03:20	15 Ara	RD	5.7	103	28	280	2.4	-1.2
Aug 15 06:11	44 Tau	RD	5.4	76	25	311	2.9	-1.8
Aug 25 22:42	2051	DD	5.9	66	8	32	-1.3	5.0
Aug 27 21:51	2299	DD	6.2	89	40	56	0.6	2.6
Sep 01 23:26	Pi Cap	DD	5.1	145	64	57	1.6	1.9
Sep 02 00:59	Rho Cap	DD	4.9	146	47	21	0.2	3.0
Sep 02 20:55	3100	DD	6.5	156	56	76	2.0	-0.2
Sep 03 02:02	3112	DD	6.4	157	41	20	0.1	2.8
Sep 05 22:02	9 Psc	RD	6.3	169	35	203	0.6	1.6
Sep 05 22:09	Kap Psc	RD	5.0	169	36	240	1.3	0.1
Sep 07 04:26	41 Psc	RD	5.4	155	29	219	1.1	2.1
Sep 11 00:55	18 Tau	RD	5.7	108	7	235	0.4	-0.2
Sep 11 02:19	555	RD	6.4	107	18	211	0.5	0.7
Sep 11 03:49	569	RD	5.3	107	25	308	3.1	-1.9
Sep 23 19:36	42 Lib	DD	5.0	58	41	98	1.1	0.9
Sep 23 20:46	42 Lib	RB	5.0	58	27	269	0.5	1.3
Sep 27 22:46	2822	DD	5.6	104	43	54	0.6	2.2
Sep 28 01:55	50 Sgr	DD	5.6	105	7	34	-0.7	2.0
Oct 06 01:02	105 Psc	RD	6.0	162	36	229	1.6	1.0
Oct 08 03:19	7 Tau	RD	6.0	137	27	235	1.9	1.0
Oct 10 03:03	844	RD	5.8	111	21	291	2.0	-1.2
Oct 10 03:51	849	RD	6.5	111	24	217	1.8	1.2
Oct 11 04:39	Eps Gem	DB	3.1	98	25	164	1.8	-3.0
Oct 11 05:18	Eps Gem	RD	3.1	97	27	219	2.8	1.9
Oct 20 19:27	2183	RB	5.5	26	16	284	0.2	0.8
Oct 22 20:59	2469	DD	6.5	50	21	31	-0.7	2.9
Oct 28 20:46	3248	DD	6.5	116	58	51	1.6	1.7
Oct 30 00:16	3371	DD	6.4	129	30	37	0.7	2.3
Nov 25 23:42	3326	DD	6.4	97	14	113	0.7	0.8
Dec 01 23:11	18 Tau	DD	5.7	169	27	89	2.1	-0.1
Dec 02 00:55	555	DD	6.4	169	24	89	1.9	0.6
Dec 05 01:52	Ome Gem	RD	5.2	148	28	281	2.0	-0.5
Dec 27 22:37	The Ari	DD	5.6	123	23	102	1.8	0.7

LUNAR OCCULTATION TABLE

PERTH (31° 57' S, 115° 51' E)

WST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 09 22:58	885	DD	5.6	158	30	48	2.5	1.3
Jan 10 00:07	136 Tau	DD	4.6	158	28	113	1.8	-0.1
Jan 10 22:29	39 Gem	DD	6.2	172	29	76	2.1	-0.1
Jan 10 22:51	40 Gem	DD	6.4	172	30	104	2.1	-0.7
Jan 12 01:53	Mu Cnc	RD	5.3	172	35	224	5.7	4.7
Jan 14 03:41	31 Leo	DB	4.4	143	47	119	1.8	-0.7
Jan 15 04:21	58 Leo	DB	4.8	130	53	86	3.0	0.5
Jan 20 01:07	2134	RD	5.9	71	9	340	-0.8	-2.4
Feb 04 19:44	44 Tau	DD	5.4	110	32	156	4.2	-6.1
Feb 05 22:11	797	DD	6.4	124	26	78	2.2	0.9
Feb 06 22:55	994	DD	6.6	138	28	91	2.1	0.4
Feb 09 04:24	Del Cnc	DD	3.9	169	7	172	-0.6	-2.1
Feb 11 21:51	75 Leo	RD	5.2	153	21	354	0.2	-3.0
Feb 11 23:07	76 Leo	RD	5.9	153	35	333	0.7	-2.3
Feb 14 22:45	85 Vir	RD	6.2	115	13	281	0.1	-1.3
Feb 17 23:54	Sig Sco	RD	2.9	81	3	274	-0.4	-1.0
Mar 07 00:43	52 Gem	DD	5.8	121	8	72	1.2	1.7
Mar 10 01:02	31 Leo	DD	4.4	161	41	97	2.1	0.4
Mar 11 01:35	58 Leo	DD	4.8	174	48	72	3.5	2.1
Mar 14 22:12	2039	RD	5.5	136	24	326	-0.2	-2.2
Mar 14 23:22	2045	RD	6.4	135	38	294	0.8	-1.7
Mar 15 00:15	2051	RD	5.9	135	49	313	0.8	-2.2
Mar 15 22:05	2157	RD	6.1	124	14	293	-0.1	-1.4
Mar 20 01:02	2719	RD	5.8	79	11	288	-0.3	-1.5
Apr 05 00:21	1331	DD	6.3	116	14	118	0.5	0.1
Apr 06 19:52	48 Leo	DD	5.1	141	42	108	1.9	-1.3
Apr 12 22:18	42 Lib	RD	5.0	144	34	296	0.4	-1.7
Apr 15 00:04	2524	RD	6.0	121	35	296	0.5	-1.9
Apr 16 00:35	Lam Sgr	DB	2.8	110	30	59	1.2	0.0
Apr 16 01:39	Lam Sgr	RD	2.8	109	44	305	0.8	-2.7
Apr 20 03:13	Lam Cap	RD	5.6	65	19	278	0.5	-1.6
May 06 22:57	1845	DD	6.5	149	66	97	2.6	0.0
May 08 01:52	83 Vir	DD	5.6	162	48	135	1.5	-1.1
May 09 19:06	2183	RD	5.5	174	20	297	0.0	-1.6
May 11 00:30	Sig Sco	DB	2.9	162	77	107	2.3	-1.2
May 11 02:06	Sig Sco	RD	2.9	162	79	276	2.6	0.0
May 12 01:10	36 Oph N	RD	5.1	151	75	201	9.9	9.9
May 12 01:10	36 Oph S	RD	5.2	151	75	200	9.9	9.9
May 12 02:09	2482	RD	6.3	150	85	231	2.8	2.6
May 18 02:56	The Aqr	DB	4.2	84	30	66	1.1	-0.1
May 18 04:14	The Aqr	RD	4.2	83	46	231	1.5	0.8
May 20 03:05	19 Psc	RD	5.0	60	9	306	0.9	-4.5
May 22 05:24	Eta Psc	DB	3.8	35	11	53	0.3	0.1
May 22 06:27	Eta Psc	RD	3.8	34	22	243	0.9	-0.1
May 27 18:43	48 Gem	DD	5.9	40	14	132	0.4	-0.3
May 29 19:35	81 Cnc	DD	6.5	68	30	177	-0.4	-2.6
May 29 20:43	Pi Cnc	DD	5.4	68	20	95	1.1	0.8
Jun 06 18:05	2269	DD	5.4	165	23	161	-0.8	-2.9
Jun 06 20:27	2286	DD	5.4	166	52	131	0.8	-2.4
Jun 11 21:22	Sig Cap	RD	5.3	138	11	271	0.0	-1.1
Jun 13 00:37	3100	RD	6.5	126	40	293	1.6	-2.8
Jun 16 01:15	Kap Psc	RD	5.0	92	14	295	0.8	-3.0
Jun 16 01:29	9 Psc	RD	6.3	91	16	252	0.6	-0.5
Jun 17 05:56	41 Psc	DB	5.4	78	47	11	0.4	2.5
Jun 18 04:26	75 Psc	RD	6.1	66	26	243	1.0	0.0
Jun 26 19:02	19 Leo	DD	6.4	50	26	52	3.7	5.6
Jun 27 20:52	35 Sex	DD	6.2	64	19	87	0.9	1.3
Jul 04 02:37	2269	DD	5.4	139	22	78	0.2	1.4
Jul 05 20:06	2524	DD	6.0	160	53	93	1.7	-1.1
Jul 06 22:02	Lam Sgr	DD	2.8	171	66	106	2.2	-1.6
Jul 06 23:31	Lam Sgr	RB	2.8	172	83	237	2.5	1.7
Jul 09 23:43	3064	RD	5.9	155	54	224	1.7	1.4
Jul 16 04:17	105 Psc	RD	6.0	84	33	219	0.9	0.9
Jul 18 05:08	7 Tau	RD	6.0	58	19	201	-0.1	1.4
Jul 19 05:43	701	RD	6.6	44	14	302	2.0	-2.2
Jul 26 21:09	1743	DD	6.6	60	15	152	0.4	-1.2
Jul 28 19:53	83 Vir	DD	5.6	84	55	71	2.4	2.3
Jul 29 19:01	2084	DD	6.5	96	76	103	2.5	-0.4
Jul 31 18:58	Sig Sco	DD	2.9	119	75	92	2.5	-0.5
Jul 31 20:35	Sig Sco	RB	2.9	120	80	291	2.6	-0.9
Aug 01 19:38	36 Oph N	DD	5.1	131	73	167	0.6	-9.7
Aug 01 19:38	36 Oph S	DD	5.2	131	73	168	9.9	9.9
Aug 01 19:53	2482	DD	6.3	131	76	136	2.1	-3.4
Aug 02 02:32	2514	DD	6.4	133	19	62	-0.2	1.7
Aug 03 03:35	2659	DD	6.2	144	16	31	-0.7	2.4
Aug 08 22:10	3370	RD	6.2	151	27	250	1.0	-0.3
Aug 10 00:23	19 Psc	RD	5.0	138	40	195	0.5	2.2
Aug 13 05:11	The Ari	RD	5.6	101	38	216	1.6	1.6
Sep 03 03:50	18 Aqr	DD	5.5	159	20	113	1.0	0.5
Sep 05 19:45	9 Psc	RD	6.3	169	12	251	0.4	-0.4
Sep 07 01:37	41 Psc	RD	5.4	155	50	278	3.4	-0.4
Sep 07 23:52	75 Psc	RD	6.1	144	33	240	1.3	0.2
Sep 09 00:03	Iot Ari	RD	5.1	132	24	234	0.9	0.2
Sep 26 23:47	25 Sgr	DD	6.5	94	21	12	-1.2	3.5
Oct 02 02:40	Kap Aqr	DD	5.0	150	22	61	0.6	1.8
Oct 08 00:20	7 Tau	RD	6.0	137	24	286	2.2	-1.5
Oct 10 01:12	849	RD	6.5	111	13	260	1.0	-0.7
Oct 11 01:29	Eps Gem	DB	3.1	98	7	120	1.2	-1.8
Oct 11 02:31	Eps Gem	RD	3.1	97	17	244	1.1	-0.2
Nov 25 19:43	Kap Aqr	RB	5.0	96	58	205	1.0	2.7
Nov 25 21:14	3326	DD	6.4	97	44	65	1.6	1.7
Dec 01 20:18	19 Tau	DD	4.3	169	19	117	2.2	-2.1
Dec 01 20:39	21 Tau	DD	5.8	169	22	110	2.1	-1.6
Dec 01 20:47	22 Tau	DD	6.4	169	23	121	2.6	-2.2
Dec 03 22:56	139 Tau	RD	4.8	162	22	216	0.9	1.1
Dec 04 22:54	Ome Gem	RD	5.2	148	15	296	1.4	-1.6

SYDNEY (33° 54' S, 151° 15' E)

EST	Object	PD	Mag	Elg°	Alt°	PA°	A	B
Jan 15 23:32	Ups Leo	RD	4.3	120	21	285	0.7	-1.5
Jan 19 00:58	2011	RD	6.3	84	20	297	0.1	-1.7
Feb 02 21:17	15 Ara	DD	5.7	83	11	108	0.9	0.7
Feb 04 22:38	44 Tau	DD	5.4	110	12	136	0.5	-0.4
Feb 07 20:12	57 Gem	DD	5.0	150	25	45	1.9	0.9
Feb 15 01:02	85 Vir	RD	6.2	115	46	325	0.5	-2.4
Feb 18 00:55	Sig Sco	DB	2.9	81	20	78	0.4	-0.8
Feb 18 01:50	Sig Sco	RD	2.9	81	31	318	-0.1	-2.4
Feb 19 02:29	36 Oph N	RD	5.1	70	29	288	0.3	-1.6
Feb 19 02:29	36 Oph S	RD	5.2	70	29	288	0.3	-1.6
Feb 19 02:49	2482	RD	6.3	70	33	312	0.0	-2.4
Mar 03 20:39	569	DD	5.3	78	11	162	-1.3	-4.2
Mar 05 19:29	136 Tau	RB	4.6	104	28	267	2.3	0.3
Mar 05 22:33	909	DD	6.0	105	11	37	3.1	4.2
Mar 07 23:23	Mu Cnc	DD	5.3	132	25	121	1.1	-0.1
Mar 11 20:03	Ups Leo	RD	4.3	175	23	274	0.9	-1.3
Mar 15 01:48	2045	RD	6.4	136	71	4	-0.7	-5.5
Mar 16 00:08	2157	RD	6.1	124	45	346	-0.4	-3.4
Mar 16 21:48	2269	RD	5.4	114	9	265	-0.1	-0.9
Mar 17 00:04	2286	RD	5.4	113	35	284	0.6	-1.5
Mar 20 02:55	2719	RD	5.8	79	39	346	9.9	9.9
Mar 23 04:07	29 Cap	RD	5.3	45	20	186	1.2	3.9
Apr 04 21:52	Del Cnc	MB	3.9	114	30	213	9.9	9.9
Apr 06 01:35	18 Leo	DD	5.7	129	8	151	0.0	-0.9
Apr 07 18:51	76 Leo	DD	5.9	152	31	85	1.5	-1.0
Apr 12 01:36	2109	RD	6.1	155	77	233	4.1	3.9
Apr 13 00:30	42 Lib	RD	5.0	144	66	11	9.9	9.9
Apr 15 02:37	2524	RD	6.0	121	72	346	0.7	-9.9
Apr 15 23:13	2652	RD	6.5	111	20	277	0.2	-1.3
Apr 16 03:52	Lam Sgr	DB	2.8	110	75	29	2.4	4.2
Apr 16 04:54	Lam Sgr	RD	2.8	109	82	311	3.4	-3.4
Apr 21 04:18	3308	RD	6.2	54	26	173	0.2	5.5
May 01 21:38	1276	DD	6.5	84	14	144	0.2	-0.6
May 07 02:07	1845	DD	6.5	149	27	61	0.9	3.2
May 08 04:31	83 Vir	DD	5.6	162	10	158	0.7	-1.7
May 09 21:09	2183	RD	5.5	174	50	360	-1.2	-5.1
May 11 01:02	2332	RD	6.1	163	82	253	2.8	1.0
May 11 03:54	Sig Sco	DB	2.9	162	52	113	1.9	0.0
May 11 05:05	Sig Sco	RD	2.9	162	37	244	0.6	2.1
May 19 04:25	3370	RD	6.2	73	41	299	3.2	-4.2
May 20 04:44	19 Psc	DB	5.0	61	32	42	0.8	0.8
May 20 05:59	19 Psc	RD	5.0	60	44	242	1.7	0.4
Jun 05 18:06	2134	DD	5.9	153	38	93	1.0	-1.2
Jun 06 20:21	2269	DD	5.4	165	56	104	1.6	-1.4
Jun 06 23:40	2286	DD	5.4	166	77	95	2.5	0.1
Jun 07 03:17	2299	DD	6.2	167	34	44	0.1	3.2
Jun 11 23:50	Sig Cap	RD	5.3	138	46	287	1.6	-2.1
Jun 12 06:12	Pi Cap	RD	5.1	136	45	260	1.3	1.5
Jun 13 04:02	3100	RD	6.5	126	70	239	2.0	1.5
Jun 14 00:49	3208	RD	6.5	115	36	219	1.1	1.1
Jun 16 02:50	Kap Psc	DB	5.0	92	36	47	1.1	0.7
Jun 16 04:01	9 Psc	RD	6.3	92	47	201	0.8	2.0
Jun 16 04:09	Kap Psc	RD	5.0	91	48	237	1.7	0.7
Jun 19 04:59	Iot Ari	DB	5.1	54	22	114	2.3	-2.5
Jun 19 05:39	Iot Ari	RD	5.1	54	28	182	-0.5	2.6
Jul 02 20:38	2109	DD	6.1	125	75	122	2.2	-1.3
Jul 05 23:31	2524	DD	6.0	160	75	86	2.4	0.6
Jul 06 19:11	2652	DD	6.5	170	37	122	0.5	-2.4
Jul 07 01:58	Lam Sgr	MD	2.8	171	56	161	9.9	9.9
Jul 16 01:41	Eta Psc	RD	3.8	86	13	196	-0.2	1.6
Jul 25 18:57	65 Leo	DD	5.6	45	22	46	2.5	7.8
Jul 28 22:30	83 Vir	DD	5.6	84	18	82	0.3	1.5
Jul 31 22:23	Sig Sco	DD	2.9	119	54	96	1.8	0.7
Jul 31 23:42	Sig Sco	RB	2.9	120	37	260	0.8	1.5
Aug 09 00:49	3370	RD	6.2	151	56	191	0.6	2.8
Aug 13 03:32	15 Ara	RD	5.7	103	34	277	2.7	-0.8
Aug 27 18:36	2286	DD	5.4	88	73	94	2.4	0.3
Aug 27 22:04	2299	DD	6.2	89	32	49	0.1	2.8
Sep 01 23:43	Pi Cap	DD	5.1	145	58	59	1.4	1.9
Sep 02 01:11	Rho Cap	DD	4.9	146	41	24	0.1	2.8
Sep 02 21:10	3100	DD	6.5	156	65	70	2.3	0.5
Sep 03 02:13	3112	DD	6.4	157	35	22	0.1	2.7
Sep 05 22:13	9 Psc	RD	6.3	169	43	207	0.9	1.7
Sep 05 22:19	Kap Psc	RD	5.0	169	44	242	1.6	0.3
Sep 07 04:42	41 Psc	RD	5.4	155	25	221	1.0	2.2
Sep 11 00:58	18 Tau	RD	5.7	108	14	235	0.6	0.0
Sep 11 02:26	555	RD	6.4	107	25	210	0.7	1.1
Sep 11 04:01	569	RD	5.3	107	30	308	3.3	-1.7
Sep 23 19:46	42 Lib	DD	5.0	58	33	91	0.8	1.1
Sep 23 20:52	42 Lib	RB	5.0	58	20	273	0.3	1.0
Sep 27 22:57	2822	DD	5.6	104	35	56	0.4	2.0
Oct 05 19:52	Eta Psc	RD	3.8	164	8	269	0.6	-1.1
Oct 06 01:17	105 Psc	RD	6.0	162	39	227	1.8	1.4
Oct 08 03:36	7 Tau	RD	6.0	137	29	239	2.1	1.2
Oct 10 03:12	844	RD	5.8	111	27	295	2.3	-1.1
Oct 10 04:09	849	RD	6.5	111	30	226	2.4	1.3
Oct 11 04:42	Eps Gem	DB	3.1	98	30	149	1.9	-2.0
Oct 22 21:05	2469	DD	6.5	50	13	29	-1.0	2.8
Oct 28 21:04	3248	DD	6.5	116	57	55	1.7	1.9
Oct 30 00:29	3371	DD	6.4	129	24	37	0.5	2.3
Nov 21 20:14	2851	DD	6.1	52	26	71	0.3	1.6
Dec 01 23:26	18 Tau	DD	5.7	169	31	87	2.3	0.3
Dec 02 01:09	555	DD	6.4	169	24	81	1.8	1.0
Dec 04 02:04	139 Tau	RD	4.8	162	29	206	4.2	5.0
Dec 05 02:03	Ome Gem	RD	5.2	148	32	292	2.0	-0.5
Dec 27 22:50	The Ari	DD	5.6	123	21	95	1.5	0.9

MOON

GEOCENTRIC POSITION

(0hr UT, Epoch 2000.0)

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY	
	R.A. Rise	Dec. Set	R.A. Rise	Dec Set	R.A. Rise	Dec Set	R.A. Rise	Dec Set	R.A. Rise	Dec Set	R.A. Rise	Dec Set	R.A. Rise	Dec Set
1	22 04 24	- 09 53 15	00 57 05	+ 11 26 16	01 35 57	+ 15 28 52	05 15 52	+ 26 45 28	08 06 15	+ 20 41 23	11 22 04	- 00 11 13	13 34 35	- 15 29 58
2	22 49 15	- 04 26 22	01 47 32	+ 16 41 40	02 29 18	+ 20 12 25	06 19 04	+ 26 06 03	09 02 21	+ 16 00 46	12 09 50	- 06 03 38	14 24 20	- 19 47 21
3	23 34 19	+ 01 17 11	02 41 47	+ 21 14 15	03 26 23	+ 23 54 43	07 20 41	+ 23 45 49	09 54 55	+ 10 33 22	12 57 35	- 11 33 16	15 15 31	- 23 07 19
4	00 20 40	+ 07 05 50	03 40 24	+ 24 42 03	04 26 59	+ 26 15 27	08 19 22	+ 19 58 43	10 44 51	+ 04 40 13	13 46 13	- 16 27 16	16 08 03	- 25 21 12
5	01 09 31	+ 12 45 44	04 43 01	+ 26 42 19	05 29 56	+ 26 58 08	09 14 43	+ 15 04 32	11 33 12	- 01 20 16	14 36 19	- 20 33 30	17 01 24	- 26 22 55
6	02 02 06	+ 17 59 14	05 48 11	+ 26 56 33	06 33 25	+ 25 54 52	10 07 05	+ 09 24 51	12 21 02	- 07 11 43	15 28 03	- 23 40 45	17 54 41	- 26 10 15
7	02 59 22	+ 22 23 45	06 53 35	+ 25 17 20	07 35 25	+ 23 09 20	10 57 16	+ 03 20 46	13 09 19	- 12 39 03	16 21 09	- 25 39 47	18 46 58	- 24 45 32
8	04 01 36	+ 25 32 36	07 56 52	+ 21 52 11	08 34 37	+ 18 56 06	11 46 13	- 02 48 07	13 58 47	- 17 28 01	17 14 52	- 26 24 50	19 37 30	- 22 15 17
9	05 07 50	+ 26 59 36	08 56 38	+ 17 01 39	09 30 31	+ 13 36 45	12 34 56	- 08 43 43	14 49 50	- 21 25 18	18 08 13	- 25 54 51	20 25 57	- 18 48 51
10	06 15 42	+ 26 27 46	09 52 33	+ 11 13 11	10 23 28	+ 07 35 34	13 24 14	- 14 09 23	15 42 28	- 24 19 20	19 00 13	- 24 13 44	21 12 22	- 14 36 54
11	07 22 13	+ 23 57 18	10 45 10	+ 04 54 53	11 14 16	+ 01 16 22	14 14 43	- 18 50 08	16 36 11	- 26 01 33	19 50 15	- 21 29 16	21 57 13	- 09 50 09
12	08 25 02	+ 19 46 27	11 35 27	- 01 28 15	12 03 50	- 04 59 08	15 06 37	- 22 32 57	17 30 06	- 26 27 51	20 38 08	- 17 51 21	22 41 08	- 04 38 56
13	09 23 13	+ 14 24 15	12 24 27	- 07 35 43	12 53 07	- 10 52 01	15 59 47	- 25 07 42	18 23 15	- 25 39 10	21 24 06	- 13 30 22	23 25 00	+ 00 46 47
14	10 17 05	+ 08 21 30	13 13 10	- 13 11 20	13 42 53	- 16 06 12	16 53 38	- 26 27 59	19 14 47	- 23 40 57	22 08 45	- 08 36 18	00 09 48	+ 06 16 46
15	11 07 36	+ 02 04 55	14 02 24	- 18 02 18	14 33 41	- 20 28 20	17 47 19	- 26 31 56	20 04 17	- 20 41 33	22 52 53	- 03 18 34	00 56 38	+ 11 39 20
16	11 55 59	- 04 04 34	14 52 40	- 21 58 15	15 25 41	- 23 47 50	18 39 58	- 25 22 05	20 51 47	- 16 50 34	23 37 28	+ 02 13 23	01 46 36	+ 16 40 09
17	12 43 23	- 09 51 14	15 44 11	- 24 50 46	16 18 41	- 25 56 59	19 30 57	- 23 04 29	21 37 40	- 12 17 33	00 23 37	+ 07 48 53	02 40 43	+ 21 00 57
18	13 30 51	- 15 02 51	16 36 45	- 26 33 27	17 12 09	- 26 51 30	20 20 04	- 19 47 11	22 22 40	- 07 11 44	01 12 31	+ 13 14 40	03 39 32	+ 24 19 22
19	14 19 11	- 19 29 18	17 29 49	- 27 02 28	18 05 20	- 26 30 44	21 07 27	- 15 39 09	23 07 39	- 01 42 21	02 05 17	+ 18 13 12	04 42 43	+ 26 11 12
20	15 08 54	- 23 01 27	18 22 37	- 26 17 13	18 57 28	- 24 57 38	21 53 36	- 10 49 32	23 53 39	+ 04 00 16	03 02 47	+ 22 21 49	05 48 43	+ 26 16 23
21	16 00 08	- 25 31 03	19 14 23	- 24 20 39	19 48 03	- 22 18 05	22 39 14	- 05 27 49	00 41 48	+ 09 43 21	04 05 07	+ 25 14 10	06 55 02	+ 24 26 43
22	16 52 34	- 26 51 20	20 04 38	- 21 18 55	20 36 55	- 18 39 53	23 25 16	+ 00 15 28	01 33 15	+ 15 10 08	05 11 09	+ 26 25 21	07 59 13	+ 20 50 32
23	17 45 33	- 26 58 07	20 53 11	- 17 20 34	21 24 17	- 14 12 06	00 12 41	+ 06 07 42	02 28 57	+ 19 58 50	06 18 27	+ 25 40 33	08 59 46	+ 15 50 20
24	18 38 10	- 25 51 00	21 40 14	- 12 35 52	22 10 38	- 09 04 41	01 02 33	+ 11 52 58	03 29 18	+ 23 43 23	07 24 12	+ 23 02 00	09 56 25	+ 09 55 29
25	19 29 36	- 23 33 45	22 26 14	- 07 16 09	22 56 39	- 03 28 37	01 55 47	+ 17 11 19	04 33 39	+ 25 57 26	08 26 18	+ 18 48 31	10 49 46	+ 03 35 17
26	20 19 18	- 20 13 47	23 11 56	- 01 33 42	23 43 11	+ 02 23 32	02 53 03	+ 21 39 02	05 40 08	+ 26 21 44	09 24 01	+ 13 28 10	11 40 52	- 02 45 00
27	21 07 10	- 16 01 04	23 58 09	+ 04 18 07	00 31 11	+ 08 17 02	03 54 16	+ 24 51 01	06 46 00	+ 24 51 40	10 17 45	+ 07 29 56	12 30 47	- 08 45 15
28	21 53 26	- 11 06 46	00 45 50	+ 10 04 31	01 21 34	+ 13 54 24	04 58 18	+ 26 25 52	07 48 54	+ 21 39 09	11 08 32	+ 01 18 58	13 20 32	- 14 09 47
29	22 38 42	- 05 42 38			02 15 10	+ 18 55 23	06 03 05	+ 26 12 10	08 47 35	+ 17 07 20	11 57 31	- 04 44 42	14 10 54	- 18 46 10
30	23 23 45	- 00 00 36			03 12 24	+ 22 57 50	07 06 18	+ 24 12 24	09 42 06	+ 11 42 45	12 45 53	- 10 25 20	15 02 19	- 22 24 16
31	00 09 32	+ 05 46 55			04 13 01	+ 25 40 10			10 33 12	+ 05 49 48			15 54 51	- 24 56 01

	AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	16 48 08	- 26 15 48	20 00 37	- 20 41 57	22 05 02	- 08 52 25	00 51 31	+ 10 54 51	03 10 38	+ 22 25 10
2	17 41 26	- 26 21 18	20 48 14	- 16 53 04	22 49 40	- 03 36 47	01 42 09	+ 15 56 39	04 11 50	+ 24 53 35
3	18 33 56	- 25 14 09	21 34 11	- 12 22 32	23 34 36	+ 01 52 44	02 36 27	+ 20 17 14	05 15 59	+ 25 45 37
4	19 24 53	- 22 59 42	22 19 01	- 07 20 49	00 20 42	+ 07 23 56	03 34 37	+ 23 34 48	06 20 53	+ 24 50 43
5	20 13 54	- 19 46 20	23 03 23	- 01 58 46	01 08 53	+ 12 42 32	04 36 01	+ 25 28 43	07 24 12	+ 22 12 44
6	21 00 57	- 15 44 07	23 48 06	+ 03 32 10	01 59 56	+ 17 31 47	05 39 05	+ 25 44 32	08 24 18	+ 18 08 24
7	21 46 19	- 11 03 53	00 34 03	+ 08 59 34	02 54 23	+ 21 32 49	06 41 47	+ 24 18 40	09 20 43	+ 13 01 31
8	22 30 36	- 05 56 27	01 22 07	+ 14 09 26	03 52 15	+ 24 26 03	07 42 22	+ 21 19 25	10 13 51	+ 07 16 43
9	23 14 32	- 00 32 36	02 13 06	+ 18 45 53	04 52 51	+ 25 54 10	08 39 49	+ 17 03 48	11 04 40	+ 01 16 13
10	23 58 59	+ 04 56 42	03 07 34	+ 22 31 06	05 54 44	+ 25 46 00	09 34 08	+ 11 52 41	11 54 15	- 04 41 03
11	00 44 54	+ 10 19 43	04 05 37	+ 25 06 24	06 56 10	+ 23 59 49	10 25 55	+ 06 07 06	12 43 43	- 10 18 45
12	01 33 17	+ 15 23 01	05 06 33	+ 26 14 42	07 55 41	+ 20 43 39	11 16 07	+ 00 06 44	13 33 57	- 15 22 07
13	02 25 04	+ 19 50 41	06 08 58	+ 25 44 31	08 52 33	+ 16 13 04	12 05 48	- 05 50 15	14 25 35	- 19 37 28
14	03 20 54	+ 23 23 54	07 11 05	+ 23 33 39	09 46 49	+ 10 47 42	12 55 55	- 11 26 38	15 18 49	- 22 52 23
15	04 20 48	+ 25 41 58	08 11 23	+ 19 50 31	10 39 03	+ 04 48 35	13 47 14	- 16 25 57	16 13 20	- 24 56 49
16	05 23 55	+ 26 25 42	09 09 06	+ 14 52 18	11 30 08	- 01 23 16	14 40 09	- 20 32 43	17 08 19	- 25 44 52
17	06 28 25	+ 25 22 56	10 04 14	+ 09 01 29	12 20 59	- 07 27 20	15 34 37	- 23 33 38	18 02 41	- 25 16 02
18	07 32 11	+ 22 33 40	10 57 21	+ 02 42 39	13 12 27	- 13 04 08	16 30 01	- 25 19 19	18 55 25	- 23 35 27
19	08 33 30	+ 18 11 17	11 49 18	- 03 40 00	14 05 06	- 17 55 42	17 25 20	- 25 45 56	19 45 51	- 20 52 23
20	09 31 38	+ 12 39 08	12 40 56	- 09 44 07	14 59 07	- 21 46 41	18 19 28	- 24 55 47	20 33 49	- 17 18 11
21	10 26 45	+ 06 25 01	13 33 02	- 15 10 07	15 54 13	- 24 25 34	19 11 32	- 22 56 15	21 19 33	- 13 04 20
22	11 19 35	- 00 03 34	14 26 02	- 19 41 48	16 49 39	- 25 45 59	20 01 09	- 19 57 41	22 03 40	- 08 21 28
23	12 11 06	- 06 22 14	15 20 03	- 23 06 48	17 44 27	- 25 47 25	20 48 21	- 16 11 14	22 46 56	- 03 19 03
24	13 02 13	- 12 10 47	16 14 43	- 25 17 08	18 37 40	- 24 34 34	21 33 38	- 11 47 25	23 30 15	+ 01 54 05
25	13 53 41	- 17 13 07	17 09 21	- 26 09 33	19 28 43	- 22 15 45	22 17 43	- 06 55 42	00 14 40	+ 07 08 50
26	14 45 59	- 21 16 50	18 03 07	- 25 45 30	20 17 27	- 19 01 00	23 01 29	- 01 44 49	01 01 15	+ 12 14 34
27	15 39 11	- 24 12 50	18 55 17	- 24 10 20	21 04 07	- 15 00 24	23 45 53	+ 03 36 15	01 51 06	+ 16 57 39
28	16 32 59	- 25 55 19	19 45 27	- 21 32 02	21 49 17	- 10 23 33	00 32 01	+ 08 57 05	02 45 06	+ 21 00 25
29	17 26 43	- 26 22 09	20 33 33	- 17 59 51	22 33 42	- 05 19 32	01 20 56	+ 14 04 24	03 43 43	+ 24 01 06
30	18 19 39	- 25 35 02	21 19 54	- 13 43 25	23 18 14	+ 00 02 17	02 13 37	+ 18 40 55	04 46 29	+ 25 36 39
31	19 11 05	- 23 39 03			00 03 51	+ 05 31 22			05 51 47	+ 25 28 40

MOON PHASES (UT)

Lunation	New Moon		First Quarter	
1064			Jan 4	11:56
1065	Jan 26	07:55	Feb 2	23:13
1066	Feb 25	01:35	Mar 4	07:46
1067	Mar 26	16:06	Apr 2	14:34
1068	Apr 25	03:23	May 1	20:44
1069	May 24	12:11	May 31	03:22
1070	Jun 22	19:35	Jun 29	11:28
1071	Jul 22	02:35	Jul 28	22:00
1072	Aug 20	10:02	Aug 27	11:42
1073	Sep 18	18:44	Sep 26	04:50
1074	Oct 18	05:33	Oct 26	00:42
1075	Nov 16	19:14	Nov 24	21:39
1076	Dec 16	12:02	Dec 24	17:36
	Full Moon		Last Quarter	
1064	Jan 11	03:27	Jan 18	02:46
1065	Feb 9	14:49	Feb 16	21:37
1066	Mar 11	02:38	Mar 18	17:47
1067	Apr 9	14:56	Apr 17	13:36
1068	May 9	04:01	May 17	07:26
1069	Jun 7	18:12	Jun 15	22:15
1070	Jul 7	09:21	Jul 15	09:53
1071	Aug 6	00:55	Aug 13	18:55
1072	Sep 4	16:03	Sep 12	02:16
1073	Oct 4	06:10	Oct 11	08:56
1074	Nov 2	19:14	Nov 9	15:56
1075	Dec 2	07:30	Dec 9	00:13
1076	Dec 31	19:13		

PERIGEE AND APOGEE OF THE MOON (UT)

PERIGEE						APOGEE					
Date	hr	km	Date	hr	km	Date	hr	km	Date	hr	km
Jan 10	11	357,497	Jul 21	20	357,463	Jan 23	0	406,118	Aug 4	1	406,028
Feb 7	20	361,488	Aug 19	5	359,639	Feb 19	17	405,129	Aug 31	11	405,269
Mar 7	15	367,017	Sep 16	8	364,053	Mar 19	13	404,299	Sep 28	4	404,432
Apr 2	2	370,013	Oct 13	12	369,067	Apr 16	9	404,232	Oct 25	23	404,166
Apr 28	6	366,040	Nov 7	7	368,903	May 14	3	404,915	Nov 22	20	404,733
May 26	4	361,153	Dec 4	14	363,479	Jun 10	16	405,787	Dec 20	15	405,731
Jun 23	11	358,014				Jul 7	22	406,232			

MERCURY

RISE AND SET TIMES

EST, Adelaide and Darwin CST, Perth WST

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney		
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	
Jan 3	06:37	20:47	06:26	20:04	06:24	20:36	07:52	20:36	06:11	21:04	06:34	20:59	06:45	20:42	06:19	20:24	Jan 3
10	06:41	20:30	06:27	19:49	06:28	20:19	07:49	20:25	06:18	20:44	06:39	20:41	06:47	20:25	06:22	20:08	10
17	06:07	19:44	05:52	19:04	05:54	19:33	07:11	19:42	05:46	19:56	06:05	19:54	06:12	19:39	05:48	19:22	17
24	05:02	18:44	04:48	18:03	04:49	18:32	06:08	18:40	04:40	18:57	05:00	18:54	05:08	18:39	04:43	18:21	24
31	04:10	18:03	03:57	17:21	03:57	17:52	05:19	17:56	03:47	18:18	04:08	18:14	04:17	17:58	03:52	17:41	31
Feb 7	03:46	17:48	03:34	17:05	03:34	17:37	04:58	17:39	03:22	18:04	03:44	17:59	03:54	17:42	03:28	17:25	Feb 7
14	03:43	17:46	03:31	17:03	03:30	17:35	04:55	17:37	03:18	18:02	03:40	17:58	03:50	17:41	03:24	17:23	14
21	03:52	17:50	03:39	17:08	03:39	17:39	05:02	17:43	03:28	18:05	03:49	18:01	03:59	17:45	03:33	17:28	21
28	04:09	17:56	03:54	17:15	03:56	17:44	05:16	17:53	03:47	18:08	04:07	18:06	04:16	17:51	03:50	17:33	28
Mar 7	04:32	18:01	04:15	17:23	04:19	17:49	05:32	18:04	04:13	18:10	04:31	18:10	04:38	17:58	04:13	17:39	Mar 7
14	05:00	18:05	04:40	17:30	04:47	17:54	05:52	18:16	04:45	18:11	05:00	18:13	05:04	18:03	04:40	17:44	14
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28	06:09	18:14	05:41	17:46	05:56	18:01	06:40	18:46	06:04	18:09	06:13	18:18	06:10	18:15	05:48	17:53	28
Apr 4	06:50	18:19	06:18	17:56	06:38	18:06	07:09	19:04	06:52	18:08	06:57	18:21	06:50	18:22	06:29	17:59	Apr 4
11	07:34	18:25	06:57	18:07	07:22	18:13	07:40	19:23	07:41	18:08	07:42	18:25	07:31	18:30	07:12	18:06	11
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May 2	08:32	18:21	07:47	18:11	08:21	18:08	08:17	19:39	08:50	17:53	08:44	18:17	08:25	18:29	08:09	18:03	May 2
9	08:07	18:01	07:23	17:50	07:56	17:48	07:54	19:16	08:25	17:34	08:19	17:58	08:01	18:08	07:44	17:43	9
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23	06:33	16:58	05:53	16:43	06:21	16:46	06:31	18:02	06:44	16:38	06:43	16:57	06:28	17:04	06:10	16:40	23
30	05:52	16:29	05:14	16:13	05:40	16:17	05:54	17:30	06:02	16:11	06:01	16:29	05:48	16:35	05:30	16:10	30
Jun 6	05:29	16:08	04:51	15:51	05:18	15:55	05:32	17:08	05:39	15:50	05:38	16:08	05:26	16:13	05:07	15:49	Jun 6
13	05:24	15:55	04:45	15:40	05:13	15:42	05:24	16:59	05:35	15:35	05:34	15:54	05:20	16:01	05:02	15:36	13
20	05:35	15:52	04:54	15:38	05:24	15:39	05:30	17:01	05:49	15:29	05:46	15:50	05:31	15:59	05:13	15:33	20
27	06:00	16:00	05:16	15:49	05:49	15:47	05:48	17:15	06:17	15:34	06:12	15:57	05:55	16:08	05:37	15:42	27
Jul 4	06:35	16:23	05:50	16:13	06:24	16:09	06:19	17:42	06:55	15:54	06:48	16:19	06:29	16:32	06:12	16:05	Jul 4
11	07:13	16:59	06:27	16:50	07:02	16:46	06:56	18:20	07:33	16:30	07:26	16:55	07:07	17:08	06:50	16:41	11
18	07:44	17:43	07:00	17:31	07:33	17:30	07:31	18:58	08:01	17:16	07:56	17:40	07:38	17:51	07:21	17:24	18
25	08:03	18:24	07:21	18:10	07:51	18:11	07:58	19:32	08:16	18:02	08:13	18:23	07:58	18:31	07:40	18:05	25
Aug 1	08:11	18:59	07:33	18:41	07:59	18:47	08:15	19:57	08:19	18:42	08:19	18:59	08:08	19:05	07:49	18:40	Aug 1
8	08:11	19:27	07:37	19:05	07:59	19:15	08:25	20:15	08:14	19:15	08:18	19:29	08:09	19:31	07:49	19:07	8
15	08:05	19:48	07:35	19:23	07:53	19:35	08:29	20:26	08:04	19:40	08:11	19:51	08:05	19:50	07:44	19:27	15
22	07:54	20:01	07:27	19:33	07:42	19:49	08:26	20:31	07:50	19:57	07:59	20:05	07:55	20:02	07:34	19:40	22
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Sep 5	07:16	19:53	06:53	19:21	07:03	19:41	07:59	20:12	07:06	19:54	07:18	19:59	07:18	19:52	06:56	19:31	Sep 5
12	06:44	19:19	06:21	18:47	06:32	19:07	07:27	19:39	06:34	19:20	06:47	19:26	06:47	19:18	06:24	18:58	12
19	06:05	18:22	05:40	17:52	05:53	18:10	06:42	18:48	05:58	18:20	06:09	18:27	06:07	18:21	05:45	18:01	19
26	05:30	17:23	05:01	16:56	05:18	17:11	05:58	17:57	05:27	17:17	05:35	17:27	05:30	17:24	05:09	17:02	26
Oct 3	05:10	16:55	04:40	16:29	04:58	16:42	05:35	17:33	05:09	16:47	05:16	16:58	05:10	16:56	04:49	16:34	Oct 3
10	05:05	17:01	04:36	16:35	04:53	16:49	05:33	17:36	05:02	16:56	05:10	17:05	05:06	17:03	04:44	16:41	10
17	05:06	17:26	04:40	16:56	04:53	17:14	05:42	17:52	04:59	17:24	05:09	17:32	05:08	17:27	04:45	17:05	17
24	05:07	17:56	04:45	17:23	04:55	17:44	05:53	18:12	04:56	17:59	05:09	18:03	05:11	17:55	04:48	17:35	24
31	05:10	18:26	04:51	17:49	04:57	18:14	06:05	18:33	04:53	18:34	05:10	18:35	05:14	18:24	04:50	18:04	31
Nov 7	05:13	18:56	04:57	18:15	05:00	18:44	06:17	18:53	04:52	19:08	05:11	19:06	05:19	18:52	04:54	18:33	Nov 7
14	05:17	19:24	05:05	18:41	05:05	19:13	06:30	19:14	04:53	19:41	05:15	19:36	05:25	19:19	04:59	19:01	14
21	05:25	19:52	05:16	19:05	05:12	19:40	06:45	19:34	04:57	20:11	05:22	20:04	05:34	19:45	05:07	19:28	21
28	05:37	20:17	05:29	19:29	05:24	20:06	07:02	19:55	05:06	20:39	05:33	20:30	05:47	20:10	05:20	19:53	28
Dec 5	05:53	20:38	05:46	19:50	05:40	20:27	07:19	20:15	05:20	21:02	05:48	20:52	06:03	20:31	05:35	20:15	Dec 5
12	06:11	20:53	06:04	20:05	05:58	20:42	07:37	20:31	05:39	21:16	06:06	21:07	06:21	20:46	05:53	20:30	12
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26	06:23	20:37	06:13	19:53	06:10	20:26	07:40	20:24	05:56	20:56	06:20	20:50	06:31	20:31	06:05	20:14	26

MERCURY

GEOCENTRIC POSITION

(0hr UT, Epoch 2000.0)

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	R.A.	Dec.	R.A.	Dec	R.A.	Dec	R.A.	Dec	R.A.	Dec	R.A.	Dec
	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "
1	20 07 26	- 21 49 33	19 31 38	- 18 58 09	21 24 01	- 16 56 30	00 46 19	+ 03 54 25	03 48 26	+ 22 44 20	03 25 25	+ 14 49 41
2	20 12 36	- 21 25 17	19 31 51	- 19 08 21	21 29 53	- 16 34 14	00 53 40	+ 04 50 24	03 50 39	+ 22 46 58	03 25 56	+ 14 46 43
3	20 17 28	- 21 00 23	19 32 36	- 19 17 48	21 35 49	- 16 10 42	01 01 04	+ 05 46 42	03 52 30	+ 22 47 13	03 26 43	+ 14 45 56
4	20 21 58	- 20 35 03	19 33 48	- 19 26 26	21 41 47	- 15 45 53	01 08 30	+ 06 43 08	03 53 59	+ 22 45 05	03 27 47	+ 14 47 18
5	20 26 05	- 20 09 31	19 35 28	- 19 34 12	21 47 47	- 15 19 49	01 15 58	+ 07 39 34	03 55 07	+ 22 40 39	03 29 08	+ 14 50 45
6	20 29 44	- 19 44 03	19 37 32	- 19 41 03	21 53 50	- 14 52 28	01 23 28	+ 08 35 47	03 55 52	+ 22 33 55	03 30 46	+ 14 56 13
7	20 32 54	- 19 18 57	19 39 58	- 19 46 54	21 59 56	- 14 23 51	01 30 58	+ 09 31 37	03 56 17	+ 22 24 58	03 32 40	+ 15 03 36
8	20 35 29	- 18 54 32	19 42 45	- 19 51 43	22 06 04	- 13 53 58	01 38 29	+ 10 26 51	03 56 20	+ 22 13 52	03 34 50	+ 15 12 49
9	20 37 28	- 18 31 10	19 45 50	- 19 55 29	22 12 14	- 13 22 51	01 45 59	+ 11 21 17	03 56 04	+ 22 00 40	03 37 16	+ 15 23 47
10	20 38 46	- 18 09 13	19 49 13	- 19 58 08	22 18 26	- 12 50 27	01 53 26	+ 12 14 40	03 55 28	+ 21 45 29	03 39 58	+ 15 36 22
11	20 39 22	- 17 49 02	19 52 51	- 19 59 40	22 24 41	- 12 16 50	02 00 51	+ 13 06 48	03 54 35	+ 21 28 26	03 42 56	+ 15 50 30
12	20 39 11	- 17 30 59	19 56 43	- 20 00 02	22 30 58	- 11 41 57	02 08 11	+ 13 57 29	03 53 26	+ 21 09 39	03 46 09	+ 16 06 03
13	20 38 14	- 17 15 24	20 00 48	- 19 59 14	22 37 17	- 11 05 50	02 15 25	+ 14 46 29	03 52 02	+ 20 49 18	03 49 38	+ 16 22 55
14	20 36 28	- 17 02 33	20 05 05	- 19 57 14	22 43 38	- 10 28 30	02 22 33	+ 15 33 38	03 50 25	+ 20 27 34	03 53 22	+ 16 40 58
15	20 33 56	- 16 52 38	20 09 32	- 19 54 00	22 50 02	- 09 49 56	02 29 32	+ 16 18 46	03 48 38	+ 20 04 41	03 57 22	+ 17 00 07
16	20 30 39	- 16 45 45	20 14 09	- 19 49 33	22 56 29	- 09 10 10	02 36 22	+ 17 01 43	03 46 42	+ 19 40 53	04 01 36	+ 17 20 13
17	20 26 42	- 16 41 57	20 18 55	- 19 43 52	23 02 57	- 08 29 11	02 43 01	+ 17 42 22	03 44 40	+ 19 16 25	04 06 06	+ 17 41 11
18	20 22 11	- 16 41 07	20 23 49	- 19 36 55	23 09 29	- 07 47 00	02 49 29	+ 18 20 36	03 42 34	+ 18 51 35	04 10 50	+ 18 02 51
19	20 17 13	- 16 43 04	20 28 51	- 19 28 43	23 16 03	- 07 03 39	02 55 43	+ 18 56 22	03 40 27	+ 18 26 39	04 15 50	+ 18 25 07
20	20 11 57	- 16 47 31	20 33 59	- 19 19 15	23 22 40	- 06 19 08	03 01 43	+ 19 29 35	03 38 20	+ 18 01 57	04 21 05	+ 18 47 50
21	20 06 33	- 16 54 08	20 39 14	- 19 08 30	23 29 20	- 05 33 28	03 07 29	+ 20 00 13	03 36 17	+ 17 37 44	04 26 36	+ 19 10 54
22	20 01 10	- 17 02 33	20 44 34	- 18 56 29	23 36 03	- 04 46 41	03 12 58	+ 20 28 14	03 34 20	+ 17 14 19	04 32 21	+ 19 34 08
23	19 55 58	- 17 12 24	20 50 00	- 18 43 12	23 42 49	- 03 58 48	03 18 11	+ 20 53 38	03 32 30	+ 16 51 57	04 38 22	+ 19 57 25
24	19 51 05	- 17 23 19	20 55 30	- 18 28 37	23 49 38	- 03 09 51	03 23 06	+ 21 16 26	03 30 49	+ 16 30 54	04 44 39	+ 20 20 35
25	19 46 37	- 17 35 00	21 01 05	- 18 12 45	23 56 31	- 02 19 52	03 27 42	+ 21 36 37	03 29 19	+ 16 11 22	04 51 11	+ 20 43 28
26	19 42 40	- 17 47 08	21 06 43	- 17 55 37	00 03 27	- 01 28 53	03 32 00	+ 21 54 14	03 28 01	+ 15 53 34	04 57 58	+ 21 05 55
27	19 39 18	- 17 59 29	21 12 26	- 17 37 11	00 10 27	- 00 36 58	03 35 59	+ 22 09 16	03 26 57	+ 15 37 38	05 05 01	+ 21 27 46
28	19 36 32	- 18 11 51	21 18 12	- 17 17 29	00 17 30	+ 00 15 50	03 39 37	+ 22 21 47	03 26 07	+ 15 23 43	05 12 19	+ 21 48 48
29	19 34 24	- 18 24 02			00 24 37	+ 01 09 28	03 42 54	+ 22 31 46	03 25 33	+ 15 11 55	05 19 52	+ 22 08 50
30	19 32 53	- 18 35 54			00 31 48	+ 02 03 50	03 45 51	+ 22 39 17	03 25 14	+ 15 02 17	05 27 40	+ 22 27 42
31	19 31 58	- 18 47 18			00 39 02	+ 02 58 51			03 25 11	+ 14 54 52		

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	05 35 42	+ 22 45 11	09 56 57	+ 13 50 16	12 10 39	- 04 45 44	11 29 51	+ 03 36 09	14 14 59	- 12 48 35	17 28 15	- 25 23 44
2	05 43 58	+ 23 01 05	10 03 21	+ 13 09 45	12 12 15	- 05 05 16	11 31 29	+ 03 42 41	14 21 13	- 13 27 13	17 34 52	- 25 30 57
3	05 52 27	+ 23 15 12	10 09 36	+ 12 28 55	12 13 36	- 05 22 35	11 33 40	+ 03 44 08	14 27 28	- 14 05 09	17 41 29	- 25 36 47
4	06 01 08	+ 23 27 21	10 15 42	+ 11 47 52	12 14 39	- 05 37 32	11 36 24	+ 03 40 37	14 33 43	- 14 42 23	17 48 05	- 25 41 12
5	06 10 00	+ 23 37 20	10 21 39	+ 11 06 40	12 15 24	- 05 49 55	11 39 38	+ 03 32 21	14 39 59	- 15 18 50	17 54 39	- 25 44 12
6	06 19 01	+ 23 45 01	10 27 28	+ 10 25 22	12 15 51	- 05 59 32	11 43 18	+ 03 19 34	14 46 15	- 15 54 31	18 01 11	- 25 45 46
7	06 28 11	+ 23 50 13	10 33 09	+ 09 44 02	12 15 57	- 06 06 10	11 47 23	+ 03 02 36	14 52 32	- 16 29 24	18 07 40	- 25 45 54
8	06 37 27	+ 23 52 51	10 38 42	+ 09 02 44	12 15 43	- 06 09 37	11 51 50	+ 02 41 45	14 58 49	- 17 03 27	18 14 06	- 25 44 34
9	06 46 48	+ 23 52 48	10 44 07	+ 08 21 31	12 15 08	- 06 09 40	11 56 36	+ 02 17 24	15 05 07	- 17 36 38	18 20 27	- 25 41 48
10	06 56 13	+ 23 50 00	10 49 24	+ 07 40 27	12 14 10	- 06 06 07	12 01 39	+ 01 49 53	15 11 26	- 18 08 56	18 26 44	- 25 37 34
11	07 05 38	+ 23 44 26	10 54 33	+ 06 59 36	12 12 51	- 05 58 47	12 06 55	+ 01 19 33	15 17 46	- 18 40 20	18 32 54	- 25 31 55
12	07 15 04	+ 23 36 07	10 59 35	+ 06 18 59	12 11 09	- 05 47 31	12 12 24	+ 00 46 46	15 24 07	- 19 10 48	18 38 57	- 25 24 50
13	07 24 27	+ 23 25 03	11 04 30	+ 05 38 41	12 09 06	- 05 32 12	12 18 03	+ 00 11 51	15 30 29	- 19 40 19	18 44 53	- 25 16 22
14	07 33 47	+ 23 11 19	11 09 17	+ 04 58 45	12 06 42	- 05 12 50	12 23 49	- 00 24 53	15 36 53	- 20 08 52	18 50 38	- 25 06 32
15	07 43 02	+ 22 55 00	11 13 56	+ 04 19 14	12 03 59	- 04 49 26	12 29 43	- 01 03 09	15 43 17	- 20 36 25	18 56 12	- 24 55 23
16	07 52 10	+ 22 36 12	11 18 28	+ 03 40 11	12 00 59	- 04 22 09	12 35 42	- 01 42 40	15 49 43	- 21 02 57	19 01 33	- 24 43 00
17	08 01 12	+ 22 15 03	11 22 52	+ 03 01 40	11 57 45	- 03 51 14	12 41 45	- 02 23 12	15 56 09	- 21 28 27	19 06 39	- 24 29 25
18	08 10 05	+ 21 51 41	11 27 08	+ 02 23 43	11 54 21	- 03 17 06	12 47 52	- 03 04 33	16 02 37	- 21 52 53	19 11 27	- 24 14 46
19	08 18 49	+ 21 26 14	11 31 17	+ 01 46 25	11 50 51	- 02 40 16	12 54 00	- 03 46 30	16 09 07	- 22 16 15	19 15 56	- 23 59 09
20	08 27 23	+ 20 58 52	11 35 17	+ 01 09 50	11 47 20	- 02 01 22	13 00 11	- 04 28 52	16 15 37	- 22 38 29	19 20 02	- 23 42 41
21	08 35 48	+ 20 29 43	11 39 09	+ 00 34 00	11 43 53	- 01 21 09	13 06 23	- 05 11 31	16 22 09	- 22 59 37	19 23 42	- 23 25 32
22	08 44 02	+ 19 58 56	11 42 53	- 00 00 59	11 40 34	- 00 40 28	13 12 36	- 05 54 18	16 28 42	- 23 19 35	19 26 53	- 23 07 52
23	08 52 06	+ 19 26 40	11 46 27	- 00 35 04	11 37 31	- 00 00 11	13 18 50	- 06 37 06	16 35 16	- 23 38 22	19 29 32	- 22 49 53
24	09 00 00	+ 18 53 03	11 49 53	- 01 08 09	11 34 47	+ 00 38 48	13 25 04	- 07 19 48	16 41 51	- 23 55 58	19 31 35	- 22 31 47
25	09 07 43	+ 18 18 14	11 53 08	- 01 40 10	11 32 28	+ 01 15 39	13 31 18	- 08 02 19	16 48 27	- 24 12 21	19 32 58	- 22 13 48
26	09 15 15	+ 17 42 19	11 56 14	- 02 11 01	11 30 36	+ 01 49 36	13 37 33	- 08 44 34	16 55 04	- 24 27 29	19 33 38	- 21 56 10
27	09 22 37	+ 17 05 26	11 59 08	- 02 40 36	11 29 17	+ 02 19 57	13 43 47	- 09 26 27	17 01 41	- 24 41 21	19 33 31	- 21 39 07
28	09 29 49	+ 16 27 42	12 01 52	- 03 08 50	11 28 32	+ 02 46 09	13 50 01	- 10 07 55	17 08 19	- 24 53 56	19 32 36	- 21 22 52
29	09 36 51	+ 15 49 13	12 04 23	- 03 35 36	11 28 22	+ 03 07 46	13 56 16	- 10 48 56	17 14 58	- 25 05 12	19 30 50	- 21 07 38
30	09 43 42	+ 15 10 05	12 06 42	- 04 00 45	11 28 48	+ 03 24 29	14 02 30	- 11 29 24	17 21 36	- 25 15 09	19 28 15	- 20 53 35
31	09 50 25	+ 14 30 24	12 08 48	- 04 24 11			14 08 44	- 12 09 18			19 24 51	- 20 40 51

VENUS

RISE AND SET TIMES

EST, Adelaide and Darwin CST, Perth WST

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney		
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	
Jan 3	08:53	22:12	08:35	21:35	08:40	22:00	09:50	22:18	08:36	22:20	08:53	22:21	08:58	22:09	08:34	21:50	Jan 3
10	09:02	22:02	08:42	21:28	08:50	21:51	09:53	22:15	08:49	22:07	09:04	22:10	09:07	22:00	08:43	21:41	10
17	09:10	21:51	08:47	21:19	08:58	21:39	09:55	22:10	09:00	21:53	09:13	21:57	09:13	21:50	08:50	21:30	17
24	09:16	21:38	08:51	21:08	09:04	21:26	09:54	22:03	09:09	21:36	09:20	21:43	09:18	21:38	08:56	21:17	24
31	09:20	21:23	08:52	20:55	09:08	21:11	09:51	21:55	09:15	21:18	09:24	21:27	09:21	21:24	08:59	21:02	31
Feb 7	09:21	21:06	08:51	20:41	09:09	20:54	09:46	21:44	09:19	20:58	09:26	21:09	09:21	21:08	09:00	20:46	Feb 7
14	09:18	20:46	08:46	20:23	09:06	20:34	09:38	21:30	09:19	20:36	09:25	20:49	09:17	20:49	08:57	20:26	14
21	09:11	20:24	08:37	20:03	08:59	20:11	09:25	21:12	09:14	20:11	09:18	20:25	09:09	20:27	08:49	20:04	21
28	08:57	19:58	08:22	19:38	08:45	19:45	09:07	20:50	09:03	19:43	09:05	19:58	08:55	20:02	08:35	19:38	28
Mar 7	08:35	19:27	07:59	19:09	08:24	19:15	08:43	20:23	08:42	19:11	08:44	19:28	08:32	19:32	08:13	19:08	Mar 7
14	08:03	18:53	07:27	18:34	07:52	18:40	08:10	19:49	08:11	18:36	08:12	18:53	08:00	18:57	07:42	18:34	14
21	07:22	18:15	06:46	17:57	07:10	18:03	07:30	19:10	07:29	18:00	07:30	18:16	07:19	18:20	07:00	17:56	21
28	06:34	17:39	05:59	17:18	06:22	17:26	06:46	18:29	06:39	17:25	06:42	17:40	06:31	17:42	06:12	17:19	28
Apr 4	05:45	17:05	05:13	16:43	05:34	16:53	06:02	17:50	05:48	16:54	05:52	17:07	05:44	17:08	05:24	16:45	Apr 4
11	05:03	16:36	04:32	16:12	04:51	16:24	05:24	17:17	05:03	16:28	05:09	16:39	05:02	16:39	04:42	16:16	11
18	04:29	16:13	03:59	15:48	04:17	16:01	04:54	16:51	04:27	16:06	04:34	16:17	04:29	16:15	04:08	15:53	18
25	04:04	15:55	03:35	15:29	03:52	15:43	04:31	16:30	04:02	15:48	04:09	15:58	04:04	15:56	03:44	15:34	25
May 2	03:48	15:39	03:19	15:13	03:36	15:27	04:15	16:15	03:45	15:33	03:53	15:43	03:48	15:41	03:27	15:19	May 2
9	03:37	15:26	03:08	15:01	03:25	15:14	04:04	16:03	03:35	15:20	03:42	15:30	03:37	15:28	03:16	15:06	9
16	03:32	15:15	03:01	14:50	03:20	15:03	03:56	15:54	03:30	15:07	03:37	15:18	03:31	15:17	03:11	14:55	16
23	03:30	15:05	02:58	14:41	03:18	14:53	03:51	15:46	03:30	14:56	03:36	15:08	03:29	15:07	03:09	14:45	23
30	03:31	14:56	02:58	14:33	03:19	14:44	03:49	15:41	03:32	14:45	03:37	14:58	03:30	14:59	03:09	14:36	30
Jun 6	03:34	14:48	03:00	14:27	03:22	14:36	03:48	15:37	03:37	14:35	03:41	14:50	03:32	14:52	03:12	14:28	Jun 6
13	03:39	14:41	03:03	14:21	03:27	14:28	03:49	15:34	03:44	14:26	03:47	14:42	03:37	14:45	03:17	14:21	13
20	03:45	14:35	03:08	14:17	03:34	14:22	03:51	15:32	03:53	14:18	03:54	14:35	03:42	14:40	03:23	14:16	20
27	03:53	14:31	03:14	14:14	03:41	14:18	03:55	15:32	04:03	14:12	04:02	14:30	03:49	14:36	03:31	14:12	27
Jul 4	04:01	14:28	03:21	14:13	03:50	14:15	03:59	15:33	04:13	14:07	04:11	14:26	03:57	14:34	03:39	14:09	Jul 4
11	04:11	14:26	03:29	14:13	03:59	14:14	04:05	15:35	04:24	14:04	04:21	14:24	04:06	14:33	03:48	14:08	11
18	04:20	14:27	03:37	14:15	04:08	14:14	04:11	15:39	04:35	14:03	04:31	14:25	04:15	14:34	03:57	14:09	18
25	04:29	14:30	03:46	14:18	04:18	14:17	04:18	15:44	04:46	14:04	04:41	14:27	04:24	14:38	04:06	14:12	25
Aug 1	04:38	14:35	03:54	14:24	04:27	14:22	04:25	15:50	04:55	14:09	04:50	14:32	04:32	14:43	04:15	14:17	Aug 1
8	04:46	14:42	04:01	14:31	04:34	14:29	04:33	15:58	05:03	14:15	04:57	14:39	04:40	14:50	04:23	14:24	8
15	04:52	14:51	04:08	14:39	04:41	14:38	04:40	16:06	05:09	14:25	05:04	14:48	04:46	14:59	04:29	14:32	15
22	04:57	15:01	04:14	14:49	04:46	14:48	04:47	16:14	05:13	14:36	05:08	14:58	04:52	15:09	04:34	14:43	22
29	05:00	15:13	04:18	14:59	04:49	15:00	04:53	16:23	05:15	14:50	05:11	15:11	04:55	15:20	04:38	14:54	29
Sep 5	05:02	15:25	04:21	15:11	04:50	15:13	04:58	16:32	05:14	15:04	05:12	15:24	04:57	15:32	04:39	15:07	Sep 5
12	05:02	15:39	04:23	15:22	04:50	15:26	05:03	16:40	05:12	15:20	05:11	15:38	04:58	15:44	04:39	15:20	12
19	05:00	15:52	04:23	15:34	04:48	15:40	05:06	16:48	05:07	15:36	05:08	15:53	04:57	15:57	04:38	15:33	19
26	04:57	16:06	04:22	15:45	04:45	15:53	05:09	16:56	05:02	15:52	05:04	16:07	04:55	16:10	04:35	15:46	26
Oct 3	04:53	16:20	04:20	15:57	04:41	16:07	05:11	17:04	04:55	16:09	05:00	16:22	04:52	16:23	04:32	16:00	Oct 3
10	04:48	16:33	04:18	16:08	04:36	16:21	05:13	17:11	04:47	16:26	04:54	16:37	04:48	16:35	04:27	16:13	10
17	04:43	16:47	04:16	16:19	04:31	16:35	05:14	17:19	04:39	16:43	04:48	16:52	04:44	16:48	04:23	16:26	17
24	04:38	17:01	04:13	16:31	04:26	16:49	05:16	17:26	04:31	17:00	04:42	17:07	04:40	17:01	04:18	16:40	24
31	04:33	17:15	04:10	16:43	04:21	17:03	05:17	17:34	04:23	17:17	04:36	17:22	04:36	17:14	04:13	16:54	31
Nov 7	04:29	17:30	04:08	16:55	04:17	17:18	05:20	17:42	04:15	17:35	04:30	17:38	04:33	17:28	04:09	17:08	Nov 7
14	04:26	17:45	04:08	17:08	04:13	17:33	05:23	17:51	04:09	17:53	04:26	17:54	04:31	17:42	04:06	17:23	14
21	04:24	18:00	04:08	17:21	04:11	17:49	05:26	18:00	04:04	18:12	04:23	18:10	04:30	17:57	04:05	17:38	21
28	04:23	18:16	04:09	17:34	04:10	18:05	05:32	18:10	04:01	18:30	04:21	18:27	04:30	18:11	04:05	17:53	28
Dec 5	04:25	18:32	04:13	17:48	04:12	18:20	05:38	18:21	04:00	18:48	04:22	18:43	04:33	18:26	04:07	18:09	Dec 5
12	04:29	18:47	04:18	18:02	04:16	18:35	05:46	18:32	04:01	19:05	04:25	18:59	04:37	18:41	04:11	18:23	12
19	04:35	19:01	04:26	18:15	04:22	18:50	05:55	18:44	04:06	19:21	04:31	19:13	04:44	18:54	04:17	18:37	19
26	04:44	19:13	04:35	18:27	04:31	19:02	06:05	18:55	04:14	19:34	04:40	19:26	04:53	19:07	04:26	18:50	26

VENUS

GEOCENTRIC POSITION

(0hr UT, Epoch 2000.0)

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	R.A.	Dec.	R.A.	Dec	R.A.	Dec	R.A.	Dec	R.A.	Dec	R.A.	Dec
	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "	hh mm ss	° ' "
1	21 59 25	- 13 51 40	23 50 18	+ 00 41 59	00 44 30	+ 11 23 16	00 04 25	+ 08 50 34	00 05 39	+ 02 12 42	01 35 01	+ 07 37 56
2	22 03 32	- 13 25 22	23 53 13	+ 01 09 50	00 44 59	+ 11 37 17	00 02 32	+ 08 28 18	00 07 36	+ 02 13 46	01 38 35	+ 07 54 52
3	22 07 38	- 12 58 48	23 56 04	+ 01 37 30	00 45 20	+ 11 50 21	00 00 44	+ 08 05 53	00 09 39	+ 02 15 41	01 42 11	+ 08 11 59
4	22 11 42	- 12 32 00	23 58 52	+ 02 04 58	00 45 33	+ 12 02 24	23 59 03	+ 07 43 27	00 11 46	+ 02 18 26	01 45 48	+ 08 29 17
5	22 15 43	- 12 04 57	00 01 37	+ 02 32 11	00 45 38	+ 12 13 23	23 57 29	+ 07 21 07	00 13 58	+ 02 21 59	01 49 28	+ 08 46 44
6	22 19 43	- 11 37 42	00 04 19	+ 02 59 11	00 45 34	+ 12 23 15	23 56 02	+ 06 59 02	00 16 15	+ 02 26 20	01 53 09	+ 09 04 19
7	22 23 40	- 11 10 14	00 06 56	+ 03 25 54	00 45 21	+ 12 31 57	23 54 44	+ 06 37 17	00 18 36	+ 02 31 26	01 56 52	+ 09 22 03
8	22 27 35	- 10 42 35	00 09 30	+ 03 52 21	00 44 59	+ 12 39 26	23 53 33	+ 06 16 00	00 21 02	+ 02 37 16	02 00 36	+ 09 39 53
9	22 31 28	- 10 14 46	00 12 01	+ 04 18 30	00 44 28	+ 12 45 40	23 52 31	+ 05 55 17	00 23 32	+ 02 43 48	02 04 22	+ 09 57 48
10	22 35 19	- 09 46 47	00 14 27	+ 04 44 20	00 43 49	+ 12 50 35	23 51 38	+ 05 35 13	00 26 05	+ 02 51 02	02 08 10	+ 10 15 48
11	22 39 08	- 09 18 39	00 16 49	+ 05 09 49	00 43 01	+ 12 54 09	23 50 54	+ 05 15 52	00 28 43	+ 02 58 56	02 12 00	+ 10 33 52
12	22 42 54	- 08 50 23	00 19 07	+ 05 34 57	00 42 04	+ 12 56 20	23 50 19	+ 04 57 19	00 31 24	+ 03 07 28	02 15 51	+ 10 51 59
13	22 46 39	- 08 22 00	00 21 20	+ 05 59 43	00 40 59	+ 12 57 06	23 49 54	+ 04 39 38	00 34 09	+ 03 16 38	02 19 44	+ 11 10 08
14	22 50 21	- 07 53 30	00 23 29	+ 06 24 04	00 39 45	+ 12 56 23	23 49 37	+ 04 22 52	00 36 57	+ 03 26 23	02 23 38	+ 11 28 18
15	22 54 01	- 07 24 55	00 25 34	+ 06 48 00	00 38 23	+ 12 54 12	23 49 29	+ 04 07 03	00 39 48	+ 03 36 41	02 27 34	+ 11 46 27
16	22 57 39	- 06 56 15	00 27 33	+ 07 11 29	00 36 54	+ 12 50 31	23 49 31	+ 03 52 13	00 42 43	+ 03 47 33	02 31 32	+ 12 04 36
17	23 01 14	- 06 27 31	00 29 27	+ 07 34 30	00 35 17	+ 12 45 19	23 49 41	+ 03 38 24	00 45 40	+ 03 58 56	02 35 31	+ 12 22 43
18	23 04 48	- 05 58 44	00 31 16	+ 07 57 02	00 33 34	+ 12 38 36	23 50 00	+ 03 25 37	00 48 41	+ 04 10 50	02 39 32	+ 12 40 47
19	23 08 19	- 05 29 55	00 33 00	+ 08 19 01	00 31 44	+ 12 30 23	23 50 28	+ 03 13 53	00 51 44	+ 04 23 11	02 43 34	+ 12 58 48
20	23 11 48	- 05 01 03	00 34 38	+ 08 40 28	00 29 49	+ 12 20 40	23 51 04	+ 03 03 12	00 54 50	+ 04 36 01	02 47 38	+ 13 16 44
21	23 15 14	- 04 32 11	00 36 10	+ 09 01 20	00 27 50	+ 12 09 30	23 51 48	+ 02 53 34	00 57 58	+ 04 49 16	02 51 43	+ 13 34 34
22	23 18 38	- 04 03 19	00 37 36	+ 09 21 35	00 25 46	+ 11 56 55	23 52 39	+ 02 44 58	01 01 09	+ 05 02 56	02 55 50	+ 13 52 19
23	23 22 00	- 03 34 29	00 38 56	+ 09 41 12	00 23 38	+ 11 42 58	23 53 39	+ 02 37 26	01 04 23	+ 05 17 00	02 59 58	+ 14 09 56
24	23 25 19	- 03 05 39	00 40 09	+ 10 00 08	00 21 29	+ 11 27 43	23 54 46	+ 02 30 55	01 07 38	+ 05 31 26	03 04 08	+ 14 27 25
25	23 28 36	- 02 36 53	00 41 16	+ 10 18 21	00 19 17	+ 11 11 15	23 56 00	+ 02 25 24	01 10 56	+ 05 46 13	03 08 19	+ 14 44 46
26	23 31 50	- 02 08 10	00 42 15	+ 10 35 48	00 17 05	+ 10 53 39	23 57 21	+ 02 20 54	01 14 17	+ 06 01 19	03 12 32	+ 15 01 56
27	23 35 02	- 01 39 32	00 43 07	+ 10 52 28	00 14 53	+ 10 35 02	23 58 48	+ 02 17 23	01 17 39	+ 06 16 45	03 16 46	+ 15 18 56
28	23 38 11	- 01 10 59	00 43 52	+ 11 08 18	00 12 42	+ 10 15 29	00 00 22	+ 02 14 49	01 21 03	+ 06 32 28	03 21 02	+ 15 35 45
29	23 41 17	- 00 42 33			00 10 33	+ 09 55 09	00 02 02	+ 02 13 12	01 24 30	+ 06 48 28	03 25 19	+ 15 52 22
30	23 44 20	- 00 14 13			00 08 26	+ 09 34 07	00 03 48	+ 02 12 30	01 27 58	+ 07 04 43	03 29 37	+ 16 08 47
31	23 47 21	+ 00 13 58			00 06 24	+ 09 12 33			01 31 28	+ 07 21 13		

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	03 33 57	+ 16 24 57	05 59 07	+ 21 48 11	08 34 26	+ 18 44 57	10 57 55	+ 07 58 19	13 20 13	- 06 50 08	15 46 37	- 19 07 00
2	03 38 19	+ 16 40 53	06 04 05	+ 21 51 01	08 39 23	+ 18 29 52	11 02 33	+ 07 31 24	13 24 52	- 07 18 38	15 51 48	- 19 25 18
3	03 42 42	+ 16 56 34	06 09 03	+ 21 53 19	08 44 19	+ 18 14 15	11 07 09	+ 07 04 15	13 29 32	- 07 46 59	15 56 59	- 19 43 04
4	03 47 06	+ 17 12 00	06 14 02	+ 21 55 02	08 49 15	+ 17 58 07	11 11 46	+ 06 36 53	13 34 13	- 08 15 10	16 02 11	- 20 00 16
5	03 51 32	+ 17 27 08	06 19 01	+ 21 56 10	08 54 09	+ 17 41 29	11 16 22	+ 06 09 18	13 38 54	- 08 43 10	16 07 25	- 20 16 55
6	03 55 59	+ 17 41 59	06 24 01	+ 21 56 45	08 59 04	+ 17 24 20	11 20 57	+ 05 41 32	13 43 37	- 09 11 00	16 12 40	- 20 32 59
7	04 00 27	+ 17 56 32	06 29 01	+ 21 56 44	09 03 57	+ 17 06 41	11 25 33	+ 05 13 34	13 48 20	- 09 38 37	16 17 56	- 20 48 28
8	04 04 57	+ 18 10 46	06 34 02	+ 21 56 08	09 08 50	+ 16 48 33	11 30 08	+ 04 45 27	13 53 03	- 10 06 02	16 23 13	- 21 03 21
9	04 09 29	+ 18 24 40	06 39 03	+ 21 54 57	09 13 42	+ 16 29 56	11 34 43	+ 04 17 09	13 57 48	- 10 33 13	16 28 31	- 21 17 37
10	04 14 02	+ 18 38 14	06 44 04	+ 21 53 11	09 18 34	+ 16 10 50	11 39 17	+ 03 48 42	14 02 34	- 11 00 10	16 33 50	- 21 31 17
11	04 18 36	+ 18 51 27	06 49 06	+ 21 50 49	09 23 25	+ 15 51 17	11 43 52	+ 03 20 08	14 07 20	- 11 26 52	16 39 10	- 21 44 18
12	04 23 11	+ 19 04 17	06 54 08	+ 21 47 51	09 28 15	+ 15 31 17	11 48 26	+ 02 51 25	14 12 08	- 11 53 18	16 44 31	- 21 56 41
13	04 27 48	+ 19 16 46	06 59 10	+ 21 44 18	09 33 04	+ 15 10 49	11 53 00	+ 02 22 36	14 16 56	- 12 19 27	16 49 53	- 22 08 25
14	04 32 26	+ 19 28 50	07 04 13	+ 21 40 08	09 37 53	+ 14 49 56	11 57 34	+ 01 53 41	14 21 45	- 12 45 18	16 55 16	- 22 19 30
15	04 37 06	+ 19 40 31	07 09 15	+ 21 35 23	09 42 41	+ 14 28 37	12 02 08	+ 01 24 40	14 26 36	- 13 10 51	17 00 40	- 22 29 55
16	04 41 47	+ 19 51 48	07 14 17	+ 21 30 02	09 47 28	+ 14 06 53	12 06 42	+ 00 55 35	14 31 27	- 13 36 05	17 06 04	- 22 39 39
17	04 46 29	+ 20 02 39	07 19 20	+ 21 24 05	09 52 14	+ 13 44 45	12 11 16	+ 00 26 26	14 36 20	- 14 00 59	17 11 30	- 22 48 42
18	04 51 12	+ 20 13 04	07 24 22	+ 21 17 33	09 57 00	+ 13 22 13	12 15 50	- 00 02 47	14 41 14	- 14 25 32	17 16 56	- 22 57 04
19	04 55 56	+ 20 23 02	07 29 25	+ 21 10 24	10 01 45	+ 12 59 18	12 20 24	- 00 32 01	14 46 09	- 14 49 43	17 22 22	- 23 04 44
20	05 00 42	+ 20 32 33	07 34 27	+ 21 02 40	10 06 30	+ 12 36 01	12 24 59	- 01 01 18	14 51 05	- 15 13 32	17 27 49	- 23 11 42
21	05 05 29	+ 20 41 37	07 39 29	+ 20 54 21	10 11 13	+ 12 12 22	12 29 33	- 01 30 35	14 56 02	- 15 36 57	17 33 17	- 23 17 57
22	05 10 17	+ 20 50 12	07 44 30	+ 20 45 27	10 15 56	+ 11 48 22	12 34 08	- 01 59 52	15 01 00	- 15 59 59	17 38 46	- 23 23 30
23	05 15 05	+ 20 58 18	07 49 32	+ 20 35 57	10 20 39	+ 11 24 01	12 38 42	- 02 29 09	15 05 59	- 16 22 36	17 44 14	- 23 28 20
24	05 19 55	+ 21 05 55	07 54 33	+ 20 25 53	10 25 20	+ 10 59 21	12 43 18	- 02 58 24	15 11 00	- 16 44 46	17 49 43	- 23 32 26
25	05 24 46	+ 21 13 01	07 59 34	+ 20 15 14	10 30 01	+ 10 34 21	12 47 53	- 03 27 37	15 16 02	- 17 06 31	17 55 13	- 23 35 49
26	05 29 38	+ 21 19 38	08 04 34	+ 20 04 01	10 34 42	+ 10 09 03	12 52 29	- 03 56 48	15 21 05	- 17 27 48	18 00 42	- 23 38 28
27	05 34 31	+ 21 25 43	08 09 34	+ 19 52 13	10 39 22	+ 09 43 27	12 57 05	- 04 25 55	15 26 09	- 17 48 38	18 06 12	- 23 40 23
28	05 39 25	+ 21 31 17	08 14 33	+ 19 39 52	10 44 01	+ 09 17 34	13 01 42	- 04 54 57	15 31 14	- 18 08 58	18 11 42	- 23 41 34
29	05 44 19	+ 21 36 19	08 19 32	+ 19 26 58	10 48 40	+ 08 51 25	13 06 19	- 05 23 54	15 36 21	- 18 28 49	18 17 12	- 23 42 01
30	05 49 14	+ 21 40 49	08 24 31	+ 19 13 30	10 53 18	+ 08 24 59	13 10 56	- 05 52 46	15 41 28	- 18 48 10	18 22 42	- 23 41 44
31	05 54 10	+ 21 44 46	08 29 29	+ 18 59 29			13 15 34	- 06 21 31			18 28 12	- 23 40 43

MARS

RISE AND SET TIMES

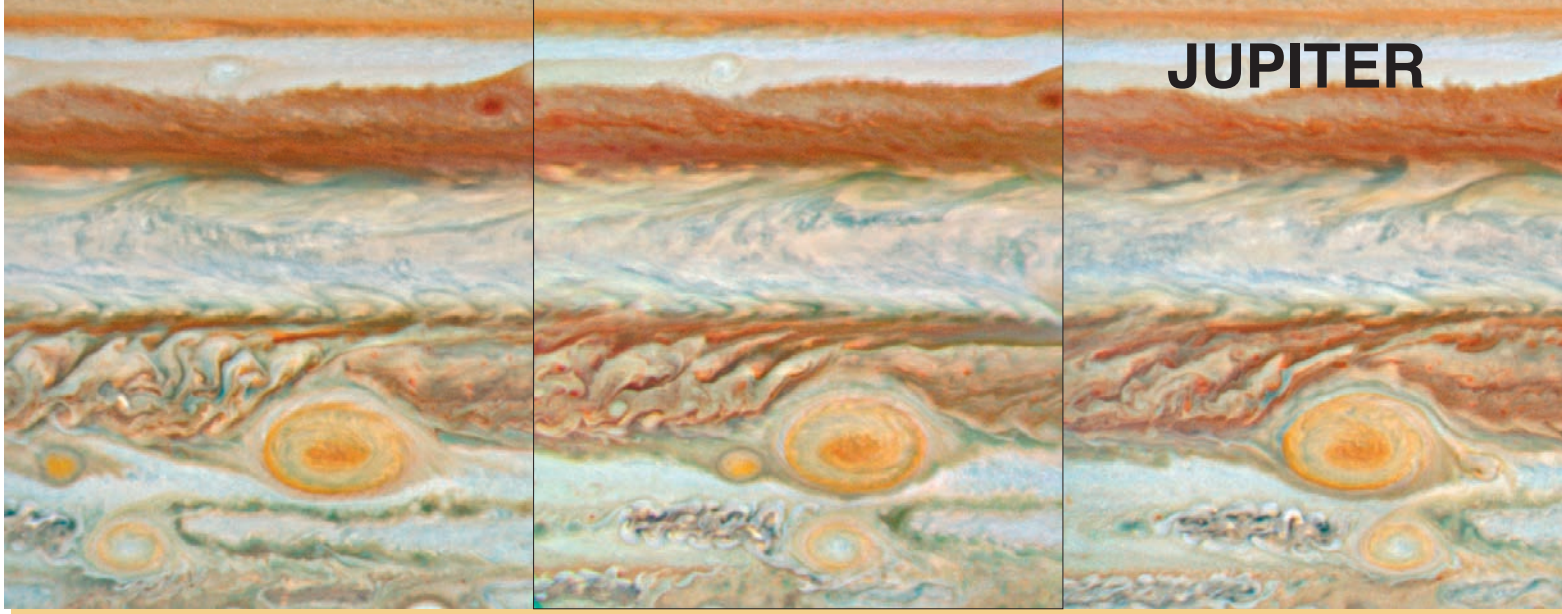
EST, Adelaide and Darwin CST, Perth WST

POSITION

0hr UT Epoch 2000.0

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney		RA	DEC
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	h m s	Set
Jan 3	04:31	19:02	04:22	18:15	04:18	18:51	05:53	18:43	04:01	19:23	04:27	19:15	04:40	18:55	04:13	18:39	18 21 29	- 24 03 50
10	04:27	18:57	04:19	18:10	04:14	18:46	05:49	18:38	03:58	19:18	04:23	19:10	04:36	18:50	04:10	18:33	18 44 38	- 23 49 11
17	04:25	18:51	04:15	18:05	04:11	18:40	05:45	18:33	03:55	19:11	04:21	19:03	04:33	18:44	04:07	18:27	19 07 48	- 23 21 39
24	04:22	18:44	04:13	17:58	04:09	18:33	05:41	18:28	03:54	19:03	04:19	18:56	04:31	18:37	04:04	18:21	19 30 55	- 22 41 24
31	04:21	18:36	04:10	17:51	04:08	18:25	05:38	18:22	03:54	18:54	04:17	18:48	04:29	18:30	04:03	18:13	19 53 53	- 21 48 47
Feb 7	04:20	18:28	04:08	17:44	04:07	18:16	05:34	18:16	03:54	18:44	04:17	18:39	04:27	18:22	04:01	18:05	20 16 39	- 20 44 23
14	04:19	18:18	04:06	17:36	04:06	18:07	05:30	18:10	03:54	18:33	04:16	18:29	04:26	18:13	04:00	17:56	20 39 09	- 19 28 53
21	04:18	18:08	04:04	17:27	04:05	17:57	05:26	18:03	03:55	18:22	04:16	18:19	04:25	18:03	03:59	17:46	21 01 22	- 18 03 05
28	04:17	17:57	04:02	17:18	04:04	17:46	05:22	17:56	03:56	18:09	04:16	18:07	04:23	17:53	03:58	17:35	21 23 16	- 16 27 56
Mar 7	04:16	17:46	04:00	17:08	04:04	17:35	05:18	17:48	03:58	17:56	04:16	17:55	04:22	17:42	03:58	17:24	21 44 51	- 14 44 31
14	04:16	17:34	03:58	16:57	04:03	17:23	05:13	17:40	03:59	17:42	04:16	17:43	04:21	17:31	03:57	17:12	22 06 05	- 12 53 52
21	04:15	17:22	03:55	16:46	04:02	17:10	05:08	17:32	04:00	17:28	04:16	17:30	04:19	17:19	03:55	17:00	22 27 02	- 10 57 05
28	04:14	17:09	03:53	16:35	04:01	16:57	05:03	17:23	04:01	17:13	04:15	17:16	04:18	17:07	03:54	16:47	22 47 42	- 08 55 19
Apr 4	04:13	16:56	03:50	16:23	04:00	16:44	04:58	17:14	04:02	16:58	04:15	17:02	04:16	16:54	03:53	16:34	23 08 07	- 06 49 44
11	04:11	16:42	03:47	16:11	03:59	16:30	04:52	17:04	04:02	16:42	04:14	16:48	04:14	16:42	03:51	16:21	23 28 19	- 04 41 29
18	04:10	16:29	03:44	15:59	03:58	16:17	04:47	16:55	04:03	16:27	04:13	16:34	04:12	16:29	03:50	16:08	23 48 21	- 02 31 38
25	04:08	16:15	03:41	15:47	03:56	16:03	04:41	16:45	04:03	16:11	04:12	16:19	04:09	16:16	03:48	15:54	00 08 15	- 00 21 17
May 2	04:06	16:01	03:38	15:35	03:54	15:49	04:35	16:36	04:03	15:55	04:11	16:05	04:07	16:02	03:46	15:41	00 28 03	+ 01 48 27
9	04:05	15:47	03:34	15:22	03:53	15:35	04:29	16:26	04:03	15:39	04:10	15:50	04:04	15:49	03:44	15:27	00 47 49	+ 03 56 30
16	04:03	15:34	03:31	15:10	03:51	15:21	04:23	16:16	04:03	15:24	04:09	15:36	04:02	15:36	03:41	15:14	01 07 33	+ 06 01 56
23	04:01	15:20	03:27	14:58	03:49	15:08	04:17	16:07	04:03	15:08	04:07	15:22	03:59	15:23	03:39	15:00	01 27 20	+ 08 03 46
30	03:58	15:07	03:24	14:46	03:47	14:54	04:11	15:57	04:03	14:53	04:06	15:08	03:56	15:10	03:37	14:47	01 47 09	+ 10 01 02
Jun 6	03:56	14:54	03:20	14:34	03:44	14:41	04:05	15:48	04:02	14:38	04:04	14:54	03:54	14:58	03:34	14:34	02 07 03	+ 11 52 51
13	03:54	14:41	03:16	14:23	03:42	14:28	03:59	15:39	04:02	14:24	04:02	14:41	03:51	14:46	03:32	14:22	02 27 02	+ 13 38 25
20	03:51	14:28	03:13	14:12	03:40	14:16	03:53	15:30	04:01	14:10	04:00	14:28	03:48	14:34	03:29	14:09	02 47 08	+ 15 17 00
27	03:48	14:16	03:09	14:01	03:37	14:04	03:47	15:21	04:00	13:56	03:58	14:15	03:44	14:22	03:26	13:58	03 07 20	+ 16 47 51
Jul 4	03:45	14:05	03:04	13:51	03:34	13:52	03:41	15:12	03:58	13:43	03:56	14:03	03:41	14:11	03:23	13:46	03 27 36	+ 18 10 21
11	03:42	13:54	03:00	13:41	03:31	13:41	03:35	15:04	03:56	13:30	03:53	13:52	03:37	14:01	03:19	13:35	03 47 57	+ 19 24 03
18	03:38	13:43	02:55	13:31	03:27	13:30	03:29	14:56	03:54	13:19	03:50	13:41	03:33	13:50	03:16	13:25	04 08 20	+ 20 28 30
25	03:34	13:33	02:50	13:21	03:23	13:20	03:22	14:47	03:51	13:07	03:46	13:30	03:28	13:41	03:11	13:15	04 28 43	+ 21 23 24
Aug 1	03:29	13:23	02:45	13:12	03:18	13:10	03:16	14:39	03:47	12:57	03:41	13:20	03:23	13:31	03:06	13:05	04 49 01	+ 22 08 36
8	03:24	13:14	02:39	13:03	03:13	13:01	03:09	14:31	03:42	12:46	03:36	13:10	03:18	13:22	03:01	12:56	05 09 13	+ 22 44 04
15	03:18	13:05	02:33	12:55	03:07	12:52	03:02	14:23	03:37	12:37	03:30	13:01	03:11	13:13	02:55	12:47	05 29 15	+ 23 09 55
22	03:11	12:56	02:25	12:46	03:00	12:43	02:55	14:15	03:30	12:28	03:24	12:52	03:04	13:04	02:48	12:38	05 49 01	+ 23 26 24
29	03:03	12:47	02:18	12:38	02:52	12:34	02:47	14:07	03:23	12:19	03:16	12:44	02:57	12:56	02:40	12:30	06 08 29	+ 23 33 54
Sep 5	02:55	12:39	02:09	12:29	02:44	12:26	02:38	13:59	03:14	12:11	03:07	12:35	02:48	12:48	02:32	12:21	06 27 32	+ 23 32 57
12	02:45	12:31	02:00	12:21	02:34	12:18	02:29	13:50	03:05	12:02	02:58	12:27	02:39	12:39	02:22	12:13	06 46 09	+ 23 24 12
19	02:35	12:22	01:50	12:12	02:24	12:09	02:19	13:41	02:54	11:54	02:47	12:18	02:28	12:30	02:12	12:04	07 04 14	+ 23 08 25
26	02:24	12:13	01:39	12:03	02:12	12:00	02:09	13:31	02:42	11:46	02:36	12:10	02:17	12:21	02:01	11:55	07 21 43	+ 22 46 32
Oct 3	02:11	12:04	01:27	11:53	02:00	11:51	01:58	13:20	02:29	11:37	02:23	12:01	02:05	12:12	01:48	11:46	07 38 32	+ 22 19 31
10	01:58	11:54	01:14	11:43	01:47	11:41	01:46	13:09	02:15	11:28	02:10	11:51	01:52	12:02	01:35	11:36	07 54 37	+ 21 48 24
17	01:44	11:44	01:00	11:32	01:33	11:31	01:33	12:58	02:01	11:18	01:56	11:41	01:38	11:51	01:21	11:25	08 09 54	+ 21 14 24
24	01:29	11:32	00:46	11:20	01:18	11:20	01:19	12:45	01:45	11:08	01:40	11:30	01:23	11:40	01:06	11:14	08 24 17	+ 20 38 51
31	01:13	11:20	00:30	11:07	01:02	11:07	01:04	12:31	01:28	10:56	01:24	11:18	01:07	11:27	00:50	11:02	08 37 40	+ 20 03 04
Nov 7	00:56	11:07	00:14	10:54	00:44	10:54	00:48	12:17	01:10	10:44	01:07	11:05	00:51	11:14	00:33	10:48	08 49 59	+ 19 28 29
14	00:38	10:52	23:54	10:38	00:26	10:39	00:32	12:01	00:51	10:29	00:48	10:50	00:33	10:59	00:15	10:33	09 01 05	+ 18 56 41
21	00:18	10:36	23:35	10:21	00:07	10:23	00:13	11:43	00:32	10:13	00:29	10:34	00:14	10:42	23:53	10:17	09 10 49	+ 18 29 26
28	23:55	10:17	23:14	10:03	23:44	10:04	23:51	11:24	00:11	09:56	00:08	10:16	23:50	10:24	23:33	09:59	09 18 59	+ 18 08 28
Dec 5	23:33	09:57	22:52	09:42	23:22	09:44	23:29	11:03	23:46	09:35	23:43	09:55	23:28	10:03	23:11	09:38	09 25 24	+ 17 55 27
12	23:10	09:34	22:29	09:19	22:58	09:21	23:06	10:40	23:22	09:12	23:20	09:32	23:05	09:40	22:47	09:15	09 29 51	+ 17 52 11
19	22:45	09:08	22:04	08:54	22:33	08:55	22:41	10:15	22:57	08:47	22:55	09:07	22:40	09:14	22:22	08:50	09 32 01	+ 18 00 19
26	22:18	08:39	21:37	08:25	22:06	08:26	22:13	09:47	22:31	08:17	22:28	08:38	22:13	08:46	21:55	08:21	09 31 42	+ 18 20 44

JUPITER



This sequence of Hubble Space Telescope images offers an unprecedented view of a planetary game of Pac-Man among three red spots clustered together in Jupiter's atmosphere.

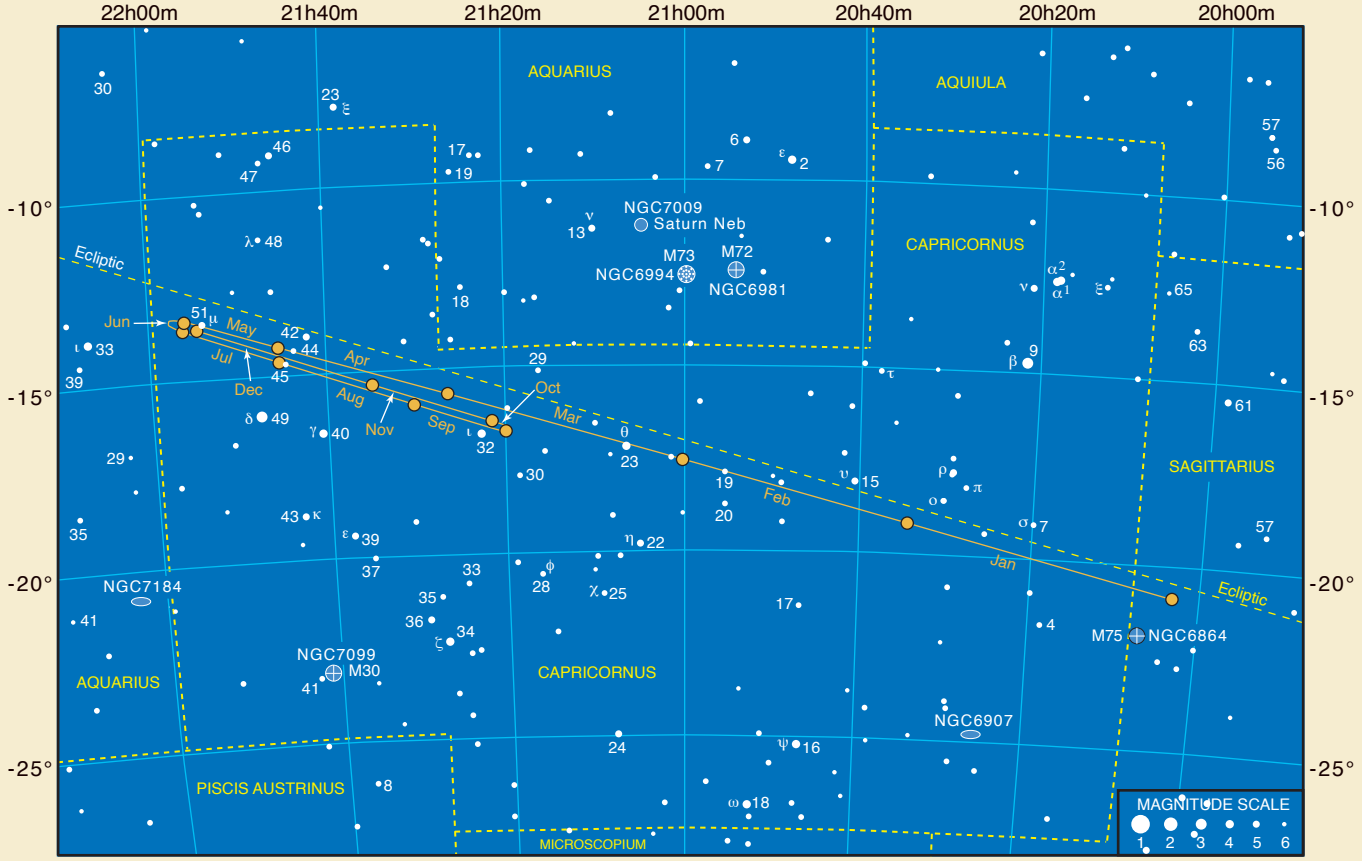
The time series shows the passage of the "Red Spot Jr." in a band of clouds below (south) of the Great Red Spot (GRS). "Red Spot Jr." first appeared on Jupiter in early 2006 when a previously white storm turned red. This is the second time, since turning red, it has skirted past its big brother apparently unscathed.

But this is not the fate of "baby red spot," which is in the same latitudinal band as the GRS. This new red spot first appeared early in 2008. The baby red spot gets ever closer to the GRS in this picture sequence until it is caught up in the anticyclonic spin of the GRS. In the final image the baby spot is deformed and pale in colour and has been spun to the right (east) of the GRS. (Amateur astronomers' observations confirm that this is the baby spot that migrated around the GRS.) The prediction is that the baby spot will now get pulled back into the GRS and disappear for good. This is one possible mechanism that has powered and sustained the GRS for at least 150 years.

These three natural-colour Jupiter images were made from data acquired on May 15, June 28, and July 8, 2008, by the Wide Field Planetary Camera 2 (WFPC2). Each one covers 58 degrees of Jovian latitude and 70 degrees of longitude (centred on 5 degrees South latitude and 110, 121, and 121 degrees West longitude, respectively).

Credit: NASA, ESA, and A. Simon-Miller (NASA Goddard Space Flight Center)

JUPITER FINDER CHART



Conjunction 24th January, Stationary 16th June, Opposition 15th August, Stationary 13th October.

JUPITER – LONGITUDE OF CENTRAL MERIDIAN

SYSTEM I (° at 0hr UT)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Date
1	252.8	100.2	195.6	045.7	100.1	314.7	013.9	232.8	091.6	149.8	002.1	053.6	1
2	050.5	257.9	353.4	203.5	257.9	112.6	171.9	030.9	249.6	307.6	159.9	211.3	2
3	208.1	055.6	151.1	001.3	055.8	270.6	329.9	188.9	047.6	105.5	317.6	009.0	3
4	005.8	213.3	308.8	159.1	213.6	068.5	127.9	347.0	205.6	263.4	115.4	166.6	4
5	163.4	010.9	106.5	316.9	011.5	226.4	285.9	145.0	003.5	061.2	273.1	324.3	5
6	321.1	168.6	264.2	114.6	169.4	024.4	083.9	303.0	161.5	219.1	070.9	122.0	6
7	118.7	326.3	062.0	272.4	327.2	182.3	241.9	101.1	319.5	017.0	228.6	279.7	7
8	276.4	124.0	219.7	070.2	125.1	340.3	040.0	259.1	117.5	174.8	026.4	077.3	8
9	074.0	281.7	017.4	228.0	283.0	138.2	198.0	057.2	275.4	332.7	184.1	235.0	9
10	231.7	079.3	175.2	025.8	080.8	296.2	356.0	215.2	073.4	130.5	341.8	032.7	10
11	029.3	237.0	332.9	183.6	238.7	094.1	154.0	013.2	231.4	288.3	139.6	190.3	11
12	187.0	034.7	130.6	341.4	036.6	252.1	312.1	171.3	029.3	086.2	297.3	348.0	12
13	344.6	192.4	288.4	139.2	194.5	050.1	110.1	329.3	187.3	244.0	095.0	145.7	13
14	142.3	350.1	086.1	297.0	352.3	208.0	268.1	127.3	345.2	041.8	252.7	303.3	14
15	299.9	147.8	243.8	094.8	150.2	006.0	066.2	285.4	143.2	199.7	050.4	101.0	15
16	097.6	305.5	041.6	252.6	308.1	164.0	224.2	083.4	301.1	357.5	208.2	258.6	16
17	255.3	103.2	199.3	050.5	106.0	322.0	022.2	241.4	099.0	155.3	005.9	056.3	17
18	052.9	260.9	357.1	208.3	263.9	119.9	180.3	039.5	257.0	313.1	163.6	213.9	18
19	210.6	058.6	154.8	006.1	061.8	277.9	338.3	197.5	054.9	110.9	321.3	011.6	19
20	008.2	216.3	312.6	163.9	219.7	075.9	136.3	355.5	212.8	268.7	119.0	169.2	20
21	165.9	014.0	110.3	321.7	017.6	233.9	294.4	153.5	010.8	066.5	276.7	326.9	21
22	323.6	171.7	268.1	119.5	175.5	031.9	092.4	311.6	168.7	224.3	074.4	124.5	22
23	121.2	329.4	065.8	277.4	333.4	189.9	250.5	109.6	326.6	022.1	232.1	282.2	23
24	278.9	127.1	223.6	075.2	131.3	347.8	048.5	267.6	124.5	179.9	029.8	079.8	24
25	076.5	284.8	021.4	233.0	289.2	145.8	206.5	065.6	282.4	337.7	187.5	237.5	25
26	234.2	082.5	179.1	030.9	087.1	303.8	004.6	223.6	080.3	135.5	345.2	035.1	26
27	031.9	240.2	336.9	188.7	245.1	101.8	162.6	021.6	238.2	293.3	142.9	192.8	27
28	189.5	037.9	134.6	346.5	043.0	259.8	320.7	179.6	036.1	091.0	300.6	350.4	28
29	347.2		292.4	144.4	200.9	057.8	118.7	337.6	194.0	248.8	098.2	148.1	29
30	144.9		090.2	302.2	358.8	215.8	276.7	135.6	351.9	046.6	255.9	305.7	30
31	302.6		248.0		156.8		074.8	293.6		204.3		103.3	31

SYSTEM II (° at 0hr UT)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Date
1	345.7	316.5	198.3	171.9	357.3	335.3	165.6	148.0	130.3	319.5	295.4	118.0	1
2	135.7	106.6	348.4	322.0	147.5	125.6	316.0	298.4	280.6	109.8	085.5	268.0	2
3	285.7	256.6	138.5	112.1	297.7	275.9	106.3	088.8	071.0	260.0	235.6	058.1	3
4	075.7	046.7	288.6	262.3	087.9	066.2	256.7	239.3	221.3	050.3	025.7	208.1	4
5	225.7	196.7	078.7	052.5	238.2	216.6	047.1	029.7	011.7	200.5	175.9	358.2	5
6	015.8	346.8	228.8	202.6	028.4	006.9	197.5	180.1	162.0	350.7	326.0	148.2	6
7	165.8	136.8	018.8	352.8	178.6	157.2	347.9	330.5	312.4	141.0	116.1	298.3	7
8	315.8	286.9	168.9	142.9	328.9	307.5	138.3	120.9	102.7	291.2	266.2	088.3	8
9	105.8	076.9	319.0	293.1	119.1	097.8	288.7	271.3	253.1	081.4	056.3	238.3	9
10	255.8	227.0	109.1	083.3	269.4	248.2	079.1	061.7	043.4	231.6	206.4	028.4	10
11	045.9	017.0	259.2	233.4	059.6	038.5	229.5	212.1	193.7	021.8	356.5	178.4	11
12	195.9	167.1	049.4	023.6	209.8	188.8	019.9	002.5	344.1	172.0	146.6	328.4	12
13	345.9	317.2	199.5	173.8	000.1	339.2	170.3	152.9	134.4	322.2	296.7	118.5	13
14	135.9	107.2	349.6	323.9	150.3	129.5	320.7	303.3	284.7	112.4	086.8	268.5	14
15	286.0	257.3	139.7	114.1	300.6	279.8	111.1	093.7	075.0	262.6	236.9	058.5	15
16	076.0	047.3	289.8	264.3	090.8	070.2	261.5	244.1	225.3	052.8	027.0	208.6	16
17	226.0	197.4	079.9	054.5	241.1	220.5	051.9	034.5	015.6	203.0	177.1	358.6	17
18	016.0	347.5	230.0	204.7	031.4	010.9	202.3	184.9	165.9	353.2	327.1	148.6	18
19	166.1	137.5	020.1	354.8	181.6	161.2	352.7	335.3	316.2	143.4	117.2	298.6	19
20	316.1	287.6	170.3	145.0	331.9	311.6	143.1	125.7	106.5	293.5	267.3	088.7	20
21	106.1	077.7	320.4	295.2	122.2	101.9	293.5	276.1	256.8	083.7	057.4	238.7	21
22	256.2	227.8	110.5	085.4	272.4	252.3	083.9	066.5	047.1	233.9	207.4	028.7	22
23	046.2	017.8	260.6	235.6	062.7	042.6	234.3	216.9	197.4	024.0	357.5	178.7	23
24	196.2	167.9	050.8	025.8	213.0	193.0	024.7	007.3	347.7	174.2	147.6	328.7	24
25	346.3	318.0	200.9	176.0	003.3	343.4	175.1	157.7	138.0	324.4	297.6	118.8	25
26	136.3	108.1	351.0	326.2	153.6	133.7	325.5	308.0	288.2	114.5	087.7	268.8	26
27	286.3	258.1	141.1	116.4	303.9	284.1	116.0	098.4	078.5	264.7	237.8	058.8	27
28	076.4	048.2	291.3	266.6	094.1	074.5	266.4	248.8	228.8	054.8	027.8	208.8	28
29	226.4		081.4	056.9	244.4	224.8	056.8	039.2	019.0	205.0	177.9	358.8	29
30	016.5		231.6	207.1	034.7	015.2	207.2	189.5	169.3	355.1	327.9	148.8	30
31	166.5		021.7		185.0		357.6	339.9		145.2		298.8	31

Jupiter is a gas giant and we can only view the upper atmospheric features. Just a small telescope (even a 60mm instrument) is required to view the equatorial belts and the Great Red Spot. When the seeing is good, numerous breaks can be glimpsed in the bands, as well as many minor spots.

There is no single correct rotation period for the features of Jupiter. The speed of movement of any feature on the 'surface' depends on its latitude, hence the multiple rotation systems used. To monitor the movement and development of any feature, amateurs often measure the time a feature crosses the central meridian of the planet. This central meridian is an imaginary line drawn from the north to south pole of Jupiter which passes through the centre of the disc.

The longitude can be worked out from the tables here. All the times on the main tables are calculated for 0hr UT of date. You will need to add multiple hours and minutes from the small Increase in Longitude tables below. For example, the longitude of central meridian for Jupiter (System I) for June 27 at 2:20am EST would be calculated as follows. First subtract 10 hours to convert to UT i.e., 16:20 hrs on June 26. From the table, the longitude on June 26 is 303.8°. To this add an adjustment for the 16 hours, which is 225.3°, and finally for the 20 minutes add 12.2°. These add up to 541.3°; less 360° gives a final answer of 181.3°.

GREAT RED SPOT TRANSIT TIME

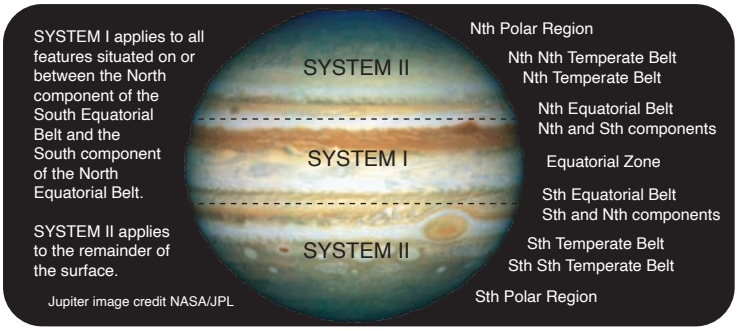
The GRS can best be seen from about one hour before transiting the central meridian to one hour after. During this two-hour period it will move approximately 70% of the diameter of Jupiter at its latitude. It can be seen a further 30 minutes either side of this period, but it tends to appear foreshortened and merging with the limb. The longitude of the GRS at the time of publication (September 2008) was 127° (System II), but it does drift over the years, for example, at the end of 2006 its longitude was 109°. For every degree of longitude greater than 127° it will transit 1.6 minutes later than shown (for every degree less than 127°, it will transit earlier by 1.6 minutes). The longitude of the GRS was obtained from the JUPOS website.

jupos.privat.t-online.de/

Increase In Longitude
SYSTEM I

Rotation: 9h 50m 30.003s

hr	deg°	hr	deg°	min	deg°
1	036.6	13	115.5	5	03.0
2	073.2	14	152.1	10	06.1
3	109.7	15	188.7	15	09.1
4	146.3	16	225.3	20	12.2
5	182.9	17	261.8	25	15.2
6	219.5	18	298.4	30	18.3
7	256.1	19	335.0	35	21.3
8	292.6	20	011.6	40	24.4
9	329.2	21	048.2	45	27.4
10	005.8	22	084.7	50	30.5
11	042.4	23	121.3	55	33.5
12	079.0	24	157.9	60	36.6



Increase In Longitude
SYSTEM II

Rotation: 9h 55m 40.062s

hr	deg°	hr	deg°	min	deg°
1	036.3	13	111.4	5	03.0
2	072.5	14	147.7	10	06.0
3	108.8	15	183.9	15	09.1
4	145.0	16	220.2	20	12.1
5	181.3	17	256.5	25	15.1
6	217.6	18	292.7	30	18.1
7	253.8	19	329.0	35	21.2
8	290.1	20	005.2	40	24.2
9	326.4	21	041.5	45	27.2
10	002.6	22	077.8	50	30.2
11	038.9	23	114.0	55	33.2
12	075.1	24	150.3	60	36.3

JUPITER – GREAT RED SPOT

Date	1st GRS	2nd GRS	3rd GRS
Jan 2		19:41	
Jan 4		(19:20)	
Jan 7		18:51	
Jan 16		(19:20)	
Jan 19		18:51	
Jan 27	5:36		
Feb 5	(6:04)		
Feb 8	5:35		
Feb 10	(5:14)		
Feb 13	4:45		
Feb 17	(6:03)		
Feb 20	5:34		
Feb 22	(5:13)		
Feb 25	4:43		
Feb 27	(4:22)		
Mar 1	(6:02)		
Mar 2	3:53		
Mar 4	5:32		
Mar 6	(5:11)		
Mar 9	4:42		
Mar 11	(4:21)		
Mar 13	(6:00)		
Mar 14	3:51		
Mar 16	5:30 *		
Mar 18	(5:09)		
Mar 19	3:01		
Mar 20	(6:48)		
Mar 21	4:40		
Mar 23	6:18 *		
Mar 25	(5:57)		
Mar 26	3:49		
Mar 28	5:28 *		
Mar 30	(5:06)		
Mar 31	2:58		
Apr 1	(6:45)		
Apr 2	4:37 *		
Apr 4	6:16 *		
Apr 5	2:07		
Apr 6	(5:54)		
Apr 7	3:46		
Apr 9	5:25 *		
Apr 11	(5:03)		
Apr 12	2:55		
Apr 13	(6:42)		
Apr 14	4:34 *		
Apr 16	6:12 *		

Date	1st GRS	2nd GRS	3rd GRS
Apr 17	2:04		
Apr 18	(5:51)		
Apr 19	3:42 *		
Apr 21	5:21 *		
Apr 22	1:13		
Apr 23	(5:00)		
Apr 24	2:51		
Apr 25	(6:38)		
Apr 26	4:30 *		
Apr 28	6:08 *		
Apr 29	2:00		
Apr 30	(5:47)		
May 1	3:38 *		
May 3	5:17 *		
May 4	1:08		
May 5	6:56 *		
May 6	2:47 *		
May 7	(6:34)		
May 8	4:25 *		
May 9	0:17		
May 10	6:04 *		
May 11	1:55		
May 12	(5:42)		
May 13	3:34 *		
May 14	(7:21)		
May 15	5:12 *		
May 16	1:04		
May 17	6:51 *		
May 18	2:42 *		
May 19	(6:29)		
May 20	4:20 *		
May 21	0:12		
May 22	5:59 *		(23:50)
May 23	1:50		
May 24	(5:37)		
May 25	3:29 *		23:20
May 26	(7:16)		
May 27	5:07 *		
May 28	0:58		
May 29	6:45 *		
May 30	2:36 *		
May 31	(6:23)		
Jun 1	4:15 *		
Jun 2	0:06		
Jun 3	5:53 *		(23:44)
Jun 4	1:44		

Date	1st GRS	2nd GRS	3rd GRS
Jun 5	(5:31)		
Jun 6	3:23 *		23:14
Jun 7	(7:10)		
Jun 8	5:01 *		(22:52)
Jun 9	0:52		
Jun 10	6:39 *		
Jun 11	2:30 *		22:22
Jun 12	(6:17)		
Jun 13	4:08 *		
Jun 14	0:00		
Jun 15	5:47 *		(23:38)
Jun 16	1:38		
Jun 17	7:25 *		
Jun 18	3:16 *		23:07
Jun 19	(7:03)		
Jun 20	4:54 *		(22:46)
Jun 21	0:45		
Jun 22	6:32 *		
Jun 23	2:23 *		22:15
Jun 24	(6:10)		
Jun 25	4:01 *		23:53 *
Jun 27	5:40 *		(23:31)
Jun 28	1:31		21:22
Jun 29	7:18 *		
Jun 30	3:09 *		23:00
Jul 1	(6:56)		
Jul 2	4:47 *		(22:38)
Jul 3	0:38		20:29
Jul 4	6:25 *		
Jul 5	2:16 *		22:07
Jul 6	(6:03)		
Jul 7	3:54 *		23:45 *
Jul 8	(7:41)		
Jul 9	5:32 *		(23:23)
Jul 10	1:23		21:15
Jul 11	7:10 *		
Jul 12	3:01 *		22:53 *
Jul 13	(6:48)		
Jul 14	4:39 *		(22:31)
Jul 15	0:30		20:22
Jul 16	6:17 *		
Jul 17	2:08 *		22:00 *
Jul 18	(5:55)		
Jul 19	3:46 *		23:38 *
Jul 20	(7:33)	19:29	
Jul 21	5:24 *		(23:15)

Date	1st GRS	2nd GRS	3rd GRS
Jul 22	1:15		21:07
Jul 23	7:02 *		
Jul 24	2:53 *		22:44 *
Jul 25	(6:40)		
Jul 26	4:31 *		(22:22)
Jul 27	0:22		20:13
Jul 28	6:09 *		
Jul 29	2:00 *		21:51 *
Jul 30	(5:47)		
Jul 31	3:38 *		23:29 *
Aug 1	(7:25)	19:20	
Aug 2	5:16 *		(23:07)
Aug 3	1:07	(18:58)	20:58
Aug 4	6:54 *		
Aug 5	2:45 *		22:36 *
Aug 6	(6:32)	18:27	
Aug 7	4:23 *		(22:14)
Aug 8	0:14		20:05
Aug 9	6:01 *		(23:52)
Aug 10	1:52	(19:43)	21:43
Aug 11	(5:39)	17:34	
Aug 12	3:30 *		23:21 *
Aug 13		19:12	
Aug 14	5:08 *		(22:59)
Aug 15	0:59	(18:50)	20:50
Aug 16	(4:46)		
Aug 17	2:37 *		22:28 *
Aug 18	(6:24)	18:19	
Aug 19	4:15 *		(22:06)
Aug 20	0:06	(17:57)	19:57
Aug 21	5:53 *		(23:44)
Aug 22	1:44	(19:35)	21:35
Aug 23	(5:31)	17:26	
Aug 24	3:22 *		23:13 *
Aug 25		19:04	
Aug 26	5:00 *		(22:51)
Aug 27	0:51	(18:43)	20:43
Aug 28	(4:38)		
Aug 29	2:29 *		22:21 *
Aug 30		18:12	
Aug 31	4:07 *		23:59 *
Sep 1		19:50 *	
Sep 2	(3:45)		(23:37)
Sep 3	1:36	(19:28)	21:28
Sep 4	(5:23)	17:19	
Sep 5	3:15 *		23:06 *

Date	1st GRS	2nd GRS	3rd GRS
Sep 6		18:57	
Sep 7	4:53 *		(22:44)
Sep 8	0:44	(18:35)	20:35
Sep 9	(4:31)		
Sep 10	2:22 *		22:14 *
Sep 11		18:05	
Sep 12	4:00 *		23:52 *
Sep 13		19:43 *	
Sep 14	(3:39)		(23:30)
Sep 15	1:30	(19:21)	21:21
Sep 17	3:08 *		23:00 *
Sep 18		18:51	
Sep 19	(2:46)		(22:38)
Sep 20	0:38	(18:29)	20:29
Sep 22	2:16 *		22:07 *
Sep 23		17:59	
Sep 24	3:54 *		23:46 *
Sep 25		19:37	
Sep 26	(3:33)		(23:24)
Sep 27	1:24	(19:16)	21:16
Sep 29	3:02 *		22:54 *
Sep 30		18:45	
Oct 1	(2:41)		(22:32)
Oct 2	0:32	(18:24)	20:24
Oct 4	2:11 *		22:02 *
Oct 5		17:54	
Oct 6	(1:49)		23:41 *
Oct 7		19:32	
Oct 8			(23:19)
Oct 9	1:19	(19:11)	21:11
Oct 11	(0:58)		22:49 *
Oct 12		18:41	
Oct 13	(2:36)		(22:28)
Oct 14	0:28	(18:19)	20:19
Oct 16	2:07 *		21:58 *
Oct 17		17:49	
Oct 18	(1:45)		23:37 *
Oct 19		19:28	
Oct 20			(23:15)
Oct 21	1:15	(19:07)	21:07
Oct 23	(0:54)		22:46 *
Oct 24		18:37	
Oct 25			(22:24)
Oct 26	0:24	(18:16)	20:16
Oct 28	(0:03)		21:55 *
Oct 30	(1:42)		23:34 *

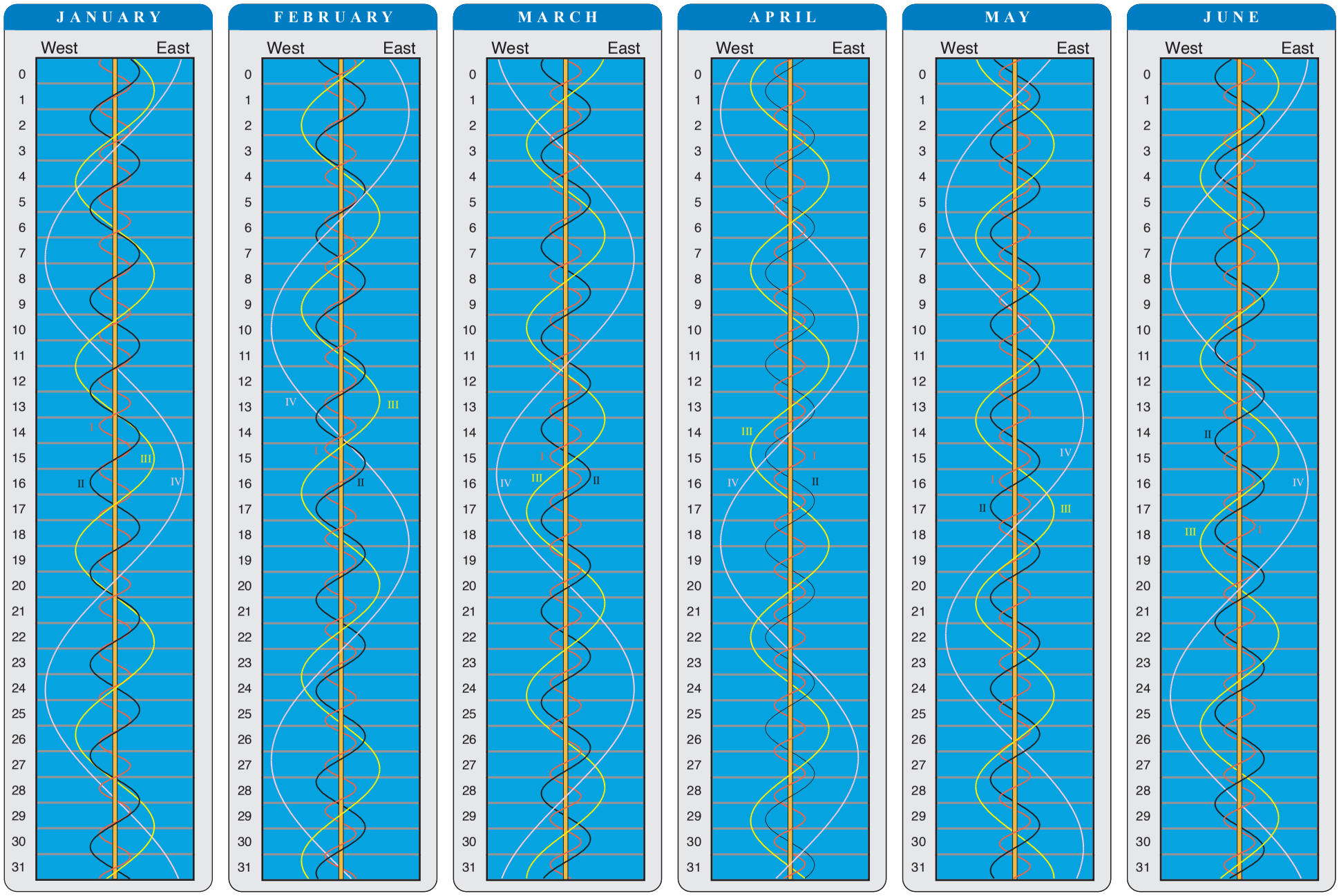
Date	1st GRS	2nd GRS	3rd GRS
Oct 31		19:25	
Nov 1			(23:12)
Nov 2	1:12	(19:04)	21:04
Nov 4	(0:51)		22:43 *
Nov 5		18:34	
Nov 6			(22:22)
Nov 7	0:22		20:13
Nov 9	(0:01)		21:52 *
Nov 11			23:31 *
Nov 12		19:23	
Nov 13			(23:10)
Nov 14		(19:02)	21:02
Nov 16			22:41 *
Nov 17		18:32	
Nov 18			(22:20)
Nov 19			20:11
Nov 20			(23:59)
Nov 21		(19:50)	21:50
Nov 23			23:30 *
Nov 24		19:21	
Nov 25			(23:09)
Nov 26		(19:00)	21:00
Nov 28			22:39 *
Nov 29		18:31	
Nov 30			(22:18)
Dec 1			20:10
Dec 3		(19:49)	21:49
Dec 5			(21:28)
Dec 6		19:20	
Dec 7			(23:08)
Dec 8		(18:59)	20:59
Dec 10			22:38 *
Dec 11		18:30	
Dec 12			(22:18)
Dec 13			20:09
Dec 15		(19:49)	21:49
Dec 17			(21:28)
Dec 18		19:19	
Dec 20		(18:59)	20:59
Dec 22			(20:38)
Dec 24			(22:17)
Dec 25			20:09
Dec 27		(19:48)	21:48
Dec 29			(21:27)
Dec 30		19:19	

1st, 2nd or 3rd GRS h:mm EST (Eastern states) h:mm* EST (All States)(h:mm) WST (WA only)

The Table Predictions are shown for transit times for Sydney and Perth (giving a reasonable indication for eastern and western Australia). Times have been excluded when Jupiter is below the horizon. If a transit is close to the time of Jupiter rising or setting, it may still be seen at least one hour before or after the prediction (allowing it to have some altitude). Predictions during daylight hours have also been omitted, except for those within 30 minutes after sunrise or 30 minutes before sunset. Even if there is a transit close to sunrise or sunset, the GRS can be seen well into the twilight period. For places that have extreme latitudes (such as Darwin or Hobart) you may need to check times against your local rise/set times for the Sun and Jupiter.

With a transit occurring every 9 hours 55 min 40 secs, two or three transits will occur every day, but a maximum of two are visible from most places. The three columns represent the 1st, 2nd and 3rd (when applicable) transits for each day for the relevant time zone. Note if the first transit for the day in EST is before 2am, the event will be the last transit (3rd) for the previous day in WST (assuming the event is visible). When the same numbered transit is visible accross the country, only the EST time is given followed by an asterisk (*). To get the WST time subtract 2 hours from the EST. For CST subtract 30 minutes from EST. For an event only visible from WA the time is given in brackets (WST). **Daylight Saving is not allowed for** and you will need to add one hour to the times in the table when in effect.

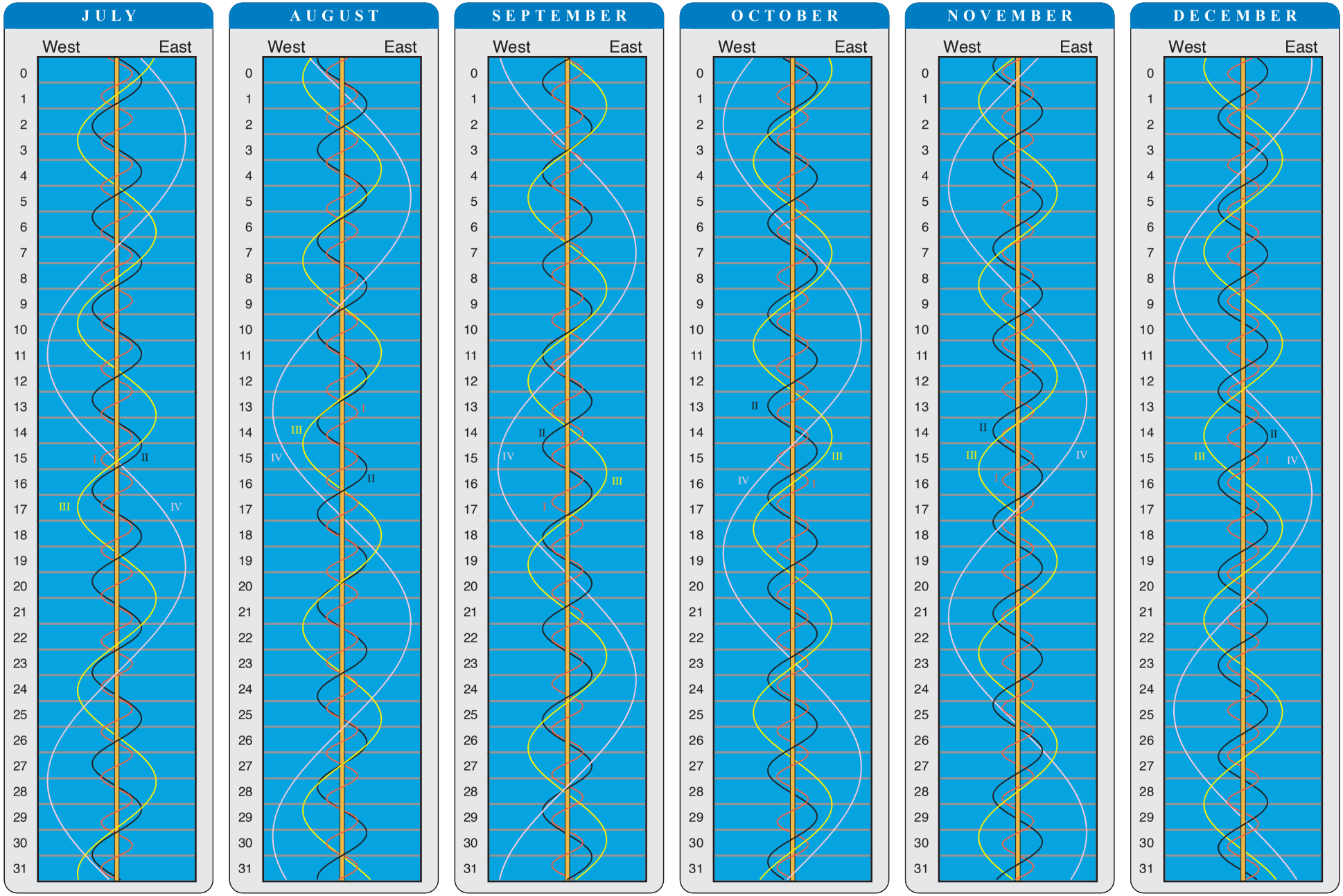
For example, on 6th October the first transit is only visible from WA at 1:49am WST. The 3rd transit for the day is visible Australia wide at 11:41pm EST (9:41pm WST).



JUPITER'S MOONS

Jupiter is like a miniature Solar System with many moons orbiting the planet. As seen from Earth, the moons appear to move from side-to-side (east-west) of Jupiter, occasionally passing in front of or behind the planet. The diagrams here show the patterns the four major moons of Jupiter make as they shuffle back and forth. Each complete period represents one orbit of the satellite. Each horizontal grey date line

represents midnight; the top edge of the line is midnight EST (14hr UT), the bottom edge of the line is midnight WST (16hr UT). The close pair of parallel vertical lines, running down the centre, represents the disc of Jupiter. It is interesting to compare the times when each moon passes over these lines, with the satellite's transit times (pp. 111-114). The same can be done with the occultation times, that is when the line disappears behind Jupiter. Satellite I is Io, II is Europa, III is Ganymede and IV is Callisto.



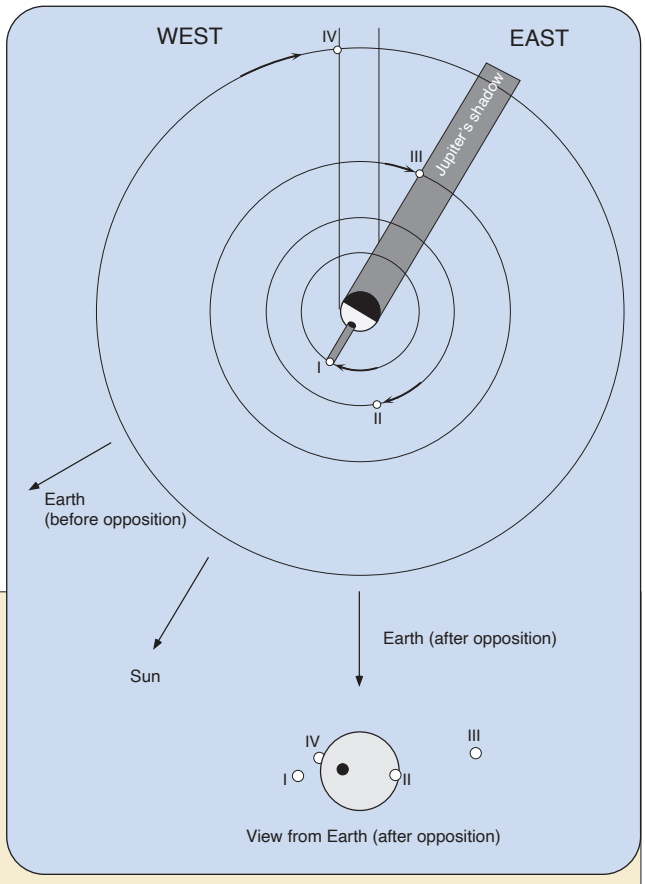
JUPITER'S MOONS

Jupiter, with its many moons orbiting the planet, can be likened to a miniature Solar System. Like the planets, these moons all lie in a similar plane. Although there are currently 63 known Jovian satellites, most of them are too faint for amateur equipment. The four Galilean Satellites, named after their discoverer, Galileo (who suggested calling them the 'Medicean Stars'), are bright enough to be visible in small telescopes, moderate-sized binoculars or even the naked-eye. The dance of these moons, as they pass back and forth across Jupiter, is illustrated in Jupiter's Moons on pages 108-109. All the moons orbit in roughly the same plane, which is very close to the Earth's orbit. Hence we see the Jovian system as edge-on. This is the key point to understanding the satellite phenomena. From our perspective on Earth, we see four types of events. They are:

1. The satellite passes in front of Jupiter. This is called a Satellite Transit.
2. The shadow of a satellite can move across the 'surface' of the planet. This is called a Satellite Shadow Transit. The start of a satellite or shadow transit is called its ingress; the finish, its egress.

   Before opposition, the shadow transit of a satellite will commence before that of the satellite itself. After opposition, the satellite will transit before the shadow. Jupiter's opposition date in 2009 is August 15.
3. A satellite can go into occultation i.e., pass behind the disc of Jupiter.
4. A satellite can be eclipsed as it passes into Jupiter's shadow. The closer Jupiter is to opposition (or conjunction), the more likely the eclipse events, or at least one event (disappearance or reappearance) will be hidden by the planet's disc. This is especially relevant for the close-in satellites. Positions for the disappearance (d) and reappearance (r) for each moon, relative to Jupiter, for each month, are presented in the diagram below.

The four moons Io, Europa, Ganymede and Callisto are bright enough to be seen in binoculars (7× or greater is recommended). It may be necessary to mount the binoculars on a tripod to help keep them steady. Initially, try looking for Callisto when it is furthest from Jupiter (maximum elongation). This happens approximately every eight days; an example would be the evening of January 15. To see the moons with binoculars may take a little practice. The power or magnification of the binoculars will determine how close to Jupiter you can follow a moon. Of course, with a small telescope you would have no problem following the moons and their shadows as they cross the disc of Jupiter. Watching a moon fade and disappear as it moves into Jupiter's shadow (an eclipse) is very impressive.



This diagram illustrates all of the Jupiter satellite events. It is only an example and does not represent any particular date.

Viewed from the Earth (after opposition):

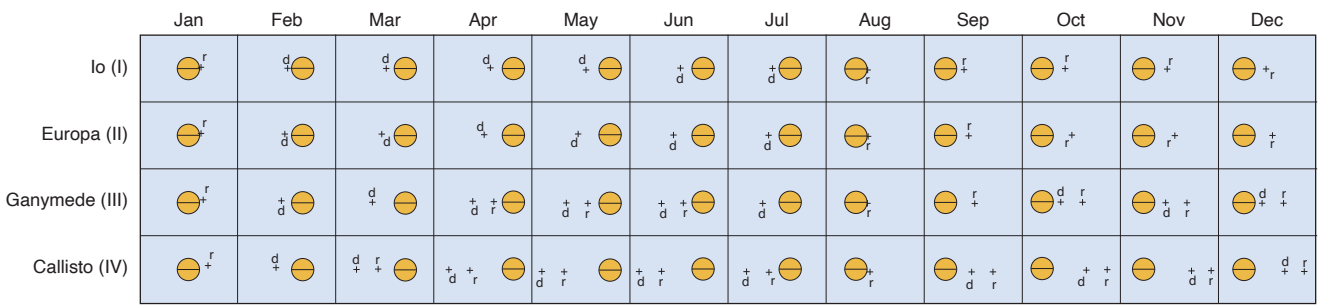
Satellite I	(Io) shadow is currently in transit. The satellite itself would have recently egressed from a transit.
Satellite II	(Europa) has just commenced a satellite transit (ingress).
Satellite III	(Ganymede) is about to be eclipsed (disappear).
Satellite IV	(Callisto) is about to move out of sight as it is occulted by Jupiter's disc.

JUPITER'S MOON EVENTS Legend (following pages))

Column 1	Date (only appears for the first event each day).
Column 2	Time in EST.
Column 3	Time in WST, a (p) after the time means it is on the previous day.
Column 4	I = Io, II = Europa, III = Ganymede, IV = Callisto
Column 5	Oc = Occultation, Sh = Shadow Transit, Tr = Satellite Transit, Ec = Eclipse
Column 6	I = Ingress, E = Egress, D = Disappearance, R = Reappearance
Column 7	Visibility where 'E' indicates the event is more suitable for the eastern states, 'W' is for events more suitable for observation from Western Australia. A blank here means the event is suitable for most of Australia.

Note: In these tables, some events may happen (as seen from your location) while Jupiter is just below the horizon, or while the Sun is just above the horizon. This allows for the variation in rise and set times for Jupiter and the Sun across Australia. Events near conjunction i.e., with Jupiter closer than 18° to the Sun, have been omitted.

ECLIPSE POSITIONS



These diagrams show the positions of the eclipse events for each satellite for mid-month, relative to Jupiter. An eclipse is when the moon passes into (disappearance or 'd') or out of (reappearance or 'r') Jupiter's shadow; west to the left, east to the right.

JUPITER MOON EVENTS

Day	EST	WST	Sat	Event	Vis
February					
15	04:20	02:20	III	Sh E	E
18	06:38	04:38	I	Tr I	W
20	04:41	02:41	II	Tr I	E
	06:37	04:37	II	Sh E	W
	07:34	05:34	II	Tr E	W
22	04:44	02:44	III	Sh I	E
	06:45	04:45	III	Tr I	W
23	05:33	03:33	IV	Tr E	E
26	05:23	03:23	I	Ec D	E
27	04:52	02:52	I	Sh E	E
	05:26	03:26	I	Tr E	E
	06:22	04:22	II	Sh I	W
	07:33	05:33	II	Tr I	W
March					
1	04:48	02:48	II	Oc R	E
3	06:24	04:24	IV	Ec D	W
5	05:05	03:05	III	Oc R	E
	07:18	05:18	I	Ec D	W
6	04:28	02:28	I	Sh I	E
	05:09	03:09	I	Tr I	E
	06:46	04:46	I	Sh E	W
	07:27	05:27	I	Tr E	W
7	04:47	02:47	I	Oc R	E
8	03:19	01:19	II	Ec D	E
	07:36	05:36	II	Oc R	W
13	06:22	04:22	I	Sh I	W
	07:10	05:10	I	Tr I	W
14	03:41	01:41	I	Ec D	E
	06:48	04:48	I	Oc R	W
15	03:08	01:08	I	Sh E	E
	03:57	01:57	I	Tr E	E
	05:53	03:53	II	Ec D	
17	03:46	01:46	II	Sh E	E
	05:31	03:31	II	Tr E	
19	06:44	04:44	III	Ec D	W
20	05:17	03:17	IV	Ec R	
	08:16	06:16	I	Sh I	W
21	05:35	03:35	I	Ec D	
22	02:44	00:44	I	Sh I	E
	03:39	01:39	I	Tr I	E
	05:02	03:02	I	Sh E	
	05:57	03:57	I	Tr E	
23	03:18	01:18	I	Oc R	E
	04:09	02:09	III	Tr E	E
24	03:30	01:30	II	Sh I	E
	05:26	03:26	II	Tr I	
	06:23	04:23	II	Sh E	W
	08:19	06:19	II	Tr E	W
26	02:33	00:33	II	Oc R	E
28	07:29	05:29	I	Ec D	W
	08:07	06:07	IV	Sh I	W

Day	EST	WST	Sat	Event	Vis
29	04:38	02:38	I	Sh I	
	05:38	03:38	I	Tr I	
	06:55	04:55	I	Sh E	W
	07:56	05:56	I	Tr E	W
30	04:19	02:19	III	Sh E	E
	04:52	02:52	III	Tr I	
	05:18	03:18	I	Oc R	
31	02:26	00:26	I	Tr E	E
	06:06	04:06	II	Sh I	
	08:13	06:13	II	Tr I	W
April					
2	05:19	03:19	II	Oc R	
5	06:31	04:31	I	Sh I	W
	07:37	05:37	I	Tr I	W
6	03:51	01:51	I	Ec D	E
	04:42	02:42	III	Sh I	
	04:59	02:59	IV	Oc D	
	07:16	05:16	I	Oc R	W
	08:18	06:18	III	Sh E	W
7	02:07	00:07	I	Tr I	E
	03:17	01:17	I	Sh E	E
	04:25	02:25	I	Tr E	
8	01:46	23:46(p)	I	Oc R	E
9	02:54	00:54	II	Ec D	E
	08:03	06:03	II	Oc R	W
10	03:00	01:00	III	Oc R	E
11	03:14	01:14	II	Tr E	E
12	08:25	06:25	I	Sh I	W
13	05:45	03:45	I	Ec D	
	08:40	06:40	III	Sh I	W
14	02:16	00:16	IV	Sh I	E
	02:53	00:53	I	Sh I	E
	04:05	02:05	I	Tr I	
	05:11	03:11	I	Sh E	
	06:23	04:23	I	Tr E	W
	07:06	05:06	IV	Sh E	W
15	03:44	01:44	I	Oc R	
16	05:29	03:29	II	Ec D	
17	02:20	00:20	III	Ec R	E
	03:37	01:37	III	Oc D	E
	07:16	05:16	III	Oc R	W
18	03:04	01:04	II	Tr I	E
	03:29	01:29	II	Sh E	E
	05:58	03:58	II	Tr E	
20	07:39	05:39	I	Ec D	W
21	04:47	02:47	I	Sh I	
	06:02	04:02	I	Tr I	
	07:05	05:05	I	Sh E	W
	08:20	06:20	I	Tr E	W
22	02:08	00:08	I	Ec D	E
	05:41	03:41	I	Oc R	
23	01:33	23:33(p)	I	Sh E	E
	02:49	00:49	I	Tr E	E
	05:22	03:22	IV	Oc R	
	08:04	06:04	II	Ec D	W

Day	EST	WST	Sat	Event	Vis
24	02:42	00:42	III	Ec D	E
	06:20	04:20	III	Ec R	
	07:50	05:50	III	Oc D	W
25	03:12	01:12	II	Sh I	
	05:46	03:46	II	Tr I	
	06:05	04:05	II	Sh E	
	08:40	06:40	II	Tr E	W
27	02:49	00:49	II	Oc R	E
28	01:34	23:34(p)	III	Tr E	E
	06:41	04:41	I	Sh I	W
	07:59	05:59	I	Tr I	W
29	04:01	02:01	I	Ec D	
	07:38	05:38	I	Oc R	W
30	01:09	23:09(p)	I	Sh I	E
	02:27	00:27	I	Tr I	E
	03:27	01:27	I	Sh E	
	04:45	02:45	I	Tr E	
May					
1	01:15	23:15(p)	IV	Sh E	E
	02:07	00:07	I	Oc R	E
	06:41	04:41	III	Ec D	W
2	05:48	03:48	II	Sh I	
	08:26	06:26	II	Tr I	W
	08:40	06:40	II	Sh E	W
4	05:29	03:29	II	Oc R	
5	02:03	00:03	III	Tr I	E
	05:42	03:42	III	Tr E	
	08:34	06:34	I	Sh I	W
6	00:39	22:39(p)	II	Tr E	E
	05:55	03:55	I	Ec D	
7	03:03	01:03	I	Sh I	
	04:23	02:23	I	Tr I	
	05:21	03:21	I	Sh E	
	06:41	04:41	I	Tr E	W
8	00:24	22:24(p)	I	Ec D	E
	04:02	02:02	I	Oc R	
9	01:10	23:10(p)	I	Tr E	E
	06:49	04:49	IV	Ec D	W
	08:23	06:23	II	Sh I	W
10	00:14	22:14(p)	IV	Oc R	E
11	02:31	00:31	II	Ec D	
	08:08	06:08	II	Oc R	W
12	00:39	22:39(p)	III	Sh I	E
	04:17	02:17	III	Sh E	
	06:08	04:08	III	Tr I	
13	00:23	22:23(p)	II	Tr I	E
	00:33	22:33(p)	II	Sh E	E
	03:16	01:16	II	Tr E	
	07:49	05:49	I	Ec D	W
14	04:56	02:56	I	Sh I	
	06:18	04:18	I	Tr I	
	07:14	05:14	I	Sh E	W
	08:36	06:36	I	Tr E	W
15	02:17	00:17	I	Ec D	
	05:56	03:56	I	Oc R	
	23:46	21:46	III	Oc R	E

Day	EST	WST	Sat	Event	Vis
16	00:46	22:46(p)	I	Tr I	E
	01:43	23:43(p)	I	Sh E	E
	03:04	01:04	I	Tr E	
17	00:25	22:25(p)	I	Oc R	E
18	03:33	01:33	IV	Tr I	
	05:07	03:07	II	Ec D	
	08:21	06:21	IV	Tr E	W
19	04:38	02:38	III	Sh I	
	08:17	06:17	III	Sh E	W
20	00:16	22:16(p)	II	Sh I	E
	02:58	00:58	II	Tr I	
	03:08	01:08	II	Sh E	
	05:51	03:51	II	Tr E	
21	06:50	04:50	I	Sh I	W
	08:12	06:12	I	Tr I	W
	09:08	07:08	I	Sh E	W
22	00:02	22:02(p)	II	Oc R	E
	04:11	02:11	I	Ec D	
	07:50	05:50	I	Oc R	W
23	00:06	22:06(p)	III	Oc D	E
	01:19	23:19(p)	I	Sh I	E
	02:40	00:40	I	Tr I	
	03:37	01:37	I	Sh E	
	03:45	01:45	III	Oc R	
	04:58	02:58	I	Tr E	
24	02:18	00:18	I	Oc R	
	23:26	21:26	I	Tr E	E
25	07:42	05:42	II	Ec D	W
26	00:55	22:55(p)	IV	Ec D	E
	05:46	03:46	IV	Ec R	
	08:38	06:38	III	Sh I	W
27	02:51	00:51	II	Sh I	
	05:31	03:31	II	Tr I	
	05:43	03:43	II	Sh E	
	08:24	06:24	II	Tr E	W
28	08:44	06:44	I	Sh I	W
29	02:36	00:36	II	Oc R	
	06:05	04:05	I	Ec D	
30	02:17	00:17	III	Ec R	
	03:12	01:12	I	Sh I	
	04:01	02:01	III	Oc D	
	04:32	02:32	I	Tr I	
	05:30	03:30	I	Sh E	
	06:51	04:51	I	Tr E	
	07:39	05:39	III	Oc R	W
31	00:33	22:33(p)	I	Ec D	E
	04:10	02:10	I	Oc R	
	23:00	21:00	I	Tr I	E
	23:59	21:59	I	Sh E	E
June					
1	01:19	23:19(p)	I	Tr E	
	22:38	20:38	I	Oc R	E
3	05:25	03:25	II	Sh I	
	08:02	06:02	II	Tr I	W
	08:18	06:18	II	Sh E	W
	08:41	06:41	IV	Sh I	W

JUPITER MOON EVENTS

Day	EST	WST	Sat	Event	Vis
4	02:00	00:00	IV	Tr E	
	23:36	21:36	II	Ec D	E
5	05:08	03:08	II	Oc R	
	07:58	05:58	I	Ec D	W
6	02:38	00:38	III	Ec D	
	05:06	03:06	I	Sh I	
	06:17	04:17	III	Ec R	
	06:24	04:24	I	Tr I	
	07:24	05:24	I	Sh E	W
	07:51	05:51	III	Oc D	W
	08:42	06:42	I	Tr E	W
7	00:09	22:09(p)	II	Tr E	E
	02:27	00:27	I	Ec D	
	06:01	04:01	I	Oc R	
	23:35	21:35	I	Sh I	E
8	00:52	22:52(p)	I	Tr I	
	01:53	23:53(p)	I	Sh E	
	03:10	01:10	I	Tr E	
9	00:29	22:29(p)	I	Oc R	E
10	01:23	23:23(p)	III	Tr E	
	08:00	06:00	II	Sh I	W
11	23:53	21:53	IV	Ec R	E
12	02:12	00:12	II	Ec D	
	06:45	04:45	IV	Oc D	
	07:37	05:37	II	Oc R	W
13	06:38	04:38	III	Ec D	
	07:00	05:00	I	Sh I	
	08:15	06:15	I	Tr I	W
	09:18	07:18	I	Sh E	W
	23:44	21:44	II	Tr I	E
14	00:10	22:10(p)	II	Sh E	E
	02:36	00:36	II	Tr E	
	04:20	02:20	I	Ec D	
	07:51	05:51	I	Oc R	W
15	01:29	23:29(p)	I	Sh I	
	02:42	00:42	I	Tr I	
	03:47	01:47	I	Sh E	
	05:00	03:00	I	Tr E	
	22:49	20:49	I	Ec D	E
16	02:18	00:18	I	Oc R	
	22:15	20:15	I	Sh E	E
	23:27	21:27	I	Tr E	E
17	00:16	22:16(p)	III	Sh E	
	01:29	23:29(p)	III	Tr I	
	05:07	03:07	III	Tr E	
19	04:48	02:48	II	Ec D	
20	02:50	00:50	IV	Sh I	
	07:42	05:42	IV	Sh E	W
	08:54	06:54	I	Sh I	W
	23:52	21:52	II	Sh I	
21	02:09	00:09	II	Tr I	
	02:44	00:44	II	Sh E	
	05:01	03:01	II	Tr E	
	06:14	04:14	I	Ec D	
22	03:23	01:23	I	Sh I	
	04:31	02:31	I	Tr I	
	05:41	03:41	I	Sh E	
	06:49	04:49	I	Tr E	
	23:18	21:18	II	Oc R	E
23	00:42	22:42(p)	I	Ec D	
	04:07	02:07	I	Oc R	
	21:51	19:51	I	Sh I	E
	22:58	20:58	I	Tr I	E
24	00:09	22:09(p)	I	Sh E	
	00:36	22:36(p)	III	Sh I	
	01:16	23:16(p)	I	Tr E	
	04:16	02:16	III	Sh E	
	05:07	03:07	III	Tr I	
	08:45	06:45	III	Tr E	W
	22:34	20:34	I	Oc R	E
26	07:24	05:24	II	Ec D	W
27	22:30	20:30	III	Oc R	E
28	02:27	00:27	II	Sh I	
	04:32	02:32	II	Tr I	
	05:19	03:19	II	Sh E	
	07:24	05:24	II	Tr E	W
	08:08	06:08	I	Ec D	W
	23:00	21:00	IV	Oc D	E
29	03:38	01:38	IV	Oc R	
	05:17	03:17	I	Sh I	
	06:19	04:19	I	Tr I	
	07:35	05:35	I	Sh E	W
	08:37	06:37	I	Tr E	W
30	01:42	23:42(p)	II	Oc R	
	02:36	00:36	I	Ec D	
	05:54	03:54	I	Oc R	
	23:45	21:45	I	Sh I	

July

Day	EST	WST	Sat	Event	Vis
1	00:46	22:46(p)	I	Tr I	
	02:04	00:04	I	Sh E	
	03:04	01:04	I	Tr E	
	04:37	02:37	III	Sh I	
	08:16	06:16	III	Sh E	W
	08:42	06:42	III	Tr I	W
	21:04	19:04	I	Ec D	E
2	00:21	22:21(p)	I	Oc R	
	21:31	19:31	I	Tr E	E
4	22:14	20:14	III	Ec R	E
	22:24	20:24	III	Oc D	E
5	02:01	00:01	III	Oc R	
	05:01	03:01	II	Sh I	
	06:52	04:52	II	Tr I	
	07:53	05:53	II	Sh E	W
6	07:11	05:11	I	Sh I	W
	08:06	06:06	I	Tr I	W
	21:00	19:00	IV	Sh I	E
	23:19	21:19	II	Ec D	
7	01:51	23:51(p)	IV	Sh E	
	04:04	02:04	II	Oc R	
	04:30	02:30	I	Ec D	
	05:43	03:43	IV	Tr I	
	07:41	05:41	I	Oc R	W
8	01:39	23:39(p)	I	Sh I	
	02:33	00:33	I	Tr I	
	03:58	01:58	I	Sh E	
	04:51	02:51	I	Tr E	
	08:37	06:37	III	Sh I	W
	21:10	19:10	II	Sh E	E
	22:54	20:54	II	Tr E	
	22:58	20:58	I	Ec D	
9	02:07	00:07	I	Oc R	
	20:08	18:08	I	Sh I	E
	21:00	19:00	I	Tr I	E
	22:26	20:26	I	Sh E	
	23:18	21:18	I	Tr E	
10	20:34	18:34	I	Oc R	E
11	22:36	20:36	III	Ec D	
12	05:29	03:29	III	Oc R	
	07:36	05:36	II	Sh I	W
	09:11	07:11	II	Tr I	W
13	09:05	07:05	I	Sh I	W
14	01:55	23:55(p)	II	Ec D	
	06:24	04:24	I	Ec D	
	06:24	04:24	II	Oc R	
15	03:34	01:34	I	Sh I	
	04:19	02:19	I	Tr I	
	05:52	03:52	I	Sh E	
	06:37	04:37	I	Tr E	
	07:18	05:18	IV	Ec D	W
	20:53	18:53	II	Sh I	E
	22:19	20:19	II	Tr I	
	23:45	21:45	II	Sh E	
16	00:52	22:52(p)	I	Ec D	
	01:11	23:11(p)	II	Tr E	
	03:53	01:53	I	Oc R	
	22:02	20:02	I	Sh I	
	22:45	20:45	I	Tr I	
17	00:21	22:21(p)	I	Sh E	
	01:03	23:03(p)	I	Tr E	
	19:34	17:34	II	Oc R	E
	22:19	20:19	I	Oc R	
18	19:30	17:30	I	Tr E	E
19	02:36	00:36	III	Ec D	
	08:53	06:53	III	Oc R	W
21	04:32	02:32	II	Ec D	
	08:17	06:17	I	Ec D	W
	08:42	06:42	II	Oc R	W
22	05:28	03:28	I	Sh I	
	06:04	04:04	I	Tr I	
	07:47	05:47	I	Sh E	W
	08:22	06:22	I	Tr E	W
	20:16	18:16	III	Sh E	E
	22:36	20:36	III	Tr E	
	23:27	21:27	II	Sh I	
23	00:35	22:35(p)	II	Tr I	
	02:19	00:19	II	Sh E	
	02:46	00:46	I	Ec D	
	03:27	01:27	II	Tr E	
	05:37	03:37	I	Oc R	
	20:01	18:01	IV	Sh E	E
	20:35	18:35	IV	Tr I	E
	23:57	21:57	I	Sh I	
24	00:30	22:30(p)	I	Tr I	
	01:12	23:12(p)	IV	Tr E	
	02:15	00:15	I	Sh E	
	02:48	00:48	I	Tr E	
	21:14	19:14	I	Ec D	E
	21:52	19:52	II	Oc R	
25	00:03	22:03(p)	I	Oc R	
	18:56	16:56	I	Tr I	E
	20:44	18:44	I	Sh E	E
	21:15	19:15	I	Tr E	
26	06:36	04:36	III	Ec D	
28	07:10	05:10	II	Ec D	W
29	07:23	05:23	I	Sh I	W
	07:49	05:49	I	Tr I	W
	20:37	18:37	III	Sh I	E
	22:18	20:18	III	Tr I	
30	00:16	22:16(p)	III	Sh E	
	01:55	23:55(p)	III	Tr E	
	02:02	00:02	II	Sh I	
	02:50	00:50	II	Tr I	
	04:40	02:40	I	Ec D	
	04:54	02:54	II	Sh E	
	05:41	03:41	II	Tr E	
	07:21	05:21	I	Oc R	W
31	01:51	23:51(p)	I	Sh I	
	02:15	00:15	I	Tr I	
	04:10	02:10	I	Sh E	
	04:33	02:33	I	Tr E	
	20:29	18:29	II	Ec D	E
	23:09	21:09	I	Ec D	

August

Day	EST	WST	Sat	Event	Vis
1	00:08	22:08(p)	II	Oc R	
	01:27	23:27(p)	IV	Ec D	
	01:47	23:47(p)	I	Oc R	
	20:20	18:20	I	Sh I	E
	20:41	18:41	I	Tr I	E
	22:39	20:39	I	Sh E	
	22:59	20:59	I	Tr E	
2	18:48	16:48	II	Tr E	E
	20:13	18:13	I	Oc R	E
6	00:38	22:38(p)	III	Sh I	
	01:36	23:36(p)	III	Tr I	
	04:18	02:18	III	Sh E	
	04:36	02:36	II	Sh I	
	05:03	03:03	II	Tr I	
	05:13	03:13	III	Tr E	
	06:34	04:34	I	Ec D	
	07:28	05:28	II	Sh E	W
	07:55	05:55	II	Tr E	W
	09:05	07:05	I	Oc R	W

JUPITER MOON EVENTS

Day	EST	WST	Sat	Event	Vis
7	03:46	01:46	I	Sh I	
	03:59	01:59	I	Tr I	
	06:05	04:05	I	Sh E	
	06:17	04:17	I	Tr E	
	23:06	21:06	II	Ec D	
8	01:03	23:03(p)	I	Ec D	
	02:24	00:24	II	Oc R	
	03:31	01:31	I	Oc R	
	22:15	20:15	I	Sh I	
	22:25	20:25	I	Tr I	
9	00:33	22:33(p)	I	Sh E	
	00:43	22:43(p)	I	Tr E	
	17:54	15:54	II	Sh I	E
	18:10	16:10	II	Tr I	E
	18:48	16:48	III	Oc R	E
	19:31	17:31	I	Ec D	E
	20:46	18:46	II	Sh E	
	21:02	19:02	II	Tr E	
	21:57	19:57	I	Oc R	
10	19:02	17:02	I	Sh E	E
	19:09	17:09	I	Tr E	E
13	04:39	02:39	III	Sh I	
	04:52	02:52	III	Tr I	
	07:11	05:11	II	Sh I	W
	07:17	05:17	II	Tr I	W
	08:19	06:19	III	Sh E	W
	08:28	06:28	I	Ec D	W
	08:29	06:29	III	Tr E	W
14	05:41	03:41	I	Sh I	
	05:43	03:43	I	Tr I	
	08:00	06:00	I	Sh E	W
	08:01	06:01	I	Tr E	W
15	01:44	23:44(p)	II	Ec D	
	02:57	00:57	I	Ec D	
	04:39	02:39	II	Ec R	
	05:14	03:14	I	Ec R	
16	00:09	22:09(p)	I	Tr I	
	00:10	22:10(p)	I	Sh I	
	02:27	00:27	I	Tr E	
	02:28	00:28	I	Sh E	
	18:26	16:26	III	Oc D	E
	20:23	18:23	II	Tr I	
	20:28	18:28	II	Sh I	
	21:23	19:23	I	Oc D	
	22:15	20:15	III	Ec R	
	23:15	21:15	II	Tr E	
	23:20	21:20	II	Sh E	
	23:43	21:43	I	Ec R	
17	18:35	16:35	I	Tr I	E
	18:39	16:39	I	Sh I	E
	19:03	17:03	IV	Oc D	E
	20:53	18:53	I	Tr E	
	20:57	18:57	I	Sh E	
18	00:25	22:25(p)	IV	Ec R	
	17:58	15:58	II	Ec R	E
	18:12	16:12	I	Ec R	E
20	08:08	06:08	III	Tr I	W
	08:41	06:41	III	Sh I	W
21	07:27	05:27	I	Tr I	W
	07:36	05:36	I	Sh I	W
22	04:00	02:00	II	Oc D	
	04:41	02:41	I	Oc D	
	07:09	05:09	I	Ec R	W
	07:17	05:17	II	Ec R	W
23	01:53	23:53(p)	I	Tr I	
	02:05	00:05	I	Sh I	
	04:11	02:11	I	Tr E	
	04:23	02:23	I	Sh E	
	21:42	19:42	III	Oc D	
	22:36	20:36	II	Tr I	
	23:03	21:03	II	Sh I	
	23:06	21:06	I	Oc D	
24	01:28	23:28(p)	II	Tr E	
	01:37	23:37(p)	I	Ec R	
	01:55	23:55(p)	II	Sh E	
	02:15	00:15	III	Ec R	
	20:19	18:19	I	Tr I	
	20:34	18:34	I	Sh I	
	22:37	20:37	I	Tr E	
	22:52	20:52	I	Sh E	
25	20:06	18:06	I	Ec R	
	20:36	18:36	II	Ec R	
26	00:57	22:57(p)	IV	Tr I	
	03:36	01:36	IV	Sh I	
	05:37	03:37	IV	Tr E	
	08:23	06:23	IV	Sh E	W
29	06:16	04:16	II	Oc D	W
	06:24	04:24	I	Oc D	W
30	03:37	01:37	I	Tr I	
	04:00	02:00	I	Sh I	
	05:55	03:55	I	Tr E	W
	06:19	04:19	I	Sh E	W
31	00:50	22:50(p)	II	Tr I	
	00:50	22:50(p)	I	Oc D	
	01:00	23:00(p)	III	Oc D	
	01:38	23:38(p)	II	Sh I	
	03:32	01:32	I	Ec R	
	03:42	01:42	II	Tr E	
	04:30	02:30	II	Sh E	
	06:16	04:16	III	Ec R	W
	22:03	20:03	I	Tr I	
	22:29	20:29	I	Sh I	

September

Day	EST	WST	Sat	Event	Vis
1	00:22	22:22(p)	I	Tr E	
	00:47	22:47(p)	I	Sh E	
	19:17	17:17	I	Oc D	E
	19:24	17:24	II	Oc D	E
	22:01	20:01	I	Ec R	
	23:14	21:14	II	Ec R	
2	18:48	16:48	I	Tr E	E
	19:16	17:16	I	Sh E	E
3	17:48	15:48	II	Sh E	E
	18:21	16:21	III	Tr E	E
	18:34	16:34	IV	Ec R	E
	20:22	18:22	III	Sh E	
6	05:22	03:22	I	Tr I	W
	05:56	03:56	I	Sh I	W
7	02:35	00:35	I	Oc D	
	03:05	01:05	II	Tr I	
	04:13	02:13	II	Sh I	
	04:20	02:20	III	Oc D	
	05:27	03:27	I	Ec R	W
	05:57	03:57	II	Tr E	W
	07:05	05:05	II	Sh E	W
	23:49	21:49	I	Tr I	
8	00:24	22:24(p)	I	Sh I	
	02:07	00:07	I	Tr E	
	02:43	00:43	I	Sh E	
	21:01	19:01	I	Oc D	
	21:41	19:41	II	Oc D	
	23:55	21:55	I	Ec R	
9	01:52	23:52(p)	II	Ec R	
	18:15	16:15	I	Tr I	E
	18:53	16:53	I	Sh I	E
	20:33	18:33	I	Tr E	
	21:12	19:12	I	Sh E	
10	18:04	16:04	III	Tr I	E
	18:24	16:24	I	Ec R	E
	19:05	17:05	II	Tr E	E
	20:23	18:23	II	Sh E	
	20:44	18:44	III	Sh I	
	21:42	19:42	III	Tr E	
11	00:23	22:23(p)	III	Sh E	
	20:05	18:05	IV	Tr E	E
	21:51	19:51	IV	Sh I	
12	02:35	00:35	IV	Sh E	
13	07:08	05:08	I	Tr I	W
14	04:21	02:21	I	Oc D	
	05:22	03:22	II	Tr I	W
	06:48	04:48	II	Sh I	W
15	01:35	23:35(p)	I	Tr I	
	02:20	00:20	I	Sh I	
	03:53	01:53	I	Tr E	
	04:38	02:38	I	Sh E	
	22:47	20:47	I	Oc D	
16	00:01	22:01(p)	II	Oc D	
	01:50	23:50(p)	I	Ec R	
	04:30	02:30	II	Ec R	
	20:01	18:01	I	Tr I	E
	20:49	18:49	I	Sh I	
	22:20	20:20	I	Tr E	
	23:07	21:07	I	Sh E	
17	18:31	16:31	II	Tr I	E
	20:06	18:06	II	Sh I	E
	20:19	18:19	I	Ec R	
	21:23	19:23	II	Tr E	
	21:28	19:28	III	Tr I	
	22:58	20:58	II	Sh E	
18	00:45	22:45(p)	III	Sh I	
	01:07	23:07(p)	III	Tr E	
	04:24	02:24	III	Sh E	
20	00:05	22:05(p)	IV	Oc D	
	04:47	02:47	IV	Oc R	W
21	06:07	04:07	I	Oc D	W
	18:20	16:20	III	Ec R	E
22	03:22	01:22	I	Tr I	
	04:16	02:16	I	Sh I	W
	05:40	03:40	I	Tr E	W
23	00:34	22:34(p)	I	Oc D	
	02:22	00:22	II	Oc D	
	03:45	01:45	I	Ec R	
	21:49	19:49	I	Tr I	
	22:44	20:44	I	Sh I	
24	00:07	22:07(p)	I	Tr E	
	01:03	23:03(p)	I	Sh E	
	19:01	17:01	I	Oc D	E
	20:51	18:51	II	Tr I	
	22:14	20:14	I	Ec R	
	22:42	20:42	II	Sh I	
	23:42	21:42	II	Tr E	
25	00:58	22:58(p)	III	Tr I	
	01:34	23:34(p)	II	Sh E	
	04:36	02:36	III	Tr E	W
	04:47	02:47	III	Sh I	W
	18:34	16:34	I	Tr E	E
	19:32	17:32	I	Sh E	E
26	20:28	18:28	II	Ec R	
28	18:18	16:18	III	Oc R	E
	18:42	16:42	III	Ec D	E
	20:48	18:48	IV	Sh E	
	22:20	20:20	III	Ec R	
29	05:10	03:10	I	Tr I	W
30	02:22	00:22	I	Oc D	
	04:46	02:46	II	Oc D	W
	05:40	03:40	I	Ec R	W
	23:37	21:37	I	Tr I	

October

Day	EST	WST	Sat	Event	Vis
1	00:40	22:40(p)	I	Sh I	
	01:56	23:56(p)	I	Tr E	
	02:58	00:58	I	Sh E	
	20:49	18:49	I	Oc D	
	23:12	21:12	II	Tr I	
2	00:09	22:09(p)	I	Ec R	
	01:17	23:17(p)	II	Sh I	
	02:04	00:04	II	Tr E	
	04:09	02:09	II	Sh E	W
	04:31	02:31	III	Tr I	W
	18:05	16:05	I	Tr I	E
	19:09	17:09	I	Sh I	E
	20:23	18:23	I	Tr E	
	21:27	19:27	I	Sh E	
3	18:38	16:38	I	Ec R	E
	23:06	21:06	II	Ec R	

JUPITER MOON EVENTS

Day	EST	WST	Sat	Event	Vis
5	18:15	16:15	III	Oc D	E
	21:53	19:53	III	Oc R	
	22:43	20:43	III	Ec D	
6	02:21	00:21	III	Ec R	
	20:29	18:29	IV	Oc R	
7	02:16	00:16	IV	Ec D	
	04:11	02:11	I	Oc D	W
8	01:27	23:27(p)	I	Tr I	
	02:36	00:36	I	Sh I	
	03:45	01:45	I	Tr E	W
	04:54	02:54	I	Sh E	W
	22:38	20:38	I	Oc D	
9	01:37	23:37(p)	II	Tr I	
	02:04	00:04	I	Ec R	
	03:53	01:53	II	Sh I	W
	04:29	02:29	II	Tr E	W
	19:55	17:55	I	Tr I	E
	21:05	19:05	I	Sh I	
	22:13	20:13	I	Tr E	
	23:23	21:23	I	Sh E	
10	20:27	18:27	II	Oc D	E
	20:33	18:33	I	Ec R	
11	01:45	23:45(p)	II	Ec R	
12	20:03	18:03	II	Sh E	E
	21:55	19:55	III	Oc D	
13	01:34	23:34(p)	III	Oc R	
	02:44	00:44	III	Ec D	
14	22:40	20:40	IV	Tr I	
15	03:18	01:18	I	Tr I	W
	03:26	01:26	IV	Tr E	W
	04:32	02:32	I	Sh I	W
16	00:29	22:29(p)	I	Oc D	
	03:59	01:59	I	Ec R	W
	04:03	02:03	II	Tr I	W
	20:31	18:31	III	Sh E	E
	21:46	19:46	I	Tr I	
	23:01	21:01	I	Sh I	
17	00:04	22:04(p)	I	Tr E	
	01:19	23:19(p)	I	Sh E	
	18:57	16:57	I	Oc D	E
	22:28	20:28	I	Ec R	
	22:56	20:56	II	Oc D	
18	04:23	02:23	II	Ec R	W
	18:32	16:32	I	Tr E	E
	19:48	17:48	I	Sh E	E
19	19:47	17:47	II	Sh I	E
	20:10	18:10	II	Tr E	E
	22:39	20:39	II	Sh E	
20	01:41	23:41(p)	III	Oc D	
23	02:21	00:21	I	Oc D	W
	19:20	17:20	III	Tr E	E
	20:30	18:30	IV	Ec D	E
	20:55	18:55	III	Sh I	
	23:39	21:39	I	Tr I	
24	00:33	22:33(p)	III	Sh E	
	00:56	22:56(p)	I	Sh I	
	01:05	23:05(p)	IV	Ec R	
	01:57	23:57(p)	I	Tr E	
	03:14	01:14	I	Sh E	W
	20:49	18:49	I	Oc D	
25	00:23	22:23(p)	I	Ec R	
	01:28	23:28(p)	II	Oc D	
	19:25	17:25	I	Sh I	E
	20:25	18:25	I	Tr E	E
	21:43	19:43	I	Sh E	
26	18:52	16:52	I	Ec R	E
	19:48	17:48	II	Tr I	E
	22:23	20:23	II	Sh I	
	22:40	20:40	II	Tr E	
27	01:16	23:16(p)	II	Sh E	
28	20:20	18:20	II	Ec R	E
30	19:33	17:33	III	Tr I	E
	23:12	21:12	III	Tr E	
31	00:57	22:57(p)	III	Sh I	
	01:32	23:32(p)	I	Tr I	
	02:52	00:52	I	Sh I	W
	03:50	01:50	I	Tr E	W
	20:38	18:38	IV	Tr E	E
	22:42	20:42	I	Oc D	

November

Day	EST	WST	Sat	Event	Vis
1	02:19	00:19	I	Ec R	W
	20:01	18:01	I	Tr I	E
	21:21	19:21	I	Sh I	
	22:19	20:19	I	Tr E	
	23:39	21:39	I	Sh E	
2	20:48	18:48	I	Ec R	E
	22:21	20:21	II	Tr I	
3	00:59	22:59(p)	II	Sh I	
	01:13	23:13(p)	II	Tr E	
4	22:58	20:58	II	Ec R	
6	23:30	21:30	III	Tr I	
7	03:10	01:10	III	Tr E	W
	03:27	01:27	I	Tr I	W
8	00:37	22:37(p)	I	Oc D	
	21:56	19:56	I	Tr I	
	23:17	21:17	I	Sh I	
9	00:14	22:14(p)	I	Tr E	
	01:35	23:35(p)	I	Sh E	W
	02:03	00:03	IV	Oc D	W
	19:05	17:05	I	Oc D	E
	19:16	17:16	IV	Ec R	E
	22:43	20:43	I	Ec R	
10	00:56	22:56(p)	II	Tr I	
	18:43	16:43	I	Tr E	E
	18:52	16:52	III	Ec D	E
	20:04	18:04	I	Sh E	E
	22:29	20:29	III	Ec R	
11	19:58	17:58	II	Oc D	E
12	01:36	23:36(p)	II	Ec R	W
13	19:47	17:47	II	Sh E	E
15	02:32	00:32	I	Oc D	W
	23:52	21:52	I	Tr I	
16	01:13	23:13(p)	I	Sh I	W
	02:10	00:10	I	Tr E	W
	21:01	19:01	I	Oc D	E
17	00:39	22:39(p)	I	Ec R	W
	19:42	17:42	I	Sh I	E
	20:39	18:39	I	Tr E	E
	21:09	19:09	III	Oc R	
	22:00	20:00	I	Sh E	
	22:53	20:53	III	Ec D	
	22:56	20:56	IV	Sh I	
18	02:30	00:30	III	Ec R	W
	19:08	17:08	I	Ec R	E
	22:38	20:38	II	Oc D	
20	19:31	17:31	II	Sh I	E
	19:45	17:45	II	Tr E	E
	22:24	20:24	II	Sh E	
23	01:49	23:49(p)	I	Tr I	W
	22:58	20:58	I	Oc D	
24	20:19	18:19	I	Tr I	E
	21:37	19:37	III	Oc D	
	21:38	19:38	I	Sh I	
	22:37	20:37	I	Tr E	
	23:55	21:55	I	Sh E	
25	01:16	23:16(p)	III	Oc R	W
	20:39	18:39	IV	Oc D	E
	21:03	19:03	I	Ec R	E
26	01:19	23:19(p)	II	Oc D	W
	01:25	23:25(p)	IV	Oc R	W
27	19:33	17:33	II	Tr I	E
	22:08	20:08	II	Sh I	
	22:26	20:26	II	Tr E	
28	01:01	23:01(p)	II	Sh E	W
	20:42	18:42	III	Sh E	E
29	20:10	18:10	II	Ec R	E

December

Day	EST	WST	Sat	Event	Vis
1	00:56	22:56(p)	I	Oc D	W
	22:17	20:17	I	Tr I	
	23:33	21:33	I	Sh I	
2	00:35	22:35(p)	I	Tr E	W
	01:48	23:48(p)	III	Oc D	W
	01:51	23:51(p)	I	Sh E	W
	19:25	17:25	I	Oc D	E
	22:59	20:59	I	Ec R	
3	19:05	17:05	I	Tr E	E
	20:20	18:20	I	Sh E	E
4	21:40	19:40	IV	Sh E	
	22:15	20:15	II	Tr I	
5	00:45	22:45(p)	II	Sh I	W
	01:08	23:08(p)	II	Tr E	W
	19:43	17:43	III	Tr E	E
	21:08	19:08	III	Sh I	E
6	00:43	22:43(p)	III	Sh E	W
	22:47	20:47	II	Ec R	
9	00:16	22:16(p)	I	Tr I	W
	01:29	23:29(p)	I	Sh I	W
	21:24	19:24	I	Oc D	
10	00:54	22:54(p)	I	Ec R	W
	19:58	17:58	I	Sh I	E
	21:04	19:04	I	Tr E	E
	22:15	20:15	I	Sh E	
11	19:23	17:23	I	Ec R	E
12	00:59	22:59(p)	II	Tr I	W
	20:20	18:20	III	Tr I	E
	20:46	18:46	IV	Oc R	E
	23:59	21:59	III	Tr E	W
13	01:09	23:09(p)	III	Sh I	W
	20:09	18:09	II	Oc D	E
15	19:34	17:34	II	Sh E	E
16	23:24	21:24	I	Oc D	W
17	20:45	18:45	I	Tr I	E
	21:53	19:53	I	Sh I	
	23:03	21:03	I	Tr E	W
18	00:11	22:11(p)	I	Sh E	W
	21:19	19:19	I	Ec R	E
20	00:39	22:39(p)	III	Tr I	W
	22:56	20:56	II	Oc D	W
21	00:51	22:51(p)	IV	Tr I	W
22	19:18	17:18	II	Sh I	E
	20:01	18:01	II	Tr E	E
	22:11	20:11	II	Sh E	
23	22:38	20:38	III	Ec R	W
24	22:46	20:46	I	Tr I	W
	23:49	21:49	I	Sh I	W
25	19:54	17:54	I	Oc D	E
	23:14	21:14	I	Ec R	W
26	19:34	17:34	I	Tr E	E
	20:35	18:35	I	Sh E	E
29	19:55	17:55	II	Tr I	E
	21:30	19:30	IV	Ec D	E
	21:55	19:55	II	Sh I	
	22:49	20:49	II	Tr E	W
30	22:45	20:45	III	Oc R	W
	23:05	21:05	III	Ec D	W
31	19:56	17:56	II	Ec R	E

JUPITER MOON MUTUAL EVENTS

Date	EST		WST		Event	Type	DL	Jup Dist	Sat Sep
	Start	End	Start	End					
May 2	00:43	00:49			II Oc III	P	0.15	5.8	0.6
May 9	04:03	04:09	02:03	02:09	II Oc III	A	0.23	5.5	0.2
May 11	00:03	00:08			I Oc II	P	0.33	4.4	0.3
May 13	06:26	06:30	04:26	04:30	II Oc I	P	0.21	3.2	0.4
May 16			05:20	05:26	II Oc III	A	0.23	5.1	0.1
May 17	04:38	04:49	02:38	02:49	IV Ec I	P	0.50	4.3	115.5
May 18	02:19	02:24	00:19	00:24	I Oc II	P	0.45	4.6	0.1
May 18			05:03	05:17	IV Ec I	Q	0.17	5.9	377.4
May 19	01:41	01:48			III Oc I	P	0.19	5.5	0.7
May 20			06:39	06:43	II Oc I	P	0.36	2.9	0.2
May 25	04:34	04:39	02:34	02:39	I Oc II	P	0.45	4.8	0.1
May 26	00:57	01:06			III Oc II	T	0.36	7.7	0.1
May 30	23:56	23:59			II Oc I	P	0.33	2.6	0.2
Jun 1	06:48	06:53	04:48	04:53	I Oc II	P	0.36	4.9	0.2
Jun 2	04:14	04:22	02:14	02:22	III Oc II	P	0.32	8.0	0.4
Jun 4			06:36	06:51	IV Ec II	P	0.56	9.2	114.4
Jun 7	02:04	02:08	00:04	00:08	II Oc I	P	0.20	2.3	0.5
Jun 8			07:01	07:06	I Oc II	P	0.29	5.1	0.4
Jun 9			05:29	05:37	III Oc II	P	0.20	8.3	0.7
Jun 10	05:24	05:39	03:24	03:39	III Ec I	P	0.21	5.8	53.8
Jun 11	00:30	00:44	22:30(p)	22:44	II Ec IV	Q	0.32	12.9	22.1
Jun 11	22:08	22:13			I Oc II	P	0.26	5.2	0.4
Jun 17			07:10	07:21	III Ec I	P	0.34	5.9	58.4
Jun 19	00:19	00:25	22:19(p)	22:25	I Oc II	P	0.21	5.3	0.5
Jun 20			07:14	07:28	IV Ec III	Q	0.51	4.2	128.1
Jun 26	02:30	02:36	00:30	00:36	I Oc II	P	0.19	5.5	0.6
Jun 28			06:11	06:21	II Ec IV	Q	0.32	7.0	122.2
Jun 30	00:50	01:09	22:50(p)	23:09	III Ec IV	A	0.68	9.6	102.4
Jul 3	04:41	04:46	02:41	02:46	I Oc II	P	0.18	5.6	0.6
Jul 10	05:25	05:31	03:25	03:31	I Ec II	P	0.21	6.4	28.4
Jul 10	06:50	06:56	04:50	04:56	I Oc II	P	0.18	5.7	0.6
Jul 13	19:55	20:01			I Oc II	P	0.19	5.7	0.6
Jul 15	21:17	21:25			III Ec I	A	0.97	4.2	48.9
Jul 17			05:47	05:54	I Ec II	P	0.30	6.4	22.8
Jul 17			07:00	07:07	I Oc II	P	0.21	5.8	0.6
Jul 18	21:53	22:01	19:53	20:01	I Ec III	A	0.55	4.9	45.3
Jul 20	20:58	21:06			I Ec II	P	0.35	6.4	19.8
Jul 20	22:04	22:11	20:04	20:11	I Oc II	P	0.22	5.8	0.5
Jul 22	00:16	00:28	22:16(p)	22:28	III Ec II	P	0.36	8.9	29.9
Jul 23	00:06	00:13	22:06(p)	22:13	III Ec I	P	0.87	3.5	40.2
Jul 25	02:59	03:16	00:59	01:16	IV Ec III	Q	0.22	13.7	56.6
Jul 26	00:44	00:52	22:44(p)	22:52	I Ec III	A	0.44	5.2	33.5
Jul 27	23:24	23:32	21:24	21:32	I Ec II	P	0.43	6.3	13.9
Jul 28	00:14	00:22	22:14(p)	22:22	I Oc II	P	0.27	5.9	0.5
Jul 29	03:56	04:10	01:56	02:10	III Ec II	P	0.63	9.2	20.5
Jul 30	02:52	02:59	00:52	00:59	III Ec I	P	0.66	2.8	29.5
Aug 2	03:38	03:46	01:38	01:46	I Ec III	A	0.38	5.4	21.3
Aug 4	01:53	02:03	23:53(p)	00:03	I Ec II	P	0.49	6.2	8.1
Aug 4	02:26	02:35	00:26	00:35	I Oc II	P	0.32	5.9	0.4
Aug 5			05:44	06:01	III Ec II	P	0.92	9.4	11.4
Aug 6	05:37	05:43	03:37	03:43	III Ec I	P	0.44	1.9	17.2
Aug 9	06:38	06:47	04:38	04:47	I Ec III	A	0.33	5.5	9.4
Aug 11	04:27	04:38	02:27	02:38	I Ec II	P	0.53	6.0	2.7
Aug 11	04:40	04:50	02:40	02:50	I Oc II	P	0.39	5.9	0.2

Date	EST		WST		Event	Type	DL	Jup Dist	Sat Sep
	Start	End	Start	End					
Aug 14	17:47	17:59			I Ec II	P	0.54	5.9	0.3
Aug 14	17:49	18:00			I Oc II	P	0.43	5.9	0.2
Aug 17	02:24	03:09	00:24	01:09	I Ec III	A	0.47	3.6	2.1
Aug 17	06:22	07:08	04:22	05:08	I Ec III	A	0.36	5.6	2.8
Aug 18			04:58	05:10	I Oc II	T	0.46	5.9	0.1
Aug 18			05:09	05:22	I Ec II	P	0.53	5.8	2.0
Aug 19	00:25	00:48	22:25(p)	22:48	I Oc II	P	0.14	5.4	0.7
Aug 21	20:10	20:24	18:10	18:24	I Oc II	T	0.46	5.8	0.0
Aug 21	20:35	20:50	18:35	18:50	I Ec II	P	0.51	5.6	4.0
Aug 26	03:22	03:37	01:22	01:37	I Oc II	P	0.19	5.7	0.6
Aug 26	04:08	04:21	02:08	02:21	I Ec II	P	0.18	6.1	6.5
Aug 26	19:15	19:36			III Oc II	P	0.15	9.1	0.9
Aug 26	20:54	21:29	18:54	19:29	III Ec II	P	0.80	8.7	9.9
Aug 28	22:41	22:59	20:41	20:59	I Oc II	P	0.42	5.7	0.2
Aug 28	23:46	00:10	21:46	22:10	I Ec II	P	0.39	5.0	7.0
Aug 29	17:35	17:47			I Ec II	P	0.28	6.3	9.0
Aug 30	17:40	18:13			I Ec III	P	0.32	4.8	17.2
Aug 30	22:04	22:50	20:04	20:50	I Ec III	A	0.43	2.4	14.0
Sep 2			03:56	04:08	I Oc II	P	0.21	5.8	0.6
Sep 2			04:58	05:09	I Ec II	P	0.38	6.4	11.6
Sep 2	23:37	00:09	21:37	22:09	III Oc II	P	0.16	8.6	0.9
Sep 5	01:37	02:05	23:37(p)	00:05	I Oc II	P	0.28	5.3	0.4
Sep 5	19:10	19:20			I Oc II	P	0.21	5.9	0.6
Sep 5	20:19	20:30	18:19	18:30	I Ec II	P	0.50	6.5	14.2
Sep 6	21:25	23:29	19:25	21:29	I Oc III	P	0.19	4.2	0.7
Sep 12	21:32	21:41	19:32	19:41	I Oc II	P	0.21	5.9	0.6
Sep 12	22:54	23:05	20:54	21:05	I Ec II	P	0.71	6.6	19.6
Sep 19	23:51	00:00	21:51	22:00	I Oc II	P	0.20	5.9	0.6
Sep 20	01:25	01:35	23:25(p)	23:35	I Ec II	A	0.92	6.7	24.9
Sep 27	02:09	02:16	00:09	00:16	I Oc II	P	0.18	5.8	0.6
Sep 27			01:53	02:01	I Ec II	P	0.89	6.7	29.9
Oct 4			02:26	02:33	I Oc II	P	0.17	5.8	0.6
Oct 7	19:30	19:37			I Ec II	P	0.56	6.7	36.3
Oct 12	19:30	19:36			II Oc III	A	0.23	2.3	0.1
Oct 14	19:52	19:58			I Oc II	P	0.16	5.6	0.6
Oct 14	21:52	21:59	19:52	19:59	I Ec II	P	0.33	6.7	39.8
Oct 19	22:32	22:38	20:32	20:38	II Oc III	A	0.23	2.7	0.2
Oct 21	22:09	22:15	20:09	20:15	I Oc II	P	0.16	5.5	0.6
Oct 27	01:39	01:44	23:39(p)	23:44	II Oc III	A	0.23	3.1	0.3
Oct 29	00:28	00:33	22:28(p)	22:33	I Oc II	P	0.18	5.4	0.6
Nov 5			00:46	00:51	I Oc II	P	0.20	5.2	0.5
Nov 9	22:56	23:00	20:56	21:00	II Oc I	P	0.40	2.3	0.1
Nov 14	20:46	20:54			III Oc II	P	0.25	8.0	0.5
Nov 17			23:11(p)	23:15	II Oc I	A	0.40	2.6	0.0
Nov 20	22:14	22:30	20:14	20:30	III Oc I	P	0.28	5.9	0.5
Nov 22			22:15(p)	22:22	III Oc II	P	0.23	7.7	0.6
Nov 22	20:36	20:41			I Oc II	P	0.33	4.7	0.3
Nov 29	22:57	23:02	20:57	21:02	I Oc II	P	0.41	4.5	0.2
Dec 4	18:55	18:59			II Oc I	P	0.34	3.2	0.2
Dec 7			23:19(p)	23:24	I Oc II	T	0.46	4.3	0.0
Dec 8	21:29	21:35	19:29	19:35	II Oc III	P	0.20	5.5	0.4
Dec 11	21:15	21:19			II Oc I	P	0.27	3.5	0.3
Dec 18			21:36	21:40	II Oc I	P	0.19	3.7	0.4
Dec 24	19:16	19:19			I Oc II	P	0.19	3.7	0.4

It has already been stated on page 23 that the plane of Jupiter's moons is close to that of the Earth's orbit. About every six years the two planes cross and for a brief period we can see the moons eclipse and occult each other. The drop in brightness does not just depend on the relative magnitudes of the satellites. It also varies depending on whether the event is complete e.g., how much of the shadow (eclipse) or the moon (occultation) covers the other moon during an event.

The mutual events table above has the following information

Date of the event (month and day).

Start and **end** times of the events (hh:mm) in EST and/or WST. If an EST time is not given, that event is likely not visible from the eastern part of Australia. Similarly for the WST zone columns. Where both are given the event is likely suitable for all Australia.

Event description e.g., II Oc I. This means satellite II occults (passes in front of) satellite I. For event II Ec I, this means satellite I passes into satellite II's shadow. Satellite I is Io, II is Europa, III is Ganymede and IV is Callisto.

Event **type** where 'P' is partial, 'A' is annular, 'T' is total and 'Q' is penumbral.

DL is the relative intensity drop at mid-event.

Jup Dist is the distance from Jupiter's centre (in Jupiter radii).

Sat Sep is the separation between the two satellites in arcseconds at closest approach.

JUPITER

RISE AND SET TIMES

EST, Adelaide and Darwin CST, Perth WST

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
Jan 3	06:27	20:34	06:16	19:50	06:14	20:23	07:41	20:23	06:02	20:51	06:25	20:46	06:35	20:28	06:09	20:11
10	06:08	20:12	05:56	19:29	05:55	20:01	07:21	20:02	05:43	20:28	06:05	20:24	06:15	20:06	05:50	19:49
17	05:48	19:50	05:36	19:07	05:35	19:39	07:01	19:41	05:23	20:06	05:46	20:01	05:55	19:44	05:30	19:27
24	05:29	19:28	05:16	18:46	05:16	19:17	06:40	19:19	05:04	19:44	05:26	19:39	05:36	19:23	05:10	19:05
31	05:09	19:06	04:56	18:24	04:56	18:55	06:20	18:58	04:45	19:21	05:07	19:17	05:16	19:01	04:51	18:44
Feb 7	04:50	18:44	04:37	18:02	04:37	18:33	05:59	18:37	04:26	18:59	04:48	18:55	04:57	18:39	04:31	18:21
14	04:30	18:22	04:17	17:40	04:17	18:10	05:39	18:16	04:07	18:36	04:28	18:33	04:37	18:17	04:12	17:59
21	04:11	17:59	03:57	17:18	03:58	17:48	05:18	17:54	03:48	18:13	04:09	18:10	04:17	17:55	03:52	17:37
28	03:51	17:37	03:37	16:56	03:38	17:26	04:58	17:33	03:29	17:50	03:49	17:47	03:57	17:32	03:32	17:15
Mar 7	03:31	17:14	03:16	16:34	03:18	17:03	04:37	17:11	03:09	17:27	03:29	17:25	03:37	17:10	03:12	16:52
14	03:11	16:51	02:56	16:11	02:58	16:40	04:16	16:49	02:50	17:04	03:09	17:02	03:17	16:47	02:52	16:29
21	02:50	16:28	02:35	15:49	02:37	16:17	03:54	16:27	02:30	16:40	02:49	16:38	02:56	16:24	02:31	16:06
28	02:29	16:05	02:14	15:26	02:17	15:54	03:33	16:05	02:09	16:16	02:28	16:15	02:35	16:01	02:11	15:43
Apr 4	02:08	15:42	01:52	15:02	01:56	15:30	03:11	15:42	01:49	15:52	02:08	15:51	02:14	15:37	01:50	15:19
11	01:47	15:18	01:31	14:39	01:34	15:06	02:49	15:19	01:28	15:28	01:46	15:27	01:52	15:14	01:28	14:56
18	01:25	14:54	01:08	14:15	01:12	14:42	02:26	14:56	01:06	15:04	01:24	15:03	01:30	14:50	01:06	14:32
25	01:03	14:29	00:46	13:51	00:50	14:18	02:03	14:32	00:44	14:39	01:02	14:39	01:08	14:26	00:44	14:07
May 2	00:40	14:05	00:23	13:26	00:27	13:53	01:39	14:08	00:21	14:14	00:39	14:14	00:45	14:01	00:21	13:43
9	00:16	13:40	23:56	13:02	00:04	13:28	01:15	13:43	23:55	13:49	00:16	13:49	00:21	13:36	23:54	13:18
16	23:49	13:14	23:31	12:36	23:36	13:03	00:51	13:18	23:31	13:23	23:48	13:23	23:54	13:11	23:30	12:52
23	23:24	12:48	23:06	12:11	23:11	12:37	00:26	12:53	23:06	12:57	23:24	12:57	23:29	12:45	23:05	12:26
30	22:58	12:22	22:41	11:45	22:46	12:11	23:56	12:27	22:41	12:31	22:58	12:31	23:03	12:19	22:39	12:00
Jun 6	22:32	11:56	22:14	11:18	22:19	11:44	23:30	12:00	22:15	12:04	22:32	12:04	22:37	11:52	22:13	11:34
13	22:05	11:29	21:47	10:51	21:52	11:17	23:03	11:33	21:48	11:37	22:05	11:37	22:10	11:25	21:46	11:07
20	21:37	11:01	21:20	10:24	21:25	10:50	22:35	11:06	21:20	11:10	21:37	11:10	21:42	10:58	21:18	10:39
27	21:09	10:33	20:51	09:56	20:56	10:22	22:07	10:38	20:51	10:42	21:09	10:42	21:14	10:30	20:50	10:11
Jul 4	20:39	10:05	20:22	09:27	20:27	09:53	21:38	10:09	20:22	10:14	20:39	10:14	20:44	10:01	20:20	09:43
11	20:09	09:36	19:52	08:58	19:57	09:25	21:08	09:40	19:52	09:45	20:09	09:45	20:15	09:32	19:51	09:14
18	19:39	09:07	19:22	08:29	19:26	08:55	20:38	09:10	19:21	09:16	19:39	09:16	19:44	09:03	19:20	08:45
25	19:08	08:37	18:51	07:59	18:55	08:26	20:08	08:40	18:49	08:47	19:07	08:47	19:13	08:34	18:49	08:15
Aug 1	18:36	08:08	18:20	07:29	18:24	07:56	19:37	08:10	18:18	08:18	18:36	08:17	18:42	08:04	18:17	07:46
8	18:04	07:38	17:48	06:59	17:52	07:26	19:06	07:39	17:45	07:48	18:04	07:47	18:10	07:34	17:46	07:16
15	17:32	07:08	17:16	06:29	17:20	06:56	18:34	07:09	17:13	07:18	17:32	07:17	17:38	07:04	17:14	06:45
22	17:00	06:37	16:45	05:58	16:48	06:26	18:03	06:38	16:41	06:48	17:00	06:47	17:06	06:33	16:42	06:15
29	16:29	06:07	16:13	05:28	16:16	05:56	17:32	06:07	16:09	06:19	16:28	06:17	16:34	06:03	16:10	05:45
Sep 5	15:57	05:37	15:42	04:58	15:44	05:26	17:01	05:37	15:37	05:49	15:56	05:47	16:03	05:33	15:38	05:15
12	15:26	05:08	15:11	04:28	15:13	04:56	16:30	05:06	15:06	05:19	15:25	05:18	15:32	05:03	15:07	04:46
19	14:56	04:38	14:41	03:59	14:43	04:27	16:00	04:37	14:35	04:50	14:55	04:49	15:02	04:34	14:37	04:16
26	14:26	04:09	14:11	03:29	14:13	03:58	15:31	04:07	14:05	04:22	14:25	04:20	14:32	04:05	14:07	03:47
Oct 3	13:57	03:41	13:42	03:01	13:44	03:30	15:02	03:39	13:36	03:53	13:56	03:51	14:03	03:36	13:38	03:19
10	13:29	03:13	13:14	02:33	13:16	03:02	14:34	03:11	13:08	03:25	13:27	03:23	13:35	03:08	13:10	02:51
17	13:01	02:45	12:46	02:05	12:48	02:34	14:06	02:43	12:40	02:58	13:00	02:56	13:07	02:41	12:43	02:23
24	12:34	02:18	12:20	01:38	12:22	02:07	13:39	02:16	12:14	02:30	12:33	02:28	12:41	02:14	12:16	01:56
31	12:09	01:52	11:54	01:12	11:56	01:40	13:13	01:50	11:48	02:04	12:07	02:02	12:15	01:47	11:50	01:29
Nov 7	11:44	01:26	11:28	00:46	11:31	01:14	12:48	01:24	11:23	01:37	11:42	01:36	11:49	01:21	11:25	01:03
14	11:19	01:00	11:04	00:20	11:06	00:48	12:23	00:59	10:59	01:11	11:18	01:10	11:25	00:55	11:00	00:38
21	10:55	00:34	10:40	23:51	10:43	00:23	11:59	00:34	10:35	00:46	10:55	00:44	11:01	00:30	10:37	00:12
28	10:32	00:10	10:17	23:27	10:20	23:55	11:35	00:10	10:13	00:21	10:32	00:19	10:38	00:05	10:14	23:44
Dec 5	10:10	23:41	09:54	23:02	09:57	23:30	11:12	23:42	09:50	23:52	10:09	23:51	10:15	23:37	09:51	23:19
12	09:48	23:17	09:31	22:39	09:35	23:06	10:49	23:19	09:29	23:27	09:47	23:27	09:53	23:13	09:29	22:55
19	09:26	22:53	09:10	22:15	09:14	22:42	10:27	22:56	09:08	23:03	09:26	23:02	09:32	22:49	09:07	22:31
26	09:05	22:29	08:48	21:51	08:53	22:18	10:05	22:33	08:47	22:39	09:05	22:39	09:10	22:26	08:46	22:07

POSITION

0hrs UT Epoch 2000.0

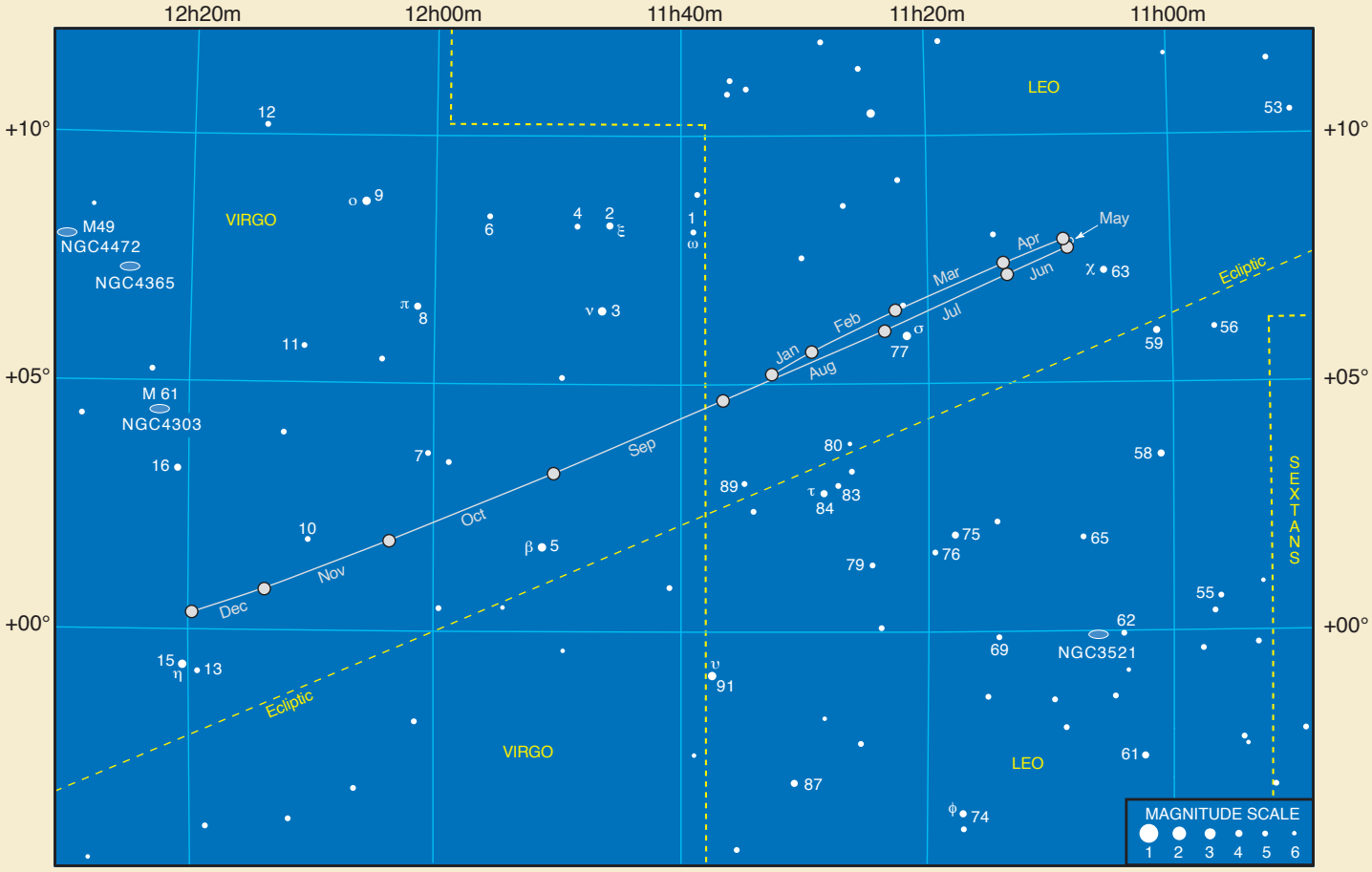
RA	DEC
h m s	Set
20 06 01	- 20 42 27
20 12 49	- 20 22 10
20 19 39	- 20 00 44
20 26 31	- 19 38 14
20 33 20	- 19 14 49
20 40 06	- 18 50 38
20 46 47	- 18 25 49
20 53 20	- 18 00 34
20 59 45	- 17 35 03
21 05 59	- 17 09 30
21 12 00	- 16 44 07
21 17 48	- 16 19 07
21 23 19	- 15 54 45
21 28 33	- 15 31 17
21 33 26	- 15 08 58
21 37 59	- 14 48 01
21 42 08	- 14 28 45
21 45 51	- 14 11 25
21 49 07	- 13 56 16
21 51 54	- 13 43 34
21 54 10	- 13 33 31
21 55 52	- 13 26 23
21 57 00	- 13 22 18
21 57 33	- 13 21 23
21 57 29	- 13 23 41
21 56 49	- 13 29 14
21 55 33	- 13 37 50
21 53 44	- 13 49 17
21 51 23	- 14 03 15
21 48 36	- 14 19 18
21 45 27	- 14 36 52
21 42 02	- 14 55 18
21 38 29	- 15 13 58
21 34 55	- 15 32 13
21 31 29	- 15 49 23
21 28 17	- 16 04 53
21 25 26	- 16 18 17
21 23 03	- 16 29 12
21 21 12	- 16 37 21
21 19 56	- 16 42 33
21 19 19	- 16 44 44
21 19 19	- 16 43 53
21 19 59	- 16 39 59
21 21 18	- 16 33 07
21 23 13	- 16 23 23
21 25 42	- 16 10 51
21 28 44	- 15 55 39
21 32 17	- 15 37 52
21 36 16	- 15 17 40
21 40 40	- 14 55 11
21 45 27	- 14 30 30
21 50 33	- 14 03 47

SATURN

This natural color mosaic was acquired by Cassini 39 degrees above the unilluminated side of the rings. Little light makes its way through the rings to be scattered in Cassini's direction in this viewing geometry, making the rings appear somewhat dark compared to the reflective planet. The ring shadows continue to caress the planet as they slide farther south toward their momentary disappearance during equinox in 2009. Three of Saturn's moons are visible: Mimas at the 2 o'clock position, Janus at the 4 o'clock position and Pandora, a faint speck just outside the narrow F ring, at the 8 o'clock position. This mosaic was constructed from 45 wide-angle camera images; 15 separate sets of red, green and blue images taken over about two hours on May 9, 2007.

Image Credit: NASA/JPL/Space Science Institute

SATURN FINDER CHART



Stationary 2nd January, Opposition 9th March, Stationary 18th May, Conjunction 18th September.

SATELLITES OF SATURN

These pages are designed to help you find the position of Saturn's major satellites.

Note, dates and times on these two pages are given in day/fractions in UT. You will need to convert your local time to this format first. Table 3 will help.

Rhea and Dione

Table 1 presents the times of the first greatest elongation to the east for each month. This location is the day 0 (zero) point on the Apparent Orbits diagram. The procedure is to work out how many orbits have elapsed since the first elongation of the month, then discard the completed number of orbits and convert the remaining fraction back to days so its position can be read directly off the diagram. This is best illustrated with an example. You wish to determine the position of Rhea for March 29 at 1am (EST).

1. Convert to UT as a fractional day. March 29 at 1am (EST) is 15hr UT on the 28th = 28.625 UT.
2. Subtract the date of the greatest elongation east for Rhea for March, i.e., 28.625 – 3.000 = 25.625.
3. Express this as the number of orbits by dividing by the period i.e., 25.625 / 4.521 = 5.668.
4. Discard the 5 completed orbits leaves 0.668
5. Multiply by the period, 0.668 × 4.521 = 3.02 days or 3 days 0.5 hr.
6. Looking at the orbital path for Rhea (see Apparent Orbits diagram), the satellite is west of Saturn, close to the 3-day mark in its orbit.

Table 1: Saturn Satellites – Time of Greatest Elongation East (dd.ddd UT)

Moon	Mimas	Enceladus	Tethys	Dione	Rhea
Magnitude [1]	12.8	11.8	10.2	10.4	9.6
Max Elong. [1]	0' 30"	0' 38"	0' 48"	1' 01"	1' 25"
Period (days) [2]	0.942	1.371	1.888	2.738	4.521
Month	Elongation (d.ddd)				
January	1.604	1.888	1.813	2.988	3.304
February	1.704	1.025	1.008	2.088	3.917
March	1.029	1.792	1.317	1.442	3.000
April	1.121	2.300	2.400	3.271	3.596
May	1.279	1.071	2.596	3.367	5.204
June	1.379	1.588	1.804	2.475	1.308
July	1.542	1.742	2.021	2.596	2.954
August	1.650	2.267	1.238	1.721	3.608
September	1.763	1.425	2.350	3.592	4.275
October	1.929	1.583	2.571	3.725	1.417
November	1.096	2.108	1.792	2.850	2.079
December	1.263	2.263	2.008	2.975	3.733

Notes 1. When at opposition 2. Mean Synodic Period

Mimas, Enceladus and Tethys

The procedure is similar to Rhea and Dione above with the times of the first greatest elongation east for each month also being listed in Table 1. However, these inner moons are so close to Saturn that while the orbits are represented on the diagram, it is difficult to put the day markers on and still have it readable. As above we calculate the fraction of the orbit and then estimate its position. Like the other major moons, these moons still orbit clockwise (as seen from south of the ecliptic), so three quarters of an orbit (0.75) would place it south of Saturn.

An example. Estimate the position for Tethys for the same date/time as Rhea above, i.e., March 29 at 1am (EST) which is 15hr UT on the 28th (28.625 UT). 14.464 orbits have elapsed since its greatest elongation east on March 1.317 UT. Discarding the 14 orbits leaves 0.464. Tethys 46.4% around its orbit so it is approaching a maximum elongation west (which would be 50%). Due to the edge on aspect of their orbits this year, Tethys is close to Rhea at this time.

Table 3
Converting Time in Australia to Universal Time (UT) *

EST	WST	Fraction of day (UT)
6pm	4pm	0.333
7pm	5pm	0.375
8pm	6pm	0.417
9pm	7pm	0.458
10pm	8pm	0.500
11pm	9pm	0.542
midnight	10pm	0.583
1am	11pm	0.625
2am	midnight	0.667
3am	1am	0.708
4am	2am	0.750
5am	3am	0.792
6am	4am	0.833
7am	5am	0.875
8am	6am	0.917

* After midnight it is still the previous day in UT, for example 1am (EST) on the 21st = 20.625 days UT

Table 4: **Iapetus**

Magnitude [1] 11.0
Max Elong. [1] 9' 35"
Period (days) [2] 79.921

Elongation East		Inferior Conjunction		Elongation West		Superior Conjunction	
				Jan	15.229	Feb	3.788
Feb	24.017	Mar	15.346	Apr	3.104	Apr	22.917
May	13.017	Jun	2.121	Jun	21.204	Jul	11.683
Aug	1.400	Aug	21.771	Sep	10.504	Oct	1.096
Oct	22.163	Nov	11.058	Dec	1.038	Dec	21.163

Notes 1. When at opposition 2. Mean Synodic Period

Iapetus

This moon's orbit is too large to place on the Apparent Orbits diagram. The shape of its orbit is similar to the others but more inclined and also orbits clockwise, however its orbit is over twice the diameter of Hyperion. In fact, even when you know its general direction it can sometimes be difficult to distinguish it from similar brightness background stars. Table 4 shows all the moon's greatest elongations east, inferior conjunctions, greatest elongations west and superior conjunctions for the year. These roughly correspond to the east, north, west and south positions respectively. For example, on April 13 Iapetus will be approximately half way between a greatest elongation west and a superior conjunction, placing the satellite southwest of Saturn.

Titan and Hyperion

Because of their long periods, compared to the moons shown opposite, it is possible to list all of their greatest elongations for the year (see Table 2). Therefore, all you need to do is work out the number of days that have elapsed since the most recent elongation and read this position directly off the diagram.

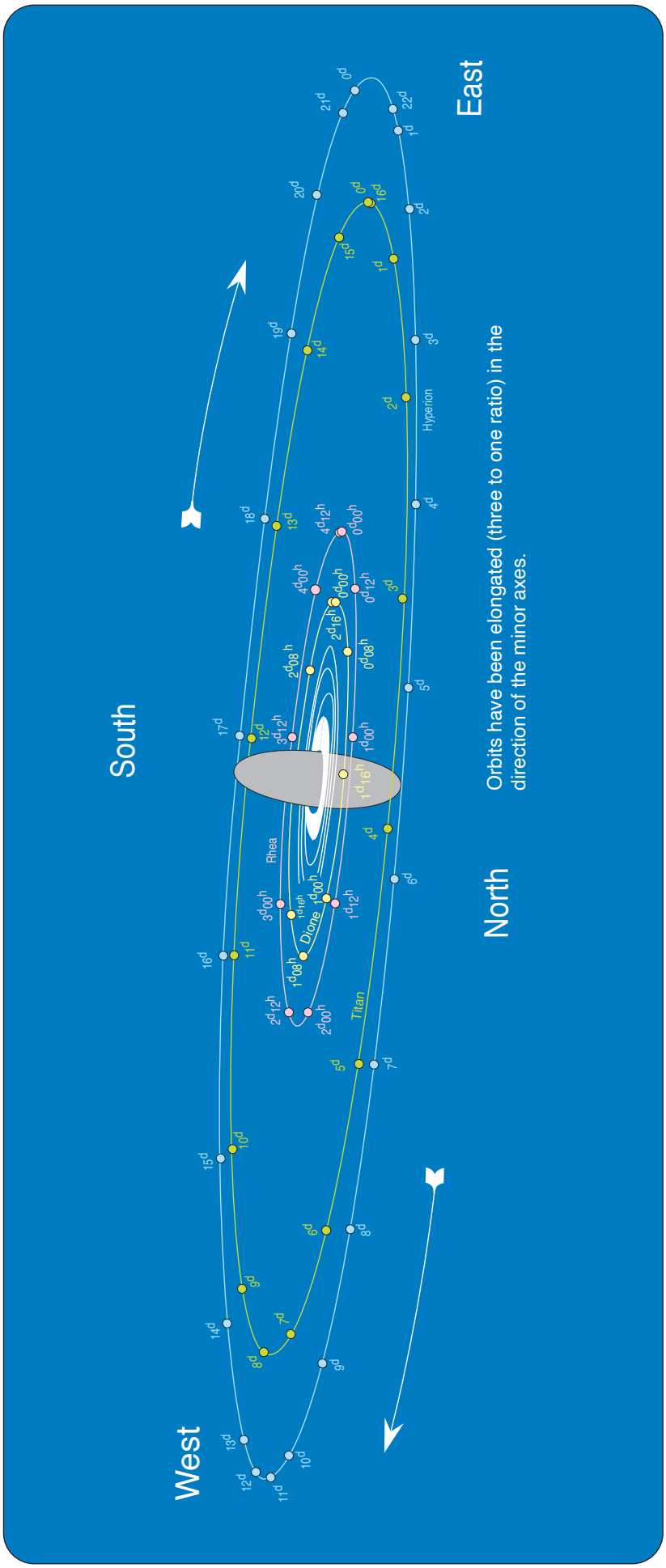
For example on March 11 at midnight EST (11.583 UT), Titan is 3.000 days past a greatest elongation east which puts it east of Saturn (3-day mark).

Table 2
Time of Greatest Elongation East (UT)

Moon	Titan	Hyperion
Magnitude [1]	8.4	14.4
Max. Elong. [1]	3' 17"	3' 59"
Period (days) [2]	15.971	21.317
	Elongation (d.ddd)	
January	3.942	1.692
	19.875	23.017
February	4.788	13.342
	20.692	
March	8.583	6.663
	24.479	27.933
Apr	9.379	18.242
	25.292	
May	11.221	9.604
	27.167	30.933
June	12.133	21.308
	28.117	
July	14.113	12.742
	30.121	
August	15.138	3.113
	31.158	24.500
September	16.183	14.925
October	2.208	6.263
	18.233	27.592
November	3.250	17.929
	19.254	
December	5.250	9.175
	21.233	30.388

Notes 1. When at opposition
2. Mean Synodic Period

APPARENT ORBITS OF SATURN'S SATELLITES



Apparent orbits of the satellites on February 10 UT. Only the inner satellites are shown. Note the three inner orbits (shown in white) are for Mimas, Enceladus and Tethys (from inner to outer). The orbits of Iapetus and Phoebe are too large to show on the above diagram.

SATURN MOON MUTUAL EVENTS

Date	Time (hh:mm:ss)				Event	Type	Mag Drop	Sat Sep Sat Rad	Impact "	Note
	Begin EST	End EST	Begin WST	End WST						
Dec 3			03:37:55	03:45:44	3 Oc 2	P	0.200	3.7	0.049	
Jan 1	03:59:53	04:10:38	01:59:53	02:10:38	4 Oc 1	T	0.125	2.5	0.012	umbral phase begins –6:00, ends +6:00
Jan 7	03:25:20	03:31:16	01:25:20	01:31:16	2 Oc 3	A	0.218	3.9	0.031	
Feb 6	21:26:30	21:31:05			2 Oc 3	P	0.207	3.9	0.051	
Apr 22	17:57:24	17:58:46			1 Ec 2	A	0.684	2.9	0.013	
May 7	00:05:49	00:09:39	22:05:49(p)	22:09:39(p)	3 Ec 2	P	3.334	3.9	0.035	
May 7	19:46:33	19:47:32	17:46:33	17:47:32	1 Ec 2	P	0.348	2.8	0.034	
May 13	23:42:19	23:44:37	21:42:19	21:44:37	2 Ec 1	P	1.830	3.0	0.014	
May 26	20:00:30	20:03:17	18:00:30	18:03:17	2 Ec 3	A	0.271	3.6	0.003	
Jun 6	18:27:07	18:28:36			3 Ec 2	T	20.605	3.9	0.018	umbral phase begins –2:13, ends +2:10
Jun 21	21:15:24	21:18:41	19:15:24	19:18:41	3 Ec 2	P	1.870	3.9	0.051	
Jun 24			21:57:06	22:12:29	5 Ec 4	P	3.414	5.6	0.019	
Jun 29			20:26:50	20:28:09	2 Ec 3	Q	0.110	2.2	0.090	
Jul 1	17:31:19	17:39:00			4 Ec 5	P	0.572	5.7	0.055	
Jul 1			22:28:01	22:28:55	1 Ec 2	A	0.831	3.2	0.003	
Jul 6			21:47:05	21:49:42	3 Ec 2	P	2.247	3.9	0.042	
Jul 7	20:03:53	20:04:11	18:03:53	18:04:11	2 Ec 3	P	0.125	3.1	0.083	
Jul 10			20:30:25	20:31:03	2 Ec 1	P	0.206	3.1	0.050	
Jul 13	19:57:51	19:58:29	17:57:51	17:58:29	5 Ec 1	T	18.980	2.6	0.012	umbral phase begins –0:27, ends +0:27
Jul 17			19:48:53	19:50:54	5 Ec 1	Q	0.894	2.7	0.111	
Jul 19	19:49:47	19:53:56	17:49:47	17:53:56	1 Ec 2	A	0.913	3.1	0.005	
Jul 21	18:07:49	18:09:29			1 Ec 4	A	0.113	3.5	0.067	
Jul 26	19:38:31	19:41:46	17:38:31	17:41:46	2 Ec 3	P	0.107	4.1	0.078	
Jul 26	19:44:08	19:46:39	17:44:08	17:46:39	5 Ec 3	Q	0.159	4.2	0.172	
Jul 26	19:48:01	19:49:04	17:48:01	17:49:04	5 Ec 2	P	0.699	4.0	0.105	
Jul 28			19:27:05	19:30:35	4 Ec 5	Q	0.062	5.4	0.177	
Aug 7			19:48:53	19:49:45	4 Ec 5	P	0.171	5.5	0.139	
Aug 10	19:24:02	19:24:10			4 Ec 2	T	19.781	3.6	0.011	umbral phase begins –0:36, ends +0:37
Dec 24			02:50:13	02:59:07	3 Ec 4	P	0.482	5.0	0.078	

Time: These are the beginning and ending times of the event in EST and/or WST if the event is likely to be visible from east or west Australia. For annular and partial events this is the umbral phase for eclipses and the begin/end for occultations. For penumbral eclipses it is the penumbral phase. For Total events, these columns have the beginning and end of totality; see the notes column to adjust for the umbral phase.

Event Oc occultation, Ec eclipse. The numbers refer to the satellites (1 Mimas, 2 Enceladus, 3 Tethys, 4 Dione, 5 Rhea) e.g., on July 1 event '4 Ec 5' means Dione eclipses Rhea.

Type of event: T total, A annular, P partial, Q penumbral

Mag Drop magnitude drop with the same albedos for all the implied satellites.

Sat Sep Apparent distance from the occulted or eclipsed satellite to the centre of Saturn in Saturnian radii.

Impact Apparent distance between the centres of the satellites for the occultations and from the eclipsed satellite to the axis of the shadow cone for the eclipses.

SATURN'S RINGS

Date	Major "	Minor "	U °	B °
Jan 1	41.70	0.55	42.429	-0.811
Jan 9	42.27	0.60	42.390	-0.872
Jan 17	42.82	0.70	42.249	-0.987
Jan 25	43.32	0.83	42.011	-1.151
Feb 2	43.77	1.00	41.683	-1.360
Feb 10	44.14	1.20	41.276	-1.608
Feb 18	44.43	1.42	40.804	-1.885
Feb 26	44.62	1.66	40.284	-2.182
Mar 6	44.71	1.90	39.735	-2.490
Mar 14	44.70	2.14	39.176	-2.796
Mar 22	44.57	2.36	38.626	-3.090
Mar 30	44.35	2.56	38.106	-3.364
Apr 7	44.04	2.73	37.634	-3.606
Apr 15	43.65	2.86	37.224	-3.810
Apr 23	43.19	2.95	36.888	-3.970
May 1	42.67	2.99	36.638	-4.081
May 9	42.12	3.00	36.481	-4.140
May 17	41.55	2.96	36.420	-4.147
May 25	40.97	2.89	36.456	-4.101
Jun 2	40.39	2.78	36.589	-4.003
Jun 10	39.82	2.64	36.818	-3.855
Jun 18	39.27	2.47	37.136	-3.660
Jun 26	38.75	2.27	37.540	-3.421
Jul 4	38.26	2.06	38.024	-3.141
Jul 12	37.81	1.82	38.581	-2.824
Jul 20	37.41	1.58	39.203	-2.474
Jul 28	37.05	1.32	39.885	-2.095
Aug 5	36.73	1.05	40.618	-1.691
Aug 13	36.47	0.77	41.395	-1.267
Aug 21	36.26	0.49	42.208	-0.827
Aug 29	36.10	0.20	43.051	-0.374
Sep 6	35.99	0.09	43.914	0.085
Sep 14	35.94	0.38	44.791	0.548
Sep 22	35.94	0.67	45.674	1.011
Sep 30	35.99	0.96	46.554	1.467
Oct 8	36.10	1.24	47.423	1.913
Oct 16	36.27	1.52	48.274	2.345
Oct 24	36.49	1.79	49.098	2.757
Nov 1	36.76	2.05	49.885	3.145
Nov 9	37.08	2.30	50.627	3.506
Nov 17	37.45	2.54	51.315	3.834
Nov 25	37.87	2.76	51.940	4.125
Dec 3	38.33	2.96	52.493	4.375
Dec 11	38.83	3.14	52.967	4.582
Dec 19	39.36	3.29	53.353	4.740
Dec 27	39.91	3.41	53.645	4.848

The Appearance of the Planets diagrams in Part I show how open the rings are for 2009. The plane of the rings is tilted, with respect to the plane of the ecliptic, by 27°. Saturn's year is 29.5 Earth years. During this period the Earth can be up to 27° above or below the plane of the rings. Every 7 years, after each of these maximum ring openings, the Earth passes through the plane of the rings and they are seen as edge-on. The rings were edge-on during 1995 and are again in September 2009. Major and minor axes (in arcseconds) are for the outer edge of the outer ring. To work out the size of the other rings, multiply by the following factors.

Inner edge of outer ring	0.8932
Outer edge of inner ring	0.8596
Inner edge of inner ring	0.6726
Inner edge of dusky ring	0.5477

'U' and 'B' are the geocentric longitude and the tilt of the rings respectively.

SATURN

RISE AND SET TIMES

EST, Adelaide and Darwin CST, Perth WST

POSITION

0hr UT Epoch 2000.0

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney		RA	DEC
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	h m s	Set
Jan 3	23:07	10:46	22:36	10:22	22:55	10:34	23:29	11:27	23:07	10:37	23:13	10:49	23:06	10:48	22:46	10:26	11 32 31	+ 05 12 37
10	22:39	10:18	22:08	09:54	22:28	10:06	23:01	10:59	22:40	10:09	22:45	10:21	22:39	10:20	22:18	09:58	11 32 17	+ 05 16 07
17	22:12	09:50	21:41	09:26	22:00	09:37	22:33	10:31	22:12	09:41	22:18	09:52	22:11	09:52	21:51	09:30	11 31 44	+ 05 21 39
24	21:44	09:21	21:12	08:57	21:32	09:09	22:05	10:02	21:44	09:12	21:50	09:24	21:43	09:23	21:23	09:01	11 30 52	+ 05 29 06
31	21:15	08:52	20:44	08:28	21:03	08:39	21:36	09:33	21:16	08:43	21:21	08:55	21:14	08:54	20:54	08:32	11 29 43	+ 05 38 17
Feb 7	20:47	08:22	20:15	07:59	20:35	08:10	21:08	09:04	20:47	08:13	20:53	08:25	20:46	08:25	20:26	08:02	11 28 18	+ 05 48 57
14	20:18	07:53	19:47	07:29	20:06	07:40	20:39	08:35	20:19	07:43	20:25	07:55	20:17	07:55	19:57	07:33	11 26 40	+ 06 00 51
21	19:50	07:23	19:18	06:59	19:38	07:10	20:09	08:05	19:50	07:13	19:56	07:25	19:49	07:25	19:28	07:03	11 24 51	+ 06 13 40
28	19:21	06:53	18:49	06:29	19:09	06:40	19:40	07:36	19:22	06:43	19:27	06:55	19:20	06:55	19:00	06:33	11 22 54	+ 06 27 04
Mar 7	18:52	06:22	18:20	05:59	18:40	06:10	19:11	07:06	18:53	06:12	18:58	06:25	18:51	06:25	18:31	06:03	11 20 52	+ 06 40 39
14	18:23	05:52	17:51	05:29	18:11	05:40	18:41	06:36	18:24	05:42	18:29	05:55	18:22	05:55	18:02	05:32	11 18 49	+ 06 54 05
21	17:54	05:22	17:22	04:59	17:42	05:10	18:12	06:07	17:56	05:12	18:01	05:24	17:53	05:25	17:33	05:02	11 16 47	+ 07 07 01
28	17:25	04:52	16:53	04:29	17:13	04:40	17:43	05:37	17:27	04:41	17:32	04:54	17:24	04:55	17:04	04:32	11 14 51	+ 07 19 06
Apr 4	16:56	04:22	16:24	04:00	16:45	04:10	17:14	05:07	16:58	04:11	17:03	04:24	16:55	04:25	16:35	04:02	11 13 04	+ 07 30 01
11	16:28	03:53	15:55	03:30	16:16	03:40	16:45	04:38	16:30	03:42	16:34	03:55	16:26	03:56	16:06	03:33	11 11 27	+ 07 39 32
18	15:59	03:23	15:26	03:01	15:47	03:11	16:16	04:09	16:01	03:12	16:06	03:25	15:58	03:26	15:38	03:04	11 10 04	+ 07 47 26
25	15:31	02:54	14:58	02:32	15:19	02:42	15:47	03:40	15:33	02:43	15:38	02:56	15:29	02:57	15:09	02:35	11 08 56	+ 07 53 32
May 2	15:03	02:26	14:30	02:04	14:51	02:14	15:19	03:12	15:05	02:14	15:09	02:28	15:01	02:29	14:41	02:06	11 08 06	+ 07 57 43
9	14:35	01:58	14:02	01:36	14:23	01:45	14:51	02:44	14:37	01:46	14:41	02:00	14:33	02:01	14:13	01:38	11 07 33	+ 07 59 55
16	14:07	01:30	13:34	01:08	13:55	01:18	14:23	02:16	14:09	01:18	14:14	01:32	14:05	01:33	13:46	01:10	11 07 19	+ 08 00 07
23	13:39	01:02	13:06	00:40	13:28	00:50	13:56	01:49	13:42	00:51	13:46	01:04	13:38	01:05	13:18	00:43	11 07 24	+ 07 58 18
30	13:12	00:35	12:39	00:13	13:00	00:23	13:29	01:22	13:15	00:24	13:19	00:38	13:11	00:38	12:51	00:16	11 07 47	+ 07 54 30
Jun 6	12:45	00:09	12:12	23:43	12:33	23:53	13:02	00:55	12:47	23:54	12:52	00:11	12:43	00:12	12:24	23:45	11 08 29	+ 07 48 46
13	12:18	23:39	11:45	23:17	12:06	23:27	12:35	00:28	12:20	23:28	12:25	23:41	12:17	23:42	11:57	23:19	11 09 29	+ 07 41 12
20	11:51	23:13	11:19	22:51	11:40	23:01	12:09	23:58	11:54	23:02	11:58	23:15	11:50	23:16	11:30	22:53	11 10 46	+ 07 31 54
27	11:25	22:48	10:52	22:25	11:13	22:36	11:43	23:33	11:27	22:37	11:32	22:50	11:24	22:51	11:04	22:28	11 12 20	+ 07 20 56
Jul 4	10:59	22:23	10:26	22:00	10:47	22:10	11:17	23:07	11:00	22:12	11:05	22:25	10:57	22:25	10:37	22:03	11 14 08	+ 07 08 27
11	10:32	21:58	10:00	21:35	10:21	21:46	10:51	22:42	10:34	21:48	10:39	22:00	10:31	22:01	10:11	21:38	11 16 11	+ 06 54 33
18	10:06	21:33	09:34	21:10	09:55	21:21	10:26	22:17	10:08	21:23	10:13	21:36	10:05	21:36	09:45	21:13	11 18 26	+ 06 39 23
25	09:41	21:09	09:09	20:46	09:29	20:57	10:00	21:52	09:42	20:59	09:47	21:12	09:40	21:12	09:19	20:49	11 20 53	+ 06 23 03
Aug 1	09:15	20:45	08:43	20:21	09:03	20:33	09:35	21:27	09:16	20:35	09:21	20:48	09:14	20:47	08:54	20:25	11 23 30	+ 06 05 42
8	08:49	20:21	08:18	19:57	08:37	20:09	09:10	21:03	08:50	20:12	08:55	20:24	08:48	20:23	08:28	20:01	11 26 16	+ 05 47 29
15	08:24	19:57	07:53	19:33	08:12	19:45	08:45	20:39	08:24	19:48	08:30	20:00	08:23	20:00	08:03	19:37	11 29 10	+ 05 28 32
22	07:58	19:34	07:27	19:09	07:46	19:21	08:20	20:14	07:58	19:25	08:04	19:37	07:58	19:36	07:37	19:14	11 32 10	+ 05 08 57
29	07:33	19:10	07:02	18:46	07:21	18:58	07:56	19:50	07:33	19:02	07:39	19:13	07:32	19:12	07:12	18:50	11 35 15	+ 04 48 55
Sep 5	07:08	18:47	06:37	18:22	06:56	18:35	07:31	19:26	07:07	18:39	07:13	18:50	07:07	18:49	06:47	18:27	11 38 25	+ 04 28 35
12	06:42	18:23	06:12	17:58	06:30	18:11	07:06	19:02	06:41	18:16	06:48	18:27	06:42	18:25	06:21	18:03	11 41 36	+ 04 08 04
19	06:17	18:00	05:47	17:35	06:05	17:48	06:42	18:38	06:16	17:52	06:22	18:03	06:17	18:02	05:56	17:40	11 44 49	+ 03 47 32
26	05:52	17:37	05:22	17:11	05:40	17:24	06:17	18:14	05:50	17:29	05:57	17:40	05:52	17:38	05:31	17:16	11 48 02	+ 03 27 07
Oct 3	05:26	17:13	04:57	16:48	05:14	17:01	05:52	17:50	05:24	17:06	05:32	17:17	05:26	17:15	05:06	16:53	11 51 13	+ 03 07 00
10	05:01	16:50	04:32	16:24	04:49	16:38	05:28	17:26	04:59	16:43	05:06	16:53	05:01	16:51	04:40	16:29	11 54 22	+ 02 47 20
17	04:36	16:26	04:07	16:00	04:24	16:14	05:03	17:02	04:33	16:20	04:41	16:30	04:36	16:27	04:15	16:06	11 57 26	+ 02 28 15
24	04:10	16:02	03:42	15:36	03:58	15:50	04:38	16:37	04:08	15:56	04:15	16:06	04:11	16:04	03:50	15:42	12 00 24	+ 02 09 56
31	03:45	15:38	03:16	15:12	03:33	15:26	04:13	16:13	03:42	15:33	03:50	15:42	03:45	15:40	03:24	15:18	12 03 16	+ 01 52 32
Nov 7	03:19	15:14	02:51	14:48	03:07	15:02	03:48	15:48	03:16	15:09	03:24	15:18	03:20	15:16	02:59	14:54	12 05 58	+ 01 36 12
14	02:54	14:50	02:25	14:23	02:42	14:38	03:23	15:23	02:50	14:45	02:58	14:54	02:54	14:51	02:33	14:30	12 08 31	+ 01 21 06
21	02:28	14:26	02:00	13:59	02:16	14:13	02:58	14:59	02:24	14:21	02:32	14:30	02:28	14:27	02:07	14:05	12 10 53	+ 01 07 24
28	02:02	14:01	01:34	13:34	01:50	13:49	02:32	14:33	01:58	13:56	02:06	14:05	02:02	14:02	01:41	13:40	12 13 01	+ 00 55 14
Dec 5	01:36	13:36	01:08	13:08	01:24	13:24	02:06	14:08	01:32	13:31	01:40	13:40	01:36	13:36	01:15	13:15	12 14 55	+ 00 44 44
12	01:09	13:10	00:42	12:43	00:57	12:58	01:40	13:42	01:05	13:06	01:14	13:14	01:10	13:11	00:49	12:50	12 16 33	+ 00 36 02
19	00:43	12:44	00:15	12:17	00:31	12:32	01:14	13:16	00:39	12:40	00:47	12:49	00:44	12:45	00:22	12:24	12 17 55	+ 00 29 15
26	00:16	12:18	23:45	11:50	00:04	12:06	00:47	12:50	00:12	12:14	00:21	12:22	00:17	12:19	23:52	11:57	12 18 59	+ 00 24 28

URANUS

RISE AND SET TIMES

EST, Adelaide and Darwin CST, Perth WST

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
Jan 3	10:30	23:01	10:06	22:30	10:17	22:49	11:11	23:22	10:20	23:01	10:32	23:07	10:32	23:00	10:10	22:40
10	10:03	22:34	09:39	22:03	09:51	22:22	10:44	22:56	09:54	22:34	10:06	22:40	10:06	22:33	09:43	22:13
17	09:37	22:07	09:13	21:36	09:25	21:55	10:18	22:29	09:28	22:07	09:40	22:13	09:39	22:06	09:17	21:46
24	09:11	21:40	08:47	21:09	08:59	21:28	09:52	22:02	09:02	21:40	09:14	21:46	09:13	21:40	08:51	21:19
31	08:45	21:14	08:21	20:43	08:33	21:02	09:25	21:36	08:36	21:14	08:48	21:19	08:47	21:13	08:25	20:53
Feb 7	08:19	20:47	07:55	20:16	08:07	20:35	08:59	21:10	08:10	20:47	08:22	20:53	08:21	20:46	07:59	20:26
14	07:53	20:20	07:29	19:50	07:41	20:08	08:33	20:43	07:45	20:20	07:56	20:26	07:55	20:20	07:33	19:59
21	07:27	19:54	07:03	19:23	07:15	19:42	08:07	20:17	07:19	19:53	07:31	20:00	07:30	19:53	07:07	19:33
28	07:02	19:27	06:37	18:57	06:50	19:15	07:41	19:51	06:54	19:27	07:05	19:33	07:04	19:27	06:42	19:06
Mar 7	06:36	19:01	06:11	18:30	06:24	18:49	07:15	19:24	06:28	19:00	06:39	19:06	06:38	19:00	06:16	18:40
14	06:11	18:34	05:46	18:04	05:58	18:22	06:49	18:58	06:03	18:33	06:14	18:40	06:12	18:34	05:50	18:13
21	05:45	18:08	05:20	17:38	05:33	17:56	06:23	18:32	05:37	18:07	05:48	18:13	05:47	18:07	05:25	17:47
28	05:19	17:41	04:54	17:11	05:07	17:29	05:57	18:06	05:12	17:40	05:23	17:47	05:21	17:41	04:59	17:20
Apr 4	04:54	17:15	04:28	16:45	04:41	17:03	05:31	17:40	04:46	17:13	04:57	17:20	04:55	17:14	04:33	16:54
11	04:28	16:48	04:03	16:18	04:16	16:36	05:05	17:13	04:20	16:47	04:31	16:54	04:30	16:48	04:08	16:27
18	04:02	16:21	03:37	15:52	03:50	16:10	04:39	16:47	03:55	16:20	04:06	16:27	04:04	16:21	03:42	16:01
25	03:36	15:55	03:11	15:25	03:24	15:43	04:13	16:21	03:29	15:53	03:40	16:00	03:38	15:55	03:16	15:34
May 2	03:10	15:28	02:45	14:59	02:58	15:16	03:47	15:54	03:03	15:26	03:14	15:33	03:12	15:28	02:50	15:07
9	02:44	15:01	02:18	14:32	02:32	14:49	03:21	15:28	02:37	15:00	02:48	15:07	02:46	15:01	02:24	14:41
16	02:18	14:34	01:52	14:05	02:06	14:23	02:54	15:01	02:11	14:33	02:21	14:40	02:19	14:34	01:58	14:14
23	01:51	14:08	01:26	13:38	01:39	13:56	02:27	14:34	01:45	14:06	01:55	14:13	01:53	14:08	01:31	13:47
30	01:25	13:41	00:59	13:11	01:13	13:29	02:01	14:07	01:18	13:39	01:28	13:46	01:26	13:41	01:04	13:20
Jun 6	00:58	13:13	00:32	12:44	00:46	13:02	01:34	13:40	00:51	13:11	01:02	13:19	00:59	13:13	00:38	12:53
13	00:31	12:46	00:05	12:17	00:19	12:34	01:07	13:13	00:24	12:44	00:35	12:51	00:32	12:46	00:11	12:26
20	00:00	12:19	23:34	11:50	23:48	12:07	00:40	12:46	23:53	12:17	00:08	12:24	00:05	12:19	23:40	11:58
27	23:33	11:52	23:07	11:22	23:21	11:40	00:12	12:19	23:26	11:49	23:36	11:57	23:34	11:52	23:12	11:31
Jul 4	23:05	11:24	22:39	10:55	22:53	11:12	23:41	11:51	22:59	11:22	23:09	11:29	23:07	11:24	22:45	11:03
11	22:37	10:56	22:12	10:27	22:25	10:45	23:13	11:23	22:31	10:54	22:41	11:02	22:39	10:57	22:17	10:36
18	22:10	10:29	21:44	10:00	21:57	10:17	22:45	10:56	22:03	10:27	22:13	10:34	22:11	10:29	21:49	10:08
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Sep 5	18:50	07:13	18:25	06:43	18:38	07:01	19:27	07:39	18:43	07:11	18:54	07:18	18:52	07:13	18:30	06:52
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Oct 3	16:55	05:20	16:30	04:50	16:43	05:08	17:33	05:45	16:47	05:19	16:58	05:25	16:57	05:19	16:35	04:59
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31	15:00	03:27	14:36	02:57	14:48	03:15	15:39	03:52	14:53	03:26	15:04	03:33	15:02	03:27	14:40	03:06
Nov 7	14:32	02:59	14:07	02:29	14:20	02:47	15:11	03:24	14:24	02:59	14:35	03:05	14:34	02:59	14:12	02:38
14	14:04	02:31	13:39	02:01	13:52	02:20	14:43	02:56	13:56	02:31	14:07	02:37	14:06	02:31	13:44	02:11
21	13:36	02:04	13:11	01:33	13:24	01:52	14:15	02:28	13:28	02:03	13:39	02:09	13:38	02:03	13:16	01:43
28	13:08	01:36	12:44	01:06	12:56	01:24	13:47	02:00	13:01	01:35	13:12	01:42	13:10	01:36	12:48	01:15
Dec 5	12:41	01:09	12:16	00:38	12:29	00:57	13:20	01:33	12:33	01:08	12:44	01:14	12:43	01:08	12:21	00:48
12	12:14	00:41	11:49	00:11	12:01	00:29	12:52	01:05	12:06	00:40	12:17	00:47	12:16	00:41	11:54	00:20
19	11:47	00:14	11:22	23:40	11:34	23:58	12:25	00:38	11:39	00:13	11:50	00:19	11:48	00:13	11:26	23:49
26	11:20	23:43	10:55	23:12	11:07	23:31	11:58	00:11	11:12	23:42	11:23	23:48	11:21	23:42	11:00	23:22

POSITION

0hr UT Epoch 2000.0

RA	DEC
h m s	Set
23 21 21	- 04 58 41
23 22 11	- 04 53 06
23 23 09	- 04 46 45
23 24 13	- 04 39 41
23 25 23	- 04 32 00
23 26 39	- 04 23 47
23 27 58	- 04 15 07
23 29 22	- 04 06 06
23 30 48	- 03 56 49
23 32 15	- 03 47 23
23 33 43	- 03 37 53
23 35 12	- 03 28 25
23 36 39	- 03 19 05
23 38 04	- 03 09 58
23 39 27	- 03 01 10
23 40 46	- 02 52 46
23 42 01	- 02 44 50
23 43 11	- 02 37 29
23 44 15	- 02 30 46
23 45 12	- 02 24 46
23 46 03	- 02 19 31
23 46 46	- 02 15 05
23 47 22	- 02 11 32
23 47 49	- 02 08 52
23 48 07	- 02 07 08
23 48 17	- 02 06 20
23 48 19	- 02 06 29
23 48 11	- 02 07 33
23 47 55	- 02 09 31
23 47 31	- 02 12 22
23 47 00	- 02 16 01
23 46 21	- 02 20 25
23 45 36	- 02 25 28
23 44 45	- 02 31 04
23 43 50	- 02 37 08
23 42 52	- 02 43 32
23 41 51	- 02 50 07
23 40 49	- 02 56 47
23 39 47	- 03 03 22
23 38 47	- 03 09 45
23 37 50	- 03 15 48
23 36 57	- 03 21 22
23 36 08	- 03 26 22
23 35 26	- 03 30 40
23 34 51	- 03 34 11
23 34 24	- 03 36 51
23 34 05	- 03 38 35
23 33 55	- 03 39 22
23 33 54	- 03 39 09
23 34 02	- 03 37 56
23 34 20	- 03 35 44
23 34 47	- 03 32 33

SATELLITES OF URANUS AND NEPTUNE

This page is designed to help you find the position of Uranus' major satellites and Neptune's moon Triton. All dates/times are given in day/fractions in UT. You will need to convert your local time to this format first. Table 1 will help.

URANUS

Table 2 presents the times of the first greatest elongation to the north for each month for **Ariel, Umbriel, Titania and Oberon**. This location is the day 0 (zero) point on the orbits diagram. Like with Saturn's satellites, the procedure is to work out how many orbits have elapsed since the first elongation of the month. Then discard the completed number of orbits and convert the remaining fraction back to days so its position can be read directly off the diagram. This is best illustrated with an example. You wish to determine the position of Umbriel for September 26 at 10pm EST.

1. Convert to UT as a fractional day. September 26 at 10pm (EST) = 26.500 UT
2. Subtract the date of the greatest elongation north for September, i.e. 26.500 – 3.788 = 22.712
3. Express this as the number of orbits by dividing by the period, i.e. 22.712 / 4.1442 = 5.480
4. Discard the five completed orbits leaves 0.480 (i.e., approaching 50% of the way around its orbit)
5. Multiply by the period, 0.480 × 4.1442 = 1.989 days or 1 day 23.7 hours
6. Looking at the orbital path for Umbriel (see orbits diagram), the satellite is south of Uranus and approaching a greatest southern elongation (near the 2 day mark). As the night goes on the satellite will get closer to its maximum southern elongation seeing it is only 2 hours from this maximum elongation (half an orbit = 2.0721 days or 2 days 1.7 hours).

Table 1: Converting Time in Australia to Universal Time (UT) *

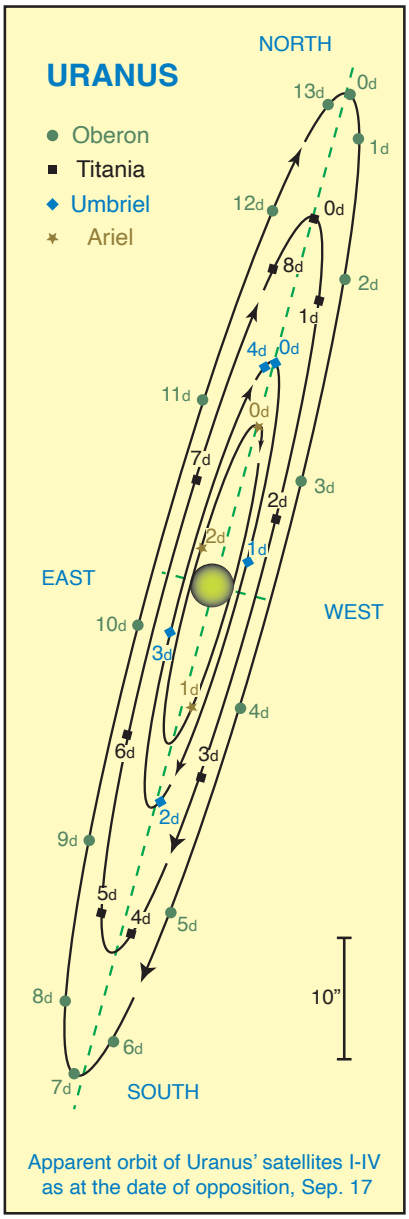
EST	WST	Fraction of day (UT)
6pm	4pm	0.333
7pm	5pm	0.375
8pm	6pm	0.417
9pm	7pm	0.458
10pm	8pm	0.500
11pm	9pm	0.542
midnight	10pm	0.583
1am	11pm	0.625
2am	midnight	0.667
3am	1am	0.708
4am	2am	0.750
5am	3am	0.792
6am	4am	0.833
7am	5am	0.875
8am	6am	0.917

* After midnight it is still the previous day in UT, for example 1am (EST) on the 21st = 20.625 days UT

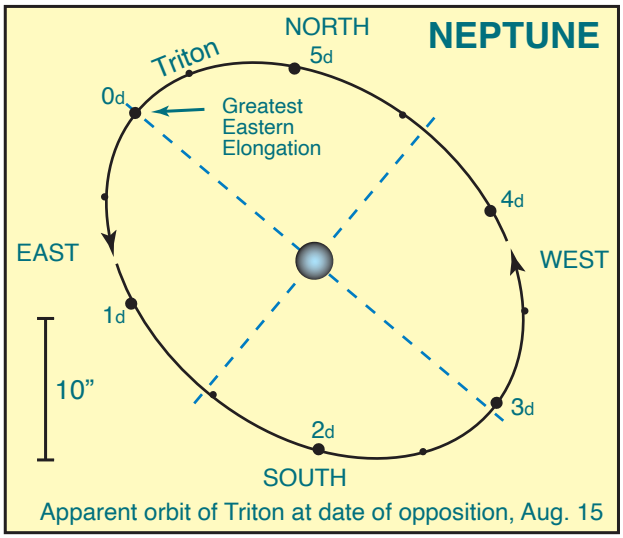
NEPTUNE

The procedure for finding Triton is identical to above with the times of the first greatest elongation east for each month also being listed in Table 2. The orientation of Triton's orbit places this day 0 (zero) point closer to northeast of Neptune (see diagram).

An example. Estimate the position for Triton for July 26 at 4am EST (25.75 UT). 4.1654 orbits have elapsed since its greatest elongation east on July 1.271 UT. Discarding the 4 orbits leaves 0.1654. Multiplying by 5.8768 (its period) gives 0.972 days. From the diagram the moon is east of Neptune, close to the 1-day mark.



Apparent orbit of Uranus' satellites I-IV as at the date of opposition, Sep. 17



Apparent orbit of Triton at date of opposition, Aug. 15

Table 2: Time of Greatest Elongation North/East (UT)

Planet	Uranus				Neptune
Moon	Ariel	Umbriel	Titania	Oberon	Triton
Magnitude [1]	13.7	14.5	13.5	13.7	13.5
Max Elong. [1]	0' 14"	0' 20"	0' 33"	0' 44"	0' 17"
Period (days) [2]	2.5204	4.1442	8.7059	13.4633	5.8768
Month	Elongation North (d.ddd)				East (d.ddd)
January	1.958	2.300	8.642	2.496	6.054
February	1.204	4.454	3.758	11.883	4.417
March	3.450	1.317	1.875	10.804	5.775
April	2.692	3.467	5.692	6.725	4.138
May	2.933	2.471	1.804	3.642	3.504
June	2.175	4.621	5.621	13.025	1.883
July	2.417	3.629	1.738	9.950	1.271
August	1.658	1.638	5.558	5.875	5.546
September	3.421	3.788	9.383	1.804	3.950
October	1.146	2.800	5.504	12.200	3.350
November	2.917	4.958	9.329	8.129	1.742
December	3.163	3.967	5.450	5.058	1.125

Notes 1. When at opposition
2. Mean Synodic Period

NEPTUNE

RISE AND SET TIMES

EST, Adelaide and Darwin CST, Perth WST

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
Jan 3	08:21	21:47	08:04	21:08	08:08	21:35	09:21	21:49	08:02	21:56	08:20	21:56	08:26	21:43	08:02	21:24
10	07:54	21:20	07:37	20:41	07:42	21:08	08:54	21:23	07:36	21:29	07:54	21:29	07:59	21:16	07:35	20:58
17	07:28	20:53	07:11	20:15	07:15	20:41	08:28	20:56	07:10	21:02	07:28	21:02	07:33	20:49	07:09	20:31
24	07:02	20:26	06:45	19:48	06:49	20:15	08:01	20:29	06:43	20:35	07:01	20:35	07:07	20:22	06:43	20:04
31	06:35	19:59	06:18	19:21	06:23	19:48	07:35	20:03	06:17	20:09	06:35	20:08	06:40	19:56	06:16	19:37
Feb 7	06:09	19:32	05:52	18:55	05:56	19:21	07:08	19:36	05:51	19:42	06:09	19:42	06:14	19:29	05:50	19:11
14	05:43	19:06	05:26	18:28	05:30	18:54	06:42	19:09	05:25	19:15	05:43	19:15	05:48	19:02	05:24	18:44
21	05:17	18:39	04:59	18:01	05:04	18:27	06:15	18:43	04:59	18:48	05:16	18:48	05:22	18:35	04:58	18:17
28	04:50	18:12	04:33	17:35	04:38	18:01	05:49	18:16	04:33	18:21	04:50	18:21	04:55	18:09	04:31	17:50
Mar 7	04:24	17:45	04:07	17:08	04:11	17:34	05:23	17:50	04:06	17:54	04:24	17:54	04:29	17:42	04:05	17:23
14	03:58	17:19	03:40	16:41	03:45	17:07	04:56	17:23	03:40	17:27	03:58	17:28	04:03	17:15	03:39	16:57
21	03:31	16:52	03:14	16:14	03:19	16:40	04:29	16:56	03:14	17:00	03:31	17:01	03:36	16:48	03:12	16:30
28	03:05	16:25	02:47	15:47	02:52	16:13	04:03	16:30	02:47	16:34	03:05	16:34	03:10	16:21	02:46	16:03
Apr 4	02:38	15:58	02:21	15:21	02:26	15:46	03:36	16:03	02:21	16:07	02:38	16:07	02:43	15:55	02:19	15:36
11	02:12	15:31	01:54	14:54	01:59	15:19	03:09	15:36	01:54	15:39	02:12	15:40	02:17	15:28	01:53	15:09
18	01:45	15:04	01:27	14:27	01:32	14:52	02:43	15:09	01:28	15:12	01:45	15:13	01:50	15:01	01:26	14:42
25	01:18	14:37	01:00	13:59	01:06	14:25	02:16	14:42	01:01	14:45	01:18	14:46	01:23	14:33	00:59	14:15
May 2	00:51	14:10	00:33	13:32	00:39	13:58	01:49	14:15	00:34	14:18	00:51	14:18	00:56	14:06	00:32	13:48
9	00:24	13:42	00:06	13:05	00:12	13:31	01:21	13:48	00:07	13:51	00:24	13:51	00:29	13:39	00:05	13:20
16	23:53	13:15	23:35	12:38	23:40	13:03	00:54	13:20	23:36	13:23	23:53	13:24	23:58	13:12	23:34	12:53
23	23:26	12:48	23:08	12:10	23:13	12:36	00:27	12:53	23:08	12:56	23:26	12:56	23:30	12:44	23:07	12:26
30	22:58	12:20	22:40	11:43	22:46	12:09	23:55	12:25	22:41	12:28	22:58	12:29	23:03	12:17	22:39	11:58
Jun 6	22:30	11:53	22:13	11:15	22:18	11:41	23:28	11:58	22:13	12:01	22:31	12:01	22:35	11:49	22:11	11:31
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Jul 4	20:39	10:02	20:21	09:24	20:26	09:50	21:36	10:07	20:22	10:10	20:39	10:10	20:44	09:58	20:20	09:40
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Aug 1	18:46	08:10	18:28	07:32	18:33	07:58	19:44	08:14	18:28	08:18	18:46	08:19	18:51	08:06	18:27	07:48
8	18:17	07:42	18:00	07:04	18:05	07:30	19:15	07:46	18:00	07:51	18:17	07:51	18:22	07:38	17:58	07:20
15	17:49	07:14	17:31	06:36	17:36	07:02	18:47	07:18	17:31	07:22	17:49	07:23	17:54	07:10	17:30	06:52
22	17:20	06:46	17:03	06:08	17:08	06:34	18:19	06:50	17:03	06:55	17:20	06:55	17:25	06:42	17:01	06:24
29	16:52	06:18	16:35	05:40	16:39	06:06	17:51	06:22	16:34	06:27	16:52	06:27	16:57	06:14	16:33	05:56
Sep 5	16:23	05:50	16:06	05:12	16:11	05:38	17:22	05:54	16:06	05:59	16:23	05:59	16:29	05:46	16:05	05:28
12	15:55	05:21	15:38	04:44	15:43	05:10	16:54	05:25	15:37	05:31	15:55	05:31	16:00	05:18	15:36	05:00
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Oct 3	14:30	03:58	14:13	03:20	14:18	03:46	15:30	04:01	14:12	04:07	14:30	04:07	14:36	03:54	14:11	03:36
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17	13:34	03:02	13:17	02:24	13:22	02:51	14:34	03:06	13:16	03:11	13:34	03:11	13:40	02:58	13:16	02:40
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Nov 7	12:11	01:39	11:54	01:01	11:59	01:28	13:11	01:43	11:53	01:49	12:11	01:48	12:17	01:36	11:53	01:17
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28	10:50	00:17	10:33	23:35	10:37	00:06	11:49	00:21	10:32	00:26	10:49	00:26	10:55	00:13	10:31	23:51
Dec 5	10:23	23:46	10:05	23:08	10:10	23:34	11:22	23:50	10:05	23:55	10:22	23:55	10:28	23:42	10:04	23:24
12	09:56	23:19	09:39	22:41	09:43	23:07	10:55	23:22	09:38	23:28	09:56	23:28	10:01	23:15	09:37	22:57
19	09:29	22:52	09:12	22:14	09:16	22:40	10:28	22:56	09:11	23:01	09:29	23:01	09:34	22:48	09:10	22:30
26	09:02	22:25	08:45	21:47	08:50	22:13	10:01	22:29	08:45	22:34	09:02	22:34	09:07	22:21	08:43	22:03

POSITION

0hr UT Epoch 2000.0

RA	DEC
h m s	Set
21 39 23	- 14 23 24
21 40 15	- 14 19 03
21 41 11	- 14 14 25
21 42 09	- 14 09 33
21 43 10	- 14 04 30
21 44 11	- 13 59 22
21 45 13	- 13 54 10
21 46 15	- 13 48 58
21 47 16	- 13 43 50
21 48 16	- 13 38 50
21 49 13	- 13 34 01
21 50 08	- 13 29 26
21 50 59	- 13 25 08
21 51 46	- 13 21 11
21 52 28	- 13 17 38
21 53 06	- 13 14 30
21 53 38	- 13 11 50
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21 54 26	- 13 08 00
21 54 40	- 13 06 53
21 54 49	- 13 06 18
21 54 51	- 13 06 16
21 54 48	- 13 06 47
21 54 38	- 13 07 49
21 54 22	- 13 09 21
21 54 01	- 13 11 22
21 53 35	- 13 13 48
21 53 05	- 13 16 38
21 52 30	- 13 19 49
21 51 52	- 13 23 16
21 51 11	- 13 26 57
21 50 28	- 13 30 46
21 49 44	- 13 34 40
21 49 00	- 13 38 35
21 48 16	- 13 42 26
21 47 33	- 13 46 09
21 46 53	- 13 49 40
21 46 15	- 13 52 55
21 45 41	- 13 55 50
21 45 11	- 13 58 23
21 44 46	- 14 00 30
21 44 27	- 14 02 09
21 44 13	- 14 03 17
21 44 06	- 14 03 54
21 44 04	- 14 03 59
21 44 10	- 14 03 30
21 44 22	- 14 02 28
21 44 40	- 14 00 52
21 45 05	- 13 58 46
21 45 35	- 13 56 08
21 46 11	- 13 53 02
21 46 53	- 13 49 29

PLUTO

RISE AND SET TIMES

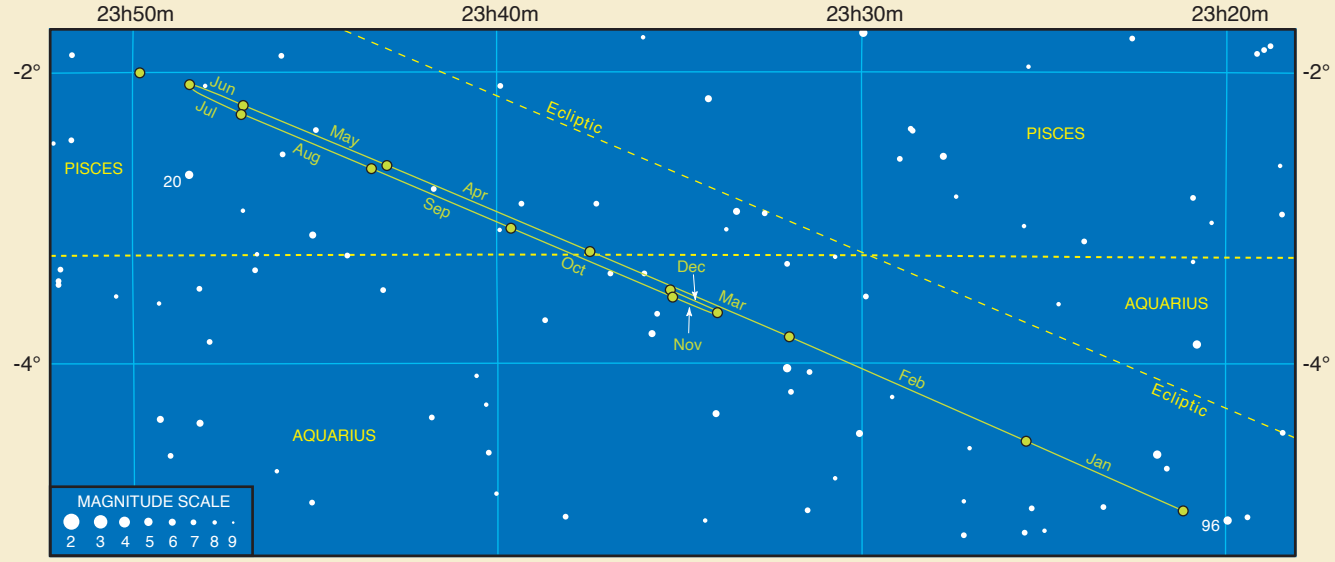
EST, Adelaide and Darwin CST, Perth WST

POSITION

0hr UT Epoch 2000.0

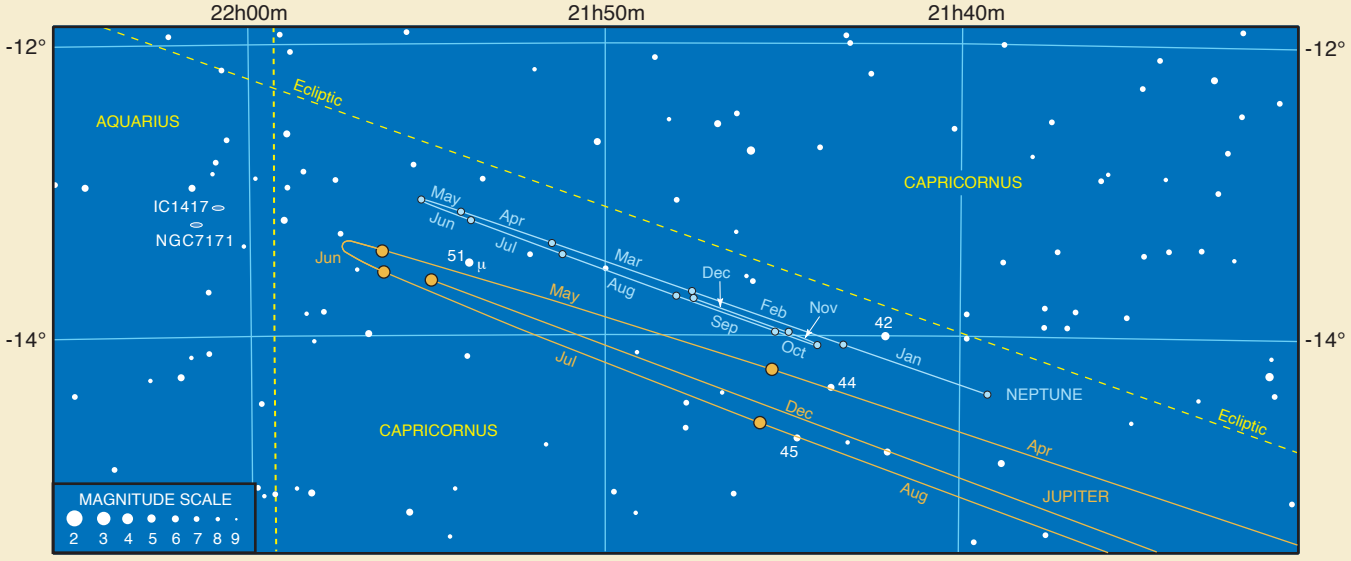
	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Perth		Sydney		RA	DEC
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	h m s	Set
Jan 3	04:36	18:23	04:22	17:42	04:24	18:12	05:44	18:19	04:14	18:37	04:35	18:34	04:43	18:18	04:18	18:01	18 05 02	- 17 44 35
10	04:10	17:57	03:56	17:16	03:57	17:46	05:17	17:52	03:48	18:10	04:08	18:07	04:16	17:52	03:51	17:34	18 06 05	- 17 44 48
17	03:43	17:30	03:29	16:49	03:31	17:19	04:51	17:26	03:21	17:44	03:42	17:41	03:50	17:25	03:25	17:08	18 07 05	- 17 44 51
24	03:17	17:04	03:03	16:23	03:04	16:52	04:24	16:59	02:55	17:17	03:15	17:14	03:23	16:59	02:58	16:41	18 08 03	- 17 44 45
31	02:50	16:37	02:36	15:56	02:37	16:26	03:57	16:33	02:28	16:50	02:49	16:48	02:57	16:32	02:32	16:15	18 08 57	- 17 44 30
Feb 7	02:24	16:10	02:09	15:29	02:11	15:59	03:31	16:06	02:01	16:24	02:22	16:21	02:30	16:06	02:05	15:48	18 09 48	- 17 44 08
14	01:57	15:44	01:43	15:03	01:44	15:32	03:04	15:39	01:35	15:57	01:55	15:54	02:03	15:39	01:38	15:21	18 10 34	- 17 43 40
21	01:30	15:17	01:16	14:36	01:17	15:05	02:37	15:12	01:08	15:30	01:28	15:27	01:36	15:12	01:11	14:54	18 11 15	- 17 43 07
28	01:03	14:50	00:49	14:09	00:50	14:38	02:10	14:45	00:41	15:03	01:01	15:00	01:09	14:45	00:45	14:27	18 11 50	- 17 42 30
Mar 7	00:36	14:23	00:22	13:42	00:23	14:11	01:43	14:18	00:14	14:36	00:35	14:33	00:43	14:18	00:18	14:00	18 12 19	- 17 41 50
14	00:09	13:56	23:51	13:15	23:52	13:44	01:16	13:51	23:43	14:09	00:07	14:06	00:15	13:51	23:47	13:33	18 12 43	- 17 41 09
21	23:38	13:28	23:24	12:47	23:25	13:17	00:49	13:24	23:16	13:42	23:36	13:39	23:44	13:23	23:19	13:06	18 13 00	- 17 40 28
28	23:11	13:01	22:56	12:20	22:58	12:50	00:22	12:57	22:49	13:14	23:09	13:11	23:17	12:56	22:52	12:38	18 13 10	- 17 39 49
Apr 4	22:43	12:33	22:29	11:53	22:30	12:22	23:50	12:29	22:21	12:47	22:42	12:44	22:50	12:29	22:25	12:11	18 13 14	- 17 39 12
11	22:16	12:06	22:01	11:25	22:03	11:54	23:23	12:01	21:54	12:19	22:14	12:16	22:22	12:01	21:57	11:43	18 13 11	- 17 38 39
18	21:48	11:38	21:34	10:57	21:35	11:27	22:55	11:34	21:26	11:51	21:46	11:49	21:54	11:33	21:29	11:16	18 13 02	- 17 38 11
25	21:20	11:10	21:06	10:29	21:07	10:59	22:27	11:06	20:58	11:24	21:19	11:21	21:27	11:05	21:02	10:48	18 12 46	- 17 37 48
May 2	20:52	10:42	20:38	10:02	20:40	10:31	21:59	10:38	20:30	10:56	20:51	10:53	20:59	10:38	20:34	10:20	18 12 25	- 17 37 32
9	20:24	10:14	20:10	09:34	20:12	10:03	21:31	10:10	20:02	10:28	20:23	10:25	20:31	10:10	20:06	09:52	18 11 59	- 17 37 23
16	19:56	09:46	19:42	09:06	19:44	09:35	21:03	09:42	19:34	10:00	19:55	09:57	20:03	09:42	19:38	09:24	18 11 28	- 17 37 23
23	19:28	09:18	19:14	08:37	19:16	09:07	20:35	09:14	19:06	09:32	19:27	09:29	19:35	09:13	19:10	08:56	18 10 52	- 17 37 30
30	19:00	08:50	18:46	08:09	18:47	08:39	20:07	08:46	18:38	09:03	18:58	09:01	19:06	08:45	18:42	08:28	18 10 14	- 17 37 47
Jun 6	18:32	08:22	18:18	07:41	18:19	08:11	19:39	08:18	18:10	08:35	18:30	08:33	18:38	08:17	18:13	08:00	18 09 32	- 17 38 12
13	18:04	07:54	17:49	07:13	17:51	07:42	19:11	07:49	17:42	08:07	18:02	08:04	18:10	07:49	17:45	07:31	18 08 48	- 17 38 46
20	17:35	07:26	17:21	06:45	17:23	07:14	18:42	07:21	17:13	07:39	17:34	07:36	17:42	07:21	17:17	07:03	18 08 04	- 17 39 30
27	17:07	06:57	16:53	06:16	16:54	06:46	18:14	06:53	16:45	07:11	17:05	07:08	17:13	06:52	16:48	06:35	18 07 18	- 17 40 22
Jul 4	16:39	06:29	16:25	05:48	16:26	06:18	17:46	06:25	16:17	06:42	16:37	06:40	16:45	06:24	16:20	06:07	18 06 34	- 17 41 23
11	16:10	06:01	15:56	05:20	15:58	05:50	17:18	05:56	15:48	06:14	16:09	06:11	16:17	05:56	15:52	05:39	18 05 50	- 17 42 32
18	15:42	05:33	15:28	04:52	15:29	05:21	16:49	05:28	15:20	05:46	15:40	05:43	15:48	05:28	15:24	05:10	18 05 09	- 17 43 49
25	15:14	05:05	15:00	04:24	15:01	04:53	16:21	05:00	14:52	05:18	15:12	05:15	15:20	05:00	14:55	04:42	18 04 30	- 17 45 14
Aug 1	14:46	04:37	14:32	03:56	14:33	04:25	15:53	04:32	14:23	04:50	14:44	04:47	14:52	04:32	14:27	04:14	18 03 55	- 17 46 46
8	14:17	04:09	14:03	03:28	14:05	03:57	15:25	04:04	13:55	04:22	14:16	04:19	14:24	04:04	13:59	03:46	18 03 24	- 17 48 23
15	13:49	03:41	13:35	03:00	13:37	03:30	14:57	03:36	13:27	03:54	13:48	03:51	13:56	03:36	13:31	03:18	18 02 58	- 17 50 06
22	13:21	03:13	13:08	02:32	13:09	03:02	14:29	03:08	12:59	03:27	13:20	03:24	13:28	03:08	13:03	02:51	18 02 37	- 17 51 53
29	12:54	02:45	12:40	02:04	12:41	02:34	14:01	02:41	12:31	02:59	12:52	02:56	13:00	02:40	12:35	02:23	18 02 22	- 17 53 44
Sep 5	12:26	02:18	12:12	01:37	12:13	02:06	13:34	02:13	12:04	02:31	12:24	02:28	12:32	02:13	12:07	01:55	18 02 13	- 17 55 38
12	11:58	01:50	11:44	01:09	11:45	01:39	13:06	01:45	11:36	02:04	11:56	02:01	12:05	01:45	11:40	01:28	18 02 10	- 17 57 33
19	11:31	01:23	11:17	00:42	11:18	01:12	12:38	01:18	11:08	01:37	11:29	01:34	11:37	01:18	11:12	01:01	18 02 14	- 17 59 29
26	11:03	00:56	10:49	00:14	10:50	00:44	12:11	00:51	10:41	01:09	11:01	01:06	11:10	00:51	10:45	00:33	18 02 24	- 18 01 24
Oct 3	10:36	00:29	10:22	23:43	10:23	00:17	11:44	00:23	10:13	00:42	10:34	00:39	10:42	00:24	10:17	00:06	18 02 40	- 18 03 17
10	10:09	23:58	09:55	23:16	09:56	23:46	11:17	23:52	09:46	00:15	10:07	00:12	10:15	23:53	09:50	23:35	18 03 03	- 18 05 08
17	09:41	23:31	09:28	22:49	09:29	23:19	10:50	23:25	09:19	23:45	09:40	23:41	09:48	23:26	09:23	23:08	18 03 32	- 18 06 54
24	09:14	23:04	09:01	22:23	09:02	22:53	10:23	22:58	08:52	23:18	09:13	23:15	09:21	22:59	08:56	22:41	18 04 07	- 18 08 36
31	08:47	22:37	08:34	21:56	08:35	22:26	09:56	22:32	08:25	22:51	08:46	22:48	08:54	22:32	08:29	22:15	18 04 48	- 18 10 12
Nov 7	08:21	22:10	08:07	21:29	08:08	21:59	09:29	22:05	07:58	22:24	08:19	22:21	08:27	22:05	08:02	21:48	18 05 33	- 18 11 41
14	07:54	21:44	07:40	21:02	07:41	21:32	09:02	21:38	07:31	21:58	07:52	21:55	08:00	21:39	07:35	21:21	18 06 23	- 18 13 02
21	07:27	21:17	07:13	20:36	07:14	21:06	08:36	21:12	07:04	21:31	07:25	21:28	07:34	21:12	07:09	20:55	18 07 17	- 18 14 14
28	07:00	20:51	06:47	20:09	06:48	20:39	08:09	20:45	06:38	21:05	06:59	21:01	07:07	20:46	06:42	20:28	18 08 14	- 18 15 18
Dec 5	06:34	20:24	06:20	19:43	06:21	20:13	07:42	20:19	06:11	20:38	06:32	20:35	06:41	20:19	06:15	20:02	18 09 14	- 18 16 12
12	06:07	19:58	05:54	19:16	05:55	19:46	07:16	19:52	05:45	20:12	06:06	20:09	06:14	19:53	05:49	19:35	18 10 16	- 18 16 56
19	05:41	19:31	05:27	18:50	05:28	19:20	06:49	19:26	05:18	19:45	05:39	19:42	05:48	19:26	05:22	19:09	18 11 20	- 18 17 30
26	05:14	19:05	05:01	18:23	05:02	18:54	06:23	18:59	04:52	19:19	05:13	19:16	05:21	19:00	04:56	18:42	18 12 24	- 18 17 55

URANUS FINDER CHART



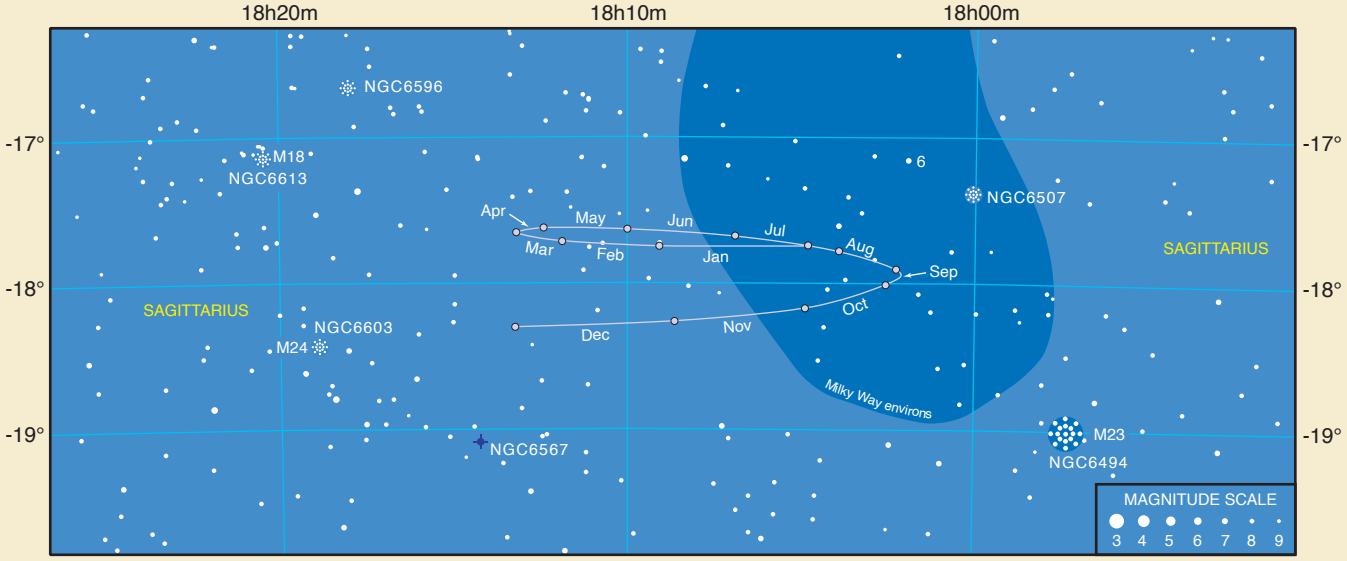
Conjunction 13th March, Stationary 2nd June, Opposition 17th September, Stationary 2nd December.

NEPTUNE FINDER CHART



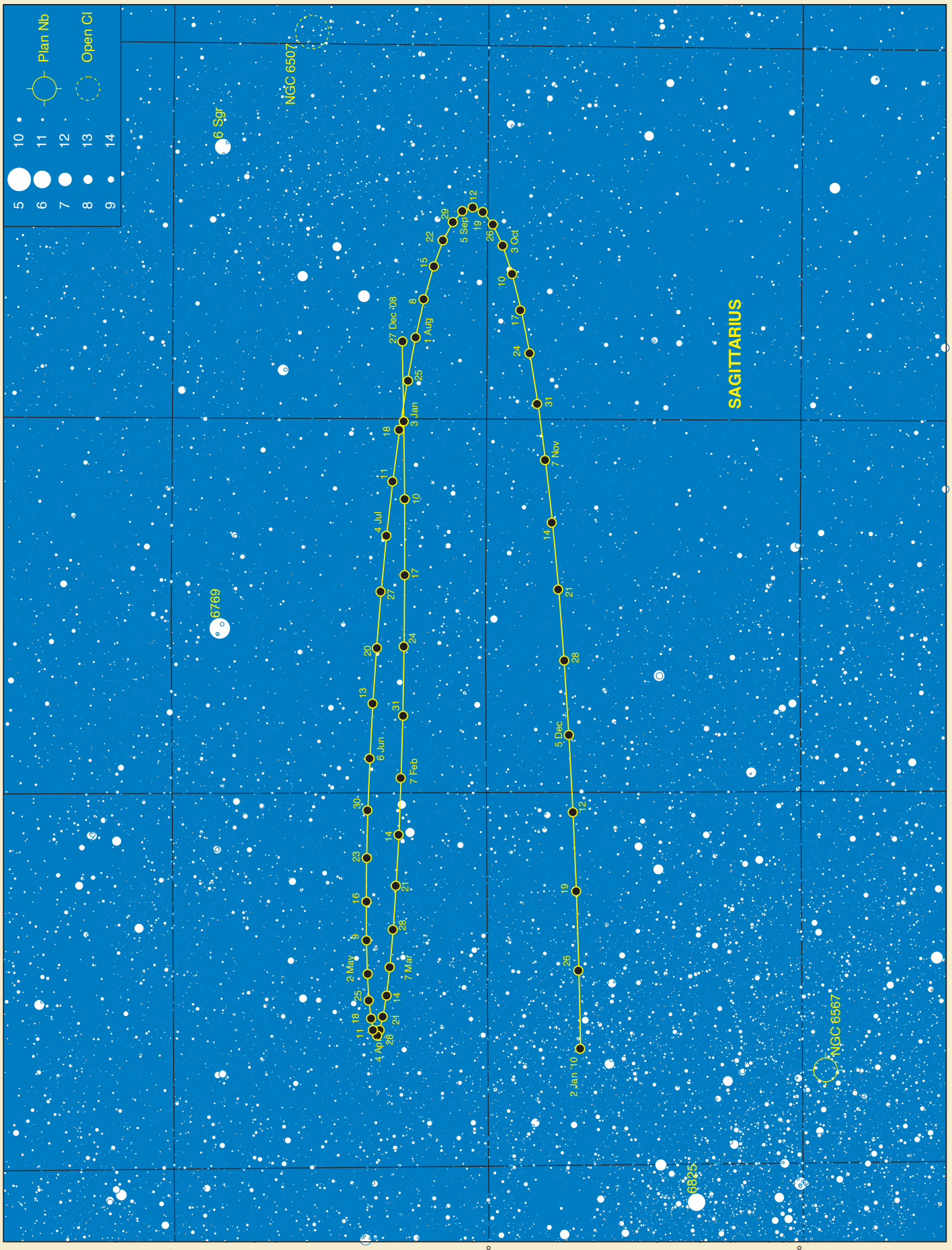
Conjunction 12th February, Stationary 29th May, Opposition 18th August, Stationary 5th November.

PLUTO POINTER CHART



Stationary 4th April, Opposition 23rd June, Stationary 12th September, Conjunction 25th December.

PLUTO FINDER CHART



MINOR PLANET POSITIONS

(0HR UT, EPOCH 2000.0)

As well as the planets, their moons and the comets, the Solar System contains numerous smaller bodies known as the minor planets or asteroids. There are now hundreds of thousands of such bodies catalogued! Most of these are found in the asteroid belt between the orbits of Mars and Jupiter. The majority of these objects are extremely faint and difficult to observe. Many can be found by imaging the area, at least twice, over several days and detecting them as they move against the distant star field. The same can be achieved by observing the field and making drawings over several days to detect which 'star' has moved. Be sure you have the right field of view! Only about sixty of these bodies can be considered bright (by amateur standards) and most of them only around their time of opposition.

The ephemerides are for the twenty two brightest minor planets for 2009. Twenty of these reach opposition in 2009. The selected asteroids are all about 10th magnitude or brighter around the time of opposition.

	1 CERES			2 PALLAS			3 JUNO			4 VESTA		
	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag
Jan 3	11 18.2	+ 18 08	7.8	04 50.4	- 31 20	8.0	19 31.6	- 13 44	10.9	02 03.3	+ 05 10	7.7
10	11 20.3	+ 18 42	7.7	04 47.1	- 30 03	8.1	19 43.0	- 13 26	10.8	02 06.5	+ 05 55	7.8
17	11 21.2	+ 19 23	7.6	04 45.3	- 28 29	8.1	19 54.4	- 13 05	10.8	02 10.6	+ 06 44	7.9
24	11 20.6	+ 20 12	7.4	04 45.1	- 26 41	8.2	20 05.8	- 12 40	10.7	02 15.8	+ 07 36	8.0
31	11 18.6	+ 21 06	7.3	04 46.4	- 24 41	8.2	20 17.3	- 12 11	10.8	02 21.8	+ 08 30	8.1
Feb 7	11 15.4	+ 22 03	7.1	04 49.3	- 22 35	8.3	20 28.7	- 11 39	10.8	02 28.6	+ 09 26	8.1
14	11 10.9	+ 22 59	7.0	04 53.7	- 20 23	8.3	20 40.2	- 11 04	10.8	02 36.1	+ 10 22	8.2
21	11 05.5	+ 23 53	6.9	04 59.3	- 18 09	8.4	20 51.6	- 10 25	10.8	02 44.2	+ 11 19	8.3
28	10 59.5	+ 24 39	6.9	05 06.3	- 15 56	8.4	21 02.9	- 09 44	10.8	02 53.0	+ 12 16	8.3
Mar 7	10 53.3	+ 25 16	7.0	05 14.3	- 13 44	8.5	21 14.1	- 09 00	10.8	03 02.2	+ 13 12	8.4
14	10 47.4	+ 25 41	7.1	05 23.4	- 11 36	8.6	21 25.2	- 08 15	10.8	03 12.0	+ 14 08	8.4
21	10 42.0	+ 25 54	7.2	05 33.4	- 09 32	8.6	21 36.2	- 07 27	10.8	03 22.1	+ 15 01	8.4
28	10 37.7	+ 25 53	7.4	05 44.2	- 07 35	8.7	21 47.1	- 06 37	10.7	03 32.7	+ 15 53	8.4
Apr 4	10 34.4	+ 25 41	7.5	05 55.7	- 05 44	8.7	21 57.8	- 05 47	10.7	03 43.6	+ 16 43	8.5
11	10 32.5	+ 25 18	7.6	06 07.8	- 04 01	8.8	22 08.4	- 04 55	10.7	03 54.9	+ 17 31	8.5
18	10 31.9	+ 24 46	7.8	06 20.5	- 02 26	8.8	22 18.8	- 04 03	10.6	04 06.5	+ 18 15	8.5
25	10 32.7	+ 24 05	7.9	06 33.6	- 01 00	8.8	22 29.0	- 03 12	10.6	04 18.3	+ 18 57	8.5
May 2	10 34.6	+ 23 18	8.0	06 47.2	+ 00 18	8.9	22 39.0	- 02 20	10.5	04 30.4	+ 19 35	8.4
9	10 37.7	+ 22 25	8.1	07 01.1	+ 01 28	8.9	22 48.7	- 01 29	10.5	04 42.7	+ 20 09	8.4
16	10 41.9	+ 21 26	8.2	07 15.2	+ 02 28	8.9	22 58.2	- 00 40	10.4	04 55.2	+ 20 40	8.4
23	10 46.9	+ 20 24	8.3	07 29.6	+ 03 20	9.0	23 07.4	+ 00 08	10.3	05 07.9	+ 21 07	8.4
30	10 52.7	+ 19 18	8.4	07 44.1	+ 04 03	9.0	23 16.3	+ 00 53	10.2	05 20.8	+ 21 30	8.3
Jun 6	10 59.3	+ 18 09	8.5	07 58.8	+ 04 38	9.0	23 24.8	+ 01 35	10.1	05 33.7	+ 21 49	8.3
13	11 06.4	+ 16 57	8.6	08 13.5	+ 05 06	9.0	23 32.9	+ 02 13	10.0	05 46.8	+ 22 04	8.2
20	11 14.1	+ 15 43	8.6	08 28.2	+ 05 25	9.0	23 40.5	+ 02 47	9.9	05 59.9	+ 22 15	8.1
27	11 22.2	+ 14 27	8.7	08 43.0	+ 05 38	9.0	23 47.6	+ 03 15	9.8	06 13.1	+ 22 21	8.1
Jul 4	11 30.8	+ 13 09	8.7	08 57.7	+ 05 44	9.0	23 54.0	+ 03 37	9.7	06 26.2	+ 22 23	8.2
11	11 39.7	+ 11 50	8.8	09 12.3	+ 05 45	9.0	23 59.8	+ 03 52	9.5	06 39.4	+ 22 21	8.3
18	11 48.9	+ 10 29	8.8	09 26.9	+ 05 39	9.0	00 04.7	+ 03 59	9.4	06 52.5	+ 22 15	8.3
25	11 58.3	+ 09 08	8.8	09 41.4	+ 05 29	9.0	00 08.8	+ 03 56	9.2	07 05.6	+ 22 05	8.4
Aug 1	12 08.0	+ 07 46	8.8	09 55.8	+ 05 14	9.0	00 11.8	+ 03 42	9.0	07 18.6	+ 21 52	8.4
8	12 17.9	+ 06 23	8.9	10 10.1	+ 04 55	8.9	00 13.7	+ 03 17	8.9	07 31.5	+ 21 34	8.4
15	12 28.1	+ 05 01	8.9	10 24.3	+ 04 32	8.9	00 14.5	+ 02 39	8.7	07 44.2	+ 21 14	8.4
22	12 38.4	+ 03 38	8.9	10 38.3	+ 04 07	8.9	00 14.0	+ 01 48	8.5	07 56.8	+ 20 50	8.4
29	12 48.8	+ 02 16	8.9	10 52.3	+ 03 39	8.8	00 12.3	+ 00 45	8.3	08 09.2	+ 20 24	8.4
Sep 5	12 59.5	+ 00 54	8.8	11 06.1	+ 03 10	8.7	00 09.4	- 00 30	8.1	08 21.4	+ 19 55	8.4
12	13 10.2	- 00 27	8.8	11 19.8	+ 02 39	8.6	00 05.6	- 01 54	7.9	08 33.4	+ 19 24	8.4
19	13 21.1	- 01 47	8.8	11 33.4	+ 02 08	8.7	00 01.1	- 03 24	7.7	08 45.1	+ 18 51	8.4
26	13 32.2	- 03 06	8.8	11 46.9	+ 01 37	8.8	23 56.3	- 04 56	7.7	08 56.5	+ 18 17	8.4
Oct 3	13 43.3	- 04 23	8.7	12 00.3	+ 01 05	8.9	23 51.6	- 06 24	7.8	09 07.7	+ 17 43	8.3
10	13 54.6	- 05 38	8.7	12 13.6	+ 00 35	9.0	23 47.4	- 07 44	8.0	09 18.4	+ 17 08	8.3
17	14 06.0	- 06 52	8.6	12 26.7	+ 00 06	9.1	23 44.0	- 08 54	8.1	09 28.9	+ 16 34	8.2
24	14 17.5	- 08 03	8.6	12 39.8	- 00 21	9.2	23 41.9	- 09 49	8.2	09 38.8	+ 16 00	8.2
31	14 29.1	- 09 12	8.5	12 52.7	- 00 45	9.2	23 41.1	- 10 30	8.4	09 48.4	+ 15 29	8.1
Nov 7	14 40.7	- 10 18	8.5	13 05.5	- 01 06	9.3	23 41.7	- 10 56	8.5	09 57.4	+ 14 59	8.0
14	14 52.4	- 11 21	8.6	13 18.1	- 01 24	9.3	23 43.8	- 11 06	8.6	10 05.8	+ 14 33	8.0
21	15 04.2	- 12 22	8.7	13 30.6	- 01 37	9.4	23 47.4	- 11 04	8.7	10 13.6	+ 14 11	7.9
28	15 16.0	- 13 19	8.8	13 42.9	- 01 45	9.4	23 52.2	- 10 48	8.8	10 20.6	+ 13 54	7.8
Dec 5	15 27.8	- 14 12	8.8	13 55.0	- 01 48	9.4	23 58.4	- 10 21	8.9	10 26.9	+ 13 43	7.7
12	15 39.6	- 15 03	8.9	14 06.8	- 01 46	9.4	00 05.6	- 09 45	9.0	10 32.1	+ 13 38	7.5
19	15 51.3	- 15 49	8.9	14 18.4	- 01 36	9.4	00 13.8	- 08 59	9.1	10 36.4	+ 13 41	7.4
26	16 03.0	- 16 32	8.9	14 29.6	- 01 19	9.4	00 22.9	- 08 06	9.2	10 39.5	+ 13 53	7.3

	6 HEBE			7 IRIS			8 FLORA			11 PARTHENOPE			14 IRENE			15 EUNOMIA		
Jan 3	14 38.7	- 03 00	11.4	16 56.8	- 23 37	11.3	13 50.3	- 05 27	11.4	22 48.8	- 11 04	11.5	13 33.5	+ 00 25	10.8	13 02.0	- 18 34	11.0
10	14 46.8	- 03 09	11.3	17 08.3	- 23 48	11.3	13 58.4	- 05 56	11.3	23 00.8	- 09 50	11.5	13 43.9	- 00 11	10.7	13 06.5	- 19 31	10.9
17	14 54.5	- 03 11	11.3	17 19.7	- 23 56	11.3	14 05.8	- 06 20	11.3	23 13.0	- 08 34	11.5	13 53.7	- 00 42	10.6	13 10.2	- 20 25	10.9
24	15 01.6	- 03 09	11.2	17 30.9	- 24 00	11.3	14 12.5	- 06 37	11.2	23 25.2	- 07 16	11.5	14 02.7	- 01 06	10.5	13 13.0	- 21 15	10.8
31	15 08.2	- 03 00	11.2	17 42.0	- 24 01	11.3	14 18.4	- 06 48	11.1	23 37.6	- 05 56	11.6	14 11.0	- 01 23	10.4	13 14.8	- 22 01	10.7
Feb 7	15 14.0	- 02 45	11.1	17 52.8	- 23 59	11.3	14 23.2	- 06 53	11.0	23 50.1	- 04 36	11.6	14 18.2	- 01 33	10.3	13 15.5	- 22 41	10.6
14	15 19.1	- 02 23	11.0	18 03.2	- 23 54	11.2	14 27.0	- 06 51	10.9	00 02.6	- 03 14	11.6	14 24.4	- 01 37	10.2	13 15.2	- 23 16	10.5
21	15 23.3	- 01 56	10.9	18 13.4	- 23 46	11.2	14 29.7	- 06 42	10.8	00 15.2	- 01 52	11.6	14 29.3	- 01 33	10.0	13 13.7	- 23 44	10.4
28	15 26.6	- 01 22	10.8	18 23.2	- 23 35	11.2	14 31.0	- 06 26	10.7	00 27.8	- 00 30	11.5	14 32.9	- 01 23	9.9	13 11.0	- 24 04	10.3
Mar 7	15 28.8	- 00 42	10.7	18 32.5	- 23 22	11.1	14 30.9	- 06 04	10.5	00 40.5	+ 00 51	11.5	14 34.9	- 01 07	9.7	13 07.2	- 24 15	10.2
14	15 29.9	+ 00 02	10.6	18 41.2	- 23 08	11.0	14 29.5	- 05 35	10.4	00 53.2	+ 02 12	11.5	14 35.4	- 00 46	9.6	13 02.5	- 24 17	10.1
21	15 29.9	+ 00 52	10.5	18 49.5	- 22 51	11.0	14 26.6	- 05 01	10.3	01 05.9	+ 03 32	11.5	14 34.3	- 00 21	9.4	12 57.0	- 24 08	10.0
28	15 28.6	+ 01 44	10.3	18 57.0	- 22 33	10.9	14 22.4	- 04 23	10.1	01 18.8	+ 04 50	11.4	14 31.6	+ 00 05	9.3	12 50.9	- 23 50	9.9
Apr 4	15 26.1	+ 02 38	10.2	19 03.8	- 22 14	10.8	14 17.0	- 03 42	10.0	01 31.6	+ 06 07	11.4	14 27.5	+ 00 31	9.1	12 44.5	- 23 23	9.8
11	15 22.4	+ 03 32	10.1	19 09.9	- 21 55	10.7	14 10.7	- 03 00	9.9	01 44.5	+ 07 21	11.3	14 22.3	+ 00 54	9.0	12 38.3	- 22 47	9.8
18	15 17.8	+ 04 24	10.0	19 15.0	- 21 35	10.6	14 03.9	- 02 21	9.8	01 57.4	+ 08 33	11.2	14 16.2	+ 01 12	8.9	12 32.4	- 22 06	9.9
25	15 12.3	+ 05 11	9.9	19 19.1	- 21 16	10.5	13 56.8	- 01 45	9.8	02 10.4	+ 09 43	11.2	14 09.8	+ 01 22	8.9	12 27.1	- 21 20	10.0
May 2	15 06.2	+ 05 52	9.9	19 22.1	- 20 58	10.3	13 50.0	- 01 15	9.9	02 23.4	+ 10 49	11.3	14 03.5	+ 01 23	9.0	12 22.7	- 20 33	10.1
9	14 59.9	+ 06 23	9.9	19 24.0	- 20 41	10.2	13 43.7	- 00 54	10.1	02 36.4	+ 11 52	11.4	13 57.7	+ 01 13	9.2	12 19.3	- 19 47	10.2
16	14 53.6	+ 06 44	9.9	19 24.5	- 20 25	10.1	13 38.3	- 00 41	10.2	02 49.5	+ 12 52	11.5	13 52.8	+ 00 53	9.4	12 16.9	- 19 04	10.3
23	14 47.6	+ 06 55	10.0	19 23.7	- 20 11	9.9	13 34.0	- 00 37	10.4	03 02.5	+ 13 48	11.6	13 49.2	+ 00 23	9.5	12 15.7	- 18 25	10.4
30	14 42.3	+ 06 54	10.1	19 21.6	- 19 59	9.7	13 30.9	- 00 43	10.5	03 15.5	+ 14 41	11.6	13 46.8	- 00 16	9.7	12 15.6	- 17 51	10.5
Jun 6	14 37.8	+ 06 41	10.2	19 18.0	- 19 48	9.5	13 29.2	- 00 57	10.6	03 28.6	+ 15 29	11.7	13 45.9	- 01 02	9.9	12 16.5	- 17 24	10.6
13	14 34.3	+ 06 19	10.3	19 13.1	- 19 40	9.3	13 28.7	- 01 19	10.8	03 41.5	+ 16 13	11.7	13 46.4	- 01 56	10.0	12 18.5	- 17 03	10.7
20	14 32.0	+ 05 48	10.4	19 07.1	- 19 33	9.1	13 29.5	- 01 48	10.9	03 54.4	+ 16 53	11.7	13 48.1	- 02 55	10.2	12 21.3	- 16 49	10.8
27	14 30.7	+ 05 09	10.5	19 00.2	- 19 27	8.9	13 31.4	- 02 23	11.0	04 07.2	+ 17 29	11.8	13 51.2	- 03 58	10.3	12 25.0	- 16 41	10.9
Jul 4	14 30.6	+ 04 24	10.6	18 52.8	- 19 22	8.7	13 34.4	- 03 04	11.1	04 19.9	+ 18 00	11.8	13 55.3	- 05 04	10.5	12 29.5	- 16 39	11.0
11	14 31.7	+ 03 33	10.7	18 45.2	- 19 17	8.8	13 38.5	- 03 49	11.2	04 32.4	+ 18 27	11.8	14 00.5	- 06 13	10.6	12 34.7	- 16 43	11.0
18	14 33.7	+ 02 38	10.8	18 37.9	- 19 13	9.0	13 43.4	- 04 38	11.3	04 44.8	+ 18 50	11.8	14 06.7	- 07 23	10.7	12 40.5	- 16 53	11.1
25	14 36.8	+ 01 40	10.8	18 31.2	- 19 09	9.1	13 49.1	- 05 30	11.4	04 56.9	+ 19 09	11.8	14 13.7	- 08 34	10.8	12 46.8	- 17 07	11.2
Aug 1	14 40.8	+ 00 39	10.9	18 25.6	- 19 06	9.3	13 55.6	- 06 24	11.4	05 08.8	+ 19 23	11.8	14 21.4	- 09 46	10.9	12 53.7	- 17 26	11.2
8	14 45.6	- 00 24	10.9	18 21.2	- 19 03	9.4	14 02.8	- 07 20	11.5	05 20.3	+ 19 34	11.8	14 29.9	- 10 57	11.0	13 01.1	- 17 49	11.2
15	14 51.2	- 01 27	11.0	18 18.3	- 19 01	9.5	14 10.6	- 08 18	11.5	05 31.5	+ 19 41	11.8	14 38.9	- 12 08	11.1	13 08.9	- 18 15	11.3
22	14 57.6	- 02 32	11.0	18 17.0	- 19 00	9.7	14 19.0	- 09 16	11.6	05 42.3	+ 19 45	11.8	14 48.5	- 13 18	11.2	13 17.1	- 18 44	11.3
29	15 04.7	- 03 36	11.1	18 17.1	- 18 59	9.8	14 28.0	- 10 15	11.6	05 52.5	+ 19 45	11.8	14 58.7	- 14 26	11.3	13 25.6	- 19 16	11.3
Sep 5	15 12.4	- 04 40	11.1	18 18.8	- 18 59	9.9	14 37.4	- 11 14	11.6	06 02.3	+ 19 43	11.7	15 09.4	- 15 32	11.3	13 34.5	- 19 50	11.3
12	15 20.6	- 05 42	11.1	18 21.9	- 18 58	10.0	14 47.3	- 12 12	11.6	06 11.4	+ 19 38	11.7	15 20.4	- 16 35	11.4	13 43.7	- 20 26	11.3
19	15 29.4	- 06 44	11.1	18 26.3	- 18 57	10.0	14 57.7	- 13 09	11.7	06 19.8	+ 19 31	11.6	15 31.9	- 17 36	11.4	13 53.2	- 21 03	11.3
26	15 38.8	- 07 44	11.1	18 32.0	- 18 55	10.1	15 08.5	- 14 06	11.7	06 27.4	+ 19 23	11.5	15 43.8	- 18 34	11.5	14 03.0	- 21 41	11.3
Oct 3	15 48.6	- 08 41	11.1	18 38.8	- 18 51	10.2	15 19.7	- 15 00	11.7	06 34.1	+ 19 14	11.5	15 56.0	- 19 29	11.5	14 13.0	- 22 20	11.3
10	15 58.9	- 09 37	11.1	18 46.6	- 18 45	10.2	15 31.2	- 15 53	11.7	06 39.9	+ 19 05	11.4	16 08.6	- 20 20	11.5	14 23.2	- 22 59	11.2
17	16 09.5	- 10 29	11.1	18 55.3	- 18 36	10.3	15 43.1	- 16 43	11.6	06 44.6	+ 18 57	11.3	16 21.4	- 21 07	11.6	14 33.7	- 23 38	11.2
24	16 20.6	- 11 19	11.1	19 04.8	- 18 24	10.3	15 55.4	- 17 30	11.6	06 48.0	+ 18 49	11.2	16 34.5	- 21 49	11.6	14 44.4	- 24 17	11.2
31	16 32.1	- 12 05	11.0	19 15.1	- 18 09	10.3	16 08.0	- 18 15	11.6	06 50.2	+ 18 43	11.1	16 47.8	- 22 28	11.6	14 55.3	- 24 54	11.1
Nov 7	16 43.9	- 12 48	11.0	19 26.0	- 17 49	10.4	16 20.9	- 18 56	11.5	06 50.9	+ 18 40	11.0	17 01.4	- 23 02	11.6	15 06.3	- 25 31	11.1
14	16 56.1	- 13 27	11.0	19 37.5	- 17 25	10.4	16 34.0	- 19 33	11.5	06 50.2	+ 18 39	10.8	17 15.0	- 23 31	11.6	15 17.5	- 26 07	11.0
21	17 08.5	- 14 01	10.9	19 49.5	- 16 56	10.4	16 47.4	- 20 07	11.4	06 47.9	+ 18 41	10.7	17 28.9	- 23 56	11.6	15 28.8	- 26 41	11.0
28	17 21.2	- 14 32	10.9	20 02.0	- 16 23	10.4	17 01.1	- 20 36	11.4	06 44.1	+ 18 46	10.5	17 42.8	- 24 15	11.5	15 40.2	- 27 13	11.0
Dec 5	17 34.2	- 14 58	10.8	20 14.8	- 15 44	10.4	17 15.0	- 21 01	11.3	06 39.0	+ 18 54	10.4	17 56.8	- 24 30	11.5	15 51.7	- 27 43	11.1
12	17 47.4	- 15 19	10.7	20 28.0	- 15 00	10.4	17 29.0	- 21 21	11.2	06 32.8	+ 19 04	10.2	18 10.8	- 24 40	11.5	16 03.3	- 28 11	11.1
19	18 00.7	- 15 35	10.7	20 41.5	- 14 11	10.3	17 43.3	- 21 36	11.1	06 25.7	+ 19 17	10.0	18 24.8	- 24 45	11.4	16 14.9	- 28 37	11.1
26	18 14.3	- 15 47	10.6	20 55.3	- 13 17	10.3	17 57.6	- 21 46	11.2	06 18.2	+ 19 30	9.9	18 38.8	- 24 46	11.3	16 26.5	- 29 00	11.2

	16 PSYCHE			18 MELPOMENE			19 FORTUNA			20 MASSALIA			27 EUTERPE			29 AMPHITRITE		
	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag
Jan 3	18 10.9	- 21 22	11.6	18 27.1	- 17 19	11.2	20 48.5	- 16 42	12.1	19 55.2	- 20 16	11.9	09 37.6	+ 15 35	9.7	12 22.8	- 00 45	10.7
10	18 22.6	- 21 18	11.6	18 41.7	- 17 14	11.2	21 02.5	- 15 46	12.1	20 07.3	- 19 41	11.8	09 34.8	+ 15 59	9.5	12 26.9	- 01 20	10.6
17	18 34.3	- 21 11	11.7	18 56.4	- 17 03	11.3	21 16.5	- 14 46	12.0	20 19.5	- 19 03	11.7	09 30.4	+ 16 31	9.3	12 29.9	- 01 49	10.5
24	18 45.9	- 21 00	11.7	19 11.2	- 16 48	11.3	21 30.6	- 13 41	11.9	20 31.5	- 18 22	11.6	09 24.6	+ 17 08	9.1	12 31.7	- 02 11	10.4
31	18 57.5	- 20 46	11.7	19 26.0	- 16 26	11.3	21 44.6	- 12 33	11.9	20 43.6	- 17 37	11.6	09 17.9	+ 17 46	8.9	12 32.3	- 02 27	10.3
Feb 7	19 08.8	- 20 30	11.7	19 40.7	- 16 00	11.3	21 58.7	- 11 21	11.8	20 55.5	- 16 50	11.7	09 10.9	+ 18 24	8.9	12 31.6	- 02 36	10.1
14	19 20.0	- 20 10	11.7	19 55.5	- 15 29	11.3	22 12.8	- 10 05	11.7	21 07.3	- 16 00	11.8	09 04.1	+ 18 58	9.1	12 29.6	- 02 37	10.0
21	19 31.0	- 19 47	11.7	20 10.2	- 14 53	11.3	22 26.8	- 08 47	11.5	21 19.0	- 15 07	11.8	08 58.2	+ 19 25	9.4	12 26.3	- 02 32	9.8
28	19 41.8	- 19 22	11.7	20 24.9	- 14 13	11.3	22 40.8	- 07 25	11.4	21 30.6	- 14 13	11.9	08 53.6	+ 19 44	9.6	12 21.9	- 02 19	9.7
Mar 7	19 52.3	- 18 56	11.7	20 39.5	- 13 28	11.2	22 54.8	- 06 02	11.5	21 42.0	- 13 16	11.9	08 50.6	+ 19 56	9.8	12 16.4	- 02 01	9.5
14	20 02.4	- 18 27	11.7	20 54.0	- 12 40	11.2	23 08.8	- 04 37	11.6	21 53.2	- 12 18	11.9	08 49.3	+ 19 59	10.1	12 10.2	- 01 39	9.4
21	20 12.2	- 17 57	11.6	21 08.4	- 11 48	11.2	23 22.8	- 03 10	11.7	22 04.2	- 11 19	11.9	08 49.7	+ 19 55	10.3	12 03.6	- 01 14	9.1
28	20 21.7	- 17 26	11.6	21 22.8	- 10 53	11.1	23 36.7	- 01 42	11.8	22 15.1	- 10 18	11.9	08 51.8	+ 19 44	10.4	11 57.0	- 00 48	9.3
Apr 4	20 30.7	- 16 54	11.5	21 37.0	- 09 56	11.1	23 50.7	- 00 13	11.8	22 25.7	- 09 17	11.9	08 55.3	+ 19 26	10.6	11 50.8	- 00 24	9.5
11	20 39.2	- 16 22	11.5	21 51.0	- 08 57	11.0	00 04.7	+ 01 15	11.8	22 36.1	- 08 16	11.9	09 00.3	+ 19 03	10.8	11 45.3	- 00 03	9.7
18	20 47.2	- 15 51	11.4	22 05.0	- 07 56	11.0	00 18.6	+ 02 44	11.9	22 46.4	- 07 14	11.9	09 06.3	+ 18 33	10.9	11 40.7	+ 00 13	9.9
25	20 54.6	- 15 20	11.3	22 18.8	- 06 54	10.9	00 32.6	+ 04 12	11.9	22 56.3	- 06 13	11.9	09 13.4	+ 17 59	11.1	11 37.3	+ 00 23	10.0
May 2	21 01.4	- 14 51	11.3	22 32.6	- 05 51	10.9	00 46.6	+ 05 39	11.9	23 06.0	- 05 13	11.9	09 21.3	+ 17 20	11.2	11 35.0	+ 00 27	10.2
9	21 07.6	- 14 25	11.2	22 46.1	- 04 49	10.8	01 00.7	+ 07 05	11.9	23 15.4	- 04 13	11.8	09 30.0	+ 16 36	11.3	11 34.1	+ 00 24	10.3
16	21 12.9	- 14 00	11.1	22 59.5	- 03 47	10.7	01 14.7	+ 08 28	11.9	23 24.5	- 03 15	11.8	09 39.2	+ 15 48	11.4	11 34.3	+ 00 14	10.5
23	21 17.5	- 13 40	11.0	23 12.8	- 02 47	10.6	01 28.8	+ 09 50	11.9	23 33.2	- 02 19	11.7	09 48.9	+ 14 56	11.5	11 35.7	- 00 02	10.6
30	21 21.1	- 13 23	10.9	23 25.9	- 01 49	10.5	01 43.0	+ 11 08	11.9	23 41.5	- 01 24	11.7	09 59.0	+ 14 00	11.6	11 38.2	- 00 23	10.7
Jun 6	21 23.8	- 13 11	10.7	23 38.8	- 00 54	10.4	01 57.1	+ 12 24	11.9	23 49.4	- 00 33	11.6	10 09.4	+ 13 01	11.7	11 41.6	- 00 51	10.8
13	21 25.4	- 13 04	10.6	23 51.5	- 00 02	10.3	02 11.3	+ 13 36	11.9	23 56.9	+ 00 16	11.5	10 20.0	+ 11 59	11.8	11 46.0	- 01 24	10.9
20	21 25.9	- 13 04	10.5	00 04.0	+ 00 44	10.2	02 25.4	+ 14 45	11.9	00 03.8	+ 01 01	11.4	10 30.9	+ 10 53	11.9	11 51.1	- 02 01	11.0
27	21 25.3	- 13 09	10.3	00 16.1	+ 01 25	10.1	02 39.6	+ 15 49	11.9	00 10.1	+ 01 43	11.3	10 42.0	+ 09 46	11.9	11 56.9	- 02 42	11.1
Jul 4	21 23.5	- 13 20	10.2	00 27.9	+ 01 59	10.0	02 53.6	+ 16 49	11.8	00 15.6	+ 02 19	11.2	10 53.1	+ 08 36	12.0	12 03.4	- 03 28	11.1
11	21 20.6	- 13 38	10.0	00 39.2	+ 02 26	9.9	03 07.6	+ 17 44	11.8	00 20.5	+ 02 51	11.1	11 04.4	+ 07 24	12.0	12 10.4	- 04 16	11.2
18	21 16.7	- 14 01	9.8	00 50.0	+ 02 44	9.7	03 21.5	+ 18 35	11.8	00 24.4	+ 03 17	11.0	11 15.8	+ 06 10	12.1	12 17.9	- 05 08	11.3
25	21 11.9	- 14 29	9.7	01 00.2	+ 02 51	9.6	03 35.1	+ 19 20	11.7	00 27.4	+ 03 36	10.9	11 27.3	+ 04 55	12.1	12 25.9	- 06 02	11.3
Aug 1	21 06.6	- 14 59	9.5	01 09.5	+ 02 48	9.4	03 48.6	+ 20 00	11.7	00 29.3	+ 03 49	10.7	11 38.8	+ 03 39	12.1	12 34.3	- 06 58	11.3
8	21 00.9	- 15 32	9.3	01 18.0	+ 02 32	9.3	04 01.7	+ 20 34	11.6	00 30.0	+ 03 54	10.6	11 50.4	+ 02 22	12.2	12 43.1	- 07 57	11.4
15	20 55.3	- 16 04	9.5	01 25.3	+ 02 03	9.1	04 14.4	+ 21 04	11.6	00 29.5	+ 03 50	10.4	12 02.0	+ 01 05	12.2	12 52.2	- 08 56	11.4
22	20 50.0	- 16 35	9.7	01 31.4	+ 01 21	8.9	04 26.7	+ 21 28	11.5	00 27.7	+ 03 38	10.2	12 13.7	- 00 13	12.2	13 01.7	- 09 57	11.4
29	20 45.4	- 17 03	9.8	01 36.1	+ 00 24	8.7	04 38.4	+ 21 48	11.4	00 24.6	+ 03 18	10.1	12 25.5	- 01 30	12.2	13 11.4	- 10 59	11.4
Sep 5	20 41.8	- 17 26	10.0	01 39.1	- 00 46	8.5	04 49.3	+ 22 02	11.4	00 20.3	+ 02 50	9.9	12 37.3	- 02 47	12.2	13 21.4	- 12 01	11.4
12	20 39.3	- 17 45	10.1	01 40.5	- 02 09	8.4	04 59.5	+ 22 12	11.3	00 15.1	+ 02 14	9.7	12 49.1	- 04 04	12.2	13 31.7	- 13 04	11.4
19	20 38.1	- 17 59	10.2	01 40.2	- 03 40	8.2	05 08.7	+ 22 19	11.2	00 09.1	+ 01 34	9.5	13 01.0	- 05 20	12.1	13 42.2	- 14 07	11.4
26	20 38.1	- 18 08	10.3	01 38.2	- 05 15	8.0	05 16.8	+ 22 21	11.1	00 02.7	+ 00 50	9.3	13 13.0	- 06 35	12.1	13 53.0	- 15 09	11.4
Oct 3	20 39.5	- 18 11	10.4	01 35.0	- 06 50	7.9	05 23.7	+ 22 20	10.9	23 56.4	+ 00 07	9.5	13 25.0	- 07 48	12.1	14 04.0	- 16 10	11.4
10	20 42.1	- 18 08	10.6	01 30.8	- 08 16	7.9	05 29.2	+ 22 17	10.8	23 50.5	- 00 34	9.7	13 37.0	- 08 59	12.0	14 15.2	- 17 11	11.3
17	20 45.9	- 18 01	10.7	01 26.1	- 09 30	7.9	05 33.0	+ 22 12	10.7	23 45.4	- 01 10	9.8	13 49.1	- 10 09	11.9	14 26.6	- 18 10	11.3
24	20 50.7	- 17 48	10.7	01 21.6	- 10 25	8.1	05 35.2	+ 22 04	10.5	23 41.4	- 01 39	10.0	14 01.2	- 11 17	11.8	14 38.2	- 19 08	11.3
31	20 56.6	- 17 31	10.8	01 17.7	- 10 59	8.2	05 35.5	+ 21 56	10.4	23 38.6	- 02 00	10.1	14 13.4	- 12 22	11.9	14 50.0	- 20 04	11.2
Nov 7	21 03.4	- 17 08	10.9	01 15.0	- 11 11	8.4	05 33.9	+ 21 46	10.2	23 37.3	- 02 11	10.2	14 25.6	- 13 24	12.0	15 01.9	- 20 58	11.1
14	21 10.9	- 16 41	11.0	01 13.6	- 11 02	8.6	05 30.5	+ 21 35	10.0	23 37.4	- 02 14	10.4	14 37.8	- 14 23	12.1	15 14.0	- 21 50	11.1
21	21 19.1	- 16 08	11.0	01 13.7	- 10 35	8.8	05 25.5	+ 21 22	9.8	23 38.9	- 02 06	10.5	14 50.0	- 15 20	12.2	15 26.3	- 22 39	11.1
28	21 28.0	- 15 32	11.1	01 15.5	- 09 51	9.0	05 19.1	+ 21 09	9.6	23 41.8	- 01 51	10.6	15 02.2	- 16 13	12.3	15 38.6	- 23 25	11.2
Dec 5	21 37.3	- 14 51	11.1	01 18.7	- 08 53	9.1	05 12.0	+ 20 55	9.4	23 45.8	- 01 27	10.7	15 14.4	- 17 03	12.3	15 51.1	- 24 09	11.2
12	21 47.1	- 14 05	11.2	01 23.4	- 07 45	9.3	05 04.5	+ 20 41	9.3	23 51.0	- 00 55	10.8	15 26.5	- 17 49	12.4	16 03.6	- 24 50	11.3
19	21 57.3	- 13 16	11.2	01 29.4	- 06 28	9.5	04 57.4	+ 20 28	9.6	23 57.2	- 00 17	10.9	15 38.5	- 18 32	12.4	16 16.1	- 25 27	11.3
26	22 07.8	- 12 23	11.2	01 36.5	- 05 04	9.6	04 51.1	+ 20 17	9.9	00 04.3	+ 00 28	10.9	15 50.4	- 19 10	12.4	16 28.7	- 26 01	11.4

	40 HARMONIA			42 ISIS			88 THISBE			89 JULIA			324 BAMBERGA			654 ZELINDA		
	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag	R.A. h mm	Dec ° '	Mag
Jan 3	07 47.0	+ 23 08	9.8	17 16.8	- 21 32	12.3	17 52.2	- 24 22	12.1	19 05.4	- 27 46	11.3	20 09.8	- 22 52	11.4	08 23.7	+ 08 56	10.2
10	07 39.2	+ 23 42	9.6	17 32.8	- 21 59	12.3	18 07.0	- 24 15	12.1	19 20.8	- 26 59	11.3	20 25.8	- 21 40	11.3	08 15.9	+ 06 56	10.0
17	07 31.2	+ 24 15	9.7	17 49.1	- 22 20	12.3	18 21.9	- 24 02	12.2	19 36.1	- 26 05	11.3	20 41.8	- 20 21	11.2	08 07.1	+ 05 03	9.9
24	07 23.5	+ 24 43	9.9	18 05.5	- 22 35	12.3	18 36.7	- 23 45	12.2	19 51.2	- 25 07	11.3	20 57.8	- 18 57	11.1	07 58.0	+ 03 22	9.9
31	07 16.6	+ 25 06	10.1	18 21.9	- 22 45	12.3	18 51.3	- 23 22	12.2	20 06.2	- 24 03	11.4	21 13.8	- 17 26	11.0	07 49.5	+ 01 57	10.0
Feb 7	07 11.1	+ 25 23	10.3	18 38.5	- 22 48	12.2	19 05.8	- 22 54	12.2	20 21.0	- 22 54	11.4	21 29.8	- 15 50	10.8	07 42.2	+ 00 48	10.2
14	07 07.2	+ 25 36	10.5	18 55.0	- 22 46	12.2	19 20.1	- 22 21	12.2	20 35.5	- 21 40	11.4	21 45.7	- 14 08	10.7	07 36.6	- 00 05	10.4
21	07 05.1	+ 25 43	10.7	19 11.6	- 22 38	12.2	19 34.2	- 21 44	12.2	20 49.9	- 20 22	11.5	22 01.6	- 12 22	10.8	07 33.2	- 00 42	10.6
28	07 04.6	+ 25 47	10.9	19 28.1	- 22 25	12.2	19 48.0	- 21 02	12.2	21 04.0	- 18 59	11.5	22 17.5	- 10 30	10.9	07 31.9	- 01 08	10.8
Mar 7	07 05.9	+ 25 46	11.0	19 44.4	- 22 07	12.1	20 01.4	- 20 16	12.2	21 17.8	- 17 32	11.5	22 33.3	- 08 35	10.9	07 32.9	- 01 25	11.0
14	07 08.8	+ 25 43	11.2	20 00.7	- 21 45	12.1	20 14.6	- 19 26	12.2	21 31.4	- 16 01	11.5	22 49.1	- 06 35	11.0	07 35.8	- 01 36	11.2
21	07 13.1	+ 25 36	11.3	20 16.8	- 21 18	12.0	20 27.4	- 18 33	12.1	21 44.7	- 14 27	11.5	23 04.8	- 04 33	11.0	07 40.6	- 01 44	11.3
28	07 18.8	+ 25 26	11.4	20 32.7	- 20 48	12.0	20 39.7	- 17 37	12.1	21 57.8	- 12 49	11.5	23 20.6	- 02 27	11.0	07 47.1	- 01 50	11.5
Apr 4	07 25.5	+ 25 12	11.5	20 48.4	- 20 14	11.9	20 51.7	- 16 39	12.1	22 10.6	- 11 08	11.5	23 36.4	- 00 19	11.1	07 54.9	- 01 57	11.6
11	07 33.2	+ 24 55	11.6	21 03.8	- 19 38	11.9	21 03.1	- 15 38	12.0	22 23.1	- 09 25	11.4	23 52.2	+ 01 50	11.1	08 04.1	- 02 06	11.8
18	07 41.8	+ 24 35	11.7	21 18.9	- 19 01	11.8	21 14.1	- 14 37	12.0	22 35.4	- 07 38	11.4	00 08.1	+ 04 00	11.1	08 14.2	- 02 18	11.9
25	07 51.0	+ 24 11	11.8	21 33.7	- 18 22	11.7	21 24.6	- 13 34	11.9	22 47.3	- 05 50	11.4	00 24.1	+ 06 11	11.1	08 25.2	- 02 34	12.0
May 2	08 00.9	+ 23 43	11.9	21 48.1	- 17 44	11.6	21 34.4	- 12 31	11.8	22 59.0	- 03 59	11.4	00 40.2	+ 08 21	11.1	08 37.0	- 02 54	12.1
9	08 11.3	+ 23 12	11.9	22 02.1	- 17 06	11.6	21 43.6	- 11 29	11.8	23 10.4	- 02 07	11.3	00 56.4	+ 10 30	11.1	08 49.4	- 03 18	12.2
16	08 22.1	+ 22 36	12.0	22 15.7	- 16 30	11.5	21 52.1	- 10 27	11.7	23 21.5	- 00 13	11.3	01 12.8	+ 12 37	11.1	09 02.4	- 03 47	12.3
23	08 33.3	+ 21 57	12.0	22 28.8	- 15 56	11.4	21 59.9	- 09 27	11.6	23 32.2	+ 01 42	11.2	01 29.4	+ 14 42	11.1	09 15.7	- 04 21	12.4
30	08 44.7	+ 21 14	12.1	22 41.3	- 15 26	11.3	22 06.8	- 08 28	11.5	23 42.6	+ 03 39	11.2	01 46.1	+ 16 44	11.1	09 29.4	- 05 00	12.5
Jun 6	08 56.4	+ 20 27	12.1	22 53.2	- 15 01	11.2	22 12.9	- 07 33	11.4	23 52.6	+ 05 36	11.1	02 02.9	+ 18 41	11.1	09 43.4	- 05 43	12.6
13	09 08.2	+ 19 37	12.1	23 04.4	- 14 42	11.1	22 17.9	- 06 42	11.3	00 02.2	+ 07 34	11.0	02 20.0	+ 20 34	11.1	09 57.6	- 06 30	12.7
20	09 20.2	+ 18 43	12.1	23 14.7	- 14 30	10.9	22 21.9	- 05 54	11.2	00 11.3	+ 09 33	11.0	02 37.2	+ 22 22	11.1	10 11.9	- 07 21	12.8
27	09 32.2	+ 17 46	12.2	23 24.2	- 14 25	10.8	22 24.6	- 05 12	11.0	00 19.9	+ 11 32	10.9	02 54.6	+ 24 04	11.1	10 26.4	- 08 16	12.8
Jul 4	09 44.4	+ 16 46	12.2	23 32.6	- 14 30	10.7	22 26.1	- 04 37	10.9	00 27.8	+ 13 31	10.8	03 12.1	+ 25 39	11.1	10 41.0	- 09 13	12.9
11	09 56.6	+ 15 43	12.2	23 39.8	- 14 44	10.5	22 26.3	- 04 08	10.7	00 35.0	+ 15 29	10.7	03 29.6	+ 27 08	11.1	10 55.7	- 10 13	13.0
18	10 08.8	+ 14 37	12.1	23 45.7	- 15 08	10.4	22 25.2	- 03 47	10.6	00 41.4	+ 17 27	10.6	03 47.2	+ 28 29	11.1	11 10.5	- 11 16	13.0
25	10 21.0	+ 13 28	12.1	23 50.0	- 15 42	10.2	22 22.7	- 03 34	10.4	00 46.9	+ 19 24	10.5	04 04.8	+ 29 43	11.1	11 25.3	- 12 20	13.1
Aug 1	10 33.3	+ 12 18	12.1	23 52.7	- 16 26	10.1	22 19.1	- 03 30	10.3	00 51.2	+ 21 18	10.4	04 22.2	+ 30 50	11.1	11 40.1	- 13 25	13.1
8	10 45.5	+ 11 05	12.1	23 53.7	- 17 18	9.9	22 14.4	- 03 33	10.1	00 54.3	+ 23 09	10.2	04 39.4	+ 31 49	11.1	11 55.0	- 14 32	13.2
15	10 57.8	+ 09 50	12.0	23 52.9	- 18 15	9.8	22 09.0	- 03 45	9.9	00 56.1	+ 24 56	10.1	04 56.3	+ 32 41	11.1	12 09.9	- 15 38	13.2
22	11 10.1	+ 08 34	12.0	23 50.4	- 19 15	9.6	22 03.1	- 04 02	9.8	00 56.2	+ 26 37	10.0	05 12.8	+ 33 26	11.1	12 24.9	- 16 45	13.2
29	11 22.3	+ 07 17	11.9	23 46.4	- 20 12	9.5	21 57.4	- 04 24	9.9	00 54.7	+ 28 09	9.8	05 28.7	+ 34 05	11.1	12 39.9	- 17 50	13.3
Sep 5	11 34.6	+ 05 59	11.9	23 41.3	- 21 02	9.4	21 52.0	- 04 48	10.0	00 51.6	+ 29 30	9.7	05 44.0	+ 34 39	11.0	12 55.0	- 18 55	13.3
12	11 46.8	+ 04 40	11.8	23 35.6	- 21 41	9.5	21 47.4	- 05 12	10.2	00 46.8	+ 30 37	9.6	05 58.5	+ 35 08	11.0	13 10.1	- 19 59	13.3
19	11 59.1	+ 03 21	11.7	23 29.7	- 22 04	9.6	21 43.9	- 05 35	10.4	00 40.6	+ 31 27	9.5	06 12.1	+ 35 33	11.0	13 25.3	- 21 01	13.3
26	12 11.3	+ 02 02	11.7	23 24.4	- 22 11	9.7	21 41.7	- 05 54	10.6	00 33.3	+ 31 57	9.4	06 24.6	+ 35 55	10.9	13 40.5	- 22 00	13.4
Oct 3	12 23.6	+ 00 43	11.8	23 20.0	- 22 01	9.9	21 40.8	- 06 09	10.8	00 25.6	+ 32 08	9.3	06 35.9	+ 36 15	10.9	13 55.7	- 22 57	13.4
10	12 35.9	- 00 36	11.9	23 16.9	- 21 35	10.1	21 41.4	- 06 18	10.9	00 17.9	+ 31 59	9.3	06 45.8	+ 36 34	10.8	14 11.0	- 23 51	13.4
17	12 48.1	- 01 53	11.9	23 15.3	- 20 55	10.3	21 43.3	- 06 22	11.1	00 11.0	+ 31 32	9.3	06 54.2	+ 36 53	10.7	14 26.4	- 24 42	13.4
24	13 00.4	- 03 10	12.0	23 15.2	- 20 02	10.5	21 46.4	- 06 20	11.2	00 05.2	+ 30 52	9.4	07 00.8	+ 37 13	10.6	14 41.8	- 25 30	13.3
31	13 12.8	- 04 25	12.0	23 16.7	- 19 00	10.7	21 50.8	- 06 11	11.4	00 01.1	+ 30 03	9.6	07 05.5	+ 37 34	10.5	14 57.2	- 26 13	13.3
Nov 7	13 25.1	- 05 38	12.1	23 19.6	- 17 49	10.9	21 56.2	- 05 56	11.5	23 58.8	+ 29 10	9.7	07 08.1	+ 37 56	10.4	15 12.6	- 26 52	13.3
14	13 37.4	- 06 49	12.1	23 23.8	- 16 32	11.0	22 02.5	- 05 35	11.6	23 58.4	+ 28 18	9.9	07 08.5	+ 38 18	10.3	15 28.0	- 27 27	13.3
21	13 49.7	- 07 58	12.1	23 29.2	- 15 09	11.2	22 09.6	- 05 09	11.7	23 59.8	+ 27 28	10.0	07 06.6	+ 38 39	10.2	15 43.3	- 27 58	13.3
28	14 01.9	- 09 04	12.1	23 35.6	- 13 43	11.4	22 17.5	- 04 36	11.8	00 02.9	+ 26 45	10.2	07 02.5	+ 38 56	10.1	15 58.6	- 28 24	13.3
Dec 5	14 14.2	- 10 07	12.1	23 42.8	- 12 13	11.5	22 26.0	- 03 59	11.9	00 07.6	+ 26 10	10.3	06 56.3	+ 39 08	10.0	16 13.8	- 28 45	13.4
12	14 26.3	- 11 07	12.1	23 50.8	- 10 42	11.6	22 35.0	- 03 17	12.0	00 13.6	+ 25 42	10.5	06 48.4	+ 39 12	9.9	16 28.9	- 29 01	13.4
19	14 38.4	- 12 03	12.1	23 59.4	- 09 08	11.8	22 44.5	- 02 31	12.1	00 20.9	+ 25 24	10.6	06 39.3	+ 39 05	9.8	16 43.8	- 29 12	13.5
26	14 50.4	- 12 56	12.1	00 08.6	- 07 33	11.9	22 54.3	- 01 40	12.1	00 29.3	+ 25 13	10.7	06 29.8	+ 38 46	9.8	16 58.5	- 29 18	13.6

COMETS FOR 2009

WHAT IS A COMET? It is a member of the Solar System, which is normally in a very eccentric orbit around the Sun. The orbits of periodic, or regularly reappearing comets are quite eccentric or oval compared to those of the planets. Comets also differ from the planets by being far less massive, containing significant quantities of water, in the form of ice, and dust. A common analogy is a 'dirty snowball' (admittedly a number of kilometres in diameter). The time a periodic comet takes to orbit the Sun varies greatly from comet to comet. The one with the shortest period, Encke, takes just over three years to orbit the Sun. There are also a number of comets that are not expected to return for hundreds of years. Each year sees the discovery of comets that have not been recorded before. The majority of these have either open-ended orbits (they are believed to be making their only visit to the Solar System and are not expected to return) or have extremely long orbital periods measured in thousands of years.

As a comet draws closer to the Sun, the nucleus or snowball heats up and the ice sublimates forming a cloud called a coma around the core. The coma can be tens of thousands of kilometres in diameter. The solar wind, on its outward journey from the Sun, sweeps the coma cloud of its lightweight ionized particles forming the ion tail of the comet. This tail always points away from the Sun. The other tail that can form is a dust tail. This is made up of dust grains that trail behind the comet along the direction of its path. The lost material from the coma will continue to be replenished from the nucleus as long as the comet stays close to the Sun. Comets do not always have tails. In fact some may only show the coma.

Comets are normally named after their discoverers (up to the first three to report the find). There are also other designations given to comets (you will see examples on the following pages). The prefix 'P/' means the comet is periodic. The number before the 'P' indicates the number of the periodic comet. For example Comet 88P/Howell indicates 'Howell' was the 88th comet confirmed to be periodic. The prefix is not assigned until the comet is found on a later return. You will also see references to another naming system, best explained with an example. Notice Comet LINEAR is referred to as 'C/2007 G1'. 2007 refers to the year, G is the seventh half-month period ('I' is not used) during the year and 1 shows it was the first discovery in this half month. Therefore C/2007 G1 (LINEAR) was the first comet discovered in the first half of April 2007.

There is no such thing as a typical comet. Like people, they are all slightly different. The orbit, overall brightness, size of the coma and tail can vary dramatically from comet to comet and even from return to return. To watch one brighten, develop a tail and then fade away over a period of a few weeks, can be a fascinating experience.

This section is devoted to the comets that are expected to be observable during 2009, most of them passing through perihelion – closest approach to the Sun – during this year. The table (opposite) lists the brightest comets along with their orbital elements. This is the data required to calculate their locations in the sky. The elements are followed by 'ephemerides' (a list of expected positions in the sky and magnitude estimates for different dates) for some of the brighter comets. These positions can be plotted on the All Sky Maps to get an idea of where they are in the sky. The magnitude parameters can often be inaccurate, having been based on their behaviour on previous returns. There are also non-gravitational effects associated with comets, which can render predicted ephemerides inaccurate, especially when extrapolating orbital elements from previous returns.

Often you will read references to a comet's return being favourable (well placed) or unfavourable. There are a few factors that determine this. For example, when the comet is at its expected maximum brightness, its apparent position in the sky could have it too close to the Sun or on the opposite side of the Sun from Earth. This would likely be considered unfavourable.

Many of the comets expected in 2009 are extremely faint and would require professional-size telescopes or long exposure photographs/images to detect them, but who knows what could be discovered tomorrow?

Comet McNaught by Ted Dobosz, Sydney NSW. Taken from Woodford (Blue Mountains) Jan 20 2007.

NOTES ON SELECTED COMETS FOR 2009 – *by Greg Bryant*

22P/Kopff: German astronomer August Kopff discovered this comet on photographs taken in August 1906. The 12th magnitude comet was revealed to be periodic within a few weeks, although the subsequent return of 1912-13 was too unfavourable for recovery. 1919 saw the comet recovered by Max Wolf quite close to the predicted position.

Since 1919, Kopff has been seen at every apparition. Its return in 1996 was extremely favourable, with the comet's closest approach to Earth (0.57 AU) occurring just days after perihelion. As a result, the comet rose to better than 8th magnitude in brightness.

81P/Wild 2: This is the second of four periodic comets discovered by Paul Wild from the Astronomical Institute of Berne. First noticed on photographs taken in January 1978, it is making its sixth observed apparition. Comet Wild 2 is noted for being a relatively 'fresh' comet in the inner Solar System. A close encounter (0.2 AU) with Jupiter in 1974 (four years before the comet's discovery) moved the comet into its current orbit. Prior to 1974, the comet is calculated to have come no closer to the Sun than 5 AU, with a period of nearly 40 years. In January 2004, NASA's Stardust probe flew past the comet.

88P/Howell: Ellen Howell discovered this comet on photographic plates taken in August 1981 with the 0.46m Schmidt telescope at Palomar. Within a fortnight, the periodic nature of the comet was confirmed. Three close approaches to Jupiter during the 20th Century have progressively brought the comet closer to the Sun, from a minimum distance of 2 AU to the current 1.4 AU. Jupiter will play a role again later this century, pushing the comet out again. This is the 6th observed apparition of comet Howell.

118P/Shoemaker-Levy 4: The team of Carolyn and Eugene Shoemaker and David Levy discovered this comet on plates taken in February 1991 with the 0.46m Schmidt telescope at Palomar. Shoemaker-Levy 4 orbits the Sun every 6.4 years at a minimum distance of around 2 AU.

144P/Kushida: Yoshio Kushida (Yatsugatake South Base Observatory, Japan) discovered this comet on January 8, 1994. Within a few days calculations had shown the comet to be periodic, orbiting the Sun every 7.6 years. Comet Kushida was recovered in 2000, ahead of its 2001 perihelion passage, and it returns to perihelion in January 2009.

169P/NEAT: The Near-Earth Asteroid Tracking programme (NEAT) in the United States discovered this comet in March 2002. It was initially deemed to be a minor planet, but observations three years later revealed it to be a comet! Additional observations have shown the comet is not always active. There is a possibility that the comet may be related to another periodic comet, 141P/Machholz 2.

P/2001 MD_7 (LINEAR): The Lincoln Near Earth Asteroid Research programme (LINEAR) discovered this comet initially as a minor planet in June 2001. The following month, LINEAR picked it up again and it was showing all the hallmarks of a comet. It orbits the Sun every 7.8 years.

P/2003 K2 (Christensen): Eric Christensen discovered this comet in May 2003 during the course of the Catalina Sky survey. It's probable that this comet is the same as an unconfirmed one reported a month earlier from the SWAN camera on board the solar observatory SOHO. The comet was shortly discovered to be periodic, orbiting the Sun every 5.7 years. Christensen can come fairly close to Earth, passing 0.37 AU this year, and 0.27 AU in 2026.

C/2006 W3 (Christensen): Another discovery for Christensen in the course of the Catalina Sky survey, this comet was detected on images taken in November 2006. It reaches perihelion in July at a distance of 3.1 AU from the Sun.

C/2007 G1 (LINEAR): Since its inception a decade ago, the LINEAR programme has seen 238 comet discoveries (as at the time of writing). Its 176th find, C/2007 G1 (LINEAR), was discovered on April 10, 2007 as an apparently asteroidal object, and subsequently confirmed to be a comet. It will reach perihelion in November 2008.

C/2007 N3 (Lulin): The Lulin Minor Bodies Tracking programme in Taiwan, which utilises a 0.41m telescope, discovered an apparently asteroidal object on July 11, 2007. Within a week, it was confirmed to be a comet, the first such discovery for the Lulin programme (and the first comet discovery from Taiwan). Comet Lulin will reach perihelion on January 10, 2009 at a distance from the Sun of 1.2 AU. It may reach 6th magnitude in February 2009 and be visible in binoculars.

C/2007 Q3 (Siding Spring): This comet was found during the course of the Siding Spring survey, using the 0.5m Uppsala Schmidt telescope at Siding Spring, near Coonabarabran. Perihelion is in October at a distance of 2.2 AU from the Sun.

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BRIGHT COMETS FOR 2009 – ORBITAL ELEMENTS (Equinox 2000.0)

Comet Name	Perihelion Date yyyy mm dd.dddd	q AU	e	Period years	ω °	Ω °	Incl. °	H1	K1
C/2007 G1 (LINEAR)	2008 11 16.3150	2.647148	1.001729		223.9830	78.9949	88.3309	5.5	10.0
C/2007 N3 (Lulin)	2009 01 10.6418	1.212288	0.999982		136.8618	338.5353	178.3730	6.5	10.0
144P/Kushida	2009 01 26.8552	1.438948	0.627824	7.6	216.0937	245.5655	4.1092	9.5	15.0
P/2003 K2 (Christensen)	2009 01 08.8585	0.533992	0.832917	5.7	345.9246	93.8471	10.2222	15.0	9.0
22P/Kopff	2009 05 25.4020	1.577587	0.544340	6.4	162.8161	120.8985	4.7239	6.5	12.5
C/2006 W3 (Christensen)	2009 07 06.6618	3.126204	1.000035		133.5190	113.5726	127.0735	4.0	10.0
P/2001 MD_7 (LINEAR)	2009 09 08.9599	1.223980	0.689603	7.8	246.7445	125.6220	12.8814	11.5	16.0
88P/Howell	2009 10 12.4730	1.363483	0.562001	5.5	235.9620	56.7565	4.3816	7.0	18.0
C/2007 Q3 (Siding Spring)	2009 10 07.2729	2.251656	1.000243		2.0914	149.4132	65.6503	4.5	10.0
169P/NEAT	2009 11 30.3044	0.607750	0.766782	4.2	217.9590	176.1910	11.2998	16.0	20.0
118P/Shoemaker-Levy 4	2010 01 02.3251	1.983925	0.427351	6.4	302.1450	151.8071	8.5094	8.5	12.0
81P/Wild 2	2010 02 22.7209	1.598059	0.537391	6.4	41.7939	136.0970	3.2375	7.0	15.0

Perihelion Date Date of closest approach to the Sun.

q The perihelion distance, in AU (Astronomical Units).

e The eccentricity of the comet's orbit. Values less than one indicate a known periodic comet with an elliptical orbit. A value equal to or greater than one indicates: an open orbit (a once only visitor to the Solar System), it has a very long period (thousands of years) or it is newly discovered and astronomers have not clearly defined its orbit.

Period The comet's period in years. The time taken for one orbit of the Sun.

ω Argument of Perihelion. The angle from the ascending node to perihelion (measured in the plane of the comet's orbit in the direction of motion of the comet).

Ω Longitude of Ascending Node. The point of intersection between the plane of the comet's orbit and the plane of the Earth's orbit (Ecliptic) as the comet moves north.

i Inclination. Angle between the plane of the comet's orbit and the plane of the ecliptic. A value greater than 90° means the comet's orbit direction is retrograde (moves in the opposite direction to the planets).

H1 The absolute total magnitude of the comet, which is the theoretical brightness of the comet if it was one AU from the Sun and the Earth.

K1 A constant used in calculating the comet's total magnitude (see 'explanation of comet ephemerides' for further details p. 133).

Calculation of ephemerides from these elements is complex (but not difficult, with the power of home computers) but beyond the scope of this book.

Comet 22P/Kopff

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg °	Mag
2009 Jan 3	15 25.8	-14 47	2.580	2.086	50	12.5
2009 Jan 10	15 41.9	-15 40	2.481	2.046	53	12.4
2009 Jan 17	15 58.4	-16 28	2.383	2.007	56	12.2
2009 Jan 24	16 15.4	-17 11	2.285	1.969	59	12.0
2009 Jan 31	16 32.8	-17 48	2.188	1.932	62	11.8
2009 Feb 7	16 50.7	-18 19	2.093	1.896	65	11.6
2009 Feb 14	17 08.9	-18 43	2.000	1.860	68	11.4
2009 Feb 21	17 27.5	-18 60	1.908	1.827	70	11.2
2009 Feb 28	17 46.5	-19 09	1.820	1.794	73	11.0
2009 Mar 7	18 05.7	-19 10	1.735	1.763	75	10.8
2009 Mar 14	18 25.2	-19 03	1.653	1.734	78	10.6
2009 Mar 21	18 44.8	-18 48	1.574	1.707	80	10.4
2009 Mar 28	19 04.5	-18 26	1.500	1.682	82	10.2
2009 Apr 4	19 24.1	-17 55	1.429	1.660	84	10.0
2009 Apr 11	19 43.7	-17 18	1.362	1.639	86	9.9
2009 Apr 18	20 03.0	-16 35	1.299	1.622	89	9.7
2009 Apr 25	20 22.0	-15 46	1.240	1.607	91	9.5
2009 May 2	20 40.5	-14 54	1.185	1.595	93	9.4
2009 May 9	20 58.5	-13 60	1.133	1.586	95	9.3
2009 May 16	21 15.8	-13 05	1.085	1.580	98	9.2
2009 May 23	21 32.2	-12 11	1.040	1.578	100	9.1
2009 May 30	21 47.7	-11 21	0.999	1.578	103	9.0
2009 Jun 6	22 02.1	-10 36	0.960	1.582	106	8.9
2009 Jun 13	22 15.3	-09 58	0.924	1.589	110	8.8
2009 Jun 20	22 27.0	-09 28	0.892	1.599	114	8.8
2009 Jun 27	22 37.2	-09 10	0.862	1.611	118	8.8
2009 Jul 4	22 45.6	-09 03	0.836	1.627	123	8.8
2009 Jul 11	22 52.2	-09 09	0.813	1.645	128	8.8
2009 Jul 18	22 56.8	-09 27	0.795	1.666	134	8.8
2009 Jul 25	22 59.4	-09 59	0.782	1.690	140	8.8
2009 Aug 1	23 00.1	-10 41	0.775	1.715	147	8.9
2009 Aug 8	22 59.0	-11 32	0.776	1.743	154	9.0
2009 Aug 15	22 56.4	-12 27	0.784	1.773	161	9.1
2009 Aug 22	22 52.8	-13 22	0.802	1.804	168	9.2
2009 Aug 29	22 48.7	-14 12	0.830	1.837	173	9.4
2009 Sep 5	22 44.6	-14 55	0.868	1.871	172	9.6
2009 Sep 12	22 41.1	-15 27	0.916	1.907	165	9.8
2009 Sep 19	22 38.4	-15 47	0.975	1.943	158	10.1
2009 Sep 26	22 36.8	-15 56	1.043	1.981	151	10.3
2009 Oct 3	22 36.5	-15 52	1.120	2.019	145	10.6
2009 Oct 10	22 37.6	-15 39	1.205	2.059	138	10.8
2009 Oct 17	22 39.8	-15 16	1.298	2.099	132	11.1
2009 Oct 24	22 43.1	-14 44	1.398	2.139	126	11.4
2009 Oct 31	22 47.5	-14 06	1.504	2.180	120	11.6
2009 Nov 7	22 52.8	-13 23	1.616	2.221	115	11.9
2009 Nov 14	22 58.9	-12 34	1.732	2.262	109	12.1
2009 Nov 21	23 05.6	-11 41	1.853	2.304	104	12.4
2009 Nov 28	23 12.9	-10 44	1.976	2.346	99	12.6
2009 Dec 5	23 20.6	-09 45	2.103	2.388	94	12.8

Comet P/2001 MD$_7$ (LINEAR)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg °	Mag
2009 Jul 25	01 23.9	-03 11	0.691	1.357	104	12.8
2009 Aug 1	01 54.7	-02 58	0.651	1.321	103	12.5
2009 Aug 8	02 26.5	-02 53	0.620	1.291	102	12.2
2009 Aug 15	02 58.4	-02 55	0.598	1.265	100	12.0
2009 Aug 22	03 29.6	-03 03	0.585	1.246	99	11.9
2009 Aug 29	03 59.4	-03 16	0.578	1.232	98	11.8
2009 Sep 5	04 27.0	-03 32	0.578	1.225	97	11.7
2009 Sep 12	04 52.0	-03 49	0.581	1.225	97	11.7
2009 Sep 19	05 14.3	-04 07	0.586	1.231	98	11.8
2009 Sep 26	05 33.5	-04 22	0.593	1.244	99	11.9
2009 Oct 3	05 49.7	-04 34	0.600	1.262	101	12.0
2009 Oct 10	06 02.9	-04 41	0.606	1.287	104	12.2
2009 Oct 17	06 13.1	-04 42	0.612	1.317	108	12.3
2009 Oct 24	06 20.1	-04 34	0.617	1.352	112	12.5
2009 Oct 31	06 24.1	-04 14	0.623	1.391	117	12.8

Comet C/2007 N3 (Lulin)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg °	Mag
2009 Jan 3	15 58.8	-19 38	1.775	1.218	41	8.6
2009 Jan 10	15 53.5	-19 23	1.595	1.212	49	8.4
2009 Jan 17	15 46.0	-19 01	1.399	1.216	58	8.1
2009 Jan 24	15 34.9	-18 25	1.190	1.230	68	7.8
2009 Jan 31	15 17.3	-17 23	0.973	1.253	80	7.4
2009 Feb 7	14 47.8	-15 23	0.757	1.285	94	7.0
2009 Feb 14	13 54.4	-11 03	0.560	1.324	115	6.5
2009 Feb 21	12 17.4	-01 32	0.428	1.370	148	6.0
2009 Feb 28	10 07.0	+11 24	0.436	1.423	170	6.2
2009 Mar 7	08 28.9	+18 31	0.582	1.480	139	7.0
2009 Mar 14	07 35.6	+20 58	0.793	1.541	119	7.9
2009 Mar 21	07 07.1	+21 50	1.027	1.606	105	8.6
2009 Mar 28	06 51.2	+22 10	1.268	1.674	95	9.3
2009 Apr 4	06 42.3	+22 19	1.509	1.745	86	9.8
2009 Apr 11	06 37.4	+22 23	1.747	1.817	78	10.3
2009 Apr 18	06 35.2	+22 24	1.978	1.890	70	10.7
2009 Apr 25	06 34.7	+22 24	2.201	1.965	63	11.1
2009 May 2	06 35.4	+22 23	2.414	2.040	57	11.5
2009 May 9	06 37.0	+22 21	2.616	2.117	50	11.8
2009 May 16	06 39.3	+22 18	2.806	2.193	44	12.2
2009 May 23	06 42.0	+22 15	2.983	2.270	38	12.4
2009 May 30	06 45.0	+22 11	3.147	2.348	32	12.7

Comet 169P/NEAT

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg °	Mag
2009 Nov 14	18 17.9	-22 48	0.866	0.683	43	12.4
2009 Nov 21	18 37.7	-25 16	0.755	0.634	40	11.4
2009 Nov 28	18 55.0	-28 29	0.639	0.609	37	10.7
2009 Dec 5	19 07.1	-32 51	0.526	0.614	33	10.4
2009 Dec 12	19 10.6	-38 50	0.423	0.648	29	10.4
2009 Dec 19	19 01.0	-46 55	0.337	0.704	28	10.6
2009 Dec 26	18 26.6	-57 21	0.269	0.775	34	10.9

Hale-Bopp on 8 April 1997 from the VLA, New Mexico. Six minutes on Kodak Royal 1000, 135mm f/2.8 lens.

Comet 88P/Howell

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg °	Mag
2009 May 30	12 19.8	+00 52	1.286	1.951	116	12.8
2009 Jun 6	12 21.0	+00 19	1.311	1.906	109	12.6
2009 Jun 13	12 23.9	-00 25	1.338	1.860	104	12.5
2009 Jun 20	12 28.4	-01 19	1.365	1.816	98	12.3
2009 Jun 27	12 34.5	-02 22	1.391	1.772	94	12.2
2009 Jul 4	12 42.1	-03 33	1.417	1.729	89	12.0
2009 Jul 11	12 51.1	-04 52	1.440	1.688	85	11.9
2009 Jul 18	13 01.4	-06 18	1.462	1.648	81	11.7
2009 Jul 25	13 13.0	-07 50	1.482	1.609	78	11.6
2009 Aug 1	13 25.9	-09 28	1.499	1.572	75	11.4
2009 Aug 8	13 40.0	-11 09	1.515	1.537	72	11.3
2009 Aug 15	13 55.4	-12 54	1.529	1.504	69	11.1
2009 Aug 22	14 12.1	-14 41	1.541	1.475	67	11.0
2009 Aug 29	14 30.1	-16 28	1.553	1.448	65	10.8
2009 Sep 5	14 49.4	-18 14	1.564	1.424	63	10.7
2009 Sep 12	15 10.0	-19 55	1.575	1.404	61	10.6
2009 Sep 19	15 31.9	-21 31	1.587	1.388	60	10.6
2009 Sep 26	15 55.1	-22 59	1.600	1.376	59	10.5
2009 Oct 3	16 19.5	-24 15	1.615	1.367	57	10.5
2009 Oct 10	16 44.9	-25 18	1.633	1.364	56	10.5
2009 Oct 17	17 11.3	-26 05	1.654	1.364	56	10.5
2009 Oct 24	17 38.3	-26 35	1.679	1.369	55	10.6
2009 Oct 31	18 05.8	-26 45	1.708	1.379	54	10.7
2009 Nov 7	18 33.3	-26 37	1.743	1.392	53	10.8
2009 Nov 14	19 00.7	-26 09	1.782	1.410	52	10.9
2009 Nov 21	19 27.5	-25 22	1.826	1.431	51	11.1
2009 Nov 28	19 53.7	-24 20	1.876	1.455	50	11.3
2009 Dec 5	20 19.0	-23 03	1.930	1.483	49	11.5
2009 Dec 12	20 43.4	-21 34	1.990	1.514	48	11.7
2009 Dec 19	21 06.7	-19 55	2.054	1.547	46	12.0
2009 Dec 26	21 29.0	-18 08	2.122	1.582	45	12.2

EXPLANATION OF COMET EPHEMERIDES

Date is for 0 hr UT (10am EST, 9:30am CST and 8am WST) of date.

R.A., Dec Right Ascension and Declination are for equinox 2000.0

Δ (delta) Geocentric distance (distance from the Earth) in AU.

R Heliocentric distance (distance from the Sun) in AU.

Elg Elongation; angular distance of the comet from the Sun.

Mag This is the expected total magnitude of the comet. The value is only an estimate and for periodic comets it is invariably based on the behaviour of its brightness during previous return(s).

The estimate of total magnitude is normally calculated using the formula: $Mag = H1 + 5 \log (\Delta) + K1 \log R$

See the table of elements for the values of H1 and K1, page 131. For many comets the K1 value is equal to 10. For newly discovered comets the value of K1 is mostly assumed to be equal to 10 until its light curve can be studied in detail. The brightness of a comet is often very uncertain, especially for those newly discovered. In fact, it is now believed that comets making their first visit to the Sun have an average K1 value of approximately 7.5. Comets have also been known to suddenly flare up or fade away and some have even shown a different behaviour in their light curve (changed values for H1 and K1) after perihelion compared to before. There are also constants of H2 and K2 used by astronomers which refer to the absolute magnitude and the K constant for the nucleus of the comet. These are not used in this publication.

Comet C/2007 Q3 (Siding Spring)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg °	Mag
2009 Jan 10	05 29.3	-52 11	3.373	3.698	102	12.8
2009 Jan 17	05 23.9	-50 58	3.327	3.643	101	12.7
2009 Jan 24	05 19.6	-49 31	3.286	3.588	100	12.6
2009 Jan 31	05 16.5	-47 50	3.248	3.533	99	12.5
2009 Feb 7	05 14.7	-45 58	3.216	3.479	97	12.5
2009 Feb 14	05 14.3	-43 55	3.187	3.425	95	12.4
2009 Feb 21	05 15.1	-41 43	3.164	3.371	94	12.3
2009 Feb 28	05 17.3	-39 25	3.145	3.318	91	12.2
2009 Mar 7	05 20.5	-37 03	3.130	3.265	89	12.1
2009 Mar 14	05 24.9	-34 37	3.121	3.213	86	12.0
2009 Mar 21	05 30.3	-32 09	3.115	3.161	84	12.0
2009 Mar 28	05 36.6	-29 41	3.114	3.110	81	11.9
2009 Apr 4	05 43.7	-27 14	3.116	3.060	78	11.8
2009 Apr 11	05 51.6	-24 50	3.123	3.010	74	11.8
2009 Apr 18	06 00.1	-22 29	3.132	2.961	71	11.7
2009 Apr 25	06 09.3	-20 12	3.145	2.913	68	11.6
2009 May 2	06 19.0	-18 01	3.159	2.866	64	11.6
2009 May 9	06 29.1	-15 55	3.176	2.820	61	11.5
2009 May 16	06 39.8	-13 55	3.194	2.775	57	11.5
2009 May 23	06 50.8	-12 01	3.213	2.731	53	11.4
2009 May 30	07 02.1	-10 14	3.233	2.689	50	11.3
2009 Jun 6	07 13.7	-08 34	3.252	2.648	46	11.3
2009 Jun 13	07 25.6	-07 00	3.270	2.608	42	11.2
2009 Jun 20	07 37.8	-05 33	3.287	2.570	38	11.2
2009 Jun 27	07 50.1	-04 13	3.302	2.533	35	11.1
2009 Jul 4	08 02.6	-02 58	3.314	2.498	31	11.1
2009 Jul 11	08 15.2	-01 50	3.324	2.465	27	11.0
2009 Jul 18	08 27.9	-00 47	3.330	2.435	24	11.0
2009 Jul 25	08 40.8	+00 11	3.332	2.406	20	10.9
2009 Aug 1	08 53.7	+01 05	3.330	2.379	17	10.9
2009 Aug 8	09 06.7	+01 55	3.324	2.355	14	10.8
2009 Aug 15	09 19.7	+02 41	3.312	2.333	12	10.8
2009 Aug 22	09 32.9	+03 24	3.296	2.313	12	10.7
2009 Aug 29	09 46.0	+04 05	3.274	2.296	12	10.7
2009 Sep 5	09 59.2	+04 45	3.246	2.282	14	10.6
2009 Sep 12	10 12.5	+05 24	3.214	2.270	17	10.6
2009 Sep 19	10 25.8	+06 03	3.176	2.261	20	10.6
2009 Sep 26	10 39.2	+06 42	3.133	2.255	24	10.5
2009 Oct 3	10 52.6	+07 24	3.084	2.252	28	10.5
2009 Oct 10	11 06.1	+08 08	3.032	2.252	32	10.4
2009 Oct 17	11 19.6	+08 55	2.975	2.254	37	10.4
2009 Oct 24	11 33.2	+09 47	2.914	2.260	41	10.4
2009 Oct 31	11 46.8	+10 45	2.850	2.268	46	10.3
2009 Nov 7	12 00.5	+11 49	2.784	2.279	50	10.3
2009 Nov 14	12 14.2	+13 01	2.716	2.293	55	10.3
2009 Nov 21	12 28.0	+14 23	2.648	2.309	60	10.2
2009 Nov 28	12 41.7	+15 54	2.581	2.328	64	10.2
2009 Dec 5	12 55.4	+17 36	2.515	2.349	69	10.2
2009 Dec 12	13 09.1	+19 29	2.452	2.373	74	10.2
2009 Dec 19	13 22.7	+21 35	2.393	2.399	79	10.2
2009 Dec 26	13 36.1	+23 53	2.340	2.428	83	10.2

Comet 144P/Kushida

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg °	Mag
2009 Jan 3	03 31.2	+15 47	0.613	1.464	132	10.9
2009 Jan 10	03 40.5	+15 39	0.631	1.452	127	10.9
2009 Jan 17	03 52.2	+15 43	0.654	1.443	122	11.0
2009 Jan 24	04 05.9	+15 54	0.681	1.439	118	11.0
2009 Jan 31	04 21.4	+16 12	0.712	1.440	115	11.1
2009 Feb 7	04 38.5	+16 32	0.748	1.444	112	11.3
2009 Feb 14	04 56.9	+16 52	0.788	1.454	109	11.4
2009 Feb 21	05 16.1	+17 10	0.832	1.467	107	11.6
2009 Feb 28	05 36.1	+17 23	0.881	1.484	105	11.8
2009 Mar 7	05 56.4	+17 30	0.935	1.505	103	12.0
2009 Mar 14	06 17.0	+17 30	0.995	1.530	101	12.3
2009 Mar 21	06 37.4	+17 22	1.059	1.558	99	12.5
2009 Mar 28	06 57.7	+17 06	1.129	1.589	97	12.8

METEOR SHOWERS

What is a meteor shower?

A meteor shower is no more than the leftover debris from a comet. A comet has been best described as a 'dirty snowball', a conglomerate of ice, gas, dust and larger particles that become meteoroids when freed from the nucleus. When a comet is near perihelion, very fine dust particles are released from the nucleus as it is warmed by the Sun. These particles are then pushed away by solar radiation or solar wind to form the classical dust tail of a comet. Pieces that are too large to be blown away end up strewn along the comet's orbit to become meteoroids.

Ultimately the meteoroids spread out over the comet's orbit, somewhat like an elliptical-shaped donut. The effects of solar radiation and the slight gravity tugs from the planets will, over time, break up the stream. If the Earth passes through a meteoroid stream we will experience a meteor shower. A typical visual meteor may be as small as a grain of sand, up to the size of a small pea. Particles in space that strike the Earth's atmosphere will have a minimum speed of 11km/s (if the body is at rest when swept up by the Earth), and an upper limit of 73km/s. The Leonid meteors, at 71km/s, are the fastest of the showers.

Incredible velocities such as these (a bullet from a rifle travels at about 1km per second) result in the meteor's kinetic energy being converted to heat when it strikes the atmosphere at an altitude of about 100km. The surrounding air is heated to incandescence by friction and as a consequence we can observe these tiny bodies as they self-destruct in our atmosphere.

Individual meteors during a shower appear to originate from a common point in the sky, known as the radiant. This focal point is named after the constellation in which the meteors appear. Individual particles of meteoroid streams travel though space in parallel paths. The apparent divergence from the radiant is only an illusion, due simply to the effect of perspective. The way that trees and buildings converge on either side of a long straight road is the same effect that is seen when a meteor shower occurs far above an observer.

The table of Meteor Showers has been compiled from the Meteor Shower Calendar produced by the International Meteor Organisation (IMO). It is the most accurate listing for naked-eye meteor observing available today. The table is complete in that both northern and southern showers are listed. Serious meteor observing should be carried out under dark skies, and preferably without the Moon. The best showers for this year, taking into consideration the lunar phase, are summarised in the monthly section.

In addition to the showers catalogued, an average of about 5 to 10 sporadic meteors (originating from random points in the sky) are visible per hour under dark sky conditions. More meteors are seen in the morning sky than in the evening; as the morning sky is facing the Earth's motion in space we tend to 'run into' and 'sweep up' meteors, whereas evening meteors must have sufficient velocity to catch up to the speeding Earth. Amateurs wishing to follow up an interest in meteors, and even make a contribution to meteor science, should contact the International Meteor Organisation. www.imo.net/

SHOWER	MOON PHASE	ACTIVITY DURATION	MAX ACT	RADIANT		DIA	VEL km/s	ZHR
				R.A.	Dec			
Quadrantids (QUA)	FQ	Jan 01-Jan 05	Jan 03	230°	+49°	5°	41	120
alpha-Centaurids (ACE)	FM	Jan 28-Feb 21	Feb 08	211°	–59°	4°	56	5
delta-Leonids (DLE)	NM	Feb 15-Mar 10	Feb 25	168°	+16°	5°	23	2
gamma-Normids (GNO)	FM	Feb 25-Mar 22	Mar 13	239°	–50°	5°	56	4
Lyrids (LYR)	NM	Apr 16-Apr 25	Apr 22	271°	+34°	5°	49	18
pi-Puppids (PPU)*	NM	Apr 15-Apr 28	Apr 23	110°	–45°	5°	18	var
eta-Aquarids (ETA)	FQ	Apr 19-May 28	May 06	338°	–01°	4°	66	70
eta-Lyrids (ELY)	FM	May 3-May 12	May 08	287°	+44°	3°	44	3
June Bootids (JBO)*	FQ	Jun 22-Jul 02	Jun 27	224°	+48°	5°	18	var
Pisces Austrinids (PAU)	FQ	Jul 15-Aug 10	Jul 28	341°	–30°	15°-10°	35	5
Southern delta-Aquarids (SDA)	FQ	Jul 12-Aug 19	Jul 28	339°	–16°	5°	41	20
alpha-Capricornids (CAP)	FQ	Jul 03-Aug 15	Jul 30	307°	–10°	8°	23	4
Perseids (PER)	LQ	Jul 17-Aug 24	Aug 12	046°	+58°	5°	59	100
kappa-Cygnids (KCG)	NM	Aug 03-Aug 25	Aug 17	286°	+59°	6°	25	3
alpha-Aurigids (AUR)	FQ	Aug 25-Sep 08	Aug 31	084°	+42°	5°	66	7
September Perseids (SPE)	LQ	Sep 05-Sep 17	Sep 09	060°	+47°	5°	64	5
delta-Aurigids (DAU)	FM	Sep 18-Oct 10	Oct 03	088°	+49°	5°	64	2
Draconids (GIA)*	LQ	Oct 06-Oct 10	Oct 08	262°	+54°	2°	20	var
Epsilon Geminids (EGE)	NM	Oct 14-Oct 27	Oct 18	102°	+27°	5°	70	2
Orionids (ORI)	NM	Oct 02-Nov 07	Oct 21	095°	+16°	10°	66	30
Leo Minorids (LMI)	FQ	Oct 19-Oct 27	Oct 24	162°	+37°	5°	62	2
Southern Taurids (STA)	FM	Sep 25-Nov 25	Nov 05	052°	+15°	10°-5°	27	5
Northern Taurids (NTA)	LQ	Sep 25-Nov 25	Nov 12	058°	+22°	10°-5°	29	5
Leonids (LEO)	NM	Nov 10-Nov 21	Nov 18	153°	+22°	5°	71	20+
alpha-Monocerotids (AMO)	FQ	Nov 15-Nov 25	Nov 21	117°	+01°	5°	65	var
December Phoenicids (PHO)	LQ	Nov 28-Dec 09	Dec 06	018°	–53°	5°	18	var
Puppid-Velids (PUP)	LQ	Dec 01-Dec 15	Dec 06	123°	–45°	10°	40	10
Monocerotids (MON)	LQ	Nov 27-Dec 17	Dec 08	100°	+08°	5°	42	2
sigma-Hydrids (HYD)	LQ	Dec 03-Dec 15	Dec 11	127°	+02°	5°	58	3
Geminids (GEM)	NM	Dec 07-Dec 17	Dec 13	112°	+33°	5°	35	120
Coma Berenicids (COM)	NM	Dec 12-Jan 23	Dec 20	177°	+25°	5°	65	5
Ursids (URS)	FQ	Dec 17-Dec 26	Dec 22	217°	+76°	5°	33	10

Notes On The Table Above

Shower Name The shower is named after the constellation that the radiant appears in or a bright star near that point. A shower marked with an asterisk (*) is only occasionally active.

Moon Phase The phase of the Moon nearest the date of maximum activity. If a Full Moon occurs near a shower's maximum period, only the very brightest of meteors will be seen.

Activity Duration The approximate dates when the shower is active.

Max Act The date when maximum activity can be expected.

Radiant The position of the shower radiant in right ascension and declination (R.A. is expressed in degrees). These coordinates refer to the radiant position on the date of maximum activity.

Dia The radiant diameter. When two figures are given, the first is the spread in R.A. and the second the spread in Dec.

Vel The apparent velocity through the atmosphere in kilometres per second. The range can be from about 11km/s (very slow) to 71km/s (very fast), medium speed is about 40km/s.

ZHR Zenith Hourly Rate at peak period. A theoretical rate assuming the radiant to be at the zenith with a sky limiting magnitude of 6.5 (perfect conditions).

RISE/SET TIME CORRECTIONS FOR OTHER LOCATIONS

The rise/set tables for the Sun, Moon and planets in Part II are given for our capital cities. Here we help people who live outside these cities make corrections to determine the rise/set times for their specific location. There are two corrections needed.

1. Correct for the difference in longitude. **For every degree of longitude east or west of Sydney, subtract or add respectively 4 minutes to both the rise and set times**. Corrections for various towns and cities are given in Table 1.
2. Correct for the difference in latitude, that also requires the declination for the object of interest. Table 2 presents these corrections (southern latitudes are negative). Note, **for rise times you add these values, for set you subtract**. For your specific latitude it is normally sufficient to interpolate these figures.

It is important that rise and set times for Sydney are used, irrespective of which town in Australia the calculations are for, when using these tables. If your local time is CST, **subtract** 30 minutes, if WST, **subtract** 2 hours. If daylight saving, **add** 60 minutes. In all these calculations, it is easier to first convert all latitudes and longitudes to decimal degrees.

Example Calculate the rise/set times for the Sun on January 10 for Albury (36° 05'S, 146° 55'E)	**Rise**	**Set**
Rise/set values for Sydney (p. 87):	4:55	19:10
Adjust for longitude (Table 1) positive as Albury is west of Sydney.	+ :17	+ :17
Adjust for latitude and declination of the Sun from table 2. Sun's declination is –21° 59' (p. 85)	– :05	+ :05
Rise and Set times for Albury are:	5:07	19:32

Location	Lat. (° ' S)	Longitude (° ' E)	Long. dif (dec. °)	correct. (mins.)
NEW SOUTH WALES				
Albury	36 05	146 55	4.3	17
Bathurst	33 25	149 34	1.7	7
Broken Hill	32 0	141 27	9.8	39
Coffs Harbour	30 13	153 08	-1.9	-8
Dubbo	32 15	148 37	2.6	11
Goulburn	34 45	149 43	1.5	6
Katoomba	33 42	150 18	0.9	4
Newcastle	32 55	151 45	-0.5	-2
Parkes	33 05	148 10	3.1	12
Tamworth	31 03	151 02	0.2	1
Wagga Wagga	35 05	147 20	3.9	16
Wollongong	34 25	150 52	0.4	2
NORTHERN TERRITORY				
Alice Springs	23 42	133 56	17.3	69
Ayers Rock	25 11	130 58	20.3	81
QUEENSLAND				
Bundaberg	24 52	152 21	-1.1	-4
Cairns	16 55	145 49	5.4	22
Longreach	23 22	144 09	7.1	28
Mackay	21 08	149 10	2.1	8
Mount Isa	20 38	139 28	11.8	47
Rockhampton	23 21	150 28	0.8	3
Surfers Paradise	28 00	153 26	-2.2	-9
Toowoomba	27 33	151 58	-0.7	-3
Townsville	19 10	146 49	4.4	18
SOUTH AUSTRALIA				
Port Augusta	32 30	137 52	13.4	54
Port Lincoln	34 42	135 59	15.3	61
Mount Gambier	37 41	140 49	10.4	42
Whyalla	33 02	137 34	13.7	55
TASMANIA				
Launceston	41 20	147 08	4.1	16
Stanley	40 40	145 08	6.1	24

Location	Lat. (° ' S)	Longitude (° ' E)	Long. dif (dec. °)	correct. (mins.)
VICTORIA				
Ballarat	37 25	143 55	7.3	29
Benalla	36 30	146 01	5.2	21
Bendigo	36 46	144 17	7.1	28
Geelong	38 09	144 10	7.1	28
Morwell	38 12	146 21	4.9	20
Shepparton	36 13	145 25	5.8	23
Swan Hill	35 13	143 30	7.8	31
Wangaratta	36 17	146 13	5.0	20
Warnambool	38 27	142 30	8.8	35
WESTERN AUSTRALIA				
Albany	35 01	117 53	33.37	133
Broome	17 58	122 14	29.02	116
Bunbury	33 20	115 38	35.62	142
Carnarvon	24 53	113 40	37.58	150
Derby	17 19	123 38	27.62	110
Esperance	33 52	121 54	29.35	117
Eucla	31 41	128 53	22.37	89
Fitzroy Crossing	18 11	125 36	25.65	103
Geraldton	28 46	114 37	36.63	147
Kalgoorlie	30 45	121 28	29.78	119
Marble Bar	21 10	119 45	31.50	126
Meekatharra	26 36	118 28	32.78	131
Mount Barker	34 38	117 40	33.58	134
Mount Magnet	28 04	117 51	33.40	134
Mount Newman	23 19	119 45	31.50	126
Mount Tom Price	22 41	117 47	33.47	134
Norseman	32 12	121 47	29.47	118
Northam	31 39	116 40	34.58	138
Port Hedland	20 18	118 35	32.67	131
Rawlinna	31 01	125 20	25.92	104
Southern Cross	31 14	119 19	31.93	128
Wagin	33 19	117 20	33.92	136
Wyndham	15 28	128 06	23.15	93
Yampi Sound	16 08	123 36	27.65	111

Table 1 **Longitude adjustments for some places relative to Sydney**

	South Latitude (negative)																
	-12°	-14°	-16°	-18°	-20°	-22°	-24°	-26°	-28°	-30°	-32°	-34°	-36°	-38°	-40°	-42°	-44°
30°	-63	-58	-53	-48	-43	-37	-32	-26	-20	-13	-7	0	8	16	25	34	44
25°	-50	-46	-42	-38	-34	-30	-25	-20	-16	-11	-5	0	6	12	19	26	34
20°	-39	-36	-33	-29	-26	-23	-19	-16	-12	-8	-4	0	5	9	15	20	26
15°	-28	-26	-24	-22	-19	-17	-14	-11	-9	-6	-3	0	3	7	10	14	18
10°	-19	-17	-16	-14	-13	-11	-9	-7	-6	-4	-2	0	2	4	7	9	12
5°	-9	-8	-8	-7	-6	-5	-5	-4	-3	-2	-1	0	1	2	3	5	6
0°	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-5°	9	8	8	7	6	5	5	4	3	2	1	0	-1	-2	-3	-5	-6
-10°	19	17	16	14	13	11	9	7	6	4	2	0	-2	-4	-7	-9	-12
-15°	28	26	24	22	19	17	14	11	9	6	3	0	-3	-7	-10	-14	-18
-20°	39	36	33	29	26	23	19	16	12	8	4	0	-5	-9	-15	-20	-26
-25°	50	46	42	38	34	30	25	20	16	11	5	0	-6	-12	-19	-26	-34
-30°	63	58	53	48	43	37	32	26	20	13	7	0	-8	-16	-25	-34	-44

Declination

Table 2 **Rise/set corrections for latitude/declination (from Sydney)**

JULIAN DATE 2009

To calculate Julian Date (JD), first convert local time to Universal Time (UT); subtract 10 hrs from EST, 9.5 hrs from CST or 8 hrs from WST, correcting the date if necessary. Next find the Julian date given in the table (below left) for the month you are interested in. Now add the day of the month. This will give you JD for 0hr UT on the date in question. Then add the fraction of day from the second table (below right) that matches the time you are calculating for.

Example: you need the Julian date at 23:00 EST on July 17th 2009. Subtract 10 hours to get UT.

23 – 10 = 13:00 hrs UT

From the table the JD for July 0 is 2455012.5
Add the day of month, 17 gives us 2455029.5

Now add the hours as a fraction of a day from the 2nd table. 13hr is 0.542. Thus JD at 23:00hr 17 July 2009 EST is 2455030.042

Julian Date (0hr UT)		
Month		Julian Date
Jan	0	2454831.5
Feb	0	2454862.5
Mar	0	2454890.5
Apr	0	2454921.5
May	0	2454951.5
Jun	0	2454982.5
Jul	0	2455012.5
Aug	0	2455043.5
Sep	0	2455074.5
Oct	0	2455104.5
Nov	0	2455135.5
Dec	0	2455165.5

Hours as decimal of a day.			
1	0.042	13	0.542
2	0.083	14	0.583
3	0.125	15	0.625
4	0.167	16	0.667
5	0.208	17	0.708
6	0.250	18	0.750
7	0.292	19	0.792
8	0.333	20	0.833
9	0.375	21	0.875
10	0.417	22	0.917
11	0.458	23	0.958
12	0.500	24	1.000

SIDEREAL TIME 2009

Jan	0	6.6527	Jul	0	18.5462
Feb	0	8.6897	Aug	0	20.5832
Mar	0	10.5296	Sep	0	22.6202
Apr	0	12.5666	Oct	0	0.5915
May	0	14.5379	Nov	0	2.6285
Jun	0	16.5749	Dec	0	4.5998

Greenwich mean sidereal time (GMST) at 0hr UT

Use the following method to calculate Local Mean Sidereal Time. First convert your local time and date to UT. Now calculate the Greenwich mean sidereal time (GMST) for that date.

GMST on day d of month at hour t UT

= GMST at 0hr UT (from table above)
+ 0.06571 d + 1.00274 t

To convert to local mean sidereal time (LMST)

LMST = GMST + east longitude (or – west)

where longitude is expressed in HOURS (not degrees!) To convert to hours, just divide by 15.

Example: Find LMST at 23 hours Sydney time (EST) on 17th July 2009.

23:00 EST = 13:00 UT
GMST for July 0 is 18.5462 hours.

GMST = 18.5462 +
(0.06571 × 17) +
(1.00274 × 13)
= 32.6989

Sydney's longitude (151.25°) is 10.0833 hrs so

LMST = 32.6989 +
10.0833
= 42.7822

Subtract from this multiples of 24 until it is in the range of 0 to 24

42.7822 – 24 = 18.7822 hrs or 18h 46m 56s

CONSTELLATIONS – Abbreviations and Culmination at 9 pm

Name	Genitive	Abr.	Map	Cul.
Andromeda	Andromedae	And	3, 9	Nov 23
Antlia	Antliae	Ant	4, 6	Apr 10
Apus	Apodis	Aps	1	Jul 5
Aquarius	Aquarii	Aqr	8, 2	Oct 9
Aquila	Aquilae	Aql	8, 9	Aug 30
Ara	Arae	Ara	1, 6	Jul 25
Aries	Arietis	Ari	3	Dec 14
Auriga	Aurigae	Aur	3, 5	Feb 4
Bootes	Bootis	Boo	7	Jun 16
Caelum	Caeli	Cae	2, 4	Jan 15
Camelopardus	Camelopardi	Cam	3, 5	Feb 6
Cancer	Cancri	Cnc	5, 4	Mar 16
Canes Venatici	Canum Venaticorum	CVn	5, 7	May 22
Canis Major	Canis Majoris	CMa	4, 2	Feb 16
Canis Minor	Canis Minoris	CMi	5, 4	Feb 28
Capricornus	Capricorni	Cap	8	Sep 22
Carina	Carinae	Car	1, 4	Mar 17
Cassiopeia	Cassiopeiae	Cas	3, 9	Nov 23
Centaurus	Centauri	Cen	1, 6	May 14
Cepheus	Cephei	Cep	9, 3	Nov 13
Cetus	Ceti	Cet	2, 3	Nov 29
Chamaeleon	Chamaeleontis	Cha	1	Apr 15
Circinus	Circini	Cir	1, 6	Jun 14
Columba	Columbae	Col	4, 2	Feb 1
Coma Berenices	Comae Berenices	Com	7, 5	May 17
Corona Australis	Coronae Australis	CrA	8, 6	Aug 14
Corona Borealis	Coronae Borealis	CrB	7	Jul 3
Corvus	Corvi	Crv	6, 4	May 12
Crater	Crateris	Crt	4, 6	Apr 26
Crux	Crucis	Cru	1	May 12
Cygnus	Cygni	Cyg	9	Sep 13
Delphinus	Delphini	Del	9, 8	Sep 14
Dorado	Doradus	Dor	2, 1	Jan 31
Draco	Draconis	Dra	7, 9	Jul 8
Equuleus	Equulei	Equ	9, 8	Sep 22
Eridanus	Eridani	Eri	2, 1	Dec 25
Fornax	Fornacis	For	2	Dec 17
Gemini	Geminorum	Gem	5, 4	Feb 19
Grus	Gruis	Gru	8, 1	Oct 12
Hercules	Herculis	Her	7, 9	Jul 28
Horologium	Horologii	Hor	2, 1	Dec 25
Hydra	Hydrae	Hya	4, 6	Apr 29
Hydrus	Hydri	Hyi	1	Dec 10
Indus	Indi	Ind	1, 8	Sep 26
Lacerta	Lacertae	Lac	9	Oct 12
Leo	Leonis	Leo	5, 7	Apr 15
Leo Minor	Leonis Minoris	LMi	5, 7	Apr 9
Lepus	Leporis	Lep	2, 4	Jan 28
Libra	Librae	Lib	6	Jun 23
Lupus	Lupi	Lup	6	Jun 23
Lynx	Lyncis	Lyn	5, 3	Mar 5
Lyra	Lyrae	Lyr	9, 7	Aug 18
Mensa	Mensae	Men	1	Jan 28
Microscopium	Microscopii	Mic	8	Sep 18
Monoceros	Monocerotis	Mon	4, 5	Feb 19
Musca	Muscae	Mus	1	May 14
Norma	Normae	Nor	6, 1	Jul 3
Octans	Octantis	Oct	1	Circum
Ophiuchus	Ophiuchi	Oph	6, 7	Jul 26
Orion	Orionis	Ori	2, 3	Jan 27
Pavo	Pavonis	Pav	1, 8	Aug 29
Pegasus	Pegasi	Peg	9, 3	Oct 16
Perseus	Persei	Per	3	Dec 22
Phoenix	Phoenicis	Phe	2, 8	Nov 18
Pictor	Pictoris	Pic	1, 2	Jan 30
Pisces	Piscium	Psc	3, 9	Nov 11
Piscis Austrinus	Piscis Austrini	PsA	2	Oct 9
Puppis	Puppis	Pup	4, 2	Feb 22
Pyxis	Pyxidis	Pyx	4	Mar 21
Reticulum	Reticuli	Ret	1	Jan 3
Sagitta	Sagittae	Sge	9	Aug 30
Sagittarius	Sagittarii	Sgr	8, 6	Aug 21
Scorpius	Scorpii	Sco	6, 8	Jul 18
Sculptor	Sculptoris	Scl	2, 8	Nov 10
Scutum	Scuti	Sct	8	Aug 15
Serpens	Serpentis	Ser	6, 7	Jul 21
Sextans	Sextantis	Sex	4	Apr 8
Taurus	Tauri	Tau	3, 5	Jan 14
Telescopium	Telescopii	Tel	8, 1	Aug 24
Triangulum	Trianguli	Tri	3	Dec 7
Triangulum Australe	Trianguli Australis	TrA	1	Jul 7
Tucana	Tucanae	Tuc	1	Nov 1
Ursa Major	Ursae Majoris	UMa	5, 7	Apr 25
Ursa Minor	Ursae Minoris	UMi	7	Jun 27
Vela	Velorum	Vel	4, 1	Mar 30
Virgo	Virginis	Vir	6, 7	May 26
Volans	Volantis	Vol	1	Mar 4
Vulpecula	Vulpeculae	Vul	9	Sep 8

BRIGHTEST and NEAREST STARS (opposite)

The column descriptions are:

Designation The name of the star in the system created by Bayer, who numbered the stars in the constellations using Greek letters (p. 152). They were usually ordered by their brightness, Alpha being the brightest in most cases.

Name Common name for each star.
Constellation The star's constellation.
RA and Dec. The position of the star, epoch 2000.0.
Magnitude App. The apparent magnitude as seen in the sky.
Magnitude Abs. The absolute magnitude. This is a good indication of how the stars' true luminosities compare. It is the brightness of the star if placed at a distance of 10 parsecs (approximately 32.6 light years) from Earth.
Spectral Type The spectral classification of the star (see below).
Parallax see glossary.
Proper Motion (see glossary).
Distance, ly is light year and **pc** is parsec (see glossary).
Note (d) is a visual double star.
(sb) is a spectroscopic binary.
(eb) is an eclipsing binary.
(v) indicates the star is variable.

The spectral type of a star gives a broad indication of its temperature and colour. The primary classes are **O**, **B**, **A**, **F**, **G**, **K** and **M**, remembered by the mnemonic **O**h **B**e **A** **F**ine **G**irl(Guy) **K**iss **M**e.

There are also now the 'colder' star classes, **L** and **T**. The classes are then broken down into ten subclasses (1 to 10) and also given a luminosity class I, II, III, IV, etc. A discussion of this is beyond this publication.

- The **O** class stars are the hottest blue stars.
- **B** and **A** are white (e.g., Sirius, Rigel).
- **F** and **G** are yellow (e.g., Capella, and the Sun).
- Late **K** (subclass > 5) and **M** stars are the cooler orange and red stars (e.g., Aldebaran, Betelgeuse).

It is an interesting exercise trying to see the colour of stars, but it is worthwhile knowing the limitations of the human eye. The photosensitive part of the eye is the retina. It consists of two types of light receptors, rods and cones. The cones perceive colour and rods see only in shades of grey. The cones only work when there is sufficient light. Starlight, to the unaided eye, activates rods and cones to different degrees. Faint stars are only seen as grey (i.e., no colour).

The colours of stars can be imaged simply. Mount a camera on a tripod and take a time exposure of several minutes. The resulting star trails often show the colours very well. An equatorially tracked time exposure (e.g., piggy-backed on a telescope) with the camera slightly out of focus results in nicely coloured discs of the brightest stars. If in focus, the colour of the brightest stars can be lost as their images can saturate the detector. All such photography should be conducted in country areas, away from city lights.

THE BRIGHTEST STARS

Designation		Name	Constellation	R.A. (2000.0)	Dec (2000.0)	Magnitude App	Abs	Spectral Type	Parallax	Distance pc	ly	Note
1	α CMa	Sirius	Canis Major	06 45.1	–16 43	–1.44	1.5	A1 V	0.3800	2.63	8.58	d
2	α Car	Canopus	Carina	06 23.9	–52 42	–0.74	–5.6	F0 Ib	0.0104	96	310	
3	α Cen	Rigil Kent	Centaurus	14 39.6	–60 50	–0.28	4.1	G2V + K0V	0.7472	1.34	4.37	d
4	α Boo	Arcturus	Bootes	14 15.7	+19 11	–0.05	–0.3	K2 III	0.0889	11.3	36.7	
5	α Lyr	Vega	Lyra	18 36.9	+38 47	0.03	0.6	A0 V	0.1289	7.76	25.3	v
6	α Aur	Capella	Auriga	05 16.7	+46 00	0.08	–0.5	G8III + G0III	0.0773	12.9	42.2	sb, v
7	β Ori	Rigel	Orion	05 14.5	–08 12	0.15	–6.8	B8 Ia	0.0042	240	780	d, v
8	α CMi	Procyon	Canis Minor	07 39.3	+05 14	0.38	2.7	F5 IV–V	0.2861	3.50	11.4	d
9	α Eri	Achernar	Eridanus	01 37.7	–57 14	0.45	–2.8	B5 IV	0.0227	44.1	144	v
10	α Ori	Betelgeuse	Orion	05 55.2	+07 24	0.50	–5.2	M2 Iab	0.0076	131	430	v
11	β Cen	Hadar	Centaurus	14 03.8	–60 22	0.61	–5.4	B1 II + B	0.0062	161	525	d, v
12	α Cru	Acrux	Crux	12 26.6	–63 06	0.74	–4.2	B0.5IV + B0.5V	0.0102	98	320	d
13	α Aql	Altair	Aquila	19 50.8	+08 52	0.76	2.2	A7 IV–V	0.1950	5.13	16.7	
14	α Tau	Aldebaran	Taurus	04 35.9	+16 31	0.87	–0.6	K5 III	0.0501	20.0	65	v
15	α Sco	Antares	Scorpius	16 29.4	–26 26	0.96	–5.1	M1.5Iab + B4V	0.0067	150	490	d, v
16	α Vir	Spica	Virgo	13 25.2	–11 10	0.98	–3.5	B1III–IV + B2V	0.0124	80	262	sb, v
17	β Gem	Pollux	Gemini	07 45.3	+28 02	1.15	1.1	K0 III	0.0967	10.3	33.7	
18	α PsA	Fomalhaut	Piscis Austrinus	22 57.7	–29 37	1.16	1.7	A3 V	0.1301	7.69	25.1	
19	α Cyg	Deneb	Cygnus	20 41.4	+45 17	1.25	–7.2	A2 Ia	0.0020	500	1600	v
20	β Cru	Mimosa	Crux	12 47.7	–59 41	1.26	–3.9	B0.5 III	0.0093	108	353	v
21	α Leo	Regulus	Leo	10 08.4	+11 58	1.36	–0.5	B7 V	0.0421	23.8	78	d
22	ε CMa	Adhara	Canis Major	06 58.6	–28 58	1.50	–4.1	B2 II	0.0076	132	430	d
23	α Gem	Castor	Gemini	07 34.6	+31 53	1.58	0.6	A1V + Am	0.0633	15.8	52	d,sb
24	λ Sco	Shaula	Scorpius	17 33.6	–37 06	1.62	–5.0	B1.5 III	0.0046	215	700	sb, v
25	γ Cru	Gacrux	Crux	12 31.2	–57 07	1.63	–0.5	M3 III	0.0371	27.0	88	v
26	γ Ori	Bellatrix	Orion	05 25.1	+06 21	1.64	–2.7	B2 III	0.0134	75	243	
27	β Tau	El Nath	Taurus	05 26.3	+28 36	1.65	–1.4	B7 III	0.0249	40.2	131	
28	β Car	Miaplacidus	Carina	09 13.2	–69 43	1.67	–1.0	A0 III	0.0293	34.1	111	
29	ε Ori	Alnilam	Orion	05 36.2	–01 12	1.69	–6.4	B0 Ia	0.0024	410	1340	
30	γ Vel	Regor	Vela	08 09.5	–47 20	1.70	–5.4	O9Ib + WC8	0.0039	258	840	sb, v

THE NEAREST STARS

No	Star Name		Constellation	R.A. 2000.0 hh mm.m	Dec ° ‘	Magnitude Apparent	Absolute	Spect Type	Parallax "	Proper Motion "/yr	Distance pc	ly
--	Sun					–26.72	4.85	G2 V				
1	Proxima Centauri		Centaurus	14 29.7	–62 40	11.09	15.53	M5.5 V	0.7720	3.85	1.30	4.23
	Alpha Centauri	A	Centaurus	14 39.6	–60 50	0.01	4.38	G2 V	0.7472	3.71	1.34	4.37
		B				1.34	5.71	K0 V				
2	Barnard’s Star		Ophiuchus	17 57.8	+04 41	9.53	13.22	M4.0 V	0.5470	10.36	1.83	5.96
3	Wolf 359		Leo	10 56.5	+07 00	13.44	16.55	M6.0 V	0.4191	4.70	2.39	7.78
4	Lalande 21185		Ursa Major	11 03.3	+35 58	7.47	10.44	M2.0 V	0.3934	4.80	2.54	8.29
5	Sirius	A	Canis Major	06 45.1	–16 43	–1.44	1.46	A1 V	0.3800	1.34	2.63	8.58
		B				8.44	11.34	DA2				
6	L 726-8 (UV Ceti)	A	Cetus	01 39.0	–17 57	12.54	15.40	M5.5 V	0.3737	3.37	2.68	8.73
		B				12.99	15.85	M6.0 V				
7	Ross 154		Sagittarius	18 49.8	–23 50	10.43	13.07	M3.5 V	0.3369	0.67	2.97	9.68
8	Ross 248		Andromeda	23 41.9	+44 10	12.29	14.79	M5.5 V	0.3160	1.62	3.16	10.32
9	Epsilon Eridani		Eridanus	03 32.9	–09 27	3.73	6.19	K2 V	0.3100	0.98	3.23	10.52
10	Lacaille 9352		Piscis Austrinus	23 05.9	–35 51	7.34	9.75	M1.5 V	0.3036	6.90	3.29	10.74
11	Ross 128		Virgo	11 47.7	+00 48	11.13	13.51	M4.0 V	0.2987	1.36	3.35	10.92
12	L 789-6 (EZ Aquarii)	A	Aquarius	22 38.6	–15 18	13.33	15.64	M5.0 V	0.2895	3.25	3.45	11.27
		B				13.27	15.58	M				
		C				14.03	16.34	M				
13	Procyon	A	Canis Minor	07 39.3	+05 14	0.38	2.66	F5 IV–V	0.2861	1.26	3.50	11.40
		B				10.70	12.98	DA				
14	61 Cygni	A	Cygnus	21 06.9	+38 45	5.21	7.49	K5.0 V	0.2860	5.28	3.50	11.40
		B				6.03	8.31	K7.0 V				
15	Σ 2398	A	Draco	18 42.8	+59 38	8.90	11.16	M3.0 V	0.2830	2.24	3.53	11.53
		B				9.69	11.95	M3.5 V				
16	Groombridge 34	A	Andromeda	00 18.4	+44 01	8.08	10.32	M1.5 V	0.2806	2.92	3.56	11.63
		B				11.06	13.30	M3.5 V				
17	Epsilon Indi		Indus	22 03.4	–56 47	4.69	6.89	K5 Ve	0.2758	4.70	3.63	11.83
18	DX Cancri		Cancer	08 29.8	+26 47	14.78	16.98	M6.5 V	0.2758	1.29	3.63	11.83
19	Tau Ceti		Cetus	01 44.1	–15 56	3.49	5.68	G8 Vp	0.2744	1.92	3.64	11.89
20	GJ 1061		Horologium	03 36.0	–44 31	13.03	15.21	M5.5 V	0.2720	0.81	3.68	11.99
21	YZ Ceti		Cetus	01 12.5	–17 00	12.02	14.17	M4.5 V	0.2688	1.37	3.72	12.13
22	Luyten’s Star		Canis Minor	07 27.4	+05 14	9.86	11.97	M3.5 V	0.2638	3.74	3.79	12.37

MESSIER OBJECTS (Epoch 2000.0)

	Other Ref	R.A.	Dec	Size	Con.	Type	Mag	Map	Notes
M1	NGC 1952	05 34.5	+ 22° 01'	6	Tau	SNR	8.4	5,3	Crab Nebula, remnant from supernova of A.D. 1054
M2	NGC 7089	21 33.5	- 00° 49'	12.9	Aqr	GC	6.5	8	
M3	NGC 5272	13 42.2	+ 28° 23'	16.2	CVn	GC	6.4	7	Large bright globular, brightens suddenly towards the middle
M4	NGC 6121	16 23.6	- 26° 32'	26.3	Sco	GC	5.9	6	Conspicuous globular near Antares
M5	NGC 5904	15 18.6	+ 02° 05'	17.4	Ser	GC	5.8	6	Bright, large very compressed in middle, slightly oval in shape
M6	NGC 6405	17 40.1	- 32° 13'	15	Sco	OC	4.2	6,8	Butterfly Cluster, 80 stars
M7	NGC 6475	17 53.9	- 34° 49'	80	Sco	OC	3.3	6,8	Ptolemy's Cluster, 80 stars brighter than 10th magnitude
M8	NGC 6523	18 03.8	- 24° 23'	90	Sgr	BN	3.5	6,8	Lagoon Nebula, densest section known as the Hourglass, dark lane
M9	NGC 6333	17 19.2	- 18° 31'	9.3	Oph	GC	7.9	6	
M10	NGC 6254	16 57.1	- 04° 06'	15.1	Oph	GC	6.6	6	
M11	NGC 6705	18 51.1	- 06° 16'	14	Sct	OC	5.8	8	Wild Duck Cluster, rich and compact open cluster
M12	NGC 6218	16 47.2	- 01° 57'	14.5	Oph	GC	6.6	6	
M13	NGC 6205	16 41.7	+ 36° 28'	16.6	Her	GC	5.9	7,9	Great Hercules Cluster, showpiece of northern skies
M14	NGC 6402	17 37.6	- 03° 15'	11.7	Oph	GC	7.6	6,7	
M15	NGC 7078	21 30.0	+ 12° 10'	12.3	Peg	GC	6.4	9	Bright, irregularly round, well resolved into faint stars
M16	NGC 6611	18 18.8	- 13° 47'	35	Ser	BN	6	6,8	Associated with Eagle Nebula
M17	NGC 6618	18 20.8	- 16° 11'	46	Sgr	BN	6	6,8	Omega or Swan Nebula
M18	NGC 6613	18 19.9	- 17° 08'	9	Sgr	OC	6.9	6,8	
M19	NGC 6273	17 02.6	- 26° 16'	13.5	Oph	GC	7.2	6	
M20	NGC 6514	18 02.3	- 23° 02'	29	Sgr	BN	6.3	6,8	Trifid Nebula, emission and reflection nebulosity cut by dark lanes
M21	NGC 6531	18 04.6	- 22° 30'	13	Sgr	OC	5.9	6,8	
M22	NGC 6656	18 36.4	- 23° 54'	24	Sgr	GC	5.1	1,6,8	Fine globular, only Omega Centauri and 47 Tucanae are brighter
M23	NGC 6494	17 56.8	- 19° 01'	27	Sgr	OC	5.5	6,8	150 stars, moderate brightness range, lies in good star field
M24	NGC 6603	18 18.4	- 18° 25'	5	Sgr	OC		6,8	Sagittarius Star Cloud, Delle Caustiche
M25	IC4725	18 31.6	- 19° 15'	32	Sgr	OC	4.6	6,8	30 stars loosely scattered
M26	NGC 6694	18 45.2	- 09° 24'	15	Sct	OC	8	8	
M27	NGC 6853	19 59.6	+ 22° 43'	15.2	Vul	PN	7.3	9	Dumbbell Nebula, bright dumbbell shaped, 14th mag. central star
M28	NGC 6626	18 24.5	- 24° 52'	11.2	Sgr	GC	6.9	1,6,8	Large, round, increasingly compressed in the middle
M29	NGC 6913	20 23.9	+ 38° 32'	7	Cyg	OC	6.6	9	
M30	NGC 7099	21 40.4	- 23° 11'	11	Cap	GC	7.5	8	
M31	NGC 224	00 42.7	+ 41° 16'	178	And	SG	3.5	3,9	Andromeda Galaxy
M32	NGC 221	00 42.7	+ 40° 52'	7.6	And	EG	8.2	3,9	
M33	NGC 598	01 33.9	+ 30° 39'	62	Tri	SG	5.7	3	Triangulum or Pinwheel Galaxy, member of Local Group
M34	NGC 1039	02 42.0	+ 42° 47'	35	Per	OC	5.2	3	
M35	NGC 2168	06 08.9	+ 24° 20'	28	Gem	OC	5.1	3,5	200 stars, magnitude 9 to 16
M36	NGC 1960	05 36.1	+ 34° 08'	12	Aur	OC	6	3,5	60 stars, magnitude 9 to 14
M37	NGC 2099	05 52.4	+ 32° 33'	24	Aur	OC	5.6	3,5	150 stars, magnitude range 9 to 12.5
M38	NGC 1912	05 28.7	+ 35° 50'	21	Aur	OC	6.4	3,5	100 stars, mag 9.5 in splendid field
M39	NGC 7092	21 32.2	+ 48° 26'	32	Cyg	OC	4.6	9	
M40	WNC 4	12 22.4	+ 58° 05'	0	UMa	DS	-	5,7	Double Star WNC4
M41	NGC 2287	06 46.0	- 20° 44'	38	CMa	OC	4.5	4	80 stars, 7th magnitude and fainter, with 6.9 mag. red star near centre
M42	NGC 1976	05 35.4	- 05° 27'	66	Ori	BN	3.7	2,3	Orion Nebula, emission and reflection nebula
M43	NGC 1982	05 35.6	- 05° 16'	20	Ori	BN		1,3	de Mairan's nebula; part of Orion Nebula
M44	NGC 2632	08 40.1	+ 19° 59'	95	Cnc	OC	3.1		Praesepe or Beehive Cluster, very large cluster, 50 stars
M45	Pleiades	03 47.0	+ 24° 07'	120	Tau	OC	1.2	3	Seven Sisters, naked-eye cluster
M46	NGC 2437	07 41.8	- 14° 49'	27	Pup	OC	6.1	4	Rich open cluster, 100 stars, planetary nebula NGC 2438 in same field
M47	NGC 2422	07 36.6	- 14° 30'	30	Pup	OC	4.4	4	Large coarse cluster with 30 stars
M48	NGC 2548	08 13.8	- 05° 48'	54	Hya	OC	5.8	4	Large cluster of 80 stars 8 to 13th mag.
M49	NGC 4472	12 29.8	+ 08° 00'	8.9	Vir	EG	8.4	7	
M50	NGC 2323	07 03.2	- 08° 20'	16	Mon	OC	5.9	4	Rich cluster, 80 stars mags 8 to 12
M51	NGC 5194	13 29.9	+ 47° 12'	11	CVn	SG	8.4	5	Whirlpool Galaxy
M52	NGC 7654	23 24.2	+ 61° 35'	13	Cas	OC	6.9	3,9	
M53	NGC 5024	13 12.9	+ 18° 10'	12.6	Com	GC	7.7	7	Bright centre region, very compressed
M54	NGC 6715	18 55.1	- 30° 29'	9.1	Sgr	GC	7.7	1,6,8	
M55	NGC 6809	19 40.0	- 30° 58'	19	Sgr	GC	6.3	8	
M56	NGC 6779	19 16.6	+ 30° 11'	7.1	Lyr	GC	8.3	9	Irregularly round, compressed in the middle
M57	NGC 6720	18 53.6	+ 33° 02'	2.5	Lyr	PN	8.6	7,9	Ring Nebula, ring structure
M58	NGC 4579	12 37.7	+ 11° 49'	5.4	Vir	SG	9.8	7	Bright diffuse nucleus, dark lanes
M59	NGC 4621	12 42.0	+ 11° 39'	5.1	Vir	EG	9.8	7	
M60	NGC 4649	12 43.7	+ 11° 33'	7.2	Vir	EG	8.8	7	
M61	NGC 4303	12 21.9	+ 04° 28'	6	Vir	SG	9.7	7	
M62	NGC 6266	17 01.2	- 30° 07'	14.1	Oph	GC	6.6	6,8	
M63	NGC 5055	13 15.8	+ 42° 02'	12.3	CVn	SG	8.6	5,7	Sunflower Galaxy
M64	NGC 4826	12 56.7	+ 21° 41'	9.3	Com	SG	8.5	7	Blackeye Galaxy
M65	NGC 3623	11 18.9	+ 13° 05'	10	Leo	SG	9.3	5	
M66	NGC 3627	11 20.2	+ 12° 59'	8.7	Leo	SG	9	5	
M67	NGC 2682	08 50.4	+ 11° 49'	30	Cnc	OC	6.9	5	200 stars mag. 10-15, large and rich
M68	NGC 4590	12 39.5	- 26° 45'	12	Hya	GC	8.2	4,6	Rich and compressed
M69	NGC 6637	18 31.4	- 32° 21'	7.1	Sgr	GC	7.7	1,6,8	
M70	NGC 6681	18 43.2	- 32° 18'	7.8	Sgr	GC	8.1	1,6,8	
M71	NGC 6838	19 53.8	+ 18° 47'	7.2	Sge	GC	8.3	9	
M72	NGC 6981	20 53.5	- 12° 32'	5.9	Aqr	GC	9.4	8	
M73	NGC 6994	20 59.0	- 12° 38'	3	Aqr	OC	9	8	
M74	NGC 628	01 36.7	+ 15° 47'	10.2	Psc	SG	9.2	3	

	Other Ref	R.A.	Dec	Size	Con.	Type	Mag	Map	Notes
M75	NGC 6864	20 06.1	- 21° 55'	6	Sgr	GC	8.6	8	
M76	NGC 650	01 42.3	+ 51° 34'	4.8	Per	PN	10.2	3,9	Little Dumbbell Nebula, Cork Nebula
M77	NGC 1068	02 42.7	- 00° 01'	6.9	Cet	SG	8.8	2	Seyfert type with very bright nucleus
M78	NGC 2068	05 46.7	+ 00° 03'	8	Ori	BN	8.0	2,3	Brightest & largest in group of 4 nebulae
M79	NGC 1904	05 24.5	- 24° 33'	8.7	Lep	GC	7.8	2,4	Rich and compressed, well resolved
M80	NGC 6093	16 17.0	- 22° 59'	8.9	Sco	GC	7.2	6	Strong central concentration, bright & large
M81	NGC 3031	09 55.6	+ 69° 04'	25.7	UMa	SG	6.9	5	Bode's Galaxy
M82	NGC 3034	09 55.8	+ 69° 41'	11.2	UMa	IG	8.4	5	Cigar Galaxy
M83	NGC 5236	13 37.0	- 29° 52'	11.2	Hya	SG	7.6	6	Southern Pinwheel Galaxy
M84	NGC 4374	12 25.1	+ 12° 53'	5	Vir	EG	9.3	7	Bright centre, in same field as M86
M85	NGC 4382	12 25.4	+ 18° 11'	7.1	Com	EG	9.2	5,7	
M86	NGC 4406	12 26.2	+ 12° 57'	7.4	Vir	EG	9.2	7	
M87	NGC 4486	12 30.8	+ 12° 24'	7.2	Vir	EG	8.6	7	Virgo A, bright, smooth & featureless
M88	NGC 4501	12 32.0	+ 14° 25'	6.9	Com	SG	9.5	7	
M89	NGC 4552	12 35.7	+ 12° 33'	4.2	Vir	EG	9.8	7	
M90	NGC 4569	12 36.8	+ 13° 10'	9.5	Vir	SG	9.5	7	
M91	NGC 4548	12 35.4	+ 14° 30'	5.4	Com	SG	10.2	7	
M92	NGC 6341	17 17.1	+ 43° 08'	11.2	Her	GC	6.5	7,9	
M93	NGC 2447	07 44.6	- 23° 52'	22	Pup	OC	6.2	4	80 stars magnitude 8 to 13
M94	NGC 4736	12 50.9	+ 41° 07'	11	CVn	SG	8.2	5,7	
M95	NGC 3351	10 44.0	+ 11° 42'	7.4	Leo	SG	9.7	4,5	
M96	NGC 3368	10 46.8	+ 11° 49'	7.1	Leo	SG	9.2	4,5	
M97	NGC 3587	11 14.8	+ 55° 01'	3.2	UMa	PN	9.7	5,7	Owl Nebula
M98	NGC 4192	12 13.8	+ 14° 54'	9.5	Com	SG	10.1	5,7	
M99	NGC 4254	12 18.8	+ 14° 25'	5.4	Com	SG	9.8	5,7	
M100	NGC 4321	12 22.9	+ 15° 49'	6.9	Com	SG	9.4	5,7	
M101	NGC 5457	14 03.2	+ 54° 21'	26.9	UMa	SG	7.7	7	Pinwheel Galaxy
M102									Same as M101
M103	NGC 581	01 33.2	+ 60° 42'	6	Cas	OC	7.4	3,9	
M104	NGC 4594	12 40.0	- 11° 37'	8.9	Vir	SG	8.3	6	Sombrero Galaxy
M105	NGC 3379	10 47.8	+ 12° 35'	4.5	Leo	EG	9.3	4,5	
M106	NGC 4258	12 19.0	+ 47° 18'	18.2	CVn	SG	8.3	5,7	
M107	NGC 6171	16 32.5	- 13° 03'	10	Oph	GC	8.1	6	
M108	NGC 3556	11 11.5	+ 55° 40'	8.3	UMa	SG	10.1	5,7	
M109	NGC 3992	11 57.6	+ 53° 23'	7.6	UMa	SG	9.8	5,7	
M110	NGC 205	00 40.4	+ 41° 41'	17.4	And	EG	8.1	3,9	

LEGEND

Other Ref/ Cat Catalogue number (NGC New General Catalogue, IC Index Catalog, 'M' Messier number)

R.A. Right Ascension (hh mm.m, Epoch 2000.0)

Dec Declination (° ', Epoch 2000.0)

Size In arcminutes

Con. Constellation

Type Object type (see intro Part I)

Mag Magnitude of object

Map All Sky Map number

Notes Common name and/or description

OTHER NON-STELLAR OBJECTS (Epoch 2000.0)

Cat	R.A.	Dec	Size	Con.	Type	Mag	Notes
SMC	00 52.7	-72° 30'	5°x4°	Tuc	IG	2.3	Small Magellanic Cloud. Visible to unaided eye from dark sky
NGC 55	00 14.9	-39° 11'	30'x6.3'	Scl	SG	8.1	A bright galaxy in the Sculptor Group
NGC 104	00 24.1	-72° 05'	30.9'	Tuc	GC	3.8	47 Tucanae, one of the finest globulars
NGC 253	00 47.6	-25° 17'	30'x6.9'	Scl	SG	7.6	Silver Coin galaxy. Large, bright edge-on spiral
Hyades	04 27.0	+16° 00'	6°	Tau	OC	0.5	Naked-eye, V-shaped cluster. 28 stars, the brightest magnitude three and four
LMC	05 23.6	-69° 45'	9°x10°	Dor	IG	0.1	Large Magellanic Cloud. Visible to unaided eye from dark sky
NGC 2070	05 38.6	-69° 05'	30'x20'	Dor	BN	5.4	30 Doradus, Tarantula Nebula, complex structure
NGC 2169	06 08.4	+13° 57'	6'	Ori	OC	5.9	Rich loose cluster, 30 stars magnitude 7 and fainter
NGC 2244	06 32.4	-04° 52'	23'	Mon	OC	4.8	100 stars, with nebulosity (Rosette Nebula)
NGC 2264	06 41.1	+09° 53'	20'	Mon	OC	3.9	Christmas Tree cluster
NGC 2301	06 51.8	+00° 28'	12'	Mon	OC	6.0	Rich cluster, 80 stars, large magnitude range
NGC 2362	07 18.8	-24° 57'	8'	CMa	OC	4.1	60 stars, large brightness range (4th mag. down)
NGC 2451	07 45.4	-37° 58'	45'	Pup	OC	2.8	Rich in stars with slight central concentration
NGC 2477	07 52.3	-38° 33'	27'	Pup	OC	5.8	160 stars, mag. 10 to 12, central concentration
NGC 2516	07 58.3	-60° 52'	29'	Car	OC	3.8	80 stars 6th mag. and fainter, central concentration
NGC 2547	08 10.7	-49° 16'	74'	Vel	OC	4.7	Rich in stars with strong central concentration
IC2391	08 40.2	-53° 04'	50'	Vel	OC	2.5	Moderately rich in bright and faint stars
IC2395	08 41.1	-48° 12'	7'	Vel	OC	4.6	40 stars 6th magnitude and fainter
NGC 2808	09 12.0	-64° 52'	13.8'	Car	GC	6.1	Large and rich, compressed centre, mag 13 – 15
NGC 3114	10 02.7	-60° 07'	35'	Car	OC	4.2	Rich cluster, stars 9 to 14th magnitude
NGC 3132	10 07.1	-40° 26'	30"	Vel	PN	8.2	The Eight Burst Nebula, ring and disc
IC2602	10 43.2	-64° 24'	50'	Car	OC	1.9	Central concentration, brightest magnitude 3
NGC 3372	10 43.8	-59° 52'		Car	BN	2.5	Eta Carinae Nebula, bright, prominent dark lanes
NGC 3532	11 06.4	-58° 40'	55'	Car	OC	3.0	Rich and large, 150 stars 7 to 12th magnitude
NGC 3766	11 36.1	-61° 37'	12'	Cen	OC	5.3	Rich cluster, 100 stars magnitude range 7 to 12th
NGC 4755	12 53.6	-60° 20'	10'	Cru	OC	4.2	Jewel Box, rich in stars, large brightness range
NGC 4945	13 05.4	-49° 28'	23'x5.9'	Cen	SG	9.0	Big edge on spiral, small galaxy in same field
NGC 5128	13 25.5	-43° 01'	31'x23'	Cen	G	6.7	Centaurus A, bright sphere crossed by dark lane
NGC 5139	13 26.8	-47° 29'	36'	Cen	GC	3.5	Omega Centauri, perhaps the finest globular cluster
NGC 5281	13 46.6	-62° 54'	5'	Cen	OC	5.9	40 stars, moderately rich in bright and faint stars
NGC 5617	14 29.8	-60° 43'	10'	Cen	OC	6.3	80 stars, large brightness range, central conc.
NGC 6025	16 03.7	-60° 30'	12'	TrA	OC	5.1	60 stars, large brightness range
NGC 6067	16 13.2	-54° 13'	12'	Nor	OC	5.6	100 stars, large brightness range, central conc.
NGC 6087	16 18.9	-57° 54'	12.5'	Nor	OC	5.4	40 stars, moderate brightness range
NGC 6124	16 25.6	-40° 40'	29'	Sco	OC	5.8	100 stars, large brightness range
NGC 6193	16 41.3	-48° 46'	14'	Ara	OC	5.2	Few stars, large brightness range
NGC 6231	16 54.0	-41° 48'	14'	Sco	OC	2.6	A few stars with strong central concentration
NGC 6397	17 40.7	-53° 40'	25.7'	Ara	GC	5.8	Loose structure, possibly the nearest globular
NGC 7009	21 04.2	-11° 22'	25"	Aqr	PN	7.9	Saturn Nebula, ring structure in a larger faint halo
NGC 7293	22 29.6	-20° 48'	12'	Aqr	PN	7.3	Helix Nebula, ring structure in large, fainter disc

PLACES OF ASTRONOMICAL INTEREST

Following is a list of places of astronomical interest. These facilities cater to the public with tours and/or displays. Information is subject to change. Links to all of the web sites listed here can be found on the Quasar Publishing site: www.quasarastronomy.com.au

NEW SOUTH WALES & ACT

Bathurst Observatory

The observatory caters mainly for schools and groups, and features a new 200 seat theatrette planetarium as well as an observatory with a 14 inch telescope for night viewing, bookings essential.
The original Bathurst Observatory has become the Bathurst Observatory Research Facility and studies continue at this site.

Address Bathurst Goldfields, Mt Panorama, Bathurst NSW 2795
Contact Bathurst Goldfields (02) 6332 2022
Email info@bathurstgoldfields.com.au
Web bathurstobservatory.com.au

Canberra Deep Space Communication Complex (Tidbinbilla)

The complex is located 35km southwest of Canberra (Tourist Drive 5) and is a major link in NASA's Deep Space Network. Tidbinbilla sends and receives radio signals from distant spacecraft as they explore our Solar System and beyond. The centrepiece is the 70-metre antenna, the largest in Australia. The Visitor Centre incorporates audio/visual presentations, exhibits, models and images from the spacecraft. A highlight is an actual Moon rock. The MoonRock Cafe and giftshop is available for meals and souvenirs.

Address Tourist Drive 5, Discovery Drive (off Paddy's River Rd), Tidbinbilla
Times 9am to 5pm, 7 days per week (except Dec 25)
Cost Free.
Contact Glen Nagle or Candy Bailey (02) 6201 7838 / 7968
Email cdscc-prc@cdscc.nasa.gov
Web www.cdscc.nasa.gov/

Koolang Observatory and Space Science Centre

Located on the border of the Central Coast and Lower Hunter, the centre is no more than two hours from most Sydney and Newcastle suburbs. Bookings are essential. Koolang staff have also developed curriculum and theme based presentations to cover all school levels K-12.

Address Great North Road, Bucketty NSW
Times Group bookings 7 days and nights. Individuals and families Friday and Saturday nights. Night shows start about an hour after sunset. Starting times 8pm for 8:30 or by arrangement.
Cost Public night shows: adults $15, concession $13, child $10; group discounts available; special prices and hours for schools (subject to change without notice).
Contact (02) 4998 8216
Email staff@koolang.com.au
Web www.koolang.com.au

Crago Observatory

This observatory is operated by the Astronomical Society of NSW. It is located on Bowen Mountain near North Richmond (northwest of Sydney). It houses a 40cm Dobsonian telescope. The observatory is open on Saturday nights (nearest to Last Quarter Moon phase). Visitors are most welcome.

Address Burralow Fire Trail, Bowen Mountain
Times 8pm till late
Cost Donation
Email VP_Crago@asnsw.com
Web www.asnsw.com/crago/index.html

CSIRO Parkes Radio Telescope

The famous Parkes observatory, 'The Dish', is located 20km north of Parkes (just off the Newell Highway). This landmark radio telescope is nearly 50 years old, but still considered to be one of the best single dish radio telescopes in the world. As well as a great view of the telescope, the visitors centre has displays, audiovisual and 3D presentations. There is also the Dish Café and a picnic area with free gas barbecues. Souvenirs and educational material are available.

Address CSIRO Parkes radio telescope, Newell Hwy (PO Box 276), Parkes NSW 2870
Times 8:30am to 4:15pm – daily except Christmas and Boxing Day
Cost Admission to the visitor's centre is free. A modest charge is made for the audio visual and 3D presentations.
Contact (02) 6861 1777
Email parkes-vdc@csiro.au
Web www.csiro.au/parkesdish

Darby Falls Observatory

The observatory is located on Observatory Road (off the road to Mt. McDonald) Darby Falls, Cowra. It offers one of the largest telescopes accessible to the public, a 500mm Newtonian. Also available are 400mm, 300mm and 200mm instruments, a 6" refractor and a flat screen planetarium.

Times Open Friday, Saturday & Sunday nights, every night during school holidays (weather permitting). Winter 7pm to 10pm, summer (daylight savings) 8:30pm to 11pm. Other times by appointment.
Contact Mark Monk (02) 6345 1900 fax (02) 6345 1920
Email darbysob@tpg.com.au

Green Point Observatory

The observatory is operated by the Sutherland Astronomical Society (SAS) in Sydney. The building houses 41cm and 35cm telescopes. Visitors are welcome any Thursday night, with guest speakers on the 1st Thursday of the month. The society also run regular open nights for the general public.

Address Cnr Green Point & Caravan Head Roads, Oyster Bay PO Box 31, Sutherland NSW 1499
Times from 8pm
Cost Gold coin donation appreciated
Contact Secretary (02) 9589 1014 (voicemail)
Email sasi@sasi.net.au
Web www.sasi.net.au

Linden Observatory

WSAAG (Western Sydney Amateur Astronomy Group) holds observing nights, where anyone can drop in and look through their telescopes. Observing nights are usually held on Saturdays closest to the New Moon. Dates can be obtained by visiting the WSAAG website.

Address 105 Glossop Road, Linden NSW 2778
Cost Donation to Linden Trust @ $5 per person
Contact Western Sydney Amateur Astronomy Group
Web www.wsaag.org/Linden.html

Magellan Observatory

Situated three hours drive south of Sydney, near Goulburn, Magellan Observatory has an extensive range of equipment for hire and comfortable accommodation in a dark sky location. Equipment includes a 24 inch computer controlled telescope in a 4 metre dome, Takahashi FSQ ED and 12.5 inch Ritchey Chretien in a 2.3 metre dome.

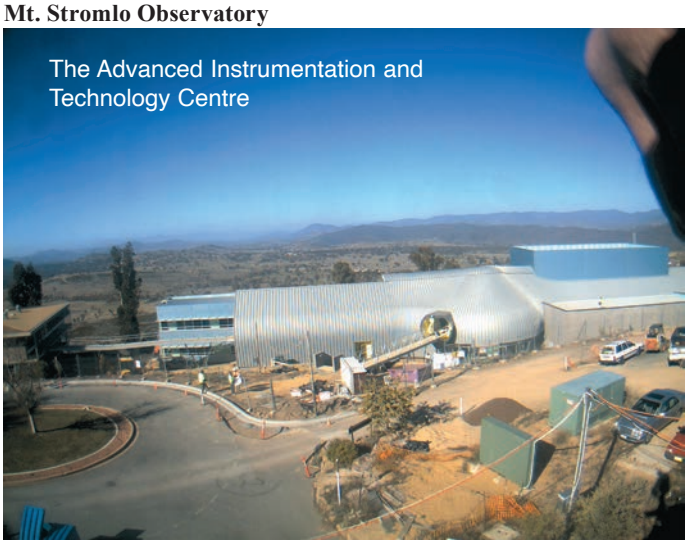
Address 461 Covan Creek Road, Lake Bathurst NSW 2580
Contact (02) 4849 4489
Email magellan@goulburn.net.au
Web www.goulburn.net.au/~magellan

Macquarie University Observatory

Located on the Macquarie University campus at North Ryde, this observatory is open to the public on Friday nights unless raining from March to November inclusive. Astronomy students will guide you with a range of telescopes. On cloudy nights, the program includes slide shows and Solar System demonstrations.

Address	Macquarie University via Culloden Rd
Times	7:30pm to 9pm (Apr–Oct), 8:30pm to 10pm DST (Oct, Nov, Mar and Apr).
Cost	$5 per person.
Contact	Lesa Moore 0427 433 388
Email	StarryLady@hotmail.com
Web	www.astronomy.mq.edu.au/observatory/

Mt. Stromlo Observatory



The oldest fully operational research observatory in Australia, Mt Stromlo Observatory (along with its sister observatory at Siding Spring) is part of the Australian National University's Research School of Astronomy and Astrophysics. Once housing telescopes dating back to 1868, Mt Stromlo Observatory was devastated by the fire storms of 18 January 2003. However, Mt Stromlo Observatory is rebuilding and the site is now open for visitors. BBQ facilities are also available.

Address	15 minutes from Canberra City, Mt Stromlo Observatory, off Cotter Road, Weston Creek, ACT (On Tourist Drive 5)
Times	Site open 9-5 seven days.
Cost	Day visits are free.
Contact	(02) 6125 0230
Email	msovc@mso.anu.edu.au
Web	www.mso.anu.edu.au/

Port Macquarie Observatory

This facility, operated by the Port Macquarie Astronomical Association Inc., is situated in Rotary Park (opposite Town Beach) Port Macquarie. A multimedia presentation is given and celestial objects can be viewed through the Meade 200 telescope. Special nights can be arranged for groups.

Address	PO Box 1453, Port Macquarie NSW 2444
Times	Sunday & Wednesday evenings (no bookings required) at 7:30 pm (8:15 pm during daylight savings). Doors open 15 minutes before session times.
Cost	$8 adults, $7 concession, $5 children, $22 family (2+2)
Contact	Jim Daniel (02) 6583 1933 or Beatrice Mason (Secretary)
Email	info@pmobs.org.au
Web	www.pmobs.org.au

Ryder Homestead Observatory

As well as providing accommodation in self contained log cabins, Ryder Homestead offers guests guided star gazing tours. Located 30 minutes north of Bathurst the Homestead enjoys very dark country skies.

Address	130 Thompson Street, Wattle Flat NSW 2795
Cost	Homestead guests free, otherwise adult $10, child $6
Contact	Rodney Watters on (02) 6337 7171
Email	info@ryderhome.com.au
Web	www.ryderhome.com.au

Siding Spring Observatory

Siding Spring Observatory is home to thirteen telescope domes and enclosures. The operational telescopes include Australia's two largest optical telescopes — 3.9m Anglo-Australian Telescope and the ANU 2.3m Advanced Technology Telescope. There are telescopes operated or owned by a number of different educational and research institutions, including the Anglo-Australian Observatory, Australian National University as well as the UNSW. The Uppsala telescope, jointly operated by ANU and University of Arizona, operates as the southern partner in the Catalina Sky Survey funded by JPL NASA. There are telescopes operated by the University of Seoul South Korea as well as the Faulkes South Telescope, operated by Las Cumbres Observatory Global Telescope Network. The latest telescope to become operational on the mountain is the Australian National University's robotic survey telescope Skymapper. Siding Spring nestles into the Warrumbungles at the entrance to the national park, 30 minutes west of Coonabarabran. The Visitor's Centre includes a cafe, souvenir shop and astronomy exhibition. From the Visitor's Centre, there is access to the viewing gallery for the 3.9m Anglo Australian Telescope. The Exploratory offers hands on displays, videos and much more. Special tours can be organised on request for groups. An open day is generally held in late October in conjunction with the Warrumbungle Festival of the Stars.

Address	Observatory Rd, Coonabarabran NSW 2357
Times	9:30am to 4pm Monday to Friday except Christmas Day 10am to 2pm Saturday, Sunday and public holidays
Cost	Exploratory: adult $5.50, child/pensioners $3.50, family $13.50
Contact	(02) 6842 6255, fax (02) 6842 6240
Email	ssovc@mso.anu.edu.au
Web	www.sidingspringexploratory.com.au

The Australia Telescope Compact Array – Narrabri

The Australia Telescope operates in the radio region of the spectrum. It uses high technology to combine signals from a number of dishes, to obtain the performance of a single theoretical dish a number of kilometres in diameter. The Compact Array is located at CSIRO's Paul Wild Observatory near Narrabri. It consists of six 22m dishes five of which are spaced along a 3km track with the sixth a further 3km to the west. From the visitors centre there are great views of the dishes, displays and video presentations.

Address	1828 Yarrie Lake Road, Narrabri NSW 2390
Times	8am to 4pm daily; unstaffed, except by request for groups (15+).
Cost	No charge to visit the centre. For groups requesting a staff guide there is a charge of $3 weekdays/$5 weekends per person and three weeks notice required.
Contact	Outreach staff (02) 6790 4070
Email	atnf-narrabri-outreach@csiro.au
Web	www.csiro.au/narrabriobservatory

University of Western Sydney Observatory

The UWS Observatory is open to the public and runs public astronomy nights, school, holiday and group programs during the day or evening. It features a 0.6 metre (24 inch) telescope which is available for night viewing by the public.

Times	Monday, Tuesday & Thursday 9am – 3pm
Cost	Adult $12, child/concession $8, family $35
Contact	Roslyn McCourt (02) 4736 0135
Email	r.mccourt@uws.edu.au
Web	www.uws.edu.au/observatory

Wollongong Science Centre and Planetarium

Operated by the University of Wollongong, this public science centre includes a planetarium (BlueScope Steel Star Theatre), observatory, laser light shows, extensive interactive exhibits, demonstration theatre (Illawarra Coal Science Theatre), and a gift and resource shop. The BlueScope Steel Planetarium has a state of the art Zeiss ZKP3 star projector, laser projector and full-dome show projector. The observatory houses a high quality computer controlled telescope which is used to observe the Sun and stars.

Address	Science Centre, Innovation Campus, Squires Way, Fairy Meadow 2519
Times	10am to 4pm, 7 days. Bookings are also available out of hours and there are scheduled astronomy evenings.
Cost	Child $7, concession $8, adult $10; discount on planetarium show tickets when purchased with general entry.
Contact	(02) 4286 5000 (ext 3) fax (02) 4283 6665
Email	gkm@uow.edu.au
Web	sciencecentre.uow.edu.au

The 2008 David Malin Awards *continued*

The Southern Cross and Pointers in the Milky Way

The winner in the amateur section (wide-field) was Phil Hart.

"This is a beautiful rendition of a part of the sky that is familiar to all of us. It was not long ago that to make a wide field picture like this, with this kind of definition you needed a 4 × 5 camera and very pricey lenses -- like Akira Fujii. This picture is a 3-part mosaic made with a modified Canon 40D camera (ISO 800) and a standard Canon 50mm F/1.4 lens. Each of the three parts is made by combining 30, four-minute exposures, so the total exposure time was six hours. The blurred stars were recorded separately through high cloud." (Note this image is also on the rear cover.)

Windswept Stars

"The winner in this (open) section is by Gary Hill with his Canon 300D. I spent a long time enjoying this, which is a very painterly image, full of visual references to the forces of the natural world and its connection to the wider Universe."

PLACES

Sydney Observatory

This is Australia's oldest observatory, situated near The Rocks on Observatory Hill and overlooking Sydney Harbour. It offers a 3-D Space Theatre and telescope tours, fascinating historic and interactive displays and night telescope tours (which include stargazing through the observatory's telescopes). There is also a mini-planetarium on offer during wet weather. Day tours include the 3-D Space Theatre, a dome tour and solar viewing (weather permitting). Sydney Observatory is part of the Powerhouse Museum.

Address	Watson Road, Observatory Hill, The Rocks Sydney
Times	10am to 5pm. Day 3-D Theatre tours run at 11am, 12noon, 2:30pm and 3:30pm weekends and school holidays, 2:30pm and 3:30pm on weekdays. Night sessions are held every night of the week. Bookings required for evening tours. Closed on Good Friday and Christmas Day.
Cost	See their web site
Contact	(02) 9921 3485
Email	observatory@phm.gov.au
Web	www.sydneyobservatory.com

QUEENSLAND

Cosmos Centre and Observatory Charleville

The public observatory is located on Cunnamulla Rd, near the Charleville airport. The Centre includes an observatory for night viewing of the stars and planets. During the day, a theatre presentation, seven interactive displays and two mini talks: an update on the latest discoveries in the Solar System and a meteorite talk where the collection is taken out of the cabinet for you to hold. Special programmes can be arranged for groups and schools. Sun viewing also available through telescopes (bookings essential).

Address	PO Box 681, Charleville 4470
Times	High season (Apr to Oct): observatory open every night (bookings essential). Daytime centre open daily 10am – 6pm. Low season (Nov to Mar): observatory open Mon, Wed, Fri & Sat nights (bookings essential). Daytime centre open Mon – Sat 10 – 5.
Cost	General observatory session $22 adult, $60 family, $20 student.
Contact	Jane Morgan (07) 4654 7771
Email	cosmosob@bigpond.net.au
Web	www.cosmoscentre.com

The Great Barrier Reef Observatory

Situated on Hamilton Island, the observatory is open to the public regularly during the dry months from April to November. Viewing is complimentary.

Address	PO Box 40, Hamilton Island Qld 4803
Contact	Ray Johnston (07) 4946 8686 or 0412 478 935
Email	ray.johnston@stardreaming.com.au
Web	www.stardreaming.com.au

Maidenwell Astronomical Observatory

The observatory is located in the heart of Maidenwell, near the Bunya Mountains, 2.5 hours drive northwest of Brisbane and 40km south of Kingaroy. They are open to the general public in the early afternoon (other times by appointment) Thursdays to Tuesdays and conduct stargazing sessions 7 nights a week. Star Theatre show times are 2pm and 4pm Thursdays to Tuesdays (Wednesdays by appointment). On sunny days, live video images of the Sun in Hydrogen Alpha light are projected onto a giant screen. At night viewing is through three Meade LX200 GPS 14" telescopes. They give special audio/visual presentations to schools and social groups and have full wheelchair and amenities access. Camping and cooking facilities are available on site. The roll off roof observation deck can seat up to 35 people at a time. They sell astro equipment and conduct a basic astronomy course once a year.

Address	Main Rd, Maidenwell Qld 4615
Times	Spring/Summer: open from 2pm, night sessions 7:30pm. Autumn/Winter: open from noon, night sessions 7pm
Cost	Discount applies to social and school groups of 30 or more.
Contact	Bookings are essential for Star Theatre and/or Stargazing sessions, phone (07) 4164 6194 or 0427 961 391
Email	nightskies@bigpond.com

Springbrook Mountain Observatory

Springbrook National Park is only a 45-minute drive from Surfers Paradise. The observatory is open to the general public, astronomical groups, schools, and researchers by appointment. This facility has a C14 with Titan Robotic Mount, C11, 5.0", 4.5" refractor, CCD equipment, hydrogen alpha filter for solar prominence observation and sunspot viewing.

Address	2337 Springbrook Road, Springbrook Qld 4213
Times	By appointment
Web	www.springbrookobservatory.com

Alloway Observatory

The observatory, situated approximately 6km South of Bundaberg, is operated by The Bundaberg Astronomical Society. The 6 metre dome houses a 480mm Newtonian telescope and a 14 inch computerised Meade telescope with CCD imaging using ST8E and Starlight Express technology. The observatory opens to the public on Friday nights. Midweek opening can also be arranged for large groups.

Address PO Box 4221, South Bundaberg Qld 4670
Times Every Friday night, other nights by appointment.
Cost $15 family; $8 adult; $4 child, discounts for groups.
Contact Mac Jonsen (07) 4153 6469 or (07) 4159 7232 (ans. service)
Email macsen2@yahoo.com

The Sir Thomas Brisbane Planetarium

This world class planetarium is located in the Brisbane Botanic Gardens, Mt Coot-tha, at Toowong in Brisbane. Programs are presented in the Cosmic Skydome which has an artificial sky projected onto the interior of a 12.5m dome. The Planetarium has been upgraded and is equipped with both the traditional Zeiss Spacemaster projector and new digital planetarium systems installed in 2004 and 2007. All shows include a current night sky tour recreated in the Skydome. The display areas contain recently-updated astronomical and space items, short videos and space news updates run in two small theatres, and the shop has astronomical and educational products. The Planetarium observatory has a variety of telescopes and sessions must be pre-booked. School shows are also available during weekdays.

Address Brisbane Botanic Gardens Mt Coot-tha, Mt Coot-tha Rd, Toowong Qld 4066
Times Tuesday–Friday: school shows and one afternoon public show. Saturday/Sunday: multiple public shows and children's shows. School shows are on a booking basis only. Additional weekday shows run during Queensland school holidays.
Cost Show charges apply
Contact (07) 3403 2578
Email bop@brisbane.qld.gov.au
Web www.brisbane.qld.gov.au/planetarium/

SOUTH AUSTRALIA

The Heights Observatory

The Heights School Observatory is located at the Heights School, Modbury, Adelaide. It was formed primarily for students of the school with an interest in astronomy, but anyone is encouraged to join. There are two main telescopes and a classroom. During the day solar observations are made.

Address Brunel Drive, Modbury Heights
Times Evening
Cost Minimal
Contact Andrew Cool
Email andrew@cool.id.au
Web www.assa.org.au/facilities/theheights/

Stockport Observatory

Owned and operated by the Astronomical Society of South Australia (ASSA), This observatory is located in the small town of Stockport (6km north-east of Hamley Bridge) approximately 80km north of Adelaide. It provides a convenient astronomical facility away from the light pollution surrounding Adelaide (population 1 million). Public star parties are held at Stockport in February, May, August and November. See web site for details.

Address Observatory Road, Stockport SA 5410
Times Public star parties 8pm to 11pm. Private bookings for groups & schools also available.
Cost $7 per person.
Contact ASSA Info Line (08) 8338 1231
Email observatories@assa.org.au
Web www.assa.org.au/facilities/stockport/

University of South Australia Planetarium

The planetarium has sessions for primary/secondary schools as well as the general public. Sessions are by appointment only. An open to the public session is available on the first Saturday of the month at 2:45pm.

Address University South Australia, Building P, Mawson Lakes Campus
Cost $5 adults, $3.50 students and concession
Contact (08) 8302 3138
Email jean.srisamnart-cooper@unisa.edu.au
Web www.unisa.edu.au/planetarium/

Arkaroola Wilderness Sanctuary and Resort

Located in the heart of the northern Flinders Ranges, Arkaroola have a total of eleven Advanced Ecotourism accredited products including ridgetop, astronomy and waterhole tours. There are also many guided and unguided bushwalks. They have three astronomical observatories offering two Celestron 360mm and three Meade Maksutov-Cassegrain computer assisted telescopes. There are also three 'star chairs' with 20 × 80 astro binoculars, spare piers and wedges suitable for BYO telescopes and astrophotography/CCD equipment.

Address Private Bag 106, Port Augusta SA 5710
Times Tours run nightly on demand and weather permitting.
Cost Cost is $40 (up to 1.5 hours per tour)
Contact (08) 8648 4848 fax (08) 8648 4846
Email res@arkaroola.com.au
Web www.arkaroola.com.au

Woomera Observatory

The recently constructed Woomera Observatory is a Woomera Board owned and operated facility. The main viewing telescope is a Celestron 14" *f*/10 SCT CGE pier mounted in a 3.5m Sirius Dome. A large selection of eyepieces, focal reducers and T-adaptors are available to suit Nikon and Cannon. Their secondary telescope is a tripod mounted Meade 10" *f*/8 SCT. The main building also has a theatrette with video projector and DVD player. Kitchen and toilet facilities are available.

Address Cariwan St, or PO Box 191, Woomera SA 5720
Times Viewing nights change seasonally, contact the Woomera Board Community Centre to find out which nights are available.
Cost Family $20, Adult $10, seniors/student/group $6 per head for a three hour viewing and presentation.
Contact Bookings through the Woomera Board Office (08) 8674 3226.
Email admin@woomeraboard.com.au
Web www.woomeraboard.com.au/observatory/

TASMANIA

Launceston Planetarium

The Planetarium, after being closed temporarily in 2008, will reopen at the Queen Victoria Museum's Inveresk Site, in Invermay Road, in mid-2009.

Address Queen Victoria Museum, Invermay Road Launceston Tas 7250
Times See web site for costs and times.
Contact (03) 6323 3777
Email enquiries@qvmag.tas.gov.au
Web www.qvmag.tas.gov.au/planetarium.html

VICTORIA

AstroTours

The Centre for Astrophysics and Supercomputing at Swinburne University of Technology is offering public 3D tours through the Universe in the Virtual Reality theatre during school holidays.

Address The Virtual Reality theatre is located on the ground floor of the AR building in room AR104.
Cost $10
Contact Carolyn Cliff (03) 9214 5569 (bookings)
Email astrotour@swin.edu.au
Web astronomy.swin.edu.au/astrotour/

Ballarat Municipal Observatory

The observatory contains three historic telescopes: The Jelbart (a 125mm refractor), the Oddie (a 220 mm Newtonian), the Baker Great Equatorial Telescope (a 650mm Newtonian, commissioned in 1886) and a 300mm Newtonian. The Adcock-Federation telescope (406mm Cassegrain-Springfield) has disabled-access. They are open every Friday and Saturday evening, (every night during school holidays) other times bookings are required. There are regular events at other times, updates on website. Astrotour 3D Movies are available in conjunction with Swinburne University of Technology.

Address Cnr of Magpie and Cobden Street, Mount Pleasant, Ballarat East PO Box 284 Ballarat 3353
Times Friday and Saturday evenings, half an hour before sunset; every night during school holidays.

Contact (03) 5332 7526
Email bas@cbl.com.au
Web observatory.ballarat.net

Old Melbourne Observatory

The historic Old Melbourne Observatory is located in the Royal Botanic Gardens Melbourne. There is a Monday night program called the 'Southern Night Sky Experience' and a program focused on the moon, called 'Lunar Tours'. Bookings are essential for both programs. The Royal Botanic Gardens Melbourne has a visitor centre, function rooms, Observatory Café, Terrace Tearooms and a Gardens Shop.

Address Birdwood Avenue, South Yarra Vic 3141
Cost Contact for details.
Contact Visitor Centre, Royal Botanic Gardens (03) 9252 2429
Email rbg@rbg.vic.gov.au
Web www.rbg.vic.gov.au

Melbourne Planetarium

This is Australia's first digital planetarium and is at Scienceworks in Spotswood. The theatre seats 160 and produces shows for all ages. The planetarium is open seven days a week from 10am and runs special evening sessions in March.

Address 2 Booker St, Spotswood Vic 3015
Times See web site for costs and times.
Contact (03) 9392 4800
Web museumvictoria.com.au/planetarium/

WESTERN AUSTRALIA

Perth Observatory

Situated in the Darling Ranges, 40km inland from the West Coast, Perth Observatory conducts international standard astronomical research and wide ranging educational outreach activities.
Star Viewing Nights are conducted as part of the observatory's public education program, using a dedicated facility with several large telescopes, including the largest in regular public use in the southern hemisphere. The observatory also has transportable telescopes to conduct Astronomy Field Nights at remote sites.
Guided tours in the day time are also conducted and can include viewing of historical astronomical artefacts in our museum, a demonstration of the operation of old and new research telescopes, a safe view of the Sun with a dedicated solar telescope, and a general or specific astronomy computer presentation.

Address 337 Walnut Rd, Bickley WA 6076
Times Normal office hours: 8:30am – 4:30pm.
Star Viewing Nights: October to May – bookings essential, session lasts approximately 1.5 hours.
Daytime Guided Tours: 10am and 12:30pm – bookings essential, session lasts approximately 1.5 hours.
Cost All services attract charges, contact the observatory for details.
Contact (08) 9293 8255 fax (08) 9293 8138 info Line (08) 9293 8109
Email enquiries@perthobservatory.wa.gov.au
Web www.perthobservatory.wa.gov.au

Gingin Observatory – The Space Place!

The observatory is situated in the Shire of Gingin, an hour north of Perth. Their main instrument is the 25 inch Brodie-Hall telescope. They have five other telescopes ranging from 11" to 16" as well as six pairs of binoculars. Also available for use are the amazing Sky Scouts from Celestron. They specialise in school programs and community groups.

Times See web site for costs and times.
Web www.gdc.asn.au/seestars.php

Pingelly Heights Observatory (Astro Ventures)

This facility specialises in the presentation of astronomical information and the viewing of the night sky through their telescopes. The observatory is one and a half hours drive from Perth. The observatory is also the home of Fair Dinkum Skies, Robotic Telescope Facility, in affiliation with New Mexico Skies Observatories in the USA. The property is Sunarise, 25 Pingelly Heights Rd (off Aldersyde Road), Pingelly. Astro Ventures caters for schools, community organisations and private parties on request.

Address PO Box 512, Pingelly WA 6308
Times Summer: 8pm to 11pm (DST) Friday and Saturday, (other nights by appointment). They are closed from May 1 to September 30.
Cost Adults $27, school-aged students (1-12) $15, pensioner/ concessions $18, family (2+2) $70.00, school groups (max 15) $12.50 per student, adult groups (12-15) $22 per person. As activities are unsuitable for children < 5, they are admitted free.
Contact For further information and reservations ring Susie or Trevor on (08) 9887 0088, 0407 380 922 or write to Astro Ventures.
Email astroventures@westnet.com.au
Web myweb.westnet.com.au/astroventures

EVENTS AND RESOURCES

The following are astronomy courses, events, magazines, web sites and radio programs for this year. This list is by no means intended to be exhaustive. Across the country there are no doubt many other evening courses held at various universities and colleges. Enquiries from the general public are most welcome. A number of the amateur astronomical societies also provide an invaluable service to public education by their lectures and open nights. You will need to contact the societies for further details. Costs given are subject to change.

GENERAL

Australia Telescope Outreach and Education

This site aims to provide the media and the general public with information about the Australia Telescope National Facility. They also provide educational resources on many aspects of astronomy.

Web outreach.atnf.csiro.au

Australian Sky & Telescope Magazine

Australian Sky & Telescope is a world-class magazine about the science and hobby of astronomy. Combining the formidable worldwide resources of its venerable parent magazine with the talents of the best science writers and photographers in Australia, Australian Sky & Telescope is a magazine produced specifically for the southern hemisphere's astronomers. Consistently delivering the latest news and developments in astronomy 8 times a year, Australian Sky & Telescope caters for everyone with an interest in space and astronomy, from the absolute beginner looking to buy their first telescope to the seasoned observer wanting to expand their collection of equipment or acquire new skills.

With its thorough equipment reviews, detailed sky maps, up-to-date news and knowledgeable advice on observing the southern skies, Australian Sky & Telescope is a powerful source of inspiration to get out and see the wonders of the Universe for themselves.

2009 is the International Year of Astronomy, and Australian Sky & Telescope will have easy-to-understand information on how to get started and more involved in astronomy.

Address PO Box 81 St Leonards NSW 1590
Fees $7.95 in newsagencies, $60 for a year (8 issues plus bonus issue)
Contact (02) 9439 1955 fax (02) 9439 1977
Email info@austskyandtel.com.au
Web www.astmag.com.au

IceInSpace

IceInSpace is a community website dedicated to promoting amateur astronomy in the southern hemisphere. They aim to help stargazers from around the world discover, discuss and enjoy the beauty of our night sky. IceInSpace is free to join and use, all you need is a valid email address. By registering you will be able to post topics on the IceInSpace Forum, communicate privately with other members (PM), respond to polls, upload content and images and access many other special features. IceInSpace is now the largest and most active astronomy community in the southern hemisphere, with over 4,600 members (as at August 2008).

Address PO Box 9127, Wyoming NSW 2250
Fees No charge
Contact Mike Salway
Email mike@iceinspace.com.au
Web www.iceinspace.com.au

International Dark-Sky Association

IDA's goal is to preserve and protect the night-time environment and our heritage of dark skies through quality outdoor lighting.

Address 32 Carina Road, Turramurra NSW 2074
Contact Reg R. Wilson (Dir. Asia/Pacific) phone/fax (02) 9488 7078
Email regrw@tpg.com.au
Web www.darksky.org

LabNotes – Tips for Teachers – Astronomy and Space

Articles are listed and tips have been written for these articles. These tips will help you run learning activities, set homework, and guide student research. For educational purposes, you may print off pages, photocopy them and hand them to your students.

Web www.abc.net.au/labnotes/read/default.htm#astronomy

National Science Week

The aim of this week is a nationwide annual celebration of Australian science and has the objective to increase public awareness of the role that science, engineering, innovation, technology and entrepreneurship play in our daily lives. Astronomy is a key component, and amateur societies are ideally placed for outreach to the public. For 2009, the theme for Science Week is 'Astronomy: Science without Limits'. It runs from August 15–23. See the web site for more information.

Web www.scienceweek.info.au, www.sciencefestival.com.au

Questacon Starlab

Starlab is an inflatable planetarium which can accommodate up to 30 students. Starlab presentations are available in Sydney, Melbourne, Brisbane and Wollongong in collaboration with other science centres.

Address National Science and Technology Centre, Canberra ACT 2600
Contact Outreach Programs Bookings Coordinator (02) 6270 2800 or fax 1 800 641 171
Web www.questacon.edu.au/html/starlab_planatarium.html

Space Association of Australia

Activities include monthly free public meetings, public displays, radio program and a newsletter to promote understanding of astronautics.

Address PO Box 351, Mulgrave North Vic 3170
Web www.space.asn.au

The Astronomical Society of Australia

The Astronomical Society of Australia is the society of professional astronomers in Australia. It has a website to provide links for Australian astronomy, both professional and amateur, including links to educational material.

Web asa.astronomy.org.au

The Planetary Society – Australian Volunteer Co-ordinators

An Australian based space exploration lobby group linked to The Planetary Society. It contains information of relevance to the Australian scene.

Web www4.tpg.com.au/users/tps-seti/index.html

EVENTS

Arkaroola Star Party Down Under

To be held on 22 – 26 January 2009 at Arakaroola Wilderness Sanctuary in the Flinders Ranges. SA. Observe the spectacular southern hemisphere skies from Australia's outback. Arkaroola Wilderness Sanctuary is situated in the majestic Flinders Ranges, 600km north of Adelaide. It has it all. Beautiful landscapes during the day, and skies at night that make you want to reach up and touch the stars. By day, relax in your air-conditioned room, make new friends in the bar or cool off by the swimming pool. In the evening, observe the night sky under ideal conditions: mild temperatures, perfect seeing, and no light pollution. The nearest township is over 130km away to the west. All lighting during the Star Party Downunder will be strictly controlled so that your observing experience will be the best it can possibly be. Jointly hosted with the Astronomical Society of South Australia.

Address Pvt Bag 106, Port Augusta SA 5710
Fees Check website for packages.
Contact Joe Grida, Convenor (08) 8272 3027 fax: (08) 8373 4977
Email joe.grida@internode.on.net
Web www.arkaroola.com.au/starparty.php

Astrofest (Parkes, NSW)

The CWAS AstroFest is sponsored by the Central West Astronomical Society and was first held in July 2004. The AstroFest incorporates a two day conference and related activities including the David Malin Astrophotography Exhibition and Competition which is open to all amateur astrophotographers. World-renowned professional and amateur astronomers share their knowledge and experience in an exciting amateur astronomy festival. The CWAS AstroFest is held annually in July, with the 2009 festival scheduled for the weekend of 18–19 July.

Address CWAS AstroFest, PO Box 819 Parkes NSW 2870
Fees To be determined.
Contact John Sarkissian (of the Local Organising Committee)
Email astrofest@cwas.org.au
Web www.parkes.atnf.csiro.au/news_events/astrofest/

Arnhem Land Astronomy & Science Fair

The 2nd Annual Science Fair for Gove, the 2008 event was expanded to include displays from other areas The keynote speaker was Internationally renowned Prof. Ray Norris from CSIRO. The event includes school science displays, a variety of guest speakers, amateur rocketry, solar & lunar observing, food and drinks stalls, prizes and loads of fun activities for the kids. Dates for the 2009 event are not yet set, but will be around the time of National Science Week in August.

Web www.ianmacleanrecommends.com/?page_id=7

Border Stargaze

The Astronomical Society of Albury Wodonga will host the Border Stargaze during new moon August 2009. An annual gathering of amateurs for observing under country skies. This major event combines public outreach activities with that of the star party format. Guest speakers, mobile planetarium (Cosmodome), workshops, astronomical activities and so much more. See the society web site for more details.

Address ASAW (Border Stargaze), PO Box 1500, Lavington NSW 2641
Fees Registration $30.00 (plus accommodation)
Contact David Chandler 0421 816 007
Email borderstargaze@iprimus.com.au
Web www.asaw.org.au

IceInSpace Astro Camp

The IceInSpace AstroCamp is being held from October 30th – November 1st 2008 at Lostock, in the beautiful clear dark skies of the Hunter Valley. Enjoy the warm weather, swimming hole and three beautiful clear nights. Features include very dark skies, bunkhouse or camping accommodation, fully equipped kitchen and toilets/showers, 240V power, swimming hole, guest speakers, workshops and a lucky door prize competition. Dates for the 2009 camp have not yet been set. Contact Mike or checkout IceInSpace for more information.

Address Lostock, Hunter Valley NSW
Fees TBA
Contact Mike Salway
Email mike@iceinspace.com.au
Web www.iceinspace.com.au/iisac

NACAA

The National Australian Convention of Amateur Astronomers is a biennial event held over Easter. The next NACAA will be in 2010 in Canberra. See web site for more details.

Address PO Box 188, Plumpton NSW 2761
Contact Albert Brakel
Email convenor@nacaa.org.au
Web www.nacaa.org.au

VASTROC (Vic)

Victorian Amateur Astronomical Society's Conventions (VASTROC) are held every second year (alternating years with NACAA Conventions). Activities include speakers, workshops, poster displays, observing and the convention dinner. The 2009 VASTROC – Galileo to Google – is being hosted by the Ballaarat Astronomical Society on 2 – 3 May. More details on the web site when available.

Address Ballarat Observatory, PO Box 284 Ballarat 3353
Fees See web site
Contact (03) 5332 7526
Email bas@cbl.com.au
Web www.vastroc.net

Queensland Astrofest (Duckadang, Qld)

The Queensland Astrofest, rated in the Top Ten of the world's best astrocamps (BBC Sky at Night 2007), is held annually at the Lions Club Camp Duckadang, situated at Linville 160 Km northwest of Brisbane. It has a dark sky with bunk house accommodation, family rooms, plenty of room for camping and caravans, and there is 240V power available for telescopes.

Activities include: presentations from professional astronomers and knowledgeable amateurs, awards, vendor sales, swap/sell and a great environment for exchanging ideas and techniques. Catered meals are available twice a day (lunch $6 and dinner $7).

After the success of the extended week in 2008, the Qld Astrofest will continue to be run over ten days in 2009, 14th to 23rd August. The Astrolabes is on the last Saturday night of the camp. Registration opens mid-February and early registration is advised. Dates for 2010 are August 6th–15th.

Address Lions Camp Duckadang, Avoca Creek Rd, Linville Qld 4306
Fees Please check the web site for registration details and costs.
Contact (07) 3274 5073 Anne-Louise Surma-Hawes (Registrar)
Email registrar@qldastrofest.org.au
Web www.qldastrofest.org.au

South Pacific Star Party

An annual national gathering of amateurs for observing under country skies. This is held at the Astronomical Society of NSW's property at Ilford, NSW. This major event now attracts over 300 people. The 2009 SPSP will be held from 22 – 24 May. See the society web site for more details.

Contact Les Sara
Email president@asnsw.com
Web www.asnsw.com

VicSouth Desert Spring Star Party

The VicSouth Desert Spring Star Party in 2009 will be held from November 13 to 16, at the Little Desert Lodge near Nhill in western Victoria. VicSouth is jointly hosted by the Astronomical Society of Victoria and the Astronomical Society of South Australia, and offers a great weekend of social, astronomical and observing activities.

Address PO Box 2082, Morphettville SA 5043
Contact 0410 422 498
Web www.vicsouth.com

NEW SOUTH WALES

Macquarie University Astronomy Course

A university-level unit titled PHYS270 Astronomy aims to give a broad description of basic astronomical subjects and concepts with essential but minimal mathematical content. The unit is open to non-award students through the Centre for Open Education.

Address Dept of Physics, Macquarie Uni NSW 2109
Contact Dr Alan Vaughan (02) 9850 8904
Email alanv@ics.mq.edu.au
Web www.coe.mq.edu.au/nonawd.html
www.astronomy.mq.edu.au

Macquarie University Astronomy Open Nights

These nights are designed for the general public. Activities include a special guest speaker, telescopes operated by local amateurs and commercial stands. There are two such nights held each year normally in March–April and September–October (a Saturday night around First Quarter Moon). The venue is Macquarie University (off Epping Rd, North Ryde, Sydney), commencing around 6:30pm.

Address Dept of Physics, Macquarie Uni NSW 2109
Fees Adults $10, children $5, family $25
Contact Dr Alan Vaughan
Email alanv@ics.mq.edu.au
Web www.astronomy.mq.edu.au

Macquarie University Foundation for Astronomy

The FFA acts as a support group for astronomy activities at Macquarie University. Membership subscription is $20 per year (students $10). Through its activities it supports community education in astronomy.

Address Dept of Physics, Macquarie Uni NSW 2109
Fees $20 ($10 students)
Contact Dr Alan Vaughan
Email alanv@ics.mq.edu.au

CHINA ECLIPSE 2008

continued

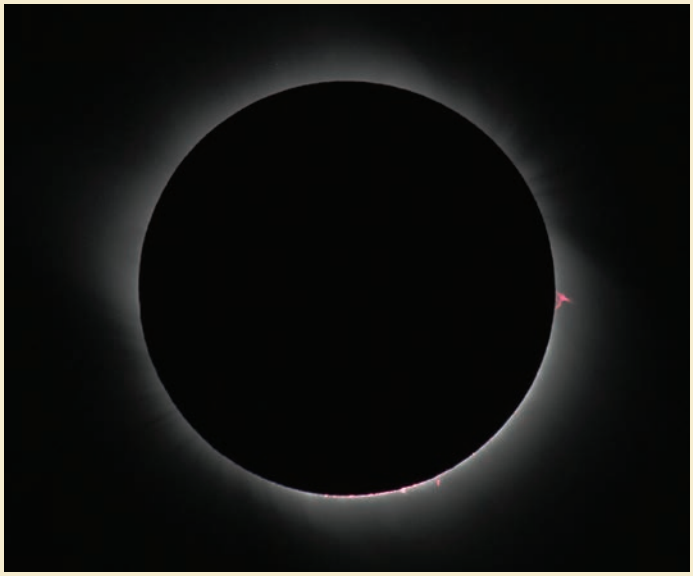
Here we struck another problem: the authorities had banned the use of GPS receivers. We ignored the ban, reprogrammed our computers for our new location, and were ready to go. The only clouds in the sky were over the snow-capped mountains to the south, with a clear view to the west and the eclipse.

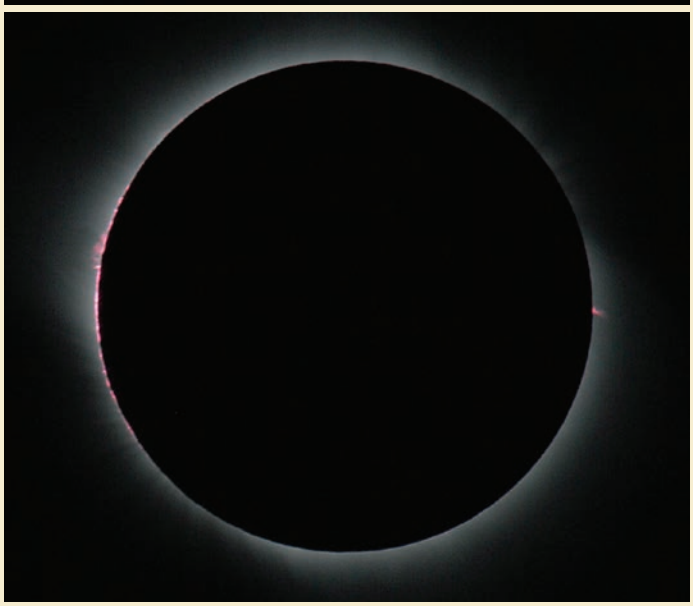
All eclipses are too short, and 2008 was no exception. The 101 seconds of totality seemed to be over in no time at all. The good news is that all our equipment worked and some excellent photographs were obtained.

We had a great time in China -- fantastic food, friendly people, cloud-free skies, and a perfect eclipse. Now on to Iwo Jima in 2009, Mangaia in 2010, …

(l-r) Warwick Kissling, Dennis Goodman, Chris Douglass, Darren Corbett, Kevin Diletti, Steve Russell, Hristo Pavlov, Desi Pavlova.

Images by Chris Douglass: Canon 5D, Canon 100-400mm lens with 2× teleconverter (800mm), and Eclipse Orchestrator software. Cropped and processed in Photoshop by Stephen Russell. Top 1/125, ISO 200, f/16; bottom 1/500, ISO 200, f/11.





Web www.astronomy.mq.edu.au

Practical Astronomy (SASPAC)

A practical astronomy course for beginners and interested amateurs. This is an 8 week course conducted by Sutherland Astronomical Society Inc (SASI). Each lecture is followed by observations with the society's equipment (weather permitting). Refer to website for course dates.

Address Green Point Observatory (Sutherland, Sydney)
Fees $130 per student subject to change
Contact The Education Officer 0422 902 730
Email education@sasi.net.au
Web www.sasi.net.au

Skyworks Planetarium

Skyworks is a multi-award winning travelling educational resource employing the use of a STARLAB Portable Planetarium to visit schools and youth groups. It is authorised by the NSW Department of Education. Programs are curriculum based to suit years K-12.

Contact Geoff & Diana Zenner (02) 9610 2899, 0427 112 899, fax (02) 9753 1898
Email info@skyworks.net.au
Web www.skyworks.net.au

Starry Night Planetarium

Marie and Philip (The Cosmic Couple) take their Starlab Planetarium to schools and community events in the Lismore/Ballina/Tweed areas. They can also be found planetary observing down at the beach.

Contact Marie and Philip (02) 6680 2448 or 0413 779 223
Email info@starrynight.com.au
Web www.starrynight.com.au

Macquarie University Planetarium

Macquarie University now operates a mobile planetarium. It simulates the appearance of the stars in the night sky. It can be set up on campus or taken to schools. The planetarium seats a maximum of 20 adults.

Address Dept of Physics, Macquarie Uni NSW 2109
Fees On application or see website.
Contact Dr Alan Vaughan (02) 9850 8904
Email alanv@ics.mq.edu.au
Web www.astronomy.mq.edu.au

Sydney Outdoor Lighting Improvement Society

Since 1998 SOLIS has been working at protecting the view of the night sky by promoting better outdoor lighting.

Address PO Box 3002, North Turramurra NSW 2074
Contact Ken Petersen (02) 9634 1736
Email solis@solis.org.au
Web www.solis.org.au

Sydney University Astronomy Courses

The University of Sydney Centre for Continuing Education runs regular astronomy courses on the main Sydney University campus, with occasional bus tours to NSW observatories. Contact the university's Centre for Continuing Education on (02) 9036 4789 to enrol.

Address Centre for Continuing Education, University of Sydney
Fees Approximately $260 for 10 weeks
Contact Dr Helen Johnston
Email h.johnston@physics.usyd.edu.au

Web www.physics.usyd.edu.au/~obyrne/cep/cep.html

QUEENSLAND

Brisbane Field Nights

The Brisbane Astronomical Society (BAS) holds regular free public viewing nights at Mt Coot-tha Lookout. Details on web site.

Address Brisbane Astronomical Society Inc
PO Box 15892, City East Qld 4002
Contact BAS Infoline (07) 3321 8511 (recorded club information service)
Email info@bas.asn.au
Web www.bas.asn.au

Brisbane TAFE Astronomy Course

A course in astronomy is now being offered through the North Brisbane Institute of TAFE at their Ithaca Campus, Fulcher Road, Red Hill. It covers many of the fundamental concepts and techniques of astronomy.

Fees $140 for 6×2 hour classes; includes practical sessions.
Contact North Brisbane Institute of TAFE 131 248
Email astronomy@ourbrisbane.com
Web bn.tafe.qld.gov.au/courses_and_careers/ace/

Funding for Astronomical Research

The Edward Corbould Research Fund has been established to encourage and assist astronomical research by Australian amateurs and students. Applications must be received by February 28th. Information on both the criteria to be met and obligations of successful applicants is available from the AAQ web site or by contacting the association.

Address PO Box 6101, St Lucia Qld 4067
Contact The General Secretary, Astronomical Association of Queensland
Email info@aaq.org.au
Web www.aaq.org.au

Travelling Telescopes in Education

They currently travel to schools with 11inch Celestron Nextstar Telescopes. Tailored informative presentation using DVDs prepared by NASA and licenced to user.

Contact Robin & Jenny Howard 0402 283 557
Email info@ttie.com.au
Web www.ttie.com.au

Stardreaming Planetarium

A portable 6 metre planetarium showing space and science films in full dome (IMAX) style. Available for schools, halls, festivals etc. Based on Hamilton Island, the planetarium is available throughout regional Queensland.

Contact Paul Thomas 0412 461 968
Email paul.thomas@stardreaming.com.au
Web www.stardreaming.com.au

Urban Observers

The South East Queensland Society holds a free public viewing night 'Urban Observers' at Indooroopilly High School, on the first Sunday of each month except January, and at Mt Coot-tha Lookout on the 3rd Sunday of the month.

Address SEQAS, PO Box 60, Everton Park Qld 4053
Contact Julie Straayer (07) 3325 2479
Email juliestraayer@hotmail.com
Web www.seqas.org

SOUTH AUSTRALIA

Astronomy Courses at Adelaide Planetarium

This is a ten week course conducted at the Adelaide Planetarium 2–3 times a year. This course gives an introduction to the basics of astronomy and has a focus on learning the constellations and brightest stars in the night sky. They also have 'Discover the Stars', 'Discover the Planets' and 'Planetarium Proms'-Music Under the Stars, among others. See their web site for details.

Address University of South Australia, Building P, Mawson Lakes Campus
Contact Jean on (08) 8302 3138
Email Jean.Srisamnart-Cooper@unisa.edu.au
Web www.unisa.edu.au/planetarium

Starlore and Solar System Astronomy

Paul Curnow presents a series of courses and presentations at the University of Adelaide Planetarium during the year. See web site for more details.

Address University of South Australia,
Building P, Mawson Lakes Campus
Contact Jean on (08) 8302 3138
Email Jean.Srisamnart-Cooper@unisa.edu.au
Web sa.apana.org.au/~paulc/index.html

TASMANIA

Introduction to Astronomy (Hobart)

Beginner astronomy courses are conducted by members of the Astronomical Society of Tasmania at the University of Tasmania's Canopus Hill Observatory site, usually twice a year in March/April and October/November.

Address Canopus Hill Observatory
Fees $40 per participant
Contact 0419 305 722
Email joroco@trump.net.au
Web ast.n3.net

VICTORIA

Amateur Astronomy Shortwave Station (VK3 EKH)

The Astronomical Society of Victoria has its own amateur radio callsign, VK3EKH. The net, conducted by Russell Ward, commences each Friday at 10pm EST on 3.543 MHz (LSB). New stations and listeners are most welcome.

Email mockrdge@alphalink.com.au
Web www.asv.org.au

Astronomy Show on Radio KLFM

The Bendigo District Astronomical Society has a fortnightly segment on Radio KLFM that can be found on 96.5 FM Bendigo and 106.3 FM Castlemaine. The segment can also be accessed online.

Contact Bendigo District Astronomical Society
Web www.klfm.com.au/audiovault.html

Astronomy, Secrets of the Night Sky

A 6 week course running at the Homesglen TAFE in Chadstone (Melbourne). Includes star formation, solar systems, galaxies, deep space, and big bang theory. Become familiar with major observatories, modern equipment and accessories under the tutelage of an experienced astronomy specialist. Suitable for absolute beginners and amateur stargazers alike, this overview includes weekly on-campus viewings with telescopes provided. See their web site for fees and dates.

Contact Short Course Department at Holmesglen (03) 9564 1555
Email ngc4755@i.net.au
Web www.shortcourses.holmesglen.vic.edu.au

The Space Show

This show is broadcast on radio station 88.3 Southern FM (88.3 MHz), 7–8pm every Wednesday. Presented by Andrew Rennie.

Web www.space.asn.au/space_show.htm

WESTERN AUSTRALIA

Astro Tours of the Kimberley

Broome's Astronomy Experience is a 2-hour educational and entertaining mind bender using big telescopes and lasers at an open bush site under dark skies. Astro Tours operates in Broome from April to December running shows for the general public, schools, community and corporate groups 6 nights a week.

Address PO Box 2537 Broome WA 6725
Contact Greg Quicke 0417 949 958 or (08) 9193 5362
Email info@astrotours.net
Web www.astrotours.net

ASTRONOMICAL SOCIETIES

The following is a list of amateur societies in Australia. A common philosophy within these organisations is the emphasis they place on public education. Enquires from anyone are most welcome, as are visitors to most meetings. Most societies now have web sites. We have not printed them here, but links to these can be found on the Quasar website: www.quasarastronomy.com.au/society.htm

NEW SOUTH WALES & ACT

Astronomical Society of Albury Wodonga meets regularly on the first Wednesday of each month (except January) at Charles Sturt University, Thurgoona Campus, off Elizabeth Mitchell Drive at 7pm.
Contact David Thurley (02) 6040 3704 or
Petra de Ruyter 0431 535 417 <enquiries@asaw.org.au>.
Address: PO Box 1500, Lavington NSW 2641

Astronomical Society of Coonabarabran meets 3rd Wednesday each month at 7:30pm at the Imperial Hotel, John St, Coonabarabran.
Contact Paul Cass (02) 6842 2994 <cpc@aaocbn.aao.gov.au>.
Address: c/- AAO Private Bag, Coonabarabran NSW 2357

Astronomical Society of NSW holds meetings twice per month, see their website for details. Contact <president@asnsw.com>.
Address: GPO Box 1123, Sydney NSW 2001

Astronomical Society of the Hunter meets at Keay Southern Cross Observatory (near Kurri Kurri) on the 1st Friday each month at 7:30pm.
Contact Col Maybury (02) 4937 4664 (ph/fax)
<cma45714@bigpond.net.au>.
Address: PO Box 69, Kurri Kurri NSW 2327

Canberra Astronomical Society meetings are held on the 3rd Thursday of every month starting at 8pm. A beginners group starts one hour before the main meeting. The venue is usually the Duffield Lecture Theatre, Mt. Stromlo Observatory, Weston, ACT. Contact <casadmin@gmail.com>.
Address: PO Box 1338, Woden ACT 2606

Central West Astronomical Society Inc (Parkes) meetings are held on the first Friday of the month at the Parkes Observatory Visitors Centre, commencing 7:30pm, visitors welcome. Contact <secretary@cwas.org.au>.
Address: PO Box 819, Parkes NSW 2870

Coffs Harbour Astronomical Society Inc meetings are held first Tuesday each month (except January) at 7pm at the William Bayldon Public School, Toormina Road, Toormina.
Contact Win Howard (02) 6653 2742 <whoward@tpg.com.au>.
Address: 11 Yarad Place, Boambee, NSW 2450

Grafton Astronomical Society meets on the first Wednesday each month at 7pm at the Grafton Aero Club, Vere Street, South Grafton 2460.
Contact Mick Austin (02) 6643 1349 or
Noelene Faulkner (02) 66421091 <jmashenden@yahoo.com>.

Hawkesbury Astronomical Association meetings are held 2nd Wednesday each month, at 7:45pm, in the Tebbutt Rooms at the Derubbin Centre, Windsor.
Contact Adrian Saw (02) 4572 1568 <asaw@exemail.com.au>.
Address: PO Box 670, Windsor NSW 2756

Illawarra Astronomical Society meetings are held at the Wollongong Science Centre and Planetarium on the second Tuesday each month (except January) at 8pm. Contact Peter MacKinnon (02) 4276 3199
Address: PO Box 1814, Wollongong NSW 2500

Macarthur Astronomical Society holds meetings, with guest speakers and workshops, every 3rd Monday of the month at 7:30pm at the University of Western Sydney – Macarthur, Room 5, Building 22.
Contact John Rombi 0425 249 301 <contact@macastro.org.au>.
Address: c/- Secretary, PO Box 17, Minto NSW 2566

Northern Sydney Astronomical Society Inc meets at St Ignatius College at Lane Cove third Tuesday of every month and conducts regular observing nights at North Turramurra Golf Club.
Contact <nsas@nsas.org.au>.
Address: PO Box 3002, North Turramurra NSW 2074

Port Macquarie Astronomical Association Inc meetings are held on the last Thursday of the month (except December) at 7:30pm at the observatory.
Contact Beatrice Mason (Sec.) (02) 6585 5254 <info@pmobs.org.au>.
Address: PO Box 1453, Port Macquarie NSW 2444

Shoalhaven Astronomers meet at Nowra Hill School 3rd Friday each month at 7:30pm. Contact <info@shoalhavenastronomers.asn.au>.
Address: PO Box 1053, Nowra NSW 2541

Sutherland Astronomical Society meets every Thursday at 8pm at the Green Point Observatory near Sutherland, with the main meeting and guest speaker on the 1st and 4th Thursdays. Junior Section meets 3rd Thursdays (primary school) and following Friday (high school) Feb – Nov at 6:30pm.
Contact Secretary (02) 9589 1014 (voice mail) <sasi@sasi.net.au>.
Address: PO Box 31, Sutherland NSW 1499

Sydney City Skywatchers meet at Sydney Observatory on the first Monday of the month at 6:30pm.
Contact <honsecretary@sydneycityskywatchers.asn.au>.
Address: Sydney Observatory, Watson Rd, The Rocks NSW 2000

Sydney Northwest Astronomy Group (SNAG) observe Friday nights under clear skies at Kenthurst.
Contact Ken Petersen (02) 9634 1736 <solissydney@telstra.com>.

The Newcastle Astronomical Society meetings are held on the last Friday each month (except December), at the University of Newcastle, Lecture Theatre GP, 1st floor of Linguistics Building at 7:30pm.
Contact Ghul Hussain (02) 0408 806 179 <info@nas.org.au>.
Address: c/- Dept. Physics, University of Newcastle Callaghan NSW 2308

University of New England and Northern Tablelands Astronomical Society meetings are held once per month at the Kirby Observatory on Wednesday evenings close to New Moon at 6:30pm (Dec and Jan 8pm). Contact Anne Parnell (02) 6772 1958 <msharpe4@une.edu.au> or <edbaker@epg.com.au>.
Address: Ms Anne Parnell, 81 Perrott St Armidale NSW 2350

Western Sydney Amateur Astronomy Group Inc meets 3rd Wednesday of the month at the Nepean Astronomy Centre, University of Western Sydney, Werrington Campus. Contact <wsaag@tpg.com.au>.
Address: PO Box 400, Kingswood NSW 2747

Wollongong Amateur Astronomy Club has monthly meetings on the first Thursday of the month, at 7:30pm, at the Unanderra Community Centre, Princess Highway Unanderra. Visitors are most welcome to attend.
Contact Andrew Wood 0402 232 409 <bandawood@bigpond.com.au>.
Address: 1 Anthony Avenue, Farmborough Heights NSW 2526

NORTHERN TERRITORY

Alice Springs Astronomical Society holds regular monthly club meetings at the Comspec Premises, call for times. Contact Richard Williamson (08) 8953 1903 <richardw@comspec.com.au>.
Address: Box 739, Alice Springs NT 0871

Darwin Astronomy Group has monthly viewing nights during the dry season as well as other activities. See web site for details.

Gove Amateur Astronomers meets monthly for viewing nights on a Saturday close to the New Moon at their dark sky site on the Dhupma Road, as announced in the local paper the Arafura Times. Contact Ian Maclean 0417 601 490 <goveastronomers@yahoo.com.au>.
Address: PO Box 178 Nhulunbuy NT 0881

QUEENSLAND

Astronomical Association of Queensland meetings are held from 4pm to 6pm on one Saturday in each month from March to December, depending on the lunar phase. The venue is the theatrette of the Sir Thomas Brisbane Planetarium, Mt Coot-tha Botanical Gardens. See their web site for details. Contact Peter Hall (07) 3378 1173 <info@aaq.org.au>.

Address: PO Box 6101, St Lucia Qld 4067

Brisbane Astronomical Society hold meetings each month except January, see their web site for details. Contact BAS Infoline (07) 3321 8511 (recorded club information service) <info@bas.asn.au>.

Address: PO Box 15892, City East Qld 4002

Bundaberg Astronomical Society meetings are held at Alloway Observatory every Friday at 7:30pm. The second Friday of the month are general meetings and are not held in January.
Contact Mac Jonsen (07) 4153 6469 <macsen2@yahoo.com>.

Address: PO Box 4221 South Bundaberg Qld 4670

Bundaberg Skywatchers meets every Friday night at 7pm, two field nights and one training night each month.
Contact Karlene Galway (07) 4181 2238 <karlene@buzzbb.net>.

Address: 534 Moorlands Road, Bundaberg Qld 4670

Mt. Isa Astronomy Group meets at their dark sky observing site at the Lions Youth Camp on Lake Moondarra (17km outside of Mount Isa). Meetings are held monthly, usually the Saturday on or preceding New Moon. Contact Len Fulham (07) 4743 5385 (AH), fax (07) 4743 3381 <lfulham@tpgi.com.au>.

Address: PO Box 1556, Mount Isa Qld 4825

Redlands Astronomical Society meets on the second Tuesday of the month at Ormiston College, Ormiston (27km SE of Brisbane), see web site for details. www.ras.org.au

Address: PO Box 2048, Wellington Point Qld 4160

South East Queensland Astronomical Society meets third Tuesday of the month at the Chermside Library from January to November. Meetings commence at 7:30pm.
Contact Julie Straayer (07) 3325 2479 <juliestraayer@hotmail.com>.

Address: PO Box 60, Everton Park Qld 4053

Southern Astronomical Society has monthly meetings at Pimpama State School, Hotham Creek Rd, Pimpama, on Saturdays (dates vary with Moon phase), at 7:30pm. Contact Kevin Dixon (07) 5537 3852

Address: PO Box 867, Beenleigh Qld 4207

Townsville Astronomy Group observe on the Saturday closest to New Moon or the following Saturday if conditions are not suitable. Viewing sites are at Bluewater, 30km north of Townsville and 'Ace Airfield', 45km out of Townsville at Woodstock (see website for details).
Contact Charles Mitchard (07) 4775 7253 <charlesmitchard@iinet.net.au>.

Address: 6 Halstead St, Gulliver Townsville 4812

Tropical Stargazers operates as the outreach arm of the Great Barrier Reef Observatory and has three branches – Mackay, Whitsunday, and Hamilton Island. Meets with monthly viewing nights — see web for details. Contact Paul Thomas (Whitsunday) (07) 4946 1966;
Ray Johnston (Hamilton Island) 0412 478 935 <star@whitsunday.net.au>.

Address: PO Box 40, Hamilton Island Qld 4803

SOUTH AUSTRALIA

Astronomical Society of South Australia meetings are held on the 1st Wednesday each month (except January) at the University of Adelaide, North Terrace Campus. Contact Secretary (08) 8821 1751, Technical Information Officer (08) 8338 1231 <info@assa.org.au>.

Address: GPO Box 199, Adelaide SA 5001

TASMANIA

Astronomical Society of Tasmania has general meetings at either the Canopus Observatory site at Cambridge or the Hutchins School conference centre, Sandy Bay on the last Tuesday each month except December. Contact Hobart 0419 305 722, Launceston – Karenne Barnes (03) 6344 7100 or Devonport – Peter Sayers (03) 6424 2588. <joroco@trump.net.au>.

Address: Secretary, Joy Coghlan, GPO Box 1654, Hobart Tas 7001

VICTORIA

Astronomical Society of Geelong meets every Friday at 8:30pm at the ASG Club Room, Geelong Showgrounds, Breakwater Road, Geelong. Contact Frank Baker 0407 345 070

Address: PO Box 1799, Geelong Vic 3220

Astronomical Society of Melbourne has monthly club nights and viewing sessions in Melbourne, plus deep sky viewing from their dark sky site located just over one hour from Melbourne in Gippsland.
Contact Chris Ellis 0412 318 125 <sales@astronomyalive.com.au>.

Address: PO Box 92, Bentleigh Vic 3204

Astronomical Society of Victoria has general meetings, held at 8pm on the 2nd Wednesday each month, except January, at the National Herbarium, Birdwood Ave, South Yarra. ASV specialist sections also hold regular meetings. Contact Linda Mockridge (Public Relations Officer)
(03) 9888 7130 <mockrdge@alphalink.com.au>.

Address: GPO Box 1059, Melbourne Vic 3001

Ballaarat Astronomical Society holds bi-monthly general meetings, 2nd Friday of the month, beginning in February.
Contact (03) 5332 7526 (society info.) <bas@cbl.com.au>.

Address: PO Box 284, Ballarat Vic 3353

Latrobe Valley Astronomical Society meets each month (except Dec and Jan) at the Wirilda Park and Conference Centre, Tyers, call for details.
Contact John Sunderland (03) 5122 3014 <lvastro@ymail.com>.

Address: PO Box 1298, Traralgon BC Vic 3844

Mornington Peninsula Astronomical Society meetings are held on the 3rd Wednesday each month (except Dec.) at 8pm, at the senior school theatrette, Peninsula School, Wooralla Drive, Mt Eliza.
Contact Peter Skilton 0419 253 252 <welcome@mpas.asn.au>.

Address: PO Box 596, Frankston Vic 3199

Oasis Stargazers Club Mildura Inc conduct regular viewing nights, which are open to the public, and once a month have a public activity night. Contact Sandra Tupou (03) 5024 7234 or Beau Devlin 0447 141 029. <oasisastronomy@yahoo.com.au>.

Address: PO Box 378CP, Mildura Vic 3500

Snake Valley Astronomical Association meet and observe at the SVAA Clubroom and observing field, Snake Valley Recreation Reserve on the closest Friday to the New Moon each month.
Contact Ken James 0418 425 207 <ken.james1@bigpond.com>.

Address: SVAA, c/o Snake Valley Post Office Vic 3351

The Astronomical Society of East Gippsland meetings are held at Bairnsdale and Perry Bridge. Dark sky site near Bairnsdale airport. Contact Mike Finn (03) 5153 2802, 0422 904 238 <mikef1@iprimus.com.au>.

Address: 53 Riley St, Bairnsdale Vic 3875

The Bendigo District Astronomical Society arranges Astronomy and Science Presentations at the Discovery Centre, Bendigo, 7:30 pm, on the first Wednesday of each month.
Contact Graeme Knight (Pres) (03) 5441 5461 <president@bdas.net>,
Michael Gallagher (Sec) (03) 5442 5572 <secretary@bdas.net>.

Address: PO Box 164 Bendigo Central Vic 3552

WEST AUSTRALIA

Astronomical Group of WA (AGWA) meets at 7pm on the first Tuesday of every month (see address below), visitors are welcome.
Contact Keith Williams (08) 9249 6825 <btow@iinet.net.au>.

Address: Unit 5 Malaga Centro, 41 Holder Way, Malaga WA 6090

Astronomical Society of the South West has observing nights at their observatory south of Bunbury on the two Fridays before the New Moon.
Contact Cameron Membrey (08) 9795 8204
<asthecrowflieswest@hotmail.com>.

Address: PO Box 1100, Bunbury WA 6231

The Astronomical Society of WA Inc meets at 8pm on the second Monday of every month (except January) at the South Perth Bridge Club, cnr Brittain Street and Barker Avenue, Como. Visitors most welcome.
Contact <aswa@aswa.info>.

Address: PO Box 421 Subiaco WA 6008

GLOSSARY

Albedo The ratio of the amount of light reflected from a Solar System object to that received by it. A perfectly reflecting body has an albedo of 1.0 or 100%.

Algol A variable star of a class known as eclipsing variables. Algol's brightness fluctuates every 69 hours as it is eclipsed by its fainter companion.

Almanac A set of tables giving positions of Sun, Moon and planets at various times, plus other astronomical information; an ***Ephemeris***.

Altazimuth coordinates The angular height (***altitude***) of an object above or below the horizon and its angular direction (***azimuth***) from north measured towards the east.

Altitude The angular elevation of an object above or below the horizon.

Angular diameter The apparent diameter of an object measured in degrees.

Angular separation The angular distance between two celestial bodies measured in degrees.

Aphelion The point in an orbit of a body most distant from the Sun. It is the opposite to ***perihelion***.

Apogee The point at which a body in orbit around the Earth reaches its farthest distance from the Earth. It is the opposite to ***perigee.***

Arcminute An angular measure (each degree is divided into 60 arcminutes).

Arcsecond An angular measure. Each degree contains 3,600 arcseconds, and each ***arcminute*** contains 60 arcseconds.

Asterism A recognisable grouping of visible stars. The stars may belong to one or more constellations. The grouping will have a name, for example 'The Teapot' in Sagittarius.

Asteroid See ***Minor Planet***.

Astronomical unit The average distance from Earth to the Sun, approximately 149.6 million km, which equals 1 AU.

Azimuth Horizontal coordinate of an object's position in the sky. Derived by drawing an imaginary vertical line from the object to the horizon below. The position is then expressed in degrees east from the north point.

Celestial equator A projection of the Earth's equator onto the ***celestial sphere***.

Celestial poles Points on the ***celestial sphere*** directly above the Earth's poles about which all the stars seem to rotate; known as the north and south celestial poles (NCP and SCP).

Celestial sphere Imaginary sphere of infinite size surrounding the Earth and to which celestial bodies seem to be attached.

Circumpolar Objects in the sky which never set. To determine which objects are circumpolar from a particular place, subtract the observer's latitude from 90°. This provides the minimum ***declination*** it must have to be considered circumpolar.

Colour index The difference in the magnitudes of an object measured at two different wavelengths. It is a measure of the colour (temperature) of a star.

Coma The head of a ***comet***, usually the brightest part.

Comet Small icy body that orbits the Sun and produces tails of gas and dust when approaching the Sun.

Conjunction An alignment of two bodies; their least ***angular separation*** as seen from Earth. When an object is said to be in conjunction, it is with the Sun (unless stated otherwise).

Conjunction — Inferior When an ***inferior planet*** (Mercury or Venus) passes between the Sun and the Earth.

Conjunction — Superior When the Earth and an ***inferior planet*** (Mercury or Venus) are situated on opposite sides of the Sun.

Constellation A pattern of stars identified by name, usually of mythological gods, people, animals, or objects.

Cosmology The study of the large-scale structure and evolution of the Universe.

CST Central Standard Time.

Culmination The instant when a celestial body crosses the ***meridian***; an object culminates when it reaches its highest point above the observers horizon.

Declination (Dec) One part of the equatorial coordinate system used to specify the location of an object in the sky. It is the angular distance of a body north (+) or south (-) of the ***celestial equator*** and is analogous to lines of latitude on the Earth.

Diurnal motion The daily motion of the sky produced by rotation of the Earth, causing the rising and setting of the Sun, Moon, planets and stars.

Eccentricity A measure of how long or thin an ellipse is. The closer the eccentricity is to zero, the more circular the orbit.

Eclipse When one object passes in front of or into the shadow of another.

Eclipse of the Moon When the Moon passes into the shadow of the Earth. It is a total eclipse when the Moon is immersed in the umbral shadow, partial if only partly covered by the ***umbra***, and penumbral if the Moon passes only through the ***penumbra*** of the Earth's shadow.

Eclipse of the Sun When the Moon passes in front of the Sun. It is total when the Moon has a larger ***angular diameter*** than the Sun and completely covers the disc, annular if smaller (leaving a ring of sunlight surrounding the Moon), and partial if only partly covered.

Ecliptic The plane of the Earth's orbit projected onto the ***celestial sphere***. It can also be defined as the Sun's path against the stars.

Ellipse An oval. The shape of the orbit of the planets. The axes of an ellipse are called the minor axis and major axis.

Elongation The ***angular separation*** of two bodies. The greatest elongations of Mercury and Venus occur when the planets are at their largest angular distance from the Sun, as viewed from the Earth.

Emission nebula A cloud of glowing gas excited by ultraviolet radiation from hot stars.

Ephemeris (plural ephemerides) A tabulated list of positions for an object calculated from its orbital elements.

Epoch A date chosen as a reference point for observations. This book uses Epoch 2000.0 for all coordinate data and is compatible with modern star atlases.

Equation of Time The difference between apparent and mean solar time.

Equinox The two times of the year when the Sun crosses the ***celestial equator***; vernal or spring equinox occurs about September 21st, and autumnal equinox about March 22nd.

EST Eastern Standard Time.

Galactic equator The great circle along the line of the Milky Way, marking the central plane of our ***galaxy***.

Galaxy A large disc or ball of billions of stars and ***nebulae***. They are the largest individual structures in the Universe.

Galilean satellites Named after their discoverer, Galileo Galilei. The four brightest satellites of Jupiter: Io, Europa, Ganymede, and Callisto, (also known as the Jovian satellites).

Geocentric As viewed or measured from the centre of the Earth.

Gibbous Phase of a planet or the Moon more than fifty percent illuminated. For example, the Moon is gibbous between First and Last quarter.

Globular Cluster A huge sphere containing thousands of stars. They surround our ***galaxy*** and are seen in other nearby galaxies.

Heliocentric As viewed or measured from the centre of the Sun.

Hour Angle The angular measure of the distance of an object from the local ***meridian***.

Inclination The angle that the plane of the orbit of one astronomical body makes with the plane of the orbit of another. Usually the reference is the ***ecliptic***.

Inferior planet A planet orbiting the Sun inside Earth's orbit. That is Mercury and Venus.

Julian date The number of days since noon on 1st January 4713 B.C. It is useful for astronomical observations as it saves confusion with other calendars. The starting date chosen was arbitrary but far enough back in time for there to be no astronomical records prior to then.

Large Magellanic Cloud (LMC) Satellite ***galaxy*** to our own Milky Way system, appearing to the unaided eye as a large nebulous patch situated in the ***constellation*** of Dorado. From mid-southern latitudes the LMC is ***circumpolar***.

Light year The distance that light traverses in a vacuum during one year (approximately 9,460,529,700,000km).

Lunation The period of time between two consecutive New Moons.

Magnitude Brightness scale of stellar objects. From one magnitude to the next the ratio of brightness is the 5th root of 100, or approximately 2.5. The lower the number the brighter the star. The brightest stars as seen from Earth are magnitude –1 (except for the Sun which is –26.7). The faintest visible to the unaided eye are magnitude 6 (under dark skies).

Magnitude — absolute The apparent magnitude a star would have if it were viewed from a distance of 10 ***parsecs*** (32.6 ***light years***).

Meridian The local meridian is an imaginary line running directly overhead from north to south. The ***right ascension*** on the meridian equals local ***sidereal*** time.

Meteor (also shooting or falling star***)*** A small particle striking the Earth's atmosphere that is heated to incandescence by friction with air molecules.

Meteor shower A group of ***meteors*** that appear to originate from a small region of the sky (the radiant).

Meteor swarm (or ***stream***) ***Meteoroids*** grouped in a localised region in orbit around the Sun (the source of ***meteor showers***).

Meteorite A ***meteor*** that survives its trip through the atmosphere and reaches the ground.

Meteoroid A small solid particle moving in orbit about the Sun.

Minor planet (Asteroid) Small rocky objects which revolve around the Sun. Most lie between the orbits of Mars and Jupiter in the asteroid belt.

Nadir The point on the ***celestial sphere*** directly opposite the ***zenith.***

Nebula A cloud of interstellar gas and dust. See also ***emission, reflection*** and ***planetary nebula.***

Node One of two points at which an orbit passes through a reference plane (usually the ***ecliptic***).

Oblateness The ratio of a planet's polar to its equatorial diameter.

Obliquity The degree of inclination (or tilt) of a planet's equator to its orbital plane.

Occultation The disappearance of one celestial body behind another.

Open star cluster A loose grouping of stars numbering from a few dozen to hundreds.

Opposition When a celestial body is opposite the Sun in the sky.

Orbit The path followed by one body as it moves around another.

Parallax An apparent shift in the positions of nearby stars (relative to more distant ones) from the changing position of the Earth in its orbit around the Sun. The size of the shift can be used to measure the distances to the nearer stars.

Parsec A unit of distance used by astronomers which is equal to 3.26 ***light years***. A parsec is defined as the distance to a celestial body whose ***parallax*** is one arcsecond.

Penumbra Area of partial illumination in the shadow of a planet surrounding the ***Umbra***. Also zone of intermediate brightness between a sunspot and the solar photosphere.

Perigee The point at which a body in orbit around the Earth most closely approaches the Earth. It is opposite to ***apogee.***

Perihelion The point in an orbit closest to the Sun, of a comet, planet or minor planet. It is opposite to ***aphelion***.

Perturbation Small changes in the motion of a body caused by the gravitational effects of another body.

Planetary nebula An expanding shell of gas ejected from a star. Thought to be the outer layers of a red giant during the latter stages of its evolution, the core of which becomes a white dwarf.

Planisphere A handheld aid used to identify which constellations are visible to an observer on any particular date and time.

Polar axis The axis around which a celestial body rotates.

Proper motion The small change in position of nearby stars due to motion across the line of sight (measured in seconds of arc per year).

Quadrature When two celestial bodies have apparent longitudes that differ by 90° as viewed from a third body.

Reflection nebula A gas cloud illuminated by a nearby star.

Retrograde motion 1. An actual motion contrary to the general direction of the bodies in the Solar System. An example of actual retrograde motion is Neptune's satellite Triton.

2. Apparent retrograde motion is the westward motion of a planet with respect to the stars. This occurs near opposition for the outer planets and near inferior conjunction for the inner planets.

Right ascension (R.A.) Part of the equatorial coordinate system used to specify the location of an object in the sky. It is the angular distance of an object from an imaginary line in the sky. It is analogous to lines of longitude on the Earth but is measured in hours (24hrs = 360°).

Sidereal time A method of keeping time which uses the motion of the stars rather than the Sun. One sidereal day is equal to 23hrs 56m 4s.

Small Magellanic Cloud (SMC) Satellite ***galaxy*** to our own Milky Way, appearing to the unaided eye as a nebulous patch in the constellation of Tucana. From mid-southern latitudes the SMC is ***circumpolar***.

Solstice The time when the Sun is farthest from the ***celestial equator***. In the southern hemisphere around June 21st marks the shortest day of the year, and around December 21st marks the longest day.

Spectral type A star's spectral classification determined by its ***spectrum***.

Spectrum The light of an object spread out like a rainbow. As well as a continuous spectrum, a star normally shows a distinctive set of dark and bright lines which are characteristic of its composition.

Superior planet A planet orbiting the Sun outside Earth's orbit.

Synodic period The time that it takes for an object to reappear at the same point in the sky, relative to the Sun, as observed from Earth.

Transit The passage of Mercury or Venus in front of the Sun's disc or the passage of a satellite or its shadow across the face of its planet.

Transit the meridian or meridian passage The passage of a heavenly body across the ***meridian***.

Twilight The short period of time before sunrise and after sunset during which there is not complete darkness.

Twilight — astronomical Astronomical twilight ends (in the evening sky) or begins (in the morning sky) when the Sun is 18° below the horizon.

Twilight — civil Civil twilight ends or begins when the Sun is 6° below the horizon.

Twilight — nautical Nautical twilight ends or begins when the Sun is 12° below the horizon.

Umbra Zone of maximum darkness in the shadow of a planet. Also the darkest part of a sunspot.

Universal time (UT) A time system measured from the Meridian of Greenwich in England.

WST Western Standard Time.

Zenith The point directly overhead (90° in altitude).

Zenith Hourly Rate A general guide to the expected intensity of any given meteor shower. It is a theoretical rate, assuming the radiant is at the ***zenith*** with a sky limiting magnitude of 6.5.

Zodiac The traditional twelve constellations that lie across the ***ecliptic*** (astrologers ignore Ophiuchus, which is very much a part of the Zodiac).

GREEK ALPHABET

Α, α	Alpha	Ε, ε	Epsilon	Ι, ι	Iota	Ν, ν	Nu	Ρ, ρ	Rho	Φ, φ	Phi
Β, β	Beta	Ζ, ζ	Zeta	Κ, κ	Kappa	Ξ, ξ	Xi	Σ, σ	Sigma	Χ, χ	Chi
Γ, γ	Gamma	Η, η	Eta	Λ, λ	Lambda	Ο, ο	Omicron	Τ, τ	Tau	Ψ, ψ	Psi
Δ, δ	Delta	θ, ϑ	Theta	Μ, μ	Mu	Π, π	Pi	Υ, υ	Upsilon	Ω, ω	Omega

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We are fortunate to live in Australia for the stars of the southern hemisphere are indeed spectacular! Have you ever gazed at the beauty of the night sky and wondered:

What is that bright star?

Which constellation is that?

Why do some 'stars' move from night to night?

Which planet is that?

Where is the Moon?

Then this book is for you. No knowledge of astronomy is needed to enjoy this publication. Not even a telescope! Five of the planets are easily visible to the unaided eye, just look up!

Astronomy 2009 has everything you need to enjoy the night sky. With nothing other than your eyes, a sense of curiosity and a copy of this book you can start enjoying the most spectacular show nature has to offer.

ESTIMATING ANGLES IN THE SKY When 0.5m (20 inches) from the eye, each division on this scale corresponds to 1° of arc.

0° 1° 2° 3° 4° 5° 6° 7° 8° 9° 10° 15° 20° 25°

Easy to use sky maps, designed for Australia

When to see shooting stars

The best times to observe the planets

Amateur astronomical societies

Public observatories in Australia

Easy to read monthly rise and set charts

Where to find comets

Drawings to easily identify the planets from the stars

In my view, this almanac is in a class of its own, perhaps even unique in the world. It manages to combine an incredibly high information content with a clarity and readability that must be the envy of other publishers.

Fred Watson, Astronomer-in-Charge
Anglo-Australian Observatory

Quasar Publishing has been producing yearbooks since 1991 and Astronomy 2009 continues with the high standard established over the years. The authors have many years experience in observational astronomy, astronomical publications, public education and the amateur astronomical community.

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