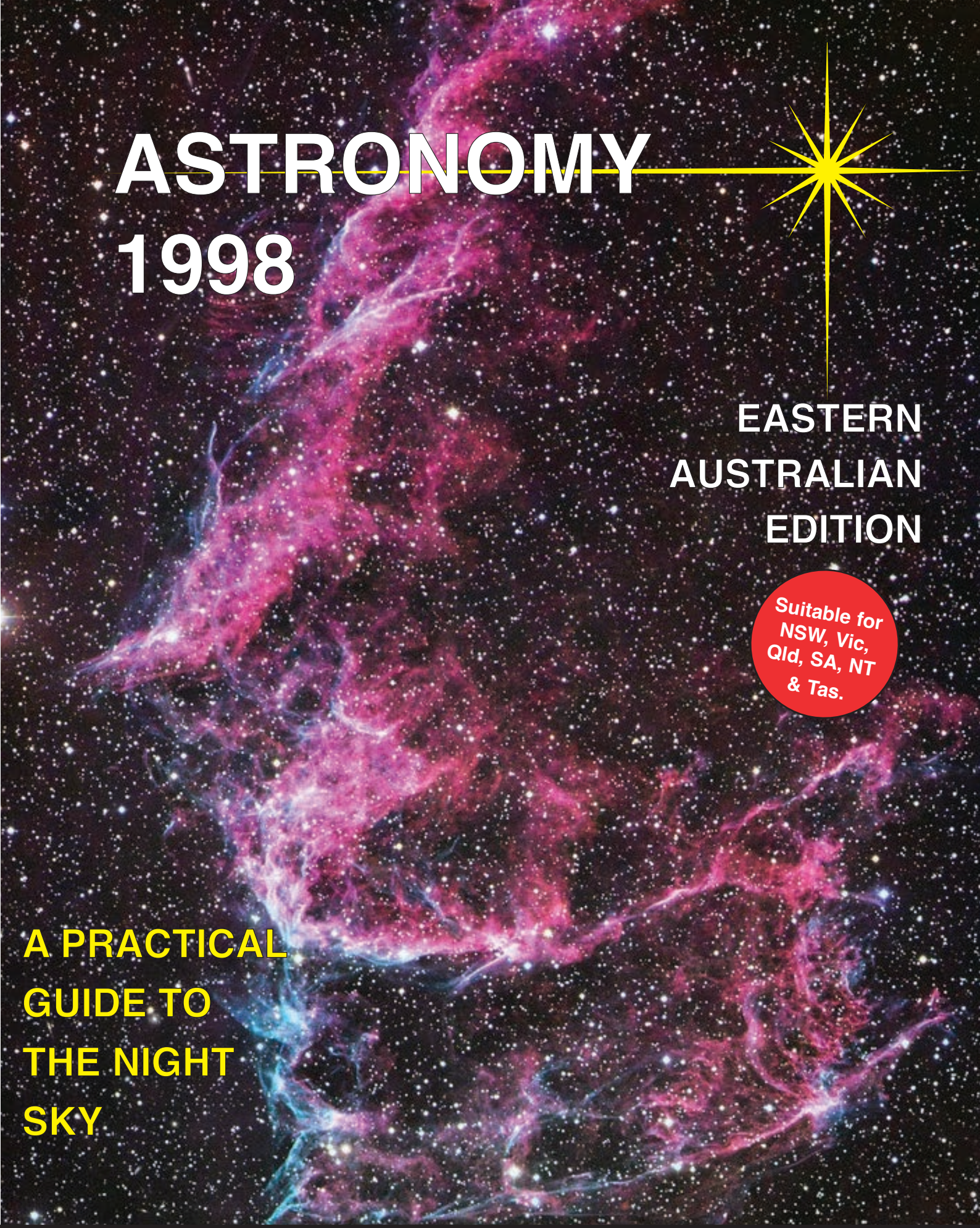

ASTRONOMY 1998

EASTERN AUSTRALIAN EDITION

Suitable for NSW, Vic, Qld, SA, NT & Tas.

A PRACTICAL GUIDE TO THE NIGHT SKY

Glenn Dawes Peter Northfield Ken Wallace

1998

January

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● New Moon ◑ First Quarter ○ Full Moon ◐ Last Quarter

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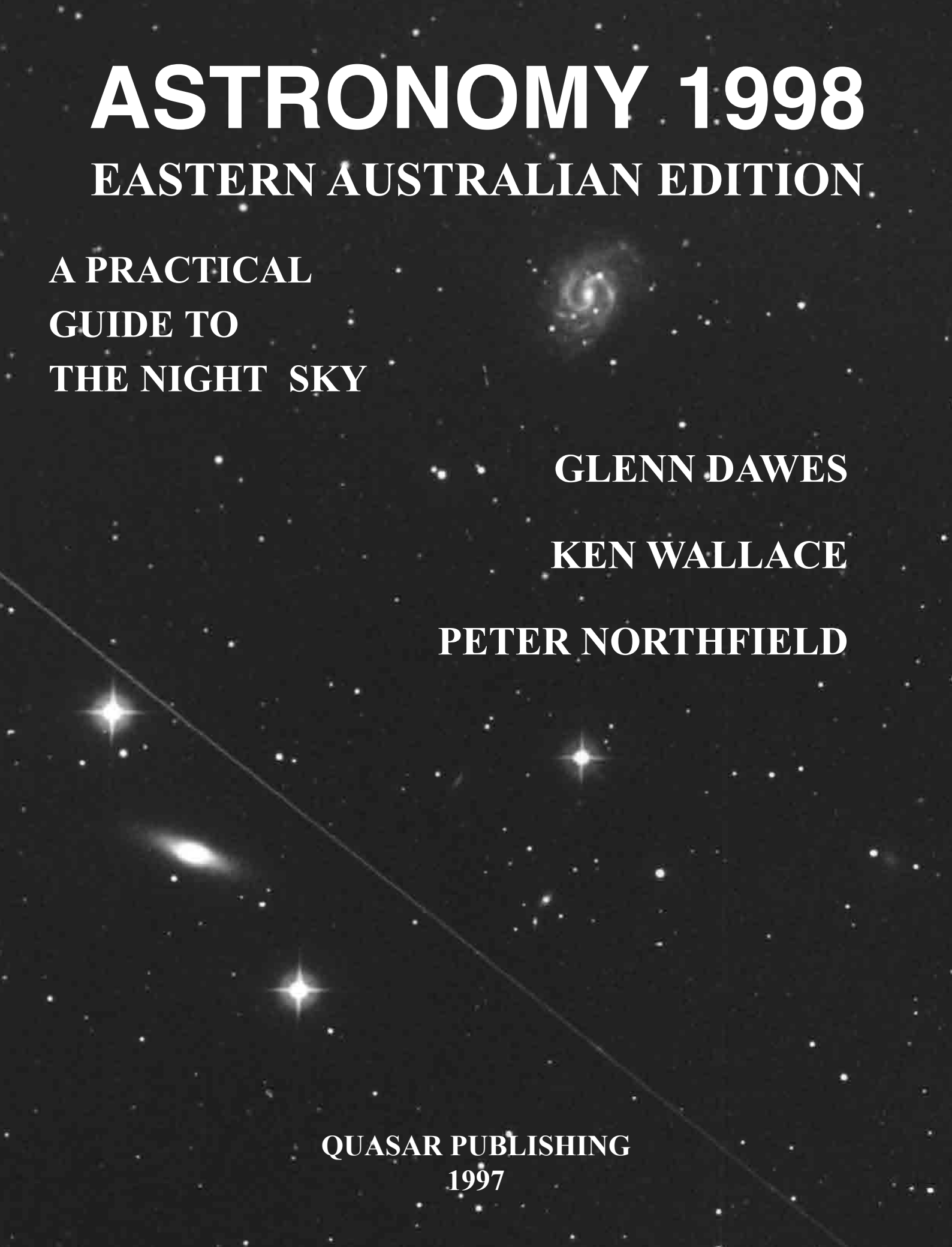

A PRACTICAL
GUIDE TO
THE NIGHT SKY

GLENN DAWES

KEN WALLACE

PETER NORTHFIELD

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Contact Perth Observatory for more information on **ASTRONOMY 1998, Western Australian Edition** Phone (08) 9293 8255 or Fax (08) 9293 8138

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INTRODUCTION TO THE 1998 EDITION

Welcome to ASTRONOMY 1998. The authors have been asked from time to time "why produce this publication?" The answer is simple. It's what we would have liked to have had many years ago when we started our discoveries of the universe. The authors recognise that each year, when we undertake this venture, we are walking a tight rope. That is, the fine line between what the newcomer to this hobby needs and the requirements of the experienced amateur. We hope we have adequately catered for everyone.

New additions for this year include an excellent, thought provoking article by Geoff McNamara on the search for planets outside our solar system. There is also a continuation of the internet article introduced in 1997. An article on Hale-Bopp gives a review of how this spectacular visitor performed during its current apparition. A new diagram has also been introduced this year which we feel is an excellent way of determining the visibility of the planets (p. 13).

This Eastern Australian Edition has been designed for observers anywhere in Australia, except W.A. A separate edition has been produced for Perth Observatory to cover Western Australia. These two editions (Eastern and Western) represent a truly national approach in the preparation of these user-friendly yearbooks.

Part I is intended as a general quick reference section for those wishing to see which planets are up tonight and when, during the year, it is the best time to observe them. This section, in particular, is ideal for those just starting their exploration of the night sky. The 'Sky View' diagrams are an easy way for you to find your way around the night sky. The planets can be identified and followed throughout the year as these wanderers' journey through the constellations. Part II leans more heavily towards the needs of the seasoned amateur. Part III, the appendices, includes excellent sections on astronomical places of interest and the amateur societies; ideal for the beginner.

As in previous editions of this yearbook, the authors would like to conclude this introduction with a brief word to the novice. Astronomy, like any science, may seem to be swamped in jargon. Unfortunately, it is impossible to avoid such words. However, where they have been necessary, astronomical terms have been explained in the text or covered in the glossary. To a beginner some of this information (especially the tables of numbers) may seem difficult to understand. It is important not to allow yourself to become overwhelmed. Comprehension will come with experience and when there is a need to know.

Wishing you clear skies and many hours of enjoyable observing.

Glenn Dawes Peter Northfield Ken Wallace.

ACKNOWLEDGEMENTS

Some of the information for this yearbook was adapted from the following sources:

- Astronomical Almanac for the Year 1998 (US Naval / Royal Greenwich Observatories)
- Astronomical Tables of the Sun, Moon and Planets (Jean Meeus)
- Cambridge Guide to the Constellations (Michael E. Bakich)
- Comet Orbital Elements courtesy International Astronomical Union
- 1998 Comet Handbook (Smithsonian Astrophysical Observatory
- Fifty Year Canon of Lunar Eclipses 1986 - 2035 (NASA RP1216)
- Fifty Year Canon of Solar Eclipses 1986 - 2035 (NASA RP1178)
- Bureau des Longitudes for Jupiter satellite events
- International Meteor Organisation Calendar for 1998
- Observer's Handbook 1995 (Royal Astronomical Society of Canada)
- Uranometria 2000.0 Vol I, II & Deep Sky Field Guide)

Data was also prepared with the assistance of the following computer software:-

- MICA ver 1.0 (US Naval Observatory)
- Occult ver 4 (David Herald)
- Voyager II, the Interactive Desktop Planetarium ver 2 (Carina Software)

Special thanks are extended to Geoff McNamara for his article "Many Worlds: One Earth" and Greg Bryant for the general comet data and text.

We would also like to thank the following for assistance in proofreading (a most difficult and underrated job, many thanks).
Greg Bryant, Brenda McNamara, Merilyn Mathews, Geoff Pearson, Roger North, Anne Barber, Rob McIntyre and Elise Dott.

The front cover is part of the Veil Nebula. Photograph by David Malin of the Anglo-Australian Observatory © IAC/RGO/D. Malin.

Star field on page 1 is part of the Virgo cluster of galaxies. The face-on barred spiral is NGC 4535, the other is NGC 4526 (NB. meteor trail towards bottom). Photo by Sydney amateur, J. Cauchi (thanks Joe). Taken on an f/4, 250mm Newtonian at prime focus using Kodak 2415 film (hypered), exposure was 35 minutes.

Photo of Comet Hale-Bopp, page 7, taken by R. Price (Bethanga, Vic). Thanks Robert.

Rear cover. Photo of Hale-Bopp taken on 8/4/97 from VLA, New Mexico. 6 mins on Kodak Royal 1000, 135mm / *f* 2.8 lens. G. Dawes.

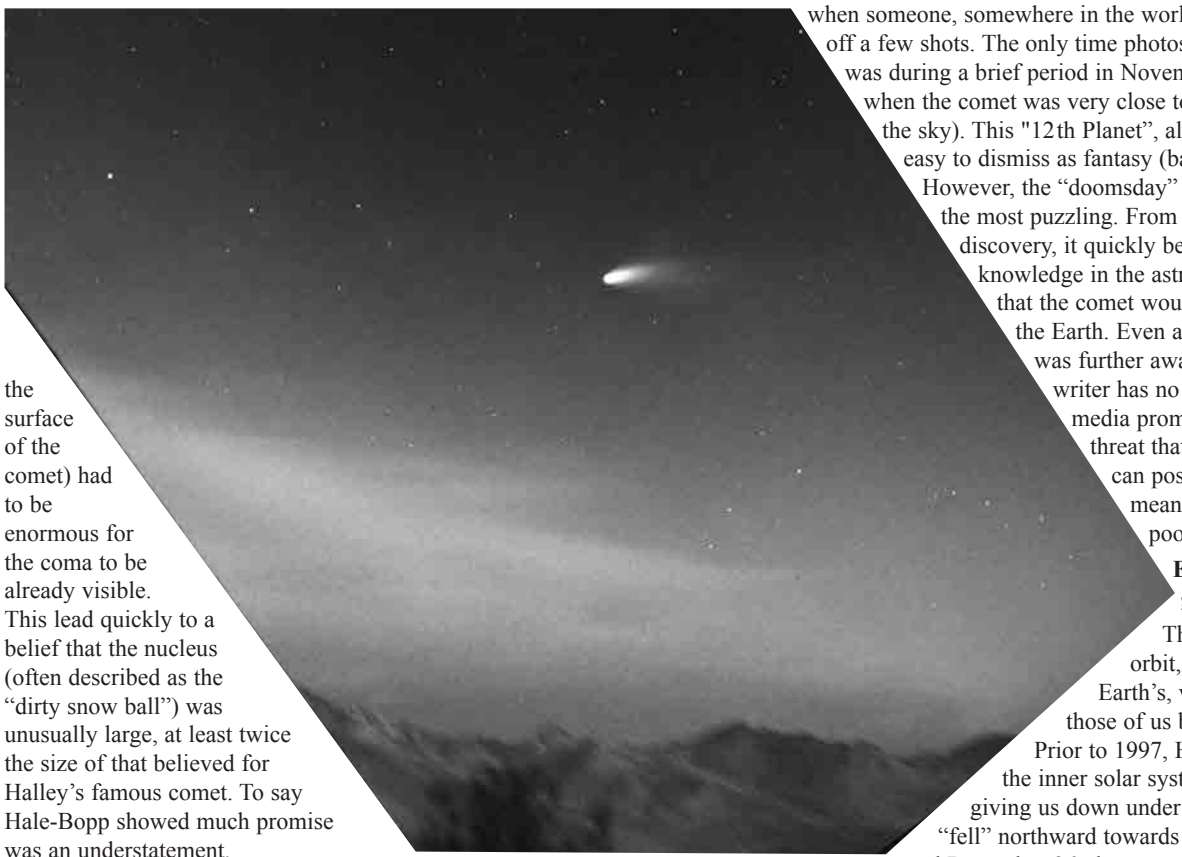
Photographs not credited are by the authors. CCD images on pages 29 and 33 were taken at the Quasar Observatory.

COMET HALE-BOPP: A CELESTIAL SPLENDOUR!

by Glenn Dawes

In the Beginning ...

In July 1995 two American amateur astronomers, Alan Hale and Thomas Bopp, independently discovered a hazy patch near the globular star cluster known as M70. At the time, through their amateur telescopes, they were just admiring the beauty of this distant "city of stars", certainly not looking for comets! Professional astronomers quickly determined the comet's orbit and came to the stunning realisation that this normally distant, frozen denizen of the solar system was still beyond the orbit of Jupiter. Most of the brighter comets are discovered within a couple of months of their , closest approach to the Sun. On the other hand, it would be nearly two years after the discovery before Hale-Bopp took centre stage in the inner solar system. It is very unusual for a comet to be discovered this far from the Sun. Especially when one considers it already had a prominent coma that was bright enough to be discovered visually in a small telescope. The level of outgassing (material evaporating from the surface of the comet) had to be enormous for the coma to be already visible. This lead quickly to a belief that the nucleus (often described as the "dirty snow ball") was unusually large, at least twice the size of that believed for Halley's famous comet. To say Hale-Bopp showed much promise was an understatement.



Of Fact and Fiction

As 1996 progressed, the comet went through some unexpected fluctuations in brightness. This was just enough to scare off the already conservative, professional astronomers from forecasting a brilliant show. Likewise, the media, in the early days, appeared to have gone a little gun shy. In the past they had had their collective fingers "burnt" with "Halley" and the earlier "Kohoutek". With Halley, the media only had themselves to blame for the public disappointment. It had been built into something it was never going to be (not during this visit anyway). Unfortunately, with Hale-Bopp, the media instead highlighted some of the fringe, "newspaper selling" aspects. An example was the "Doomsday comet" and let's not forget its companion UFO (no self respecting comet would travel the universe without its alien valet). The famous photo published by an amateur astronomer in the USA, proclaiming to show a UFO, holds a lesson for all of us. It once again demonstrated that a computer is only as smart as the person who is driving it! The Heaven's Gate fiasco lead to a media boom period and perhaps a slump in sales of a certain popular brand of sports shoe.

Of course there is always another "fringe" element. One internet web site proclaimed that NASA had suppressed photos of Hale-Bopp during a certain period. You see, at that time, the comet made a close approach to the so-called "12th Planet". This planet, in a few years, will wipe out all life on the Earth. It was obvious (to them) that the government wished to conceal the truth. An X-files fan may equate this to "the truth is out there". Reality shows their claims to hold as much "truth" as this popular sci-fi thriller. The truth is, Hale-Bopp is likely the most photographed comet in history. This is especially the case when one considers that the common, low cost, CCD cameras around today were not available at the time of Halley's Comet. There were hundreds of photographs of Hale-Bopp posted each day on a multitude of internet sites. One would think that not a minute past when someone, somewhere in the world was not "snapping" off a few shots. The only time photos could not be taken was during a brief period in November and December when the comet was very close to the Sun (as seen in the sky). This "12th Planet", along with the UFO, is easy to dismiss as fantasy (bad fiction at that). However, the "doomsday" aspect was perhaps the most puzzling. From the time of its discovery, it quickly became common knowledge in the astronomical community that the comet would come nowhere near the Earth. Even at its closest, the comet was further away than the Sun! The writer has no problem with the media promoting the potential threat that "near earth asteroids" can pose. If this was their meaning, Hale-Bopp was a poor illustration.

Early 97, the curtain goes up.

The tilt of the comet's orbit, compared to the Earth's, was unfortunate for those of us below the equator. Prior to 1997, Hale-Bopp approached the inner solar system from "below", giving us down under a great view as it "fell" northward towards the Sun. In November and December 96, the comet was too close to the Sun. In January 97, Hale-Bopp burst into the morning skies for our northern friends, now too far north for us southerners. During the March/April 97 approach to the Sun, its most spectacular period, the northern hemisphere had this visitor all to themselves. It was now clearly visible to the person on the street. Hale-Bopp's convenient position in the evening sky (by late March) helped ensure that many (millions?) curious people would view this celestial visitor.

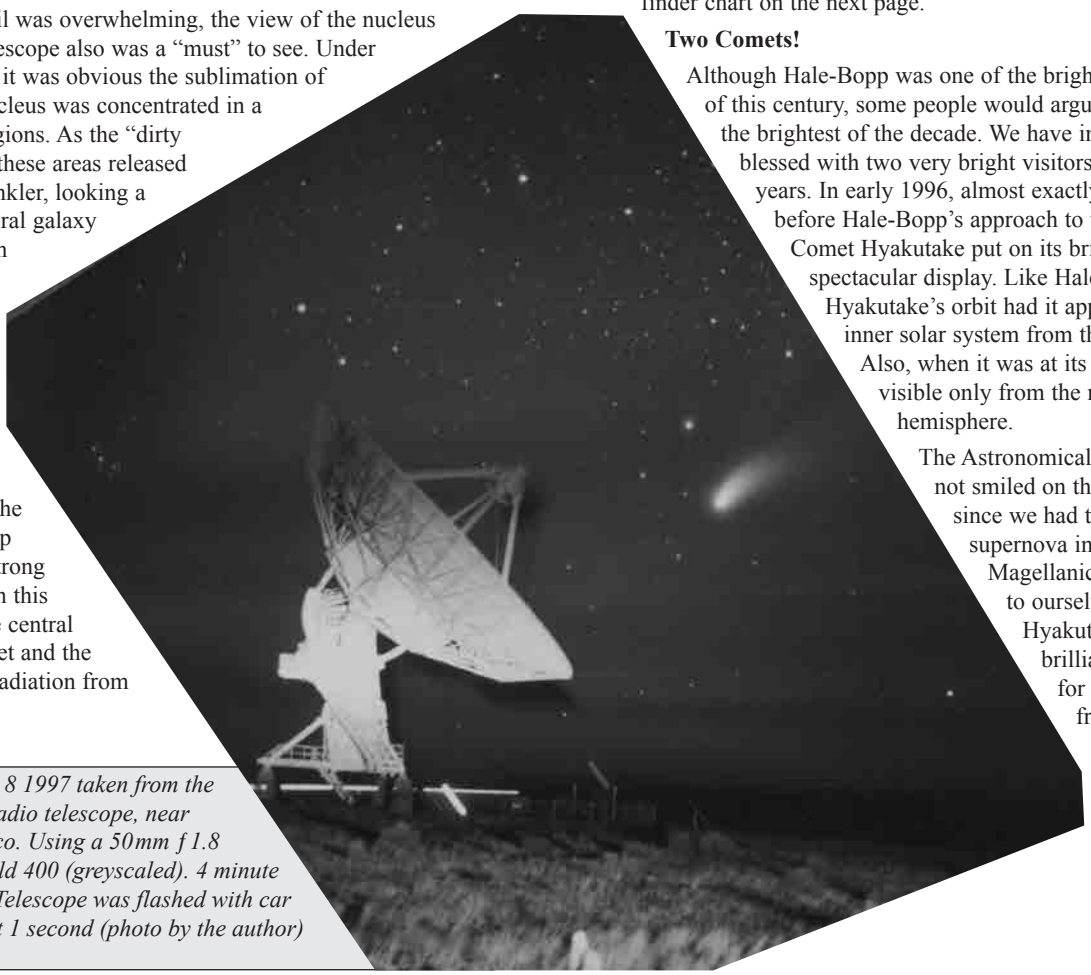
A hundred years ago comets would have been much easier to see from cities than they are today. The dimly lit tails now have to compete with the glow of the modern light polluted skies. Despite this challenge, Hale-Bopp had such a bright dust tail that a few

Hale-Bopp on March 21 1997, taken near the Sierra Mountains, California. Using a 55mm f 2.8 lens with Fuji 800 (greyscaled). Two minute exposure (guided). NB. clouds and Mountains illuminated by a Full Moon. (photo by the author)

degrees was clearly visible from suburban Los Angeles during late March and April. The view from dark skies, away from the city, was spectacular! The dust tail could be seen to span around 15 to 20 degrees to the naked eye (this is about the width of an open hand held at arm's length). That was only half the show, for the normally fainter gas or ion tail was also visible and of a similar length to the* dust tail. A pair of low powered binoculars gave a view similar to the photograph on the back cover of this book, perhaps not quite as colourful. An astronomical object needs to be quite bright for people to see colour (even through a telescope) and the ion tail really needed a photo to show it as blue.

To get a reasonable picture of the comet, one did not need to spend thousands of dollars on telescopes with elaborate photographic equipment. In fact pointing a camera through a telescope, to capture the brilliant tails, would have been a hindrance. The tail was just too big for most telescopic fields of view. All that was needed was a normal 35mm camera with a fast 50mm lens, mounted rigidly on a tripod, with the ability to lock its shutter open for about 30 seconds to 2 minutes (i.e., an old fashioned "B" setting). Some sensitive 400 ASA (or faster) film did the rest. Overnight the astronomy magazines around the world, became filled with wonderful images of the comet near the horizon with a host of spectacular foreground scenes. These included: a multitude of observatory domes, radio telescopes, city scenes and even waterfalls. One photographer used an Egyptian pyramid! Even taking "shots" during Full Moon was effective. The illumination of clouds and mountains by moonlight can give a great effect (see photo in this article). It is interesting to note that almost from the day of closest approach to the Sun (April 1), the dust tail developed a noticeable bend. This is clearly visible on photos taken with such simple equipment. Because of the Earth's rotation on its axis, exposures greater than 30 seconds would show the stars to "trail". To avoid this, some ability to follow the stars would be needed, such as attaching the camera to a tracking telescope.

Even though the tail was overwhelming, the view of the nucleus through a small telescope also was a "must" to see. Under high magnification it was obvious the sublimation of the ice from the nucleus was concentrated in a couple of active regions. As the "dirty snowball" rotated, these areas released material like a sprinkler, looking a bit like a barred spiral galaxy (see top of photo on page 1). These arms, along with a few compression arcs of material, were clearly visible in amateur telescopes. These arcs are similar to the bow waves of a ship moving against a strong current in a river. In this case, the ship is the central nucleus of the comet and the flowing water the radiation from the Sun.



Hale-Bopp on April 8 1997 taken from the Very Large Array Radio telescope, near Socorro, New Mexico. Using a 50mm f 1.8 lens with Kodak Gold 400 (greyscaled). 4 minute exposure (guided). Telescope was flashed with car headlights for about 1 second (photo by the author)

A Grand Southern Exit

By May, the comet now heading south, once again moved into the realm of us "southerners". It was still quite bright but not as obvious as its northern show a month earlier. The main reason for this was the comet remained quite close to the Sun. When it was in the evening sky from Australia, Hale-Bopp was never totally out of the western twilight glow. Its spectacular tail was drowned out by the still bright sky. The tail was also shortened by perspective. As the comet left the Sun, the tail pointed away from the Earth. Despite these problems, the comet was still an obvious object in the early evening sky, showing a small tail even to the unaided eye. This was providing it was caught in a brief period from about 40 mins after sunset until the comet was too close to the horizon. Having a low western horizon, unblocked by trees, was also a big help. Through binoculars, the tail's bend was quite pronounced.

Early June was probably Hale-Bopp's best view from Australia in the evening sky, the closest it came to being under dark skies. Sitting up near the star Betelgeuse, the comet was now visible from even urban areas about one hour after sunset. By early July the orbit of the Earth around the Sun had quickly moved Hale-Bopp into the morning sky. In early August this brief visitor was for the first time, since late 1996, clearly visible under dark southern skies i.e., well above the horizon and not in a twilight or dawn sky. At the time of writing (August 97), the comet was in the eastern pre-dawn sky and still visible to the unaided eye. Binoculars clearly showed a tail about 5 degrees in length.

Hale-Bopp has now returned to the southern heavens where it will remain for many years. Actually it will be about 2,000 years before it once again repeats its long fall towards the Sun. Like its journey into the solar system, it should remain visible in amateur telescopes for a couple of years, at least. In early 1998, it may still be visible a small fuzzy patch through binoculars (no promises). See the finder chart on the next page.

Two Comets!

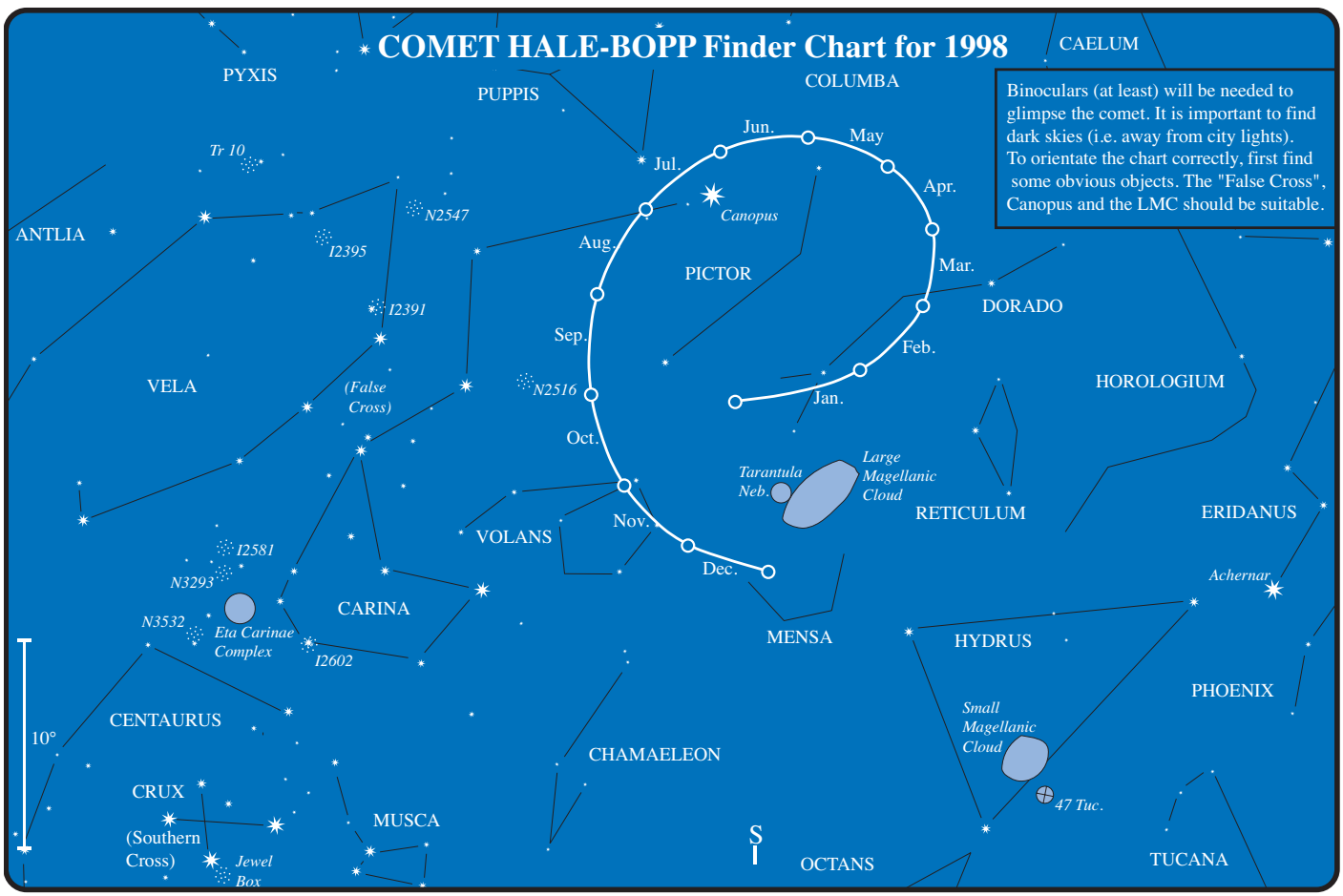
Although Hale-Bopp was one of the brightest comets of this century, some people would argue it was not the brightest of the decade. We have indeed been blessed with two very bright visitors in as many years. In early 1996, almost exactly one year before Hale-Bopp's approach to the Sun, Comet Hyakutake put on its brief and spectacular display. Like Hale-Bopp, Hyakutake's orbit had it approach the inner solar system from the south. Also, when it was at its best, it was visible only from the northern hemisphere.

The Astronomical Gods have not smiled on the "south" since we had the supernova in the Large Magellanic Cloud all to ourselves in 1987. Hyakutake was brilliant briefly for a few days from the southern

hemisphere, but in the early morning. This was not exactly an ideal time for parents to introduce their children (or themselves) to the wonders of comets. Unfortunately it was gone so quickly that Australian amateur astronomers had no time to alert the media to this "searchlight" in the sky. The writer had friends and relatives, who live in the country, making their own "naked eye" discovery and wondering why they had not heard about it before. Those people probably do not appreciate how lucky they were to make such a find by just going outside and looking up!

In appearance, Hyakutake was very different to Hale-Bopp. There were three main reasons for this. Firstly, it passed very close to the Earth (about 10% of the distance to the Sun) so its tail appeared much bigger because it was nearby. Second, it passed closer to the Sun than Hale-Bopp, giving it the chance to grow more active and brighter. Finally, the comet had a well-developed ion tail with no dust tail. During April 96, this narrow tail was reported, by people under dark skies, to stretch across half the sky (unfortunately from the northern hemisphere only)! The ion tail was incredible. The view as one scanned along its tail with binoculars, discovering the various knots and discontinuities, had to be seen to be believed. Despite all this, Hale-Bopp will likely be the brilliant comet of the nineties that people will remember. As mentioned above, Hale-Bopp was obvious even under city lights i.e., where most people live. Dark country skies were needed to really appreciate the beauty of Hyakutake. This, coupled with the two year anticipated wait, will ensure Hale-Bopp's place in history.

Hale-Bopp on July 29 1997. Taken by Albury amateur, Robert Price. 10 minute exposure (guided) using EKTA 1000 (greyscaled), through a 125mm Wright/Schmidt camera.



MANY WORLDS: ONE EARTH

by Geoff McNamara

When astronomers announced in 1991 that the first planets outside our solar system had at last been found, it caused quite a stir. The surprise wasn't so much that planets existed elsewhere in the Galaxy - after all, it would have been more of a shock if our solar system had turned out to be the only system of planets in the Milky Way. No, the surprise was where the first 'extrasolar planets' were found. Rather than orbiting a star like the Sun, the first extrasolar planets were discovered orbiting the remnants of a dead star called a pulsar, the last place anyone would have thought of looking. Since then, planets have been popping up all over the place, including around sun-like stars. But as we all should have expected, these extrasolar planetary systems couldn't be more different from our own if they tried. The Galaxy is nothing if not diverse.

Although the discovery of planets outside our solar system is an historical event, we shouldn't be all that surprised that they exist. After all, philosophers and scientists have been speculating for centuries that planets exist around other stars. Occasionally one spoke too soon, as in the case of the Italian Giordano Bruno who was burned at the stake for, among other things, his ideas on extrasolar planets. Galileo, another who considered the Earth to be no more - and no less! - than a world hurtling through space was also persecuted. The idea that we live on a world that is far from a freak of nature is a tenacious one, and for many it seemed absurd to think "This is it, there are no other planets in the Galaxy".

Evidence had been accumulating for centuries that the things we see in our local region of space - the Sun and the other stars - are common throughout the universe. The fact that the Earth and the other planets revolve around our own star, the Sun, has been understood for hundreds of years. So, the assumption that planets exist around other stars seems logical. But finding extra-solar planets has been a difficult job for astronomers.

The problem is a simple one: glare. Each of the stars visible in the night sky is at least as bright as the Sun; their brilliance is reduced to mere points of light only by their immense distance from us. Planets, on the other hand, orbit stars the way the Earth revolves around the Sun, and are visible only because they reflect the light of the star they orbit. Take away the starlight and planets are as dark and cold as a moonless night.

So, while stars are as bright as the Sun, planets are only as bright as the Moon. Placed side-by-side there is no competition. Further, compared with the immense distance between us and the stars, the distance between a planet and its star is minuscule. Seen from a distance, any planets that may be in orbit around a distant star would be lost in the blinding glare of the star.

The situation seemed hopeless until about ten years ago. Astronomers using an orbiting telescope called the Infrared Astronomical Satellite noticed that a few stars are surrounded by dust, the very stuff that planets are made from. Astronomers took a closer look at the space surrounding the individual stars using a special device to block out the glare of the stars themselves. They found the dust, all right. Surrounding each of the stars was a large, flat disk of dust and rubble. One of these stars turned out to be truly spectacular. The star Beta Pictoris was surrounded by a dust disk that, seen from our vantage point on Earth, was edge-on and extended well beyond the glare of the star itself. Beta Pictoris is almost exactly what astronomers think our solar system looked like when it was forming some four and a half thousand million years ago.

But the most startling examples of protoplanetary disks, or proplyds, found so far exist in the Great Orion Nebula, a star-forming region in the constellation of Orion. The Great Orion Nebula can be seen with the naked eye from the southern hemisphere on any summer night using the charts in Astronomy 1998. But to see the proplyds you need to look a little deeper.

Using the Hubble Space Telescope, astronomers searched the Orion Nebula for proto-stars - stars in the process of condensing out of giant interstellar clouds of hydrogen. What they found exceeded all their expectations. The protostars they saw were surrounded by disks of dust and rubble, planets in the early stages of development. And not just one or two isolated examples, but dozens of young stars with embryonic planetary systems. It seems proplyds are a natural by-product of star formation. Not only isn't our solar system unique, it may be downright common!

But these discoveries still don't confirm the existence of extrasolar planets. After all, a proto-planetary disk is not a planet. Over the last few years, however, evidence for planets around other stars has turned up from an unexpected source. While protoplanetary disks were found around young stars, planets were found spinning around the remnants of dead stars.

The discovery of the first extrasolar planets by Alex Wolszczan and Dale Frail in 1991 was an exciting event. The astronomers had analysed the (entirely natural) radio signals emitted from a pulsar, the burned-out core of a once massive star that has ended its life as a supernova. Beaming radio waves from its magnetic poles, a pulsar flashes a radio beacon around the Galaxy like a celestial lighthouse. Every time the beam flashes across the Earth we see it as a radio pulse. But the speed of these things is fantastic: pulsars spin on their axes up to many hundreds of times every second. The other extraordinary thing about pulsars is that they're regular as clockwork, in fact they're almost perfect clocks. The regularity of pulsars is so reliable that they've been used, for example, to verify certain aspects of the theory of General Relativity.

This regularity is what drew Wolszczan and Frail's attention to the pulsar B1257+12. It showed irregularities in the rate at which the radio pulses were reaching Earth. Looking closer they found that the variation was regular, rhythmic. After carefully analysing the way the pulses varied, the two astronomers announced that the pulsar was being tidally dragged this way and that by at least two planets larger than the Earth. As the planets orbited the pulsar they exerted a gravitational pull on the spinning star the same way the Moon pulls the ocean tides of the Earth. A few years later they announced the existence of a third planet, this time closer to the mass of the Moon. Recently it has been suggested that yet a fourth planet, perhaps the size of Saturn, is orbiting the pulsar.

Despite their masses, it is unlikely the pulsar planets have anything in common with the Earth. Astronomers aren't even sure whether they existed before the supernova explosion that produced the pulsar or formed later on from the debris the supernova left behind. Certainly they do not support life as we know it: life could survive neither the supernova explosion nor the intense radiation from the resulting pulsar. However, pulsar planets confirm that planets can and do form outside the solar system, and so represent an important step in understanding extra-solar planets. Since the initial discovery of pulsar planets, a number of other candidates have appeared, some confirmed, others uncertain.

The next major advance in the search for extrasolar planets came in 1995 when the first planet orbiting a sun-like star was found near the star 51 Pegasi. Once again it was the gravitational tug-of-war between the star and planet that gave the game away. As a planet - any planet - orbits its parent star it tends to pull the star this way and that. Even though the star far outweighs the planet, the pair's motion through space is shifted rhythmically, and the star-planet combination resembles a pair of mis-matched dancers turning and wobbling across the dance floor.

Astronomers can detect this rhythmic motion by observing a phenomenon called Doppler shift. Starlight can be broken up into component colours, just as sunlight passing through rain produces a rainbow. A star's spectrum has distinct features called spectral lines which are caused by elements within the star. These spectral lines always appear at the same place in the spectrum. But since light travels in waves, it can reveal the motion of the stars. If a star is moving towards us, the light waves it emits are compressed and so spectral lines appear shifted towards the shorter wavelength blue end of the spectrum; when moving away, the starlight is 'stretched' and so spectral lines appear shifted towards the longer wavelength red end of the star's spectrum. This effect is called Doppler shift.

If the star is moving at a constant speed then the stretching or compression is also constant; the spectral lines appear blue or red shifted, but steady. However, if the star is accompanied by a planet then the amount the light waves are stretched or compressed will vary as the star wobbles through space. This causes the spectral lines to shift back and forth in the star's spectrum. Tiny as this movement is, it's enough to reveal the cyclic motion of a star as it speeds through space. The simplest explanation for the wobbling is the existence of a planet.

By looking carefully at the Doppler shift of hundreds of stars, astronomers have found several extrasolar planets. Most of these planets are large - often several times the mass of our largest planet, Jupiter - but this is simply due to the fact that big planets cause a bigger wobble in the stars' motion and so are easier to detect. What has been a surprise is just where these giant planets orbit their stars. In the case of 51 Pegasi, the planet is almost half the size of Jupiter, but orbits a mere seven and a half million kilometres from the star, hurtling around the star in just over four days! Other examples include a planet ten times the mass of Jupiter orbiting at a distance of a third the Sun-Earth distance in 84 days, roughly the same distance and period of our innermost planet, Mercury.

Adding to the bizarre nature of extrasolar planets is the eccentricity of their orbits. All of the planets in the solar system have elliptical, or oval-shaped orbits, but only just. The shape of the orbit of a planet can be found by looking at its period. Kepler showed that planets travel faster when they are nearer the Sun and slower when they're farther away. By watching how a planet behaves during its orbit, astronomers can calculate the shape of the orbit. In the case of the Earth, with an eccentricity (that is, how far from a circle its orbit is) of 0.017, our distance from the sun varies from 0.98 to 1.02 AU, a difference of almost six million kilometres. The planet with the greatest eccentricity is tiny Pluto with its ever-present companion Charon. These two orbit the Sun with an eccentricity of 0.248, a variation which carries it alternately well within Neptune's orbit and far beyond it over a 248 year period.

The shape of extrasolar planet orbits can be found by watching how they orbit their star: does the planet orbit at a constant speed, implying a near-circular orbit, or does it travel sometimes fast and sometimes slow, implying a highly eccentric orbit? It was expected that extrasolar planets would orbit their stars in a similar way that all of the planets in the solar system orbit the Sun, that is with eccentricities under 0.25.

You can imagine astronomers' surprise when a planet six and a half times the mass of Jupiter was found flying around the star 70 Virginis with a period of 116 days and an eccentricity of 0.4! This was the first of the "eccentric planets".

Of course, there are plenty of theories as to how and why a planet exists in such a strange orbit, but nothing was settled on by the time a planet was found orbiting the star 16 Cygni B. This star, itself part of a stellar trinary system, is orbited by a planet about one and a half times the mass of Jupiter in an orbit with an eccentricity of 0.67, more than the average eccentricity of short period comets in our solar system. This planet, the most eccentric so far found, orbits around 16 Cygni B every 804 days.

What a surprising Galaxy of planets it's turning out to be.

And we haven't finished yet. There are many plans to search for more extrasolar planets. One involves searching for terrestrial, that is Earth-like planets by watching them pass in front of their parent stars. This may sound an improbable method. After all, a planet the size of the Earth passing in front of a star like the Sun will dim the star's brightness by only a fraction of a percent. Nonetheless, observations have already begun using telescopes that can detect brightness fluctuations of as little as 0.6%, the amount a star's brightness would drop if a planet two and a half times the diameter of the Earth was to pass in front of it.

Still other projects involve using the world's largest telescopes - the twin 10 metre Keck telescopes on Mauna Kea in Hawaii. When linked, these telescopes will mimic the performance of a telescope with a 90 metre aperture. The resolution of such an instrument is thought to be enough to detect an Earth-sized planet orbiting a Sun-like star. Astronomers plan to do this within the next few years. Astronomers are also planning to take extrasolar planetary astronomy to new heights with the planned launch of at least three space-based infrared observatories designed specifically for the detection of extrasolar planets.

But why all the fuss? Why are astronomers so keen to find extrasolar planets? Finding out whether planets exist around other stars will answer two important questions. Firstly, it will help put our own planet's existence into perspective by answering the question: is the Earth unique? The second reason is more speculative but just as important, and is tied to the first: if planets exist elsewhere, why not life? Everything we've seen so far suggests that the solar system is not unique, and so finding life elsewhere in the universe would simply be the next logical step.

The Copernican revolution began with the notion that the Earth was far from the centre of the Universe. Since then we have encountered many things that can be seen to belittle our place in the Universe. But far from detracting from our importance, the discovery of extrasolar planets adds to what should be a sense of fascination with the existence of our own world. Planets in greater number don't make us more common. By their diversity and dissimilarity with our world, they emphasise the uniqueness of the Earth and its inhabitants.

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ASTRONOMY AND THE INTERNET

In Astronomy 1997, the authors listed many of their favourite, and some lesser known, astronomical web sites. This year we wish to continue this list and also highlight any address changes. This list and 1997's (in HTML format) are available via email from the authors <gdawes@s054.aone.net.au>.

GENERAL SITES

The American Association of Variable Star Observers (AAVSO)

http://www.aavso.org/

The AAVSO is the largest organisation of variable star observers worldwide. Its purpose is to co-ordinate variable star observations which are made mainly by amateur astronomers. These are then compiled and processed and made available to professional astronomers or researchers. The AAVSO process over 300,000 observations yearly, from observers all over the world. Since the AAVSO was formed in 1911 it has processed over 8 million observations. Variable stars are stars that change in brightness. These brightness changes can vary from a fraction of a magnitude to over 10 magnitudes. The period of these changes can vary from seconds to years, depending on the type of variable star.

This site includes: how to join the AAVSO, online Variable star charts, some selected light curves and reviews of their numerous publications including how to order the renowned AAVSO Variable Star Atlas. There is also a bulletin which gives predicted dates of maxima and minima for 561 long period and semi-regular variables. The AAVSO will even sell you a shirt with a light curve of Mira, ties and caps!

Association of Lunar and Planetary Observers (ALPO)

http://www.lpl.arizona.edu/alpo/

Lots of information regarding ALPO publications and meetings. Probably the most interesting feature is the links to hundreds of amateur astronomical societies around the world (even a few Australian societies made it in!)

Astronomy Picture of the Day

http://antwrp.gsfc.nasa.gov/apod/astropix.html

Certainly worth a look. Some of the images are unusual, lesser known, astronomical objects. There is also normally a good explanation as well.

Astronomy Today

http://www.prenhall.com/%7Echaisson/

This site is dedicated to the 2nd edition of this book by Chaisson & McMillan. There is is a brief chapter by chapter overview with images. If you wish to test your astronomical knowledge, the True/False quiz is a lot of fun - you find out your results straight away.

Clementine Lunar Image Browser

http://www.nrl.navy.mil/clementine/clib/

Opens with a full projection of the Moon. You set the resolution (i.e., km per pixel) and click (or enter the latitude and longitude) on the area of the Moon you wish to look at. Certainly "the" site for the frustrated lunar observer on a cloudy night.

Comet Hale-Bopp Homepage (JPL)

http://galileo.ivv.nasa.gov/comet/

This location goes into some detail on the discovery of "Hale-Bopp". There are also up-to-date photos of the comet with some 4,000 images available on this site. This includes some excellent images taken by Aussie observers in the twilight sky during June and July 1997.

International Dark-Sky Association

http://www.darksky.org/

There is no doubt that the view of the Milky Way under dark country skies is a heritage that should not be lost to the glow of the increasing urban areas. IDA's goal is to be effective through educating people about the value and effectiveness of quality night time lighting. It also wishes to promote solutions to the adverse environmental impact of light pollution and space debris.

Mars Pathfinder Mission

http://sparkli.tip.csiro.au/mars/default.html

I don't think there is anyone who was not fascinated by the Mars rover. This is a great site if you wish to find out the current Mars weather report or check out the latest images from the lander. There is even a scientific analysis of a dust devil that swept over the lander about a month after it landed. There is also a link to the latest information from the Mars Global Surveyor Mission.

SETI Institute:

http://www.seti-inst.edu/

Nothing has probably inspired the imagination of Man more than the possibility of life elsewhere in the Universe. The Search for Extraterrestrial Intelligence is nearly as old as radio astronomy. In recent years there has been renewed interest in this subject (sorry, for those of the "Little Green Men" set, we are not talking UFOs).

Learn all about Project Phoenix, mankind's latest and greatest attempt to detect intelligent radio signals from near-by stars. Examine the results from the latest observations. Also take a sneak look at the latest sci-fi movie "Contact" (Carl Sagan's novel) and find out just how close it comes to reality. The descriptions of the SETI educational programs are interesting. Anything that encourages the youth of today to examine and question the universe is a real bonus.

Solar Data Analysis Centre (NASA)

http://umbra.nascom.nasa.gov/sdac.html

Another high quality NASA site. This one is dedicated to observations of the Sun. Results from solar space missions are included i.e. SOHO, Solar Max. This includes plans for future space telescopes. Also the latest images of the Sun can be obtained in just about any wavelength from sites such as Sacramento Peak. For those planning a future expedition, the NASA Eclipse Bulletins are available from this site.

Spacelinks

http://spacelink.nasa.gov/.index.htm

For those who are overwhelmed by the complexity of NASA on the web, this is a wonderful reference source. This is NASA's equivalent to its own search engine. As a test, the phrase "Hadley Rille" brought up 59 links, including many on Apollo 15 and various NASA photos from both ground based and unmanned probes such as Lunar Orbiter 5. Warning, unless you have unlimited time from your internet service provider, this could get expensive, as it is quite addictive!

AUSTRALIAN WEB SITES

Astronomical Societies

There are now quite a few societies with homepages. Addresses are listed as part of the appendix on astronomical societies (p. 132). The following societies have had a change of address since Astronomy 1997 was published.

Astronomical Society of Frankston

http://www.peninsula.starway.net.au/~aggro/

AstroVic Page (Astronomical Society of Victoria)

http://www.gsat.net.au/astrovic/

We wish to welcome the following newcomers:

Astronomical Society of Alice Springs

http://www.ozemail.com.au/~kkramer/astalice.html

The usual society details are given such as meeting place/dates and observing nights. The site showcases the excellent astrophotography of their president Karl Kramer. There are also some interesting links to other non astronomical sites in NT.

Canberra Astronomical Society

http://msowww.anu.edu.au/cas/

This site includes: membership details, a comprehensive calendar, a good summary of current sky events, electronic astro magazines, features from their own journal "Southern Cross" and a great list of links to other "Aussie" societies. There is also a good section on Astro-images highlighting the work of member Steve Crouch (taking excellent colour images with a CCD is not as easy as he makes it look)

Sutherland Astro Society

http://www.ozemail.com.au/~sasi

This is a "well rounded" site with the homepage going into quite a lot of detail on such topics as: membership, SAS adult education courses, public open nights, group bookings and forthcoming events. The society is hosting the 18th National Australian Convention of Amateur Astronomers over Easter 1998 and this is well covered at this site.

Taree Astronomical Society

http://www.midcoast.com.au/users/rosco/rosco.html

This site gives a good overview of the society and its activities. It is also a good source of some basic astro information (e.g., what time will Venus rise tonight?) and links to a few other astronomical sites.

Western Sydney Astronomical Group

http://physics.st.nepean.uws.edu.au/nac/wsaag.html

This web site is brief and is a "no frills" description of the history of the society and their activities. It is part of the Nepean Astronomy Centre's homepage.

GENERAL AUSTRALIAN ASTRONOMICAL SITES

Michael Horn's Comet Hale-Bopp Gallery

http://www.ozemail.com.au/~mhorn/halebopp.html

A great collection of this Queensland amateur's photos of Hale-Bopp. Approximately 15 images cover the evening period of April to June 1997 and it is certain more will follow from the morning period commencing in August.

Koolang Observatory and Space Science Centre

http://users.hunterlink.net.au/koolang

Koolang Observatory is located on the Central Coast of NSW. Their homepage is expected to be operational in October-November 1997.

Nepean Astronomy Centre

http://physics.st.nepean.uws.edu.au/nac/

This university facility is located at the Werrington North campus of the University of Western Sydney (UWS) Nepean, about 50km from the centre of Sydney. This relatively new web site describes the centre and their public activities. It also has a collection of images taken with a CCD camera through the centre's 0.6m telescope.

Nick William's "Astronomical Links"

http://www.ozemail.com.au/~nwilliam/bas/links.htm

This is a wonderful collection of Australian astronomy links. This is then followed by an equally impressive collection of general sites from the rest of the world. These have been broken up into topics such as charts, ATM, astrophotography, supernovae, professional astronomical sites and space (great NASA links). Why type any of the addresses in this article, grab them here!

The Golden Grove Observatory

http://www.iinet.net.au/~astro/

This is the only commercial observatory near the Perth metro area. It is situated in the scenic Chittering Valley, one hours drive north of Perth in the Golden Grove tourist orchard. The web site details the telescopes available for use, opening hours and how to make a booking.

SEA*ACT

(Science Educators Association of the Australian Capital Territory)

http://www.spirit.net.au/~auriga/

A good source for lots of educational links in Astronomy and general science. Emphasis is placed on Australian science related museums, astronomy centres, electronic magazines, and organisations. This www site is much more than just astronomy. There is even a section on resources specifically suitable to the primary school teacher. Worth spending some time just exploring.

SETI Australia:

http://coder-dc.macarthur.uws.edu.au/html/indexn2.htm

This is a relatively new group formed at the University of Western Sydney (see also SETI, on the previous page, in general sites).

Southern Star Education - Mobile Planetarium Service

http://www.ozemail.com.au/~ssemps/

This service operates in SE Queensland concentrating on school groups. The site outlines what shows are available and which age groups they best suit. There is also a good summary of upcoming astronomical events, good links to astronomy and space related sites, conferences and star parties.

Sydney Observatory

http://www.phm.gov.au/observe/

This site is part of the Powerhouse Museum's home page. Information available includes: hours of opening, entry fees, a map, an overview of presentations/night viewing and a brief history of the observatory.

The Science Centre and Planetarium, Wollongong

http://www.uow.edu.au/science_centre/

This page is still in its early days. There are some good links to general science/education sites.

Sky at Night

http://bintel.com.au/Night_Sky.html

Now you can get the Famous Mike Smith "Sky at Night" monthly bulletin for free (no postage required) and in colour!

Mt. Stromo Exploratory

http://msowww.anu.edu.au/exploratory/index.html

This web page, like the Exploratory is still under construction. However, even in these early days this site shows promise. This is worth bookmarking for further developments.

And finally a few changes of web addresses:

Canberra Planetarium & Observatory is now at:

http://www.cfmeu.asn.au/Planetarium/

Weather Forecast page has changed to

http://www.bom.gov.au/weather/

This site is a great source for the latest satellite photos for those planning their observing runs.

Visual Satellite Observers Homepage has moved to

http://www2.plasma.mpe-garching.mpg.de/sat/vsohp/satintro.html

The Sir Thomas Brisbane Planetarium has changed its address to

http://www.powerup.com.au/~stop/

The previous site should remain active for a while.

OBSERVING THE SOLAR SYSTEM

by Ken Wallace

Who can ever forget their first tantalising glimpse of the lunar landscape or Saturn through the telescope? It probably created the initial spark that led beyond the idle curiosity stage, and into a deeper commitment to the hobby. Planetary observing is primarily where most amateur astronomers begin their favourite pursuit.

Ironically, no matter where the interest eventually leads, the amateur is drawn back to the solar system from time to time. The enticement could be a favourable opposition of Mars, or an eclipse of the Sun or Moon. Perhaps a rare event like the bombardment of the Jovian atmosphere by fragments of a comet, or simply an aesthetically interesting conjunction in the evening sky.

Since most of us live under light polluted city skies, there is not a lot that can be accomplished with what has been popularly termed "deep sky", that is, everything outside our solar system. Hoards of deep sky observers evacuate our cities every New Moon weekend, escaping to favourite country observing sites. There is merit and dedication in all this, but light pollution should not necessarily mean an end to the hobby. If you are city bound you just need to examine the options available. Instead of chasing faint and distant fuzzies at the very ends of the Universe, why not try some of the celestial wonders that are closer to us. Of the many different astronomical objects to be seen, some of the best are in our own vicinity, the solar system. Light pollution has very little effect on the Moon and Planets, and you can view our heavenly neighbours at your leisure from the comfort of your own backyard.

Some members of our solar system, like comets and meteors, are best left for dark skies. The relative rarity and uniqueness of a bright comet or good meteor shower deserves some effort and preparation to gaze at their beauty. There is a chance this year that the Leonid Meteor Shower will put on a display of intense activity (see November monthly text). This spectacle occurs very 33 years, and while there are no guarantees on the Leonids performance, it could virtually rain meteors from the sky! To see the Leonids a site away from city lights, with a good east to north outlook, should be chosen.

The purest and simplest form of observing our celestial neighbours is with the unaided eye. Since ancient times astronomers were aware that five 'stars' appeared to move about the heavens, while the others remained fixed. The Greeks called these thanino (planetes), or wanderers; we call these objects the planets Mercury, Venus, Mars, Jupiter and Saturn. During each year some of the planets will, in the course of their orbits, appear nearby each other, or close to the Moon, or a bright star. An occurrence of this type is called a conjunction, and all the memorable ones can be previewed in the 'Sky Views' presented in the monthly section in this publication.

Unaided eye observation of the planets may seem dull to some, but a good conjunction can be a spectacular event, even in the days leading up to and after closest approach. The crescent Moon, Venus and Jupiter conjunction in April is a good example, and will be one of the highlights of the year. Another conjunction in December when Jupiter and the Moon appear extremely close, will also create a splendid sight, in the early evening sky.

An occultation occurs when the Moon passes directly between the Earth and a planet or star. When this happens the object will disappear behind the eastern lunar limb, and reappear sometime later from the western limb. In one hour the Moon will move across the sky the equivalent of its own diameter, or about 0.5° of sky. Therefore, the maximum duration of an occultation will be about one hour, if the event is central. If an occultation occurs after New Moon and before Full Moon, a bright star or planet will suddenly vanish behind the dark limb, a truly magical sight! An occultation of Jupiter by the Moon takes place in October, and more information on this event and the conjunctions listed above will be found in the monthly section.

Observing without optical aid can be fun, and whenever walking outside most amateurs will invariably spend a few minutes generally looking around the night sky, appreciating its beauty. The unaided eye view however, does have some limitations; for a start we can only see the five brightest planets, Mercury, Venus, Mars, Jupiter and Saturn (Uranus can be seen with the unaided eye under good country skies, but remember we are city dwellers). A modest pair of binoculars can expand our solar system to seven planets, Uranus (6th magnitude) and Neptune (8th magnitude) and a few of the brighter asteroids are now within our grasp. So too are the four Galilean satellites of Jupiter and Saturn's largest moon Titan. Binoculars can also reveal the larger lunar craters along the terminator, and at Full Moon the magnificent ray systems of craters like Tycho. The use of binoculars will be further discussed in the "Getting Started" section.

To appreciate the true uniqueness of our solar system, we must replace our binoculars with a telescope. It is not always the case that the bigger the telescope, the better the view when it comes to solar system objects. Often the small modern day refractor will out perform its bigger cousins, and for the planets at least, optical quality will generally outweigh aperture any day. The real adversary to planetary observing is unsteady "seeing" or turbulence in our atmosphere, and large telescopes are worst affected.

Some of the bad seeing effects can be minimised by observing over a grassy backyard, rather than on a large paved or concrete area that radiates heat stored from the day. Similarly move the telescope away from large buildings, and try to avoid looking over them. Always allow a telescope that has been stored indoors, at least 10 or 15 minutes to stabilise to the ambient temperature. Always begin with a low to medium magnification and if the seeing permits, only then increase to higher powers. Perseverance will often reward the observer with good views. Even on an unsteady night there will be moments when a clear window develops, and suddenly crisp sharp detail can be seen.

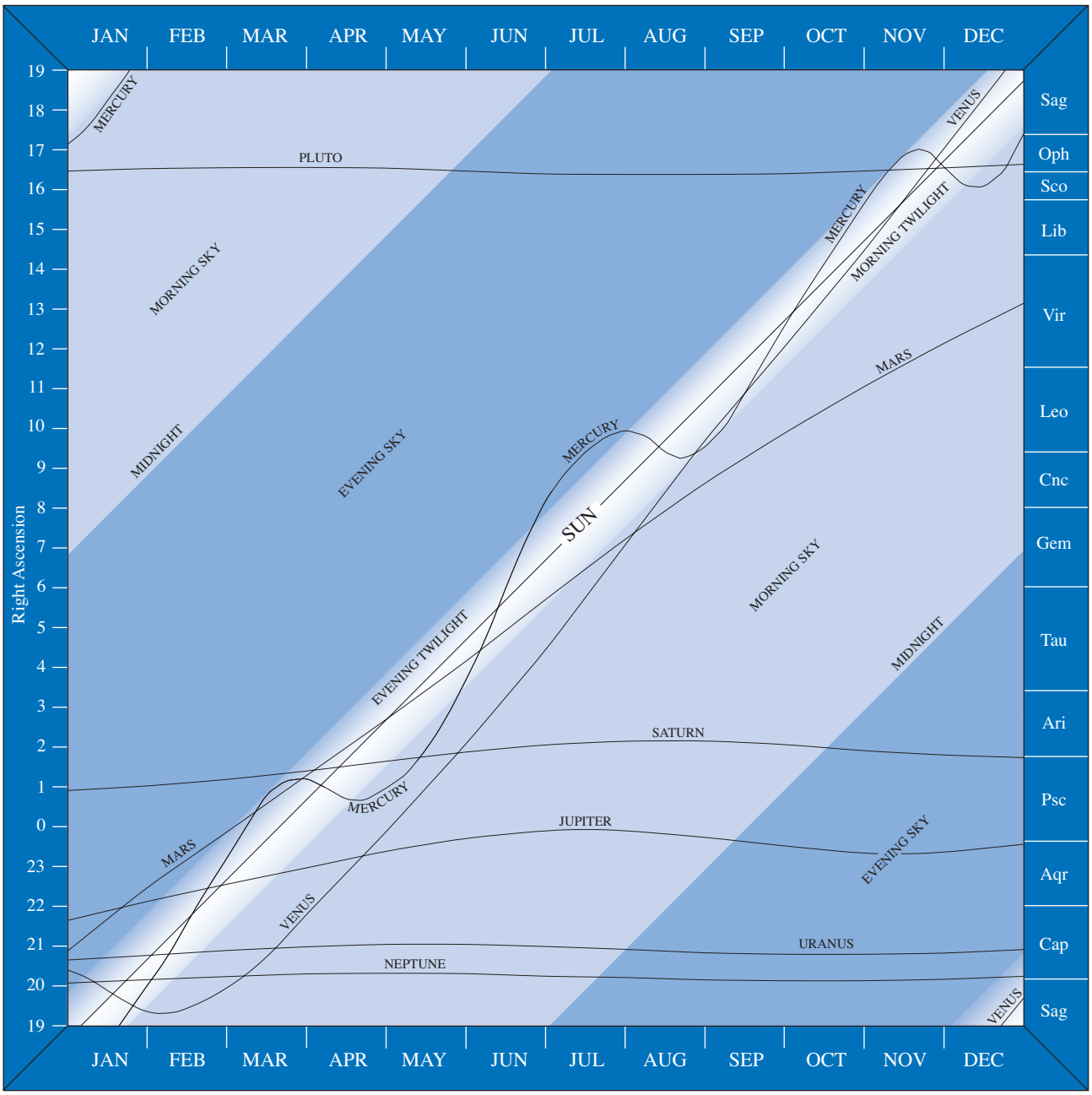
To the telescope user the solar system becomes a treasure trove of unique sights. The lunar landscape unfolds before the observer in desolate beauty, craters along the terminator stand out in stark contrast. This harsh world is not static as one would imagine, beads appear when the Sun strikes high peaks and crater walls on the terminator. Half hour later the entire rim may be visible, and after a few hours the pool of darkness that was the crater floor suddenly bursts into daylight. The lunar like phases and changing size of the inner planets, Mercury and Venus are fun to watch. Mars at opposition attracts much attention with the chance to see polar caps, surface markings and huge global dust storms (the next good Martian oppositions occur in the years 2001 and 2003).

The giant among the planets, Jupiter, displays changing detail in its cloud belts, and even has a storm that has been raging for at least 300 years (the Great Red Spot). Jupiter's family of moons make extraordinary viewing as they shuttle back and forth, undergoing eclipses, occultations and transits (see Jupiter's Moons, Part II). Saturn, the jewel of the solar system, with its magnificent system of rings, displays a beauty and poise that is always breathtaking. The greenish blue discs of Uranus and Neptune present an easy challenge to track down, and complete our tour of the solar system as it was

known up until 1930. Pluto, the faint (14th magnitude) and stellar-like ninth planet, requires large apertures and dark skies.

The solar system is a good place to have a bit of fun while learning the basics. It is not unusual for the amateur to then specialise, since the astronomical field is so diverse. This concentration of effort may be within the solar system, or it may present other challenges which need dark skies. One thing is certain though, you can spot an amateur astronomer. Whenever he or she walks outside at night, the amateur will always look up. Without optical aid, some time will always be spent in awe and wonder at the Moon, planets and stars, even from light polluted skies.

VISIBILITY OF THE PLANETS



The "Visibility of the Planets" diagram (above) 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 derived. 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 the planet is situated 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 (Jupiter in mid July is in the morning sky in Pisces).

Mercury and Venus are at conjunction when they cross the Sun line and at their greatest elongations when furthest from it. Mercury in the evening sky this year will be at its best in July when its path extends beyond the twilight. When an outer planet crosses the midnight line, it is at opposition and is visible the entire night. Where an outer planet's line shows a negative curve or downward slope, it is in retrograde motion. Note that Mars does not come to opposition until 1999 and therefore does not cross the midnight line nor present a negative curve.

Perhaps the most important aspect of the diagram, particularly for the unaided eye observer, is the ability to predict when planetary conjunctions occur. The conjunction of the year with Venus and Jupiter, mentioned earlier, is clearly shown where their paths cross in the April morning sky.

GETTING STARTED

If you are just a beginner, this page is for you. If the tables of numbers in the back of this book seem a little daunting, forget them. You don't need them (yet). Neither do you need a telescope to discover the most spectacular show nature has to offer, the night sky. You just need this book to guide you along on your voyage of discovery of the Universe.

This page will concentrate on the first part of this book, the 'Monthly sections', for this area has the most to offer the novice.

ASTRONOMY 1998 can be used from anywhere in eastern and central Australia. While the charts showing the appearance of the night sky have been drawn for Sydney, the change in the appearance of the sky between cities and towns - even across a country so vast as Australia - is so small you probably won't notice it. The rise/set graphs are useful since they give an approximate local time of rising and setting - no matter where you live!

Times are given in Australian Eastern Standard Time (in Part I). No adjustment has been made for daylight-saving time since the timing of this varies from state to state (check your newspapers for details).

SO WHAT CAN THIS BOOK HELP ME SEE?

The night sky regularly puts on displays for us called conjunctions. Since the planets including Earth are moving round 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, the Moon or a star, it's called a conjunction. When the Moon joins the scene, it's a wonderful sight.

Conjunctions can be spectacular events. An example of a good conjunction this year is the one between Venus, Jupiter and the Moon on April 23 (see Sky View p. 35). Venus and Jupiter lie together with the Moon above them in the eastern dawn sky. This is simply a chance alignment of the planets and the Moon. 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 metres or kilometres because the numbers would be so large. Instead, let's 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 1 second to reach us, Venus is 7 minutes and Jupiter 47 minutes. If you include the faint star, Phi Aquarii (just above Venus) we are talking an incredible 330 years! Distances in astronomy do challenge the imagination! This conjunction is only part of the gathering of planets in the morning sky during April and May. Mercury and Saturn join in with further great conjunctions on May 13 and 29. Certainly worth the early rise!

Conjunctions are fun to watch, free, and entertaining. The equipment needed to see conjunctions? You guessed it... nothing!

The best times to see conjunctions are shown in the Sky View diagrams (there are 6 such drawings for each month). Each Sky View shows you an area of the sky that contains a conjunction or another interesting feature. The horizon is shown at the bottom of most Sky Views along with any useful notes. At the top of each Sky View is the date you should look. Since the planets move fairly slowly in the sky, many conjunctions occur over a number of days. This means you can often see the planets and stars starting to take their "places" days before, and then drift apart for days after the event. The Moon is about the only exception. It moves quite a bit each day against the background stars. This is why the Moon's position for more than one day is sometimes shown on the same diagram. All the planets visible in a Sky View are labelled, as are the brighter stars.

To use a Sky View, simply go outside under the night sky at the time given and face the direction shown on the Sky View horizon. What you see in the Sky View will be a temporary map of the sky in front of you. Incidentally, if you don't know the directions around your house, use a street directory to show you which way is north.

There is more to the night sky than conjunctions. There are meteor showers, comets, minor planets (asteroids) and constellations. Not to mention the fascinating movements of the planets as they wander against the background stars. These are all described in Part I of this publication.

Part I is divided into months. At the beginning of each monthly section is a curious looking graph called a rise/set chart. This series of squiggly lines is your guide to knowing when the planets, Sun and Moon rise and set. To use the chart, simply look at the current date on the bottom of the chart and follow that line upwards until it intersects the object of interest. The rise or set time of the object can now be read on the left-hand edge of the chart. For example, on June 22 the Moon and Venus rise together at approximately 4:20am. Incidentally, when you see objects rising or setting together look for a Sky View on that date. It might be a great conjunction.

Each of these monthly sections also has diagrams showing the relative size and appearance of each planet as seen through a telescope. There is also a description of celestial happenings and highlights - kind of like a celestial movie goer's guide - and in plain English! Want to know what Venus is up to in March? The description will tell you. A diary of events is also included that summarises the month's features. To see some of these celestial features you'll need a pair of binoculars or a small telescope.

There is one piece of equipment that every sky watcher should have - a red tinted torch. Any torch will do. Simply tape some red cellophane over the end of the torch so that it gives off a dull red glow. The aim is to preserve your night vision, or 'dark adaptation'. When your eyes become used to the dark, they won't react to a red light and so you can use the charts and illustrations and still enjoy the night sky.

While on the subject of lights, make sure as many lights near your observing site are turned off. The less glare around you the easier it will be to enjoy the night sky. Encourage neighbours to turn off their outside lights, too. A major modern threat to the night sky is light pollution; stray light scatters upwards into the night sky where it drowns out the stars. So, the more lights we all turn off, the less light pollution, the more power we save and the less natural resources we consume. Perhaps it is time the environmentalists had a look at this. After all, it is the only form of pollution where it costs less to fix!

The Sky Views don't show all the sky. By their very nature they concentrate on the ecliptic or zodiac regions of the sky i.e., where the planets and Moon wander. A good companion to this publication would be a basic star atlas or a planisphere. These will show all of the sky, but not the Sun, Moon and planets because they move. The planisphere is useful by showing at a glance all of the constellations visible at the time you are observing. An example is shown on page 19. Once you start to look around the sky with a planisphere, you may be pleasantly surprised how easy it is to recognise a few of the constellations. These star patterns will quickly become familiar and will soon be like old friends.

Part II of ASTRONOMY 1998 contains specialised data generally designed for the more experienced enthusiast. The novice however should not miss the appendices. If you wish to pursue the hobby further, the authors strongly recommend that beginners check out the local amateur community. Learn from these experts and look through their equipment, before spending hundreds or thousands of dollars on a telescope that may not suit you or your needs. The public observatories, planetariums and courses can also be great resources. Use them.

A Word about Binoculars

Probably the most cost effective accessory for the beginner are binoculars. Good quality binoculars can be purchased at the same cost of 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 cheap way of gauging his/her level of

dedication. This does not mean the authors are suggesting the quality of the binoculars should be poor. It is recommended that even binoculars should be purchased from a reputable optics or telescope dealer i.e., someone who appreciates the quality required for star gazing. Astronomy is indeed a severe test on optics. Such shops can also assist with mounts to hold the binoculars steady. These are often brackets designed to attach to a tripod (sorry, another possible expense). To observe details on the Moon or looking for Jupiter's moons, it is recommended that binoculars are not hand held. Sometimes you can brace yourself on the arms of a chair or the roof of a car. This can be important if the power of the binoculars are more than 10X. A power of 7X is considered a reasonable compromise. It can give a good field of view with adequate magnification to glimpse some of the inner moons of Jupiter. The size of the aperture normally comes down to what is comfortable for the person to handhold and the budget. A pair of 7X50 (7 times magnification, 50mm diameter front lens) is fairly popular with amateurs.

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

- Helping to find stars and planets in the bright twilight sky.
- Looking at the craters and rays of the Moon.
- Looking for fainter stars marked in star atlases or on the Sky Views 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. Also the contrast between the yellow of Alpha Centauri vs. the blue of Beta Centauri is interesting.
- The crescent phases of Venus.
- Stars and planets close to the horizon.
- Looking for earth satellites in the early evening sky.
- Monitoring the change in magnitude of some of the brighter variable stars. This is not covered in this publication but there are a number of organisations that can help with finder charts/ predictions.

Start with your local astronomical society.

- Observing the moons of Jupiter as they oscillate across the planet from night to night (see the diagrams on pages 102-104). It is also possible to observe an occasional eclipse disappearance or reappearance for one of the outer satellites (pp. 99-101) as the moon passes into/out of the shadow of the planet.
- Lunar occultations of some of the brighter stars. See also Part II. Probably small binoculars are best suited for magnitude 4 or brighter events, preferably on a dark limb. There is no reason why one should not time the event as described on page 85.
- Looking for bright comets (from dark skies).
- Looking for some of the brighter minor planets near opposition (start with Ceres or Vesta). A good exercise is to sketch the field a couple of times a few days apart and see which "star" has moved.
- Searching out Uranus and Neptune (see finder chart on page 114).

Most of the above activities can be done from a typical suburban backyard. It is not necessary to drive for an hour to reach dark skies. Also scanning the skies for satellites can open up a whole new universe of discovery as various star clusters and nebulae drift through your field of view.

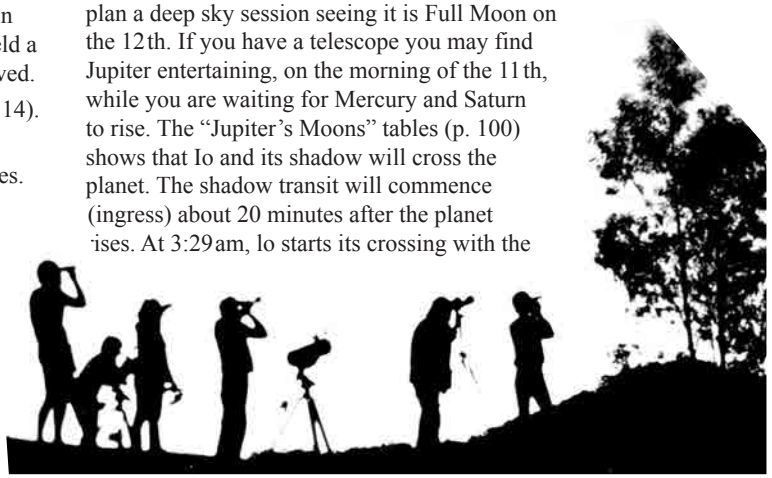
Finally, it is worth remembering that a pair of binoculars is prone to dewing just like a refracting telescope. A couple of cardboard tubes, sticking out only about 75mm can prevent dew and also eliminate stray light.

How do I use this Book to plan my observing?

This publication was never intended to be read from cover to cover. It is a reference work, which, if you look close enough, gives you a number of pieces to the puzzle. Also the "puzzle" is quite different depending on whether you are using your eyes, binoculars, or a telescope. The data that an astrophotographer would find useful could again differ. To illustrate how to use the book we will select two dates during the year.

You are planning to go out and observe on January 19 (for once the weather forecast looks OK). A good place to start is the new "Visibility Chart" (p. 13). Looking around mid January it looks as if most of the visible planetary activity is happening in the early evening with a possible conjunction of Mars and Jupiter (in Capricornus) around this time during twilight (notice the lines crossing). Saturn is well placed in the evening sky (in Pisces), Pluto in the morning and Mercury in the morning twilight sky. Venus appears very close to the Sun and probably unobservable as it passes from the evening into the morning sky. Uranus and Neptune are in the evening twilight sky but they too will have passed into the morning twilight sky by early February. Turning to the January monthly section, the rise/set chart confirms these observations. The "Highlights" and Sky View on January 21 confirms the conjunction. It appears that on the evening of 19th, Jupiter and Mars will be closing in for their closest encounter of 0.2° in two days time (they are already less than 2° apart). The Moon will rise just before 11pm AEST (midnight, daylight saving), but looking at the Lunar Occultation Tables (pp. 86-91) there does not seem to be any bright events due for late on the 19th or in the morning of 20th. For those with telescopes, there is some time available to observe Saturn before it sets just before 11pm. The Saturn section tells us that Titan is about 1 day away from a greatest elongation west (20th @ 23.9hr AEST). Close to Titan will be 14th magnitude Hyperion, which is 2 days from greatest elongation west (a test for the larger scopes and dark skies are needed). The "Diary" mentions a conjunction between minor planet 43 Ariadne and globular M80 in Scorpius on the 19th. At a distance of only 0.4°, this would make a great target for some prime focus astrophotographers (certainly a Schmidt camera). A check with a planisphere shows Scorpius to be a late morning constellation. Therefore this is a morning event on January 19. With twilight commencing just after 5am, around 4am would be a good time to grab a shot. Unfortunately, there will be the Moon in the western sky to contend with; a 20 day old Moon will have risen just after 10pm on the 18th.

It is the evening of May 10. A quick check of the Visibility chart shows the solar system action has certainly switched to the morning sky. Saturn, Mercury, Venus, Jupiter, Uranus, Pluto and Neptune are all in the morning sky (this could be a long night). Mars is not available, being too close to the Sun. The chart shows that Mercury and Saturn have a conjunction around this time. The May monthly section confirms the conjunction will occur on the morning of 13th. The Sky View shows that tomorrow morning (11th) Saturn and Mercury will be 2.6° apart in the dawn sky. This is not the time to plan a deep sky session seeing it is Full Moon on the 12th. If you have a telescope you may find Jupiter entertaining, on the morning of the 11th, while you are waiting for Mercury and Saturn to rise. The "Jupiter's Moons" tables (p. 100) shows that Io and its shadow will cross the planet. The shadow transit will commence (ingress) about 20 minutes after the planet rises. At 3:29am, Io starts its crossing with the



shadow leaving (egressing) at 4:35 am. Io leaves an hour later during twilight. Venus that morning will be displaying a gibbous phase (a bit like a 9 day old Moon), as shown in the "Appearance of the Planets" diagram. At only 17 seconds of arc, this could be a real challenge for binoculars.

These are examples of ways to apply the information within this book.

SOME ASTRONOMICAL TERMS TO GET YOU STARTED

There are several astronomical terms you'll come across in ASTRONOMY 1998, 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. There are nine planets in our Solar System, and the Earth is the third planet out from the Sun. The diagram on page 74 gives a good overview. There are also a number (actually several thousand) of 'minor planets' that move around the Sun, mostly between the orbits of Mars and Jupiter. The Moon and all the planets we see in the sky do not glow in their own right. They are only visible because of the sunlight they reflect.

Star Just like the Sun! A star is an enormous sphere of glowing gas that gives off tremendous amounts of light and heat. They shine by their own light caused by nuclear reactions going on deep inside them. It's a testament to the enormous distances between the stars when you realise that the Sun is a relatively average star (i.e., not exactly super bright), while some stars visible in the night sky are tens or hundreds of times larger and brighter.

Magnitude The brightness of a star or a planet in the night sky is described as its magnitude (sometimes abbreviated to 'mag.'). The numbers work backwards. The faintest star you're likely to see with the naked eye is about 6.0 magnitude, 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!

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. It is an interesting exercise to go out on nights when there are conjunctions and doing your own measurements of the objects' separations and compare your results with the predictions in this book.

Twilight does not really end until the Sun is 18 degrees below the horizon; this is called 'astronomical twilight'. This happens about 90 minutes after sunset (or before sunrise) and is different from what people would normally call the end of twilight. This would be Civil twilight, which begins or ends when the Sun is 6° below the horizon (about 30 minutes before sunrise or after sunset). Only when astronomical twilight has ended, is the sky considered truly dark (assuming the Moon isn't above the horizon!). But keep in mind that many celestial features can be seen even during twilight; binoculars can also help. The actual time between sunset and end of twilight (and the beginning of twilight and sunrise) does vary with latitude. The further south, the longer the time of twilight. Compare the times of twilights and rise/sets in Part II between Darwin and Hobart.

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 planets, this is normally when they are due north.

INTRODUCTION TO PART I

Part I of this publication is designed as a quick reference section for anyone who wants a summary of tonight's sky, without having to refer to lengthy, complicated tables. Precise data, like the exact rise/set time or position (RA and Declination) of the planets is contained in Part II.

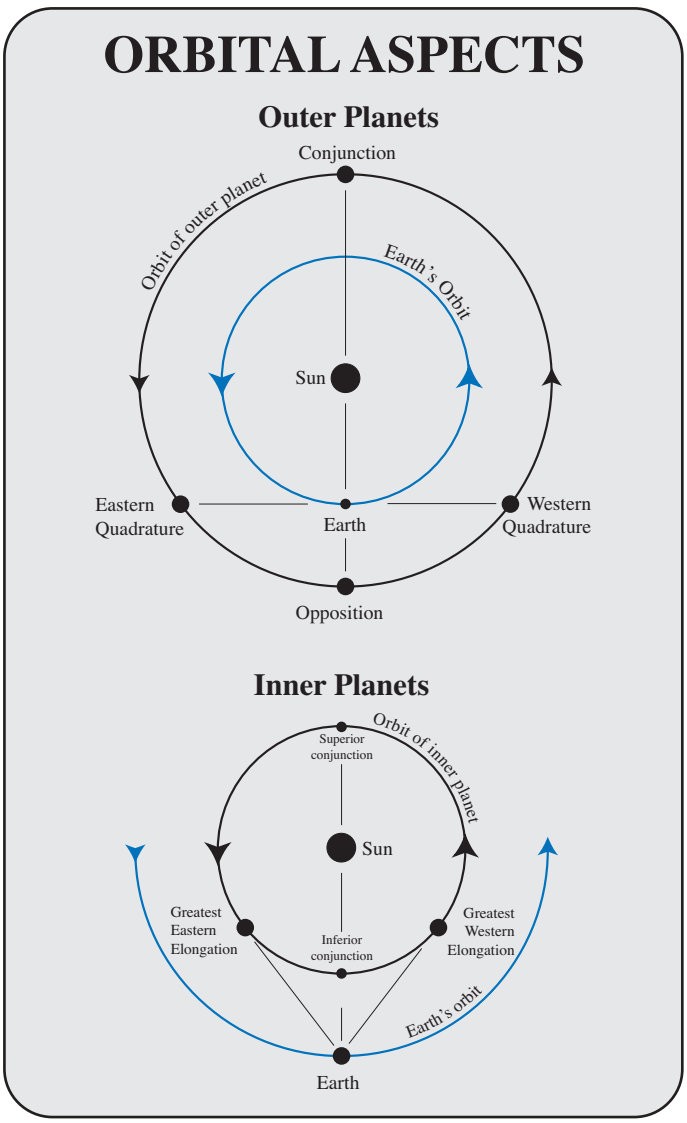
Is This Useful for Where I Live? Part I is useful for anywhere in eastern Australia (some of it is common for the world). The information in Part I of this handbook, has been calculated for Sydney, NSW, Latitude = 33° 54' S, Longitude = 151° 15' E.

Time. The times used in Part I are in Australian Eastern Standard Time (AEST). AEST is the mean solar time on the meridian of longitude of 150°E. For Australian Central Standard Time (ACST) subtract 30 minutes from the times given. For other time zones make the appropriate adjustments. No adjustments have been made in this book for Daylight Saving, also known as 'Summer Time'. When daylight saving is in force, the time is one hour ahead of AEST. You will need to add one hour to any AEST time for the correct local time.

A **conjunction** of two objects is when they are closest to each other as seen from Earth i.e., their minimum angular separation. See also discussion on page 14. It is also common to hear this word referring to a planet and the Sun being close together (not exactly the best time to go observing the planet).

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). Inferior planets i.e., the inner planets, Mercury and Venus, can never reach opposition. Their orbits are both inside Earth's. The Earth needs 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 i.e., 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.



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 morning sky above. The two bands of 'lighter' shading show the times of morning and evening astronomical twilight. If you are using a telescope you'll soon learn to avoid trying to observe a planet near the horizon (i.e., close to rise or set times). Turbulence in the much thicker atmosphere (i.e., at lower altitude) gives very poor 'boiling' images. If accurate rise/set times are required, you will need to refer to the specific tables for the object of interest in Part II of this publication. You can also adjust for rural locations using the appendix on page 126.

APPEARANCE OF THE PLANETS

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

MONTHLY HIGHLIGHTS

This describes a few of the more interesting events during the month. It is also a quick reference source for where and when to look for the brighter planets.

THE MOON

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

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 20 brightest asteroids that reach opposition this year (see also pp. 120-121). An entry is included if the asteroid reaches opposition during that month, i.e., the time it is brightest. It lists the magnitude and constellation the asteroid is in at the time of opposition.

COMETS

This brief section deals with the comets known to be visible during 1998. It points out the comets that are bright during the month and includes any interesting conjunctions. We have seen some spectacular comets over the last 2 years (see also feature article on page 5). Let's hope the trend continues in 1998. Comet Hale-Bopp, now well in the southern skies, will continue to be visible (at least through binoculars) for a number of months into 1998.

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 Lyrids lies near or within the constellation of Lyra. The monthly section lists the major showers for 1998 that are suitable for observation. These selected showers are those largely unaffected by moonlight during their peak period. Full details for all showers are given in Part II (p. 122). It can take great patience to watch for meteors but the occasional fireball can make it all worthwhile. It is best to do your searching on moonless nights and under dark skies i.e., 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. The presentation is keyed to those people who would like to know 'what's happening tonight (astronomically speaking)?' Included are:

- Lunar phases and key events in the planets' orbits.
- Selected conjunctions between the Sun, Moon, comets, asteroids (minor planets), brighter stars and deep sky objects (see also page 125 for descriptions of some of the brighter deep sky objects).

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 were designed to cater for everyone and are geocentric. This is how they would look from a position corresponding to the centre of the Earth. The exact time of closest approach may be in daylight from Australia or the objects of interest may not be above the horizon for us. The planetary text and Sky Views have been tailor made to suit Australia. Hence the times and angles given in the Diary of Events could differ from those on a Sky View. Sometimes a lunar conjunction is followed by an 'Occn.'. This indicates that 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 also has a diameter of 0.5°). Occultations involving the planets or the brightest stars are mentioned in the 'Moon' text.

Abbreviations. These include:

- G which is for a galaxy (SG is a spiral galaxy, IG - Irregular, ES - elliptical).
- OC represents a open cluster
- GC is a globular cluster
- PN is a planetary nebula
- m.p. equals a minor planet
- Occn. is an occultation

There are also some astronomical catalogues

- NGC stands for New General Catalogue
- IC stands for Index Catalogue
- M for the number in the Messier catalogue.

CONSTELLATION OF THE MONTH

This section concentrates on a particular constellation. Information includes:

- History of the constellation including any associated legends.
- How some of the brighter stars were named.
- Some well known or unusual stars (including double stars) or deep sky objects.
- What is needed to observe these celestial bodies.
- A star map plotting the objects mentioned in the text or an image of an interesting object in the constellation.

SKY VIEWS

These diagrams are designed to help you find the planets. The date/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 45 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' include:

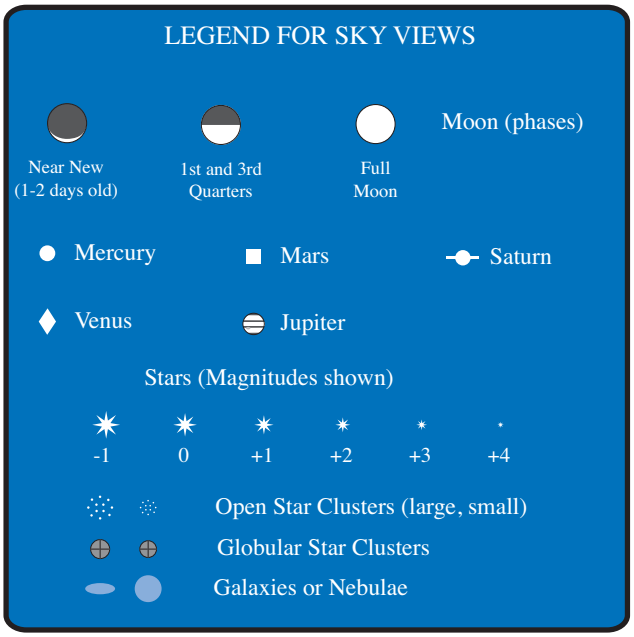
- The Moon (showing approximate phase) and the planets visible with the naked eye.
- All stars down to about 4.5 magnitude.
- Names of the brightest stars.
- Bright star clusters, nebulae and galaxies (down to approximately 5.5 magnitude). These objects are named using the following codes. A prefix of 'N' means the object is in the New General Catalogue (NGC), an 'T' is the Index Catalogue (IC) and 'M' is a number in the Messier catalogue. Many of these deep sky objects are also listed on page 125 in 'Non Stellar Objects'.
- Constellations are labelled (capital letters) with black lines joining key stars (according to convention in some astronomy atlases and books).

See also the legend in this introduction.

When using these 'windows to the sky' it is important to keep in mind that the horizon shown is theoretical (e.g., like looking out over the ocean). You will soon learn to make mental adjustments for local hills, trees and buildings, etc. The scale has been kept constant and the view is 37° in azimuth (along the horizon) by 49° in altitude (a 10° reference scale is also marked). Sometimes the object of interest is so high that the field of view is not large enough to include the horizon.

The Sky Views are useful for more than just the date and time shown. The pattern of stars relative to the horizon is the same one month later, but 2 hours earlier. Of course the planets and the Moon will have moved. Compare the Sky Views for February 15 to 17 (11 pm) with March 14 to 16 (9 pm). A few minutes playing with a planisphere (p. 9) will also illustrate this yearly motion of the stars.

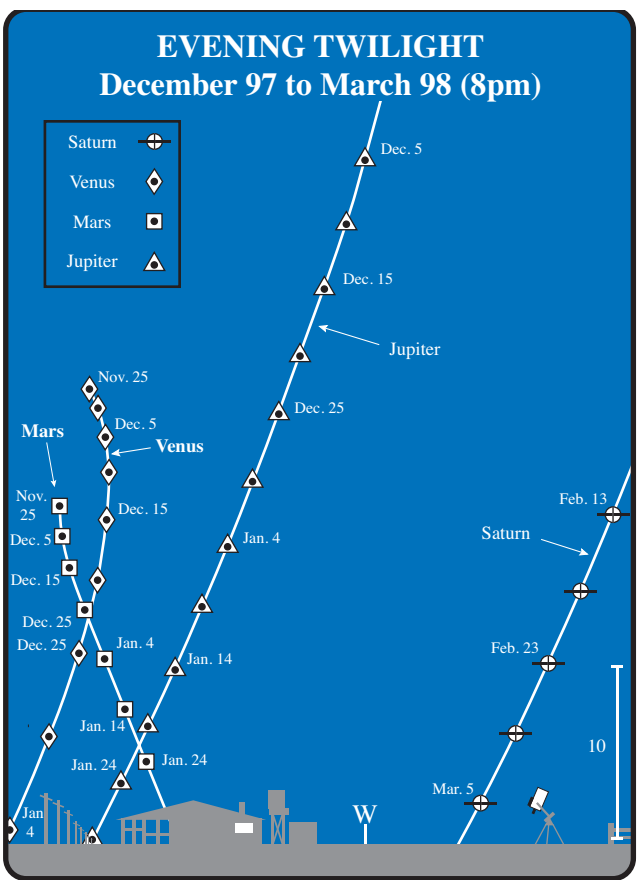
Uranus and Neptune have been excluded from the Sky Views as they are not generally visible to the naked eye. Uranus would certainly need dark sky conditions to be seen. Neptune will need at least binoculars. In either case, because of the many faint stars of similar brightness close by, finder charts would be needed to identify these outer worlds. Pluto needs at least a 20 cm telescope to glimpse this faint member of our Solar System and also is not shown. Finder charts are on pages 114 and 115.

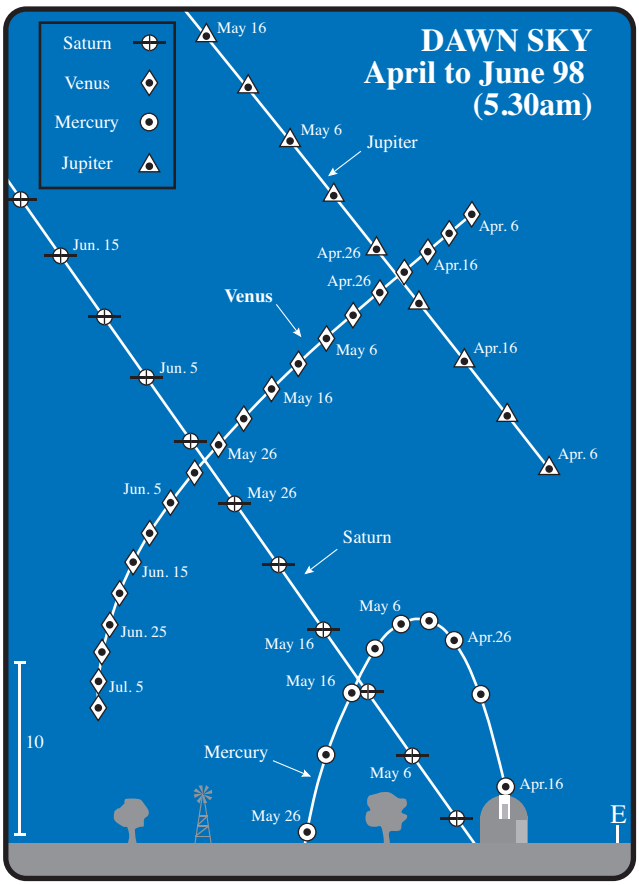


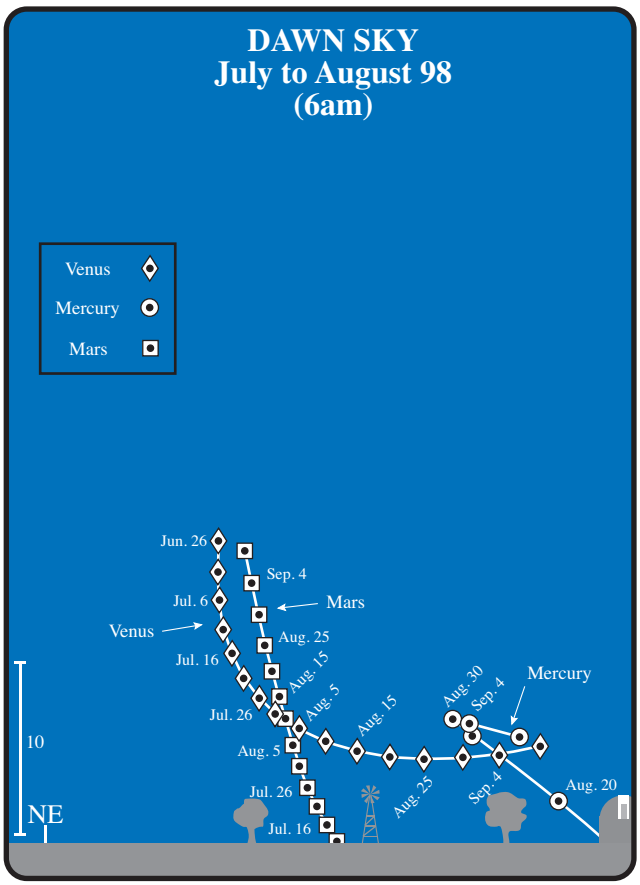
MOVEMENT OF THE PLANETS

These diagrams are designed to help observers know when the planets first become observable after being in conjunction with the Sun, or when they are about to go into conjunction with our star. The drawings are particularly useful as an observing guide for Mercury. The new diagram this year, (p. 13), allows you to see at a glance whether an object is in the morning or evening sky.

All times are AEST. For summer time (daylight saving) add 1 hour.







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. It is useful for many years.

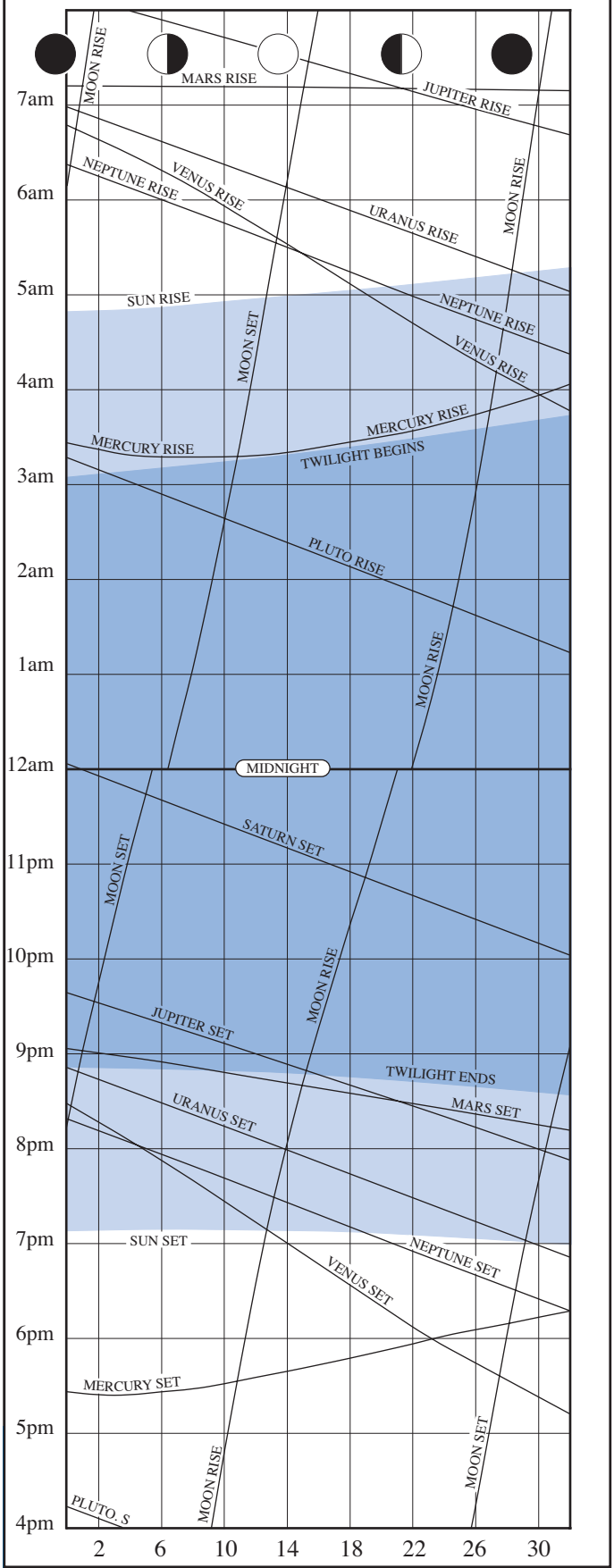
The 'Night Sky' planisphere is a high precision, low distortion aid to the visual observer. It is double sided, designed for the southern hemisphere, and printed with a light background for easy night readability. Its plastic construction makes for a durable and moisture resistant product.

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

These planispheres are available direct from Quasar Publishing (address on page 2). It comes in 2 sizes: the large 22cm version is $16, the small 13cm one is $10, price includes postage.

JANUARY

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

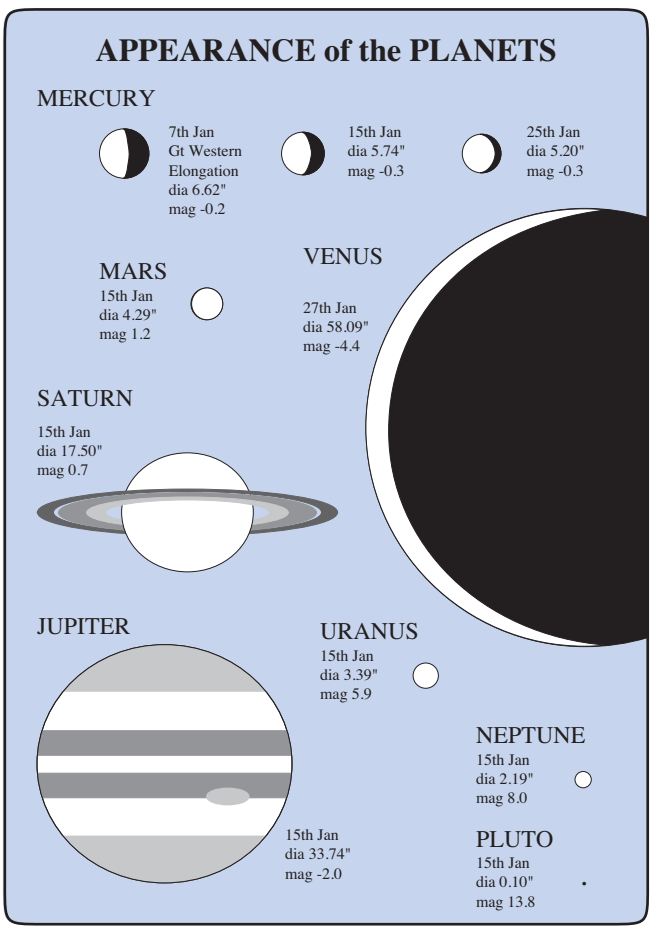
JANUARY HIGHLIGHTS

- Mercury in the morning twilight sky.
- Venus moves from the evening to the morning sky.
- Mars is in the evening twilight sky. On 21st, Mars has a close encounter with Jupiter.
- Jupiter is in the early western evening sky.
- Saturn is in the evening sky.

THE MOON

3rd	Moon at perigee (closest to Earth - 365,020 km distant, angular size 32.7 arc minutes).
5th	Occultation of Saturn by the Moon. Not visible from Australia.
6th	First Quarter
9th	Occultation of Aldebaran by the Moon. Not visible from Australia, but the closest approach of around 1° from our skies can be seen in the evening sky (see Sky View).
13th	Full Moon
19th	Moon at apogee (furthest from Earth - 400,325 km distant, angular size 29.9 arc minutes).
21st	Last Quarter
28th	New Moon
30th	Moon at perigee (closest to Earth - 367,860 km distant, angular size 32.5 arc minutes).

APPEARANCE of the PLANETS



THE PLANETS

MERCURY rises in the morning sky around the beginning of astronomical twilight. The planet is at its greatest elongation west of the Sun (23°) on the 7th. For morning observers the best period this year to see this fast moving and elusive planet is from the end of April to . mid-May. Out of interest, Mercury passes less than 1° from two deep sky objects in Sagittarius this month. On the 11th and 12th the planet will be near the open star cluster NGC6469, and on the 13th and 14th it will be close to M20, the famous Trifid Nebula (NGC6514). Just 45 minutes prior to sunrise on the 27th, Mercury will be 6º from the thin crescent Moon, with Venus rising 3.5° below the Moon (see Sky View).

VENUS can be seen briefly in the evening sky early in the month. It then moves into inferior conjunction on the 16th, and becomes a morning object in late January. During early January, Venus is part of a five planet alignment with Jupiter, Mars, Uranus and Neptune all within 25° of each other. All the planets are located within Capricornus, with the exception of Neptune which lies just over the border in Sagittarius. 45 minutes before sunrise on the 27th, Venus will be seen rising 3.5° below the thin crescent Moon, with Mercury 6° to the south of the Moon (see Sky View).

MARS begins the month 6° south of the 3 day old crescent Moon in the evening twilight sky (see Sky View). From the beginning of the month the distance between Mars and Jupiter slowly diminishes, and on the 21st they will be very close at 0.2° apart, a fine sight! (see Sky View). After the Jupiter encounter Mars moves from Capricornus into Aquarius. On the 30th, Mars will be flanked by Jupiter and the 2 day old thin crescent Moon, making a pleasant early evening scene (see Sky View).

JUPITER, in Capricornus, begins the new year 7° above the 3 day old crescent Moon. On the following evening the Moon appears the same distance away but is higher and further north (see Sky View). On the 21st, Jupiter and Mars form a spectacular pair as detailed above. After the Mars rendezvous Jupiter moves into Aquarius where it remains for the next four months, On the 30th, Jupiter, Mars and the 2 day old Moon will be seen close together low in the western evening twilight (see Sky View).

SATURN is visible in the evening sky until March when it becomes too close to the Sun for observation. With the exception of a small sojourn over the border into Cetus the planet remains in the constellation of Pisces throughout the year. On the 5th, the First Quarter Moon can be seen less than 1° from Saturn (see Sky View); in South Africa and South East Asia, observers will witness an occultation. This is the 11th in a series of fourteen occultations between Saturn and the Moon that began in April 1997 and finishes in March this year; the next series begins in the year 2001.

URANUS & NEPTUNE are both unsuitable for observation this month as they are too close to the Sun. Conjunction with the Sun occurs on 29th for Uranus and 20th for Neptune:

PLUTO rises in the early morning sky. Never far from the globular star cluster M107 (NGC6171) the planet remains mostly in Ophiuchus, with a brief loop into Scorpius during August and September.

MINOR PLANETS 230 Athamantis is at opposition on 27th at magnitude 10.5 in Hydra.

COMETS

Hale-Bopp: 97's Great Comet begins the year in Dorado, visible throughout the night. During January, it will fade from magnitude 6.9 to 7.4.

Wolf-Harrington: Observers will find this comet moving south-west through Hydra. Beginning the month at 12th magnitude and rising after 8:30pm, the comet will rise earlier each night, and by month's end will be visible all night, having faded to magnitude 12.8.

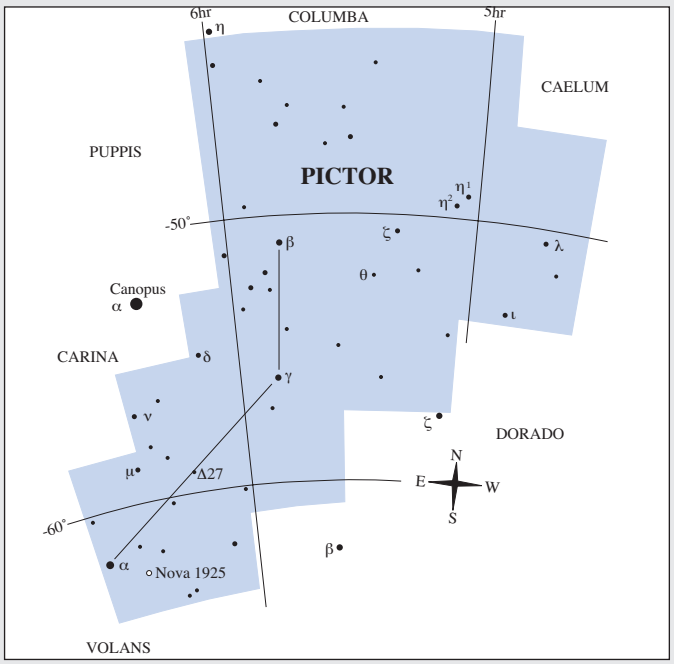
CONSTELLATION OF THE MONTH - PICTOR (PIC)

Pictor, The Painter's Easel, was named Equuleus Pictoris by the French astronomer Nicolas Louis de Lacaille. It is one of 14 constellations created by Lacaille during a stay at the Cape of Good Hope in 1751-2. and was shortened to Pictor by Gould in 1877. Some of Lacaille's new constellations were rather insignificant, having been created from "left over" stars that were not included in the mythology of the ancients. Pictor is one of his inconspicuous constellations, but some interesting facts about it make it worthy as a constellation of the month.

The three brightest stars that represent the easel are Alpha (3.5 magnitude), Beta (4th) and Gamma (5th). The relative faintness of these stars does not exactly make the constellation stand out. It can however be easily identified, as Alpha and Beta Pictoris form a triangle with the bright star Canopus.

Pictor is home to Kapteyn's Star, a faint (8.8 magnitude) red dwarf noted for its large proper motion, which is second only to Barnard's "Runaway Star" (See Astronomy 1997 - Constellation of the Month - July). The star was discovered in 1897 by the Dutch astronomer Jacobus Cornelius Kapteyn, some nineteen years before Barnard discovered his namesake. At a distance of 12.6 light years, Kapteyn's Star is the 24th closest star to our Solar System; moving at 8.65 are seconds per year it will cover one degree in about 416 years. An interesting comparison can be made when looking at the absolute magnitude of these stars compared to our Sun. The absolute magnitude is the apparent brightness of a star if it was placed at a distance of 10 parsecs. Barnard's and Kapteyn's stars would appear as 13th and 11th magnitude respectively, compared to the Sun at 5th. They are pretty "wimpy" compared to an average star. Incidentally it was Edmund Halley (of Halley's Comet fame) who is credited with the discovery of proper motions amongst the 'fixed' stars in the year 1718.

Beta Pictoris is another of Pictor's interesting stars. In 1984 the Las Campanas Observatory in Chile took a CCD image of the star, and found an edge-on disk of material around the star. The disk appears small (about 2.5 are seconds across), but has been calculated to extend some 60 billion kilometres from the star. While no planets have been detected, it is thought that this disk is the early stages of the formation of a system of planets.



Novae generally do not occur far from our galaxy's denser regions, but Pictor gave birth to a "new" star in 1925. Nova Pictoris 1925 was discovered on May 25th by R. Watson in South Africa when at 2nd magnitude. By early June the star had increased in brightness to 1st magnitude, but one month later had faded to 4th. In August of the same year the star again brightened, this time to 2nd magnitude and by December it was lost from naked eye view. From photographic plates of the region it was discovered that the star was originally about 13th magnitude prior to outburst. Aside from a few minor fluctuations over the years, the star has now settled back to its pre-nova brightness.

JANUARY

Tempel-Tuttle: Most Australian observers will only be able to sight this comet during the first week of January in the morning sky, when it brightens from 12th to 11th magnitude as it moves through Canes Venatici. Tempel-Tuttle then heads north, returning next month.

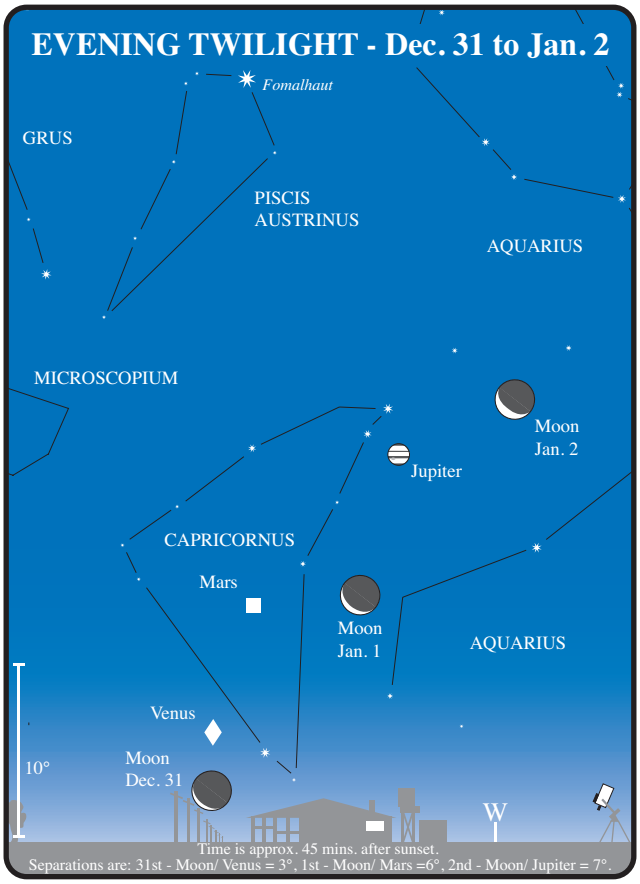
Hartley 2: This comet can initially be found in Aquarius, setting after -11pm at a brightness of magnitude 7.9. During the month, Hartley 2 moves through Cetus and into Pisces, fading to magnitude 8.8, and setting before 11:30pm.

METEOR SHOWER

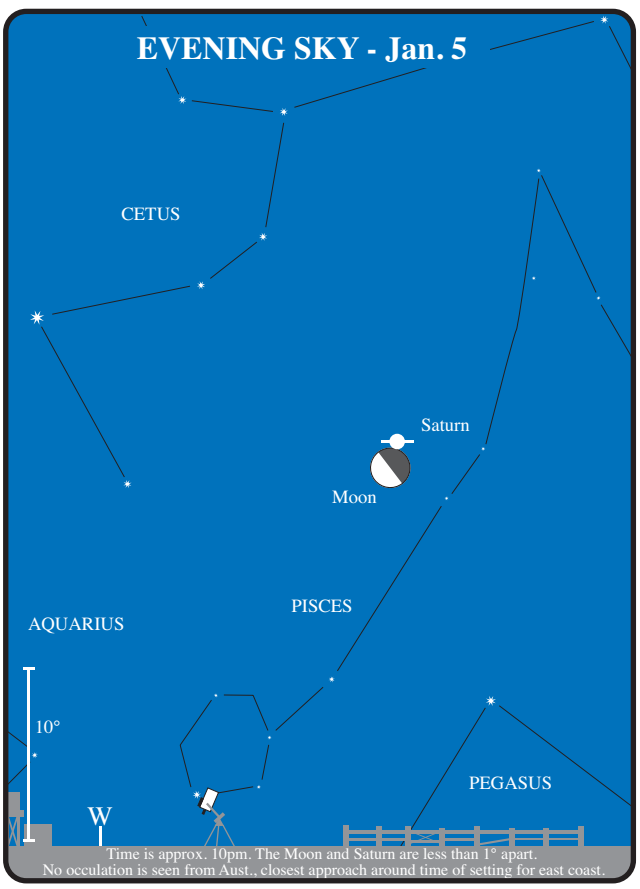
The Quadrantids are a strong and consistent northern shower. However, it is difficult for southern observers with the radiant below the early morning north eastern horizon. Although, if observing just before dawn, the occasional long-pathed member may be glimpsed. The Quadrantids are active from January 1-5, and peak on the 3rd, the zenith hourly rate is 120, but can vary from 60 to 200.

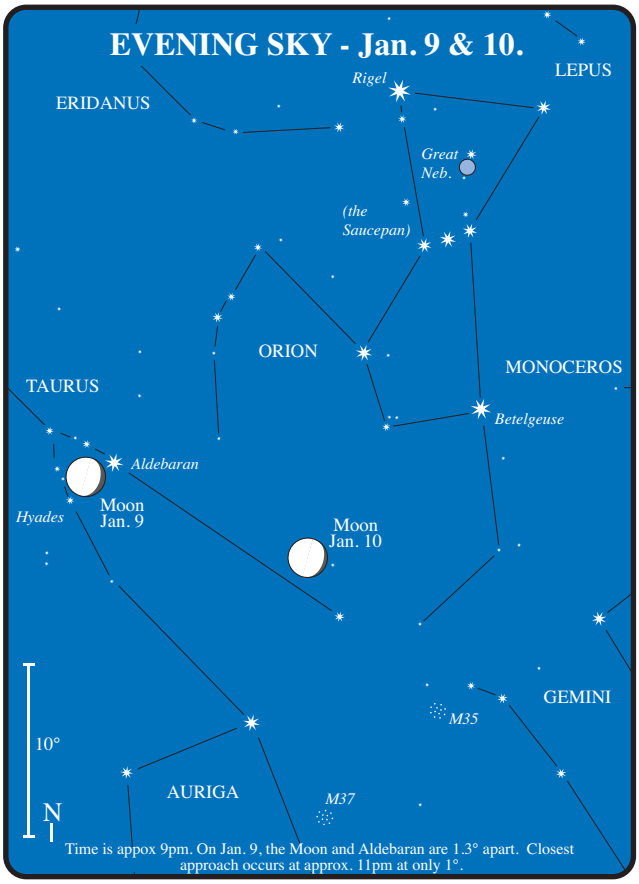
DIARY

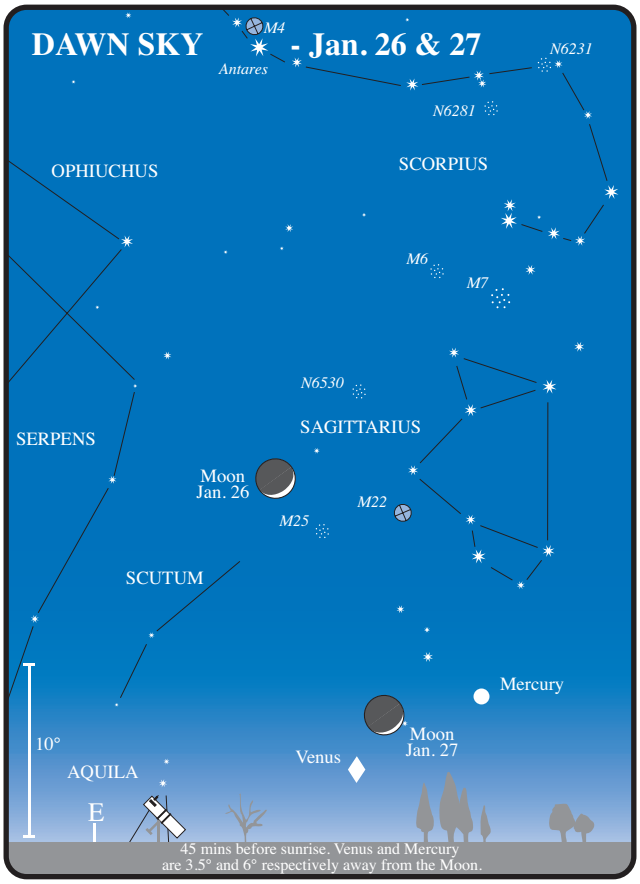
1st		m.p. 1 Ceres 0.7°E of NGC 7492 (GC) in Aquarius.
1st	1 PM	Mars 4°S of the Moon.
2nd	9 AM	Jupiter 3°S of the Moon.
3rd	7 PM	Moon at perigee.
4th		m.p. 52 Europa 1.4°S of Comet Hartley 2.
5th	7 AM	Earth at perihelion.
5th	10 PM	Saturn 0.2°N of the Moon; Occn.
6th		Comet Tempel-Tuttle 1°S of NGC 4490 (SG) in Canes Venatici.
6th	12:18 AM	First quarter Moon.
7th		Comet Tempel-Tuttle 1°S of NGC 4449 (IG) in Canes Venatici.
7th		Mars at perihelion.
7th	1 AM	Mercury greatest elongation W.(23°).
9th	11 PM	Aldebaran 0.4°S of the Moon; Occn.
10th	3 AM	Venus 4°N of Neptune.
12th		m.p. 43 Ariadne 0.2°W of Delta Scorpii.
12th		Mercury 0.6°E of NGC 6469 (OC) in Sagittarius.
13th		Mercury 0.6°NW of M20 (Trifid Nebula) in Sagittarius.
13th	3:24 AM	Full Moon.
16th	9 PM	Venus in inferior conjunction.
18th		Mercury at descending node.
19th		m.p. 43 Ariadne 0.4°SW of M80 (GC) in Scorpius.
19th	7 AM	Moon at apogee.
20th	9 AM	Neptune in conjunction with the Sun.
21st		Comet Hale-Bopp 0.5°NE of NGC 1947 (SG) in Dorado.
21st		m.p. 7 Isis 0.05°N of NGC 6401 (GC) in Ophiuchus.
21st	5:40 AM	Last quarter Moon.
21st	11 AM	Mars 0.2°S of Jupiter.
24th		m.p. 1 Ceres 0.7°NW of NGC 7727 (SG) in Aquarius.
25th		m.p. 18 Melpomene 0.2°SE of M107 (GC) in Ophiuchus.
25th		Venus at perihelion.
27th	3 AM	Mercury 8°S of Venus.
27th	10 AM	Venus 3°N of the Moon.
27th	11 AM	Mercury 5°S of the Moon.
28th	4:01 PM	New Moon.
29th		Mercury at aphelion.
29th	6 AM	Uranus in conjunction with the Sun.
29th	10 PM	Juno stationary.
30th	3 AM	Jupiter 2°S of the Moon.
30th	11 AM	Mars 1.7°S of the Moon.
30th	Midnight	Moon at perigee.
31st		Comet Tempel-Tuttle 2.5°W of M33 (SG) in Triangulum.



All times are AEST. For daylight saving add 1 hour.







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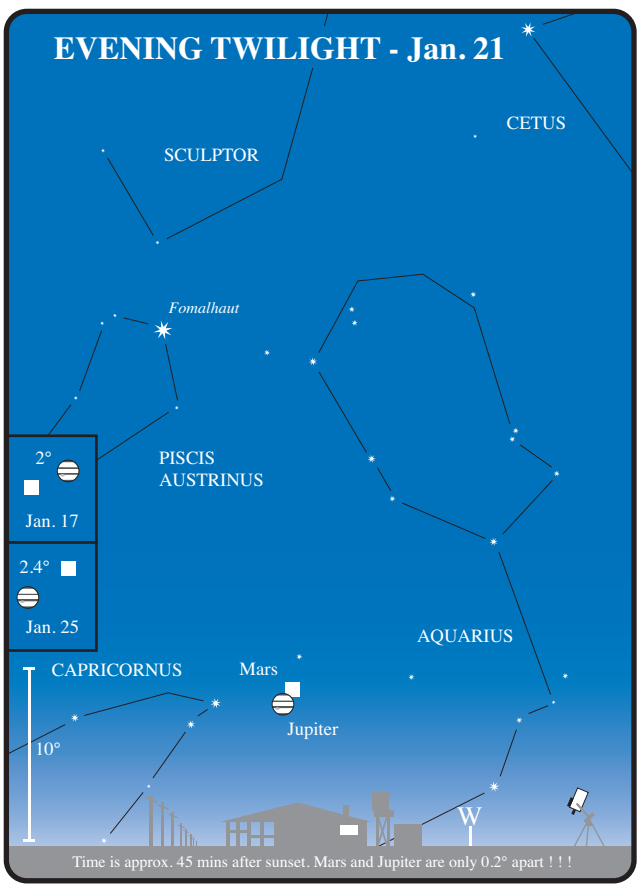
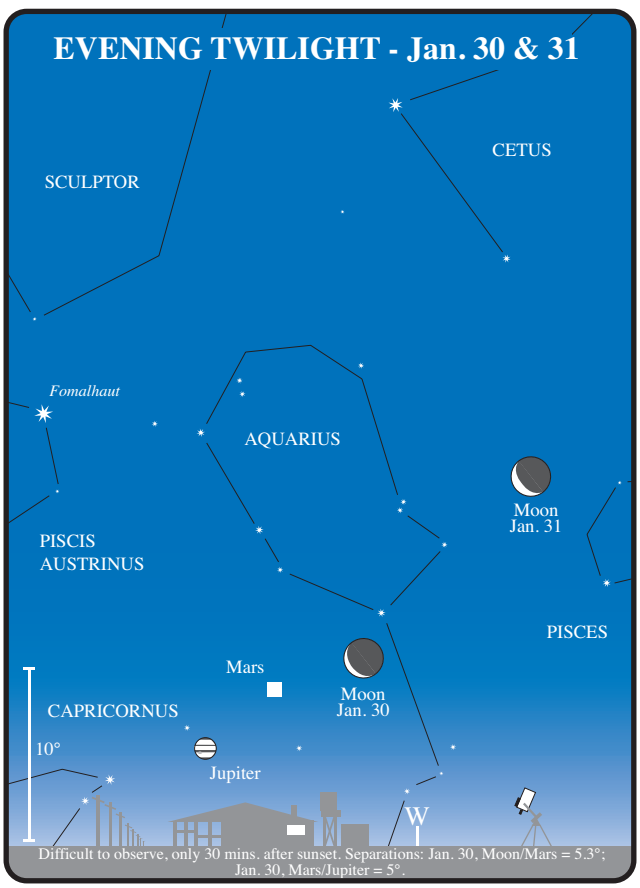
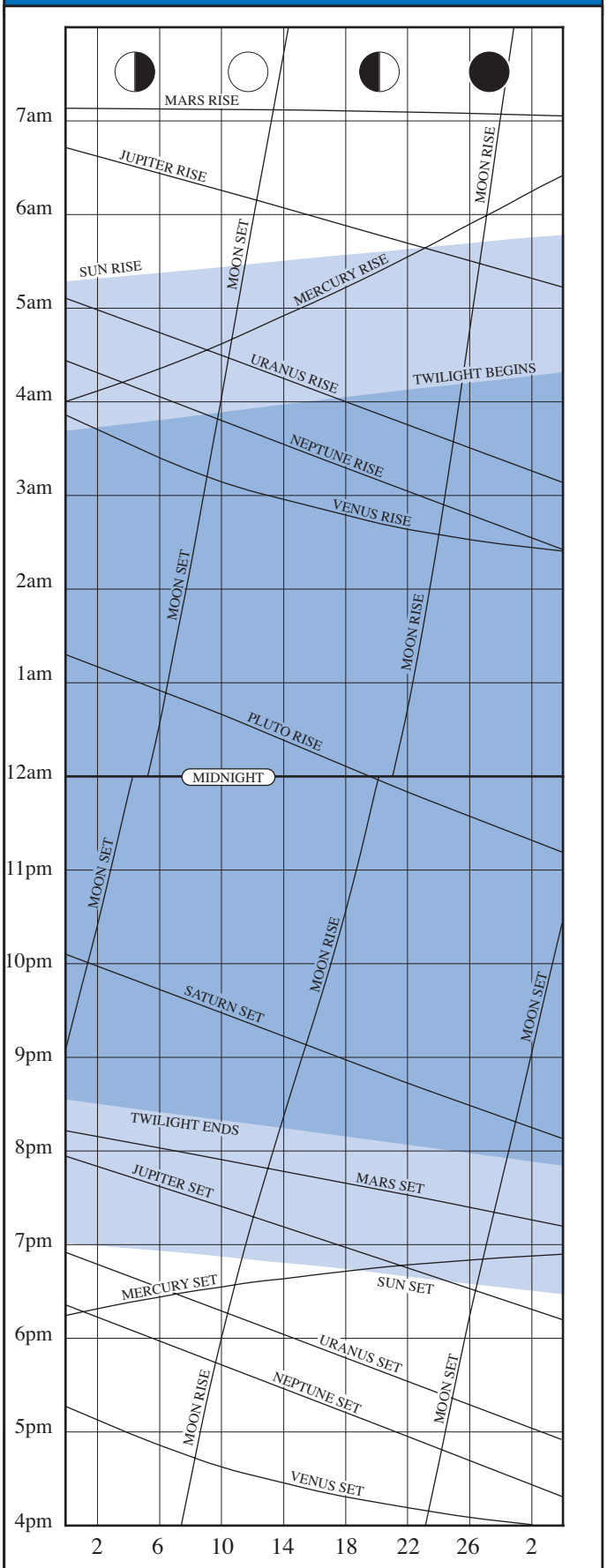




FEBRUARY

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

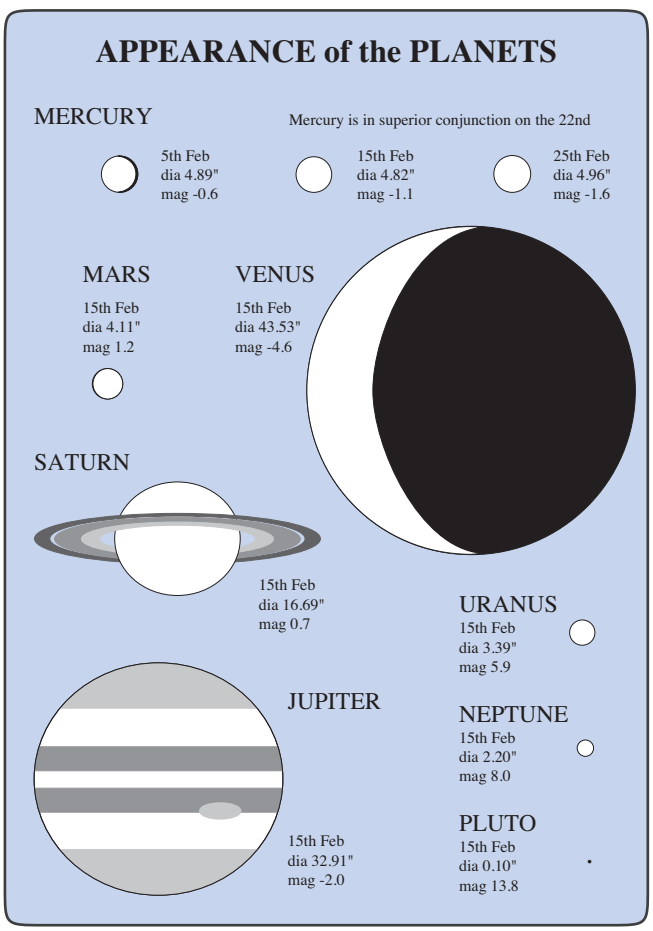
FEBRUARY HIGHLIGHTS

- Mercury can be glimpsed early in the month, low in the morning twilight glare.
- Venus in the pre-dawn eastern morning sky
- Mars low in the early western evening twilight sky.
- Jupiter not visible, too close to the Sun.
- Saturn is low in the early western evening sky.

THE MOON

2nd	Occultation of Saturn by the Moon. Not visible from Australia.
4th	First Quarter
6th	Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach for eastern Australia is approximately 4° on the evening of the 5th (see Sky View).
11th	Full Moon
16th	Moon at apogee (furthest from Earth - 400,770 km distant, angular size 29.8 arc minutes).
20th	Last Quarter
27th	New Moon
27th	Total Solar Eclipse. Visible from parts of Pacific and Atlantic Oceans, Central America, West Indies.
28th	Moon at perigee (closest to Earth - 360,530 km distant, angular size 33.2 arc minutes).
28th	Occultation of Mars by the Moon. Not visible from Australia.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is in superior conjunction with the Sun on the 22nd (on the opposite side of the Sun to the Earth). At this time, the planet moves from the morning into the evening sky. This evening return will be difficult to see (the planet remains too close to the Sun), the best period for evening observation of the planet will be late June to early August.

VENUS After the planet's brief stay in the evening sky last month, Venus remains as the morning star until early September, when it again becomes too close to the Sun for observation. In December, Venus will again grace the evening twilight. During February, Venus reaches its greatest brightness of -4.6 magnitude, and can be seen near the 26 day old thin crescent Moon on the 24th (see Sky View).

MARS is in Aquarius for the first three weeks of February, and then moves into Pisces. The planet can only be seen in the western evening twilight sky, and by next month will be lost in the Sun's glare. The occultation mentioned above, in the Moon section (28th), is a daytime event visible from New Zealand and South America.

JUPITER is situated too close to the Sun for observation this month, it will reappear in the morning sky mid March.

SATURN appears low in the early western evening sky this month, and by March the planet will be lost in the twilight. On the 1st and 2nd the 5 day old Moon will appear about 7° from Saturn (see Sky View); from South America observers will witness an occultation on the 2nd. This is the 12th in a series of fourteen occultations between Saturn and the Moon that began in April 1997 and finishes in March this year; the next series begins in the year 2001.

URANUS & NEPTUNE. Both planets reappear in the morning sky mid-month after their conjunction with the Sun in January. Uranus is in Capricornus and remains in that constellation for the entire year. Neptune is also in Capricornus but crosses over into Sagittarius mid-September and back into Capricornus mid-November.

PLUTO Rising around midnight, mid month, is in the constellation Ophiuchus.

MINOR PLANETS 30 Urania is at opposition on 8th at magnitude 10.4 in Leo.

COMETS

Hale-Bopp: This comet will once again be visible all night, slowly moving through Dorado. During this month, Hale-Bopp will fade from magnitude 7.4 to 7.8.

Wolf-Harrington: This month should see the last visual observations of this comet for this apparition. Visible all night in Hydra, the comet will fade from magnitude 12.8 to 13.4

CONSTELLATION of the MONTH - PUPPIS (Pup)

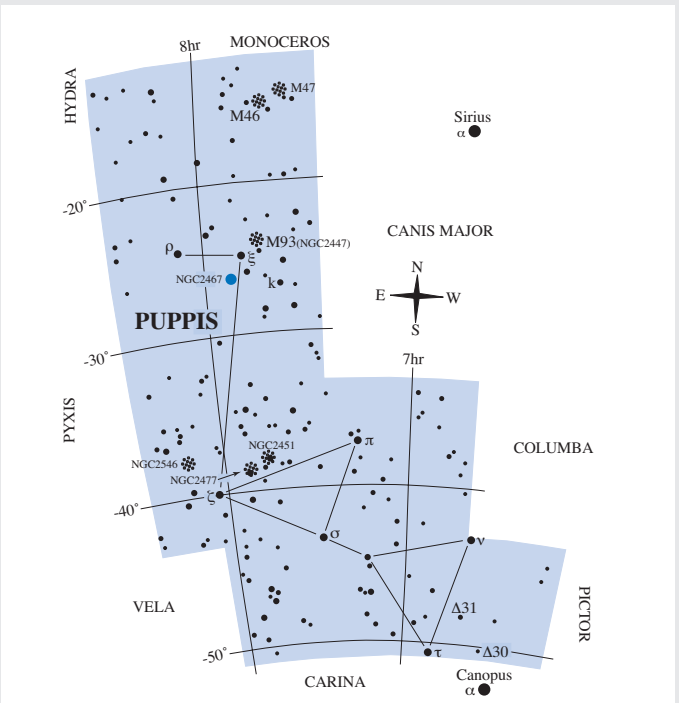
Puppis was originally part of a larger constellation named Argo Navis, the Argonaut's ship from Greek mythology. For convenience Argo Navis was subdivided into smaller constellations by the French astronomer Nicolas Louis de Lacaille in the 1750s. It is now, Puppis the Prop or Stern, Carina the Keel. Vela the Sail, and Pyxis the Compass. When the division took place the stars retained their original designations, hence Puppis does not contain an Alpha or Beta, both of these now belong to Carina. The three brightest stars of Puppis are Zeta (2.25 magnitude), Pi (2.7), and Rho (2.8).

Culminating at 9pm late February, Puppis offers some of the best southern objects for binoculars and small telescopes. With the Milky Way running through the constellation, it abounds in bright stars. open star clusters and double stars and is a good region for binoculars. There are at least 25 open star clusters (three of which are Messier objects, M46, M47 and M93) and many of these are well suited for small apertures.

M46, also known as NGC2437, is an excellent open cluster of about two hundred stars forming arcs and lines, fifty of which can be seen in a small telescope with low power. A small annular planetary nebula (NGC2438) lies to the north of centre, and can be seen in 150 to 200 mm instruments. The nebula is not associated with the cluster, being about twice the distance away. Just 1.5 degrees to the west is M47 (NGC2422), a cluster that contrasts strongly with M46. M47 has about twenty five stars of magnitude 6 and fainter, that form an attractive uneven scattering of bright and faint suns. Two orange 8th magnitude stars make a nice contrast with the predominantly blue and white population. M47 even has two double stars in its ranks, Struve 1121 and 1120, both easy in small telescopes. Within 5 degrees of the constellation's brightest star Zeta, three more open clusters can be located NGC2451. NGC2477 and NGC2546.

Puppis has so many good open clusters, it is difficult to pick the best, however NGC2477 is hard to beat, a real gem. It is 25 are minutes across and condensed toward the centre, with the stars forming gentle curved arcs and lines. With about half the population of three hundred 11th magnitude stars condensed within a 12 are minute ball, it looks like a loose globular cluster.

Aside from the many open clusters, Puppis has one globular cluster, and a few galaxies. Considering its position within the southern Milky Way, it is not surprising that galaxies are so few. It also comes as no surprise that the constellation abounds in double and multiple stars. Burnham's Celestial Handbook lists over 125 of them. Many of these objects are truly superb and we will only mention a few of the easiest and best ones for small telescopes.



k Puppis: an excellent yellow pair of almost equal 4.5 magnitude.

Dunlop 30 (also Rumker 65); a fine pair of unequal magnitude, yellow and red.

Sigma Puppis; 3rd and 8th magnitude stars orange and white.

Dunlop 31; an orange and white pair in good field. 5th and 8th magnitude.

There is also an odd nebulous object in Puppis designated as NGC2467. Within this gaseous 4 are minute diameter envelope lies the stars that excite the nebula causing it to glow. One of these stars appears to be a protostar (known to astronomers as Herbig-Haro objects) with an unusual jet of gas emanating from it. The jet can be seen with a 30cm or larger telescope under dark skies (away from city lights).

FEBRUARY

Tempel-Tuttle: This comet appears in the evening sky in early February, located in Pisces at 10th magnitude and setting around 9pm. By month's end, the comet will have faded to magnitude 10.6 and will be setting around 8pm. Observations will be somewhat difficult.

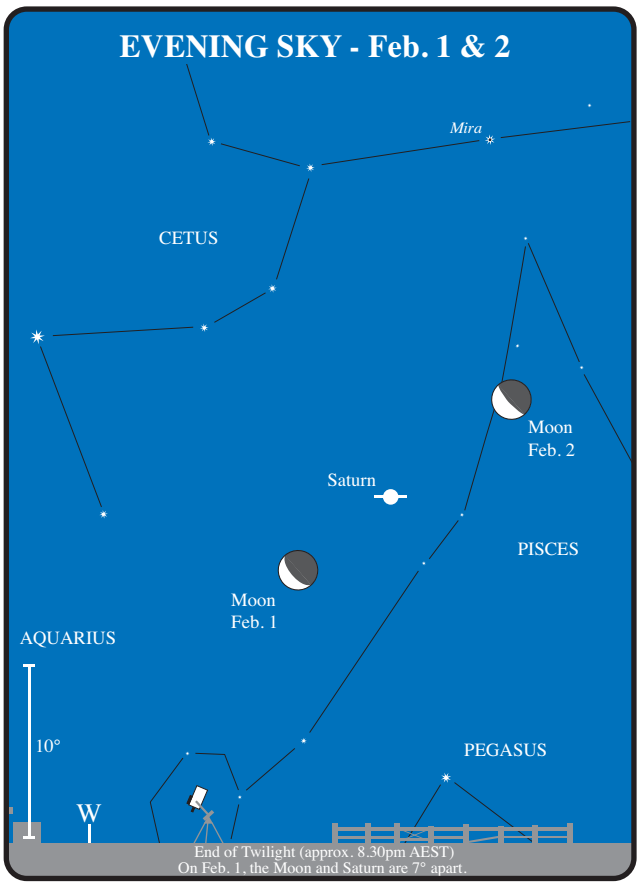
Hartley 2: Observers will find this comet initially in Cetus, setting before 11:30 pm at a brightness of magnitude 8.8. During the month, it passes near Mira, Delta Ceti, and M77 before moving into Taurus, where it ends the month at magnitude 10.3.

METEOR SHOWERS

The **delta-Leonids** are not well placed for southern observers, but with the radiant near the sickle or head of Leo, it will be above the northern horizon for a few hours late evening and early morning. With predominantly faint meteors, this shower is considered a minor one. It is active from 15th February to 10th March, with maximum on the 24th; a low zenith hourly rate of around 2 can be expected..

DIARY OF EVENTS

2nd		m.p. 4 Vesta 0.7°SE of NGC 676 (SG) in Pisces.
2nd		Pluto 1.4°S of m.p. 6 Hebe.
2nd	7 AM	Saturn 0.6°N of the Moon; Occn.
2nd	9 PM	Mercury 2°S of Neptune.
4th		Comet Hartley-2, 0.9°N of NGC 936 (SG) in Cetus.
4th	8:53 AM	First quarter Moon.
6th	4 AM	Aldebaran 0.2°S of the Moon; Occn.
6th	4 AM	Venus stationary.
7th		Comet Hartley-2, 0.3°W of NGC 1055 (SG) in Cetus.
8th	3 PM	Mercury 1.4°S of Uranus.
9th		m.p. 43 Ariadne 0.3°NE of NGC 6284 (GC) in Ophiuchus.
11th	8:23 PM	Full Moon.
14th	10 PM	Pallas in conjunction with the Sun.
16th		Venus at greatest latitude N (heliocentric).
16th	1 AM	Moon at apogee.
18th		Mercury at greatest latitude S (heliocentric).
20th		m.p. 7 Isis 0.2°S of NGC 6629 (PN) in Sagittarius.
20th	1:27 AM	Last quarter Moon.
20th	Noon	Venus greatest brilliancy.
22nd	6 PM	Mercury in superior conjunction.
23rd		m.p. 43 Ariadne 1°S of NGC 6401 (GC) in Ophiuchus.
23rd	7 PM	Jupiter in conjunction with the Sun.
24th		m.p. 18 Melpomene 0.1°S of NGC 6309 (PN) in Ophiuchus.
24th		m.p. 7 Isis 0.2°N of NGC 6642 (GC) in Sagittarius.
24th	3 AM	Venus 1.6°N of the Moon.
24th	4 PM	Neptune 3°S of the Moon.
25th	8 AM	Uranus 3°S of the Moon.
26th		Venus 1°S OF NGC 6822 (SG) In Sagittarius.
27th		m.p. 7 Isis 0.7°N of M22 (GC) in Sagittarius.
27th	3:26 AM	New Moon; eclipse.
28th	6 AM	Moon at perigee.
28th	8 AM	Mars 0.7°N of the Moon; Occn.



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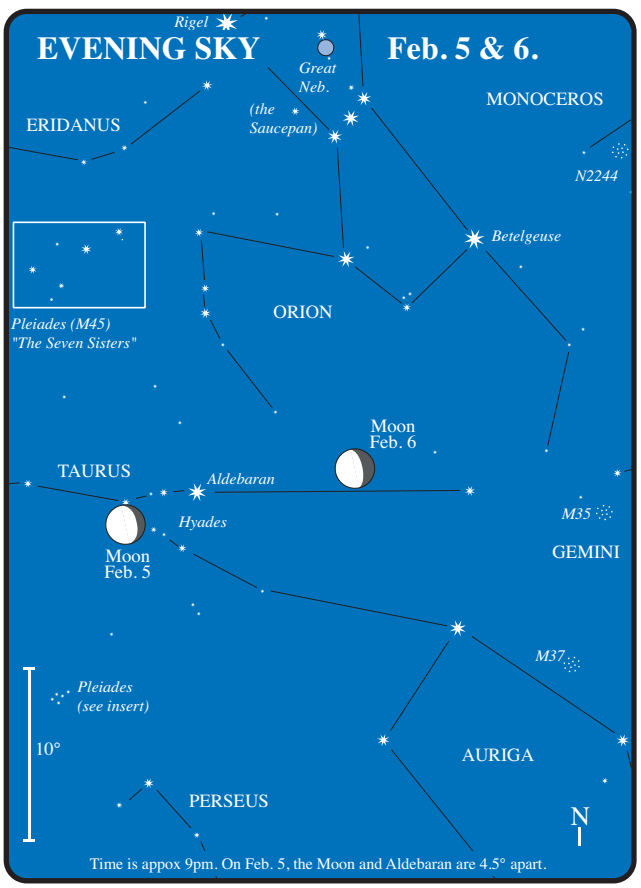

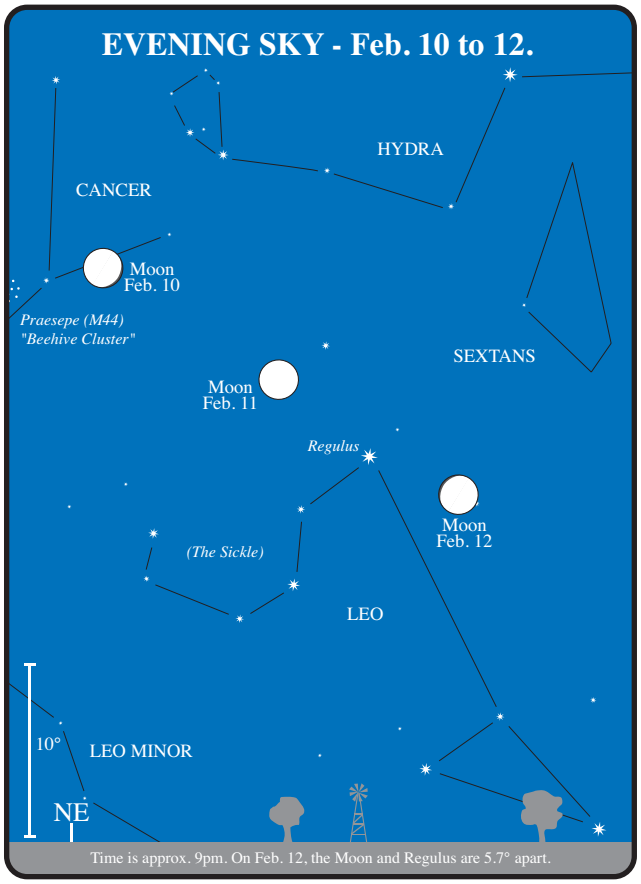

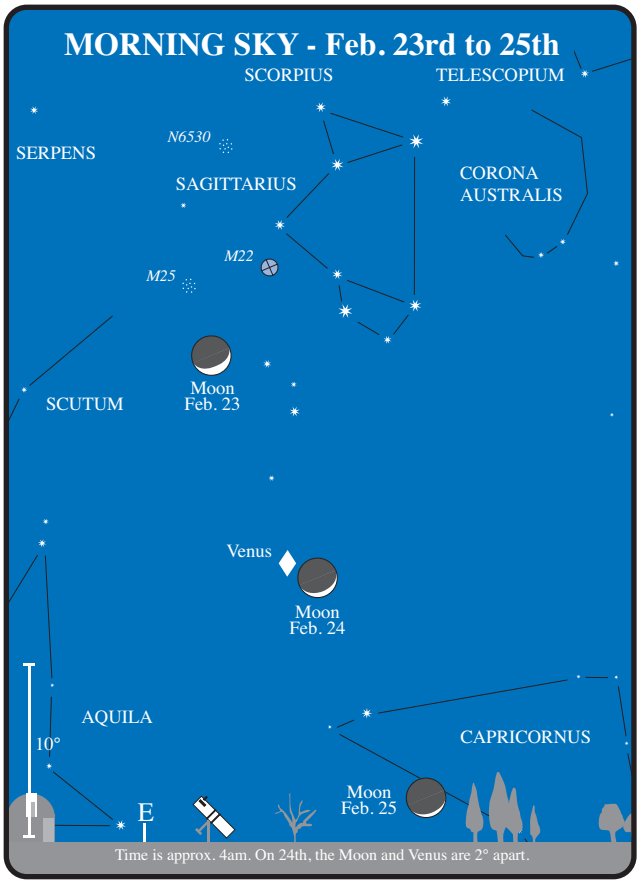

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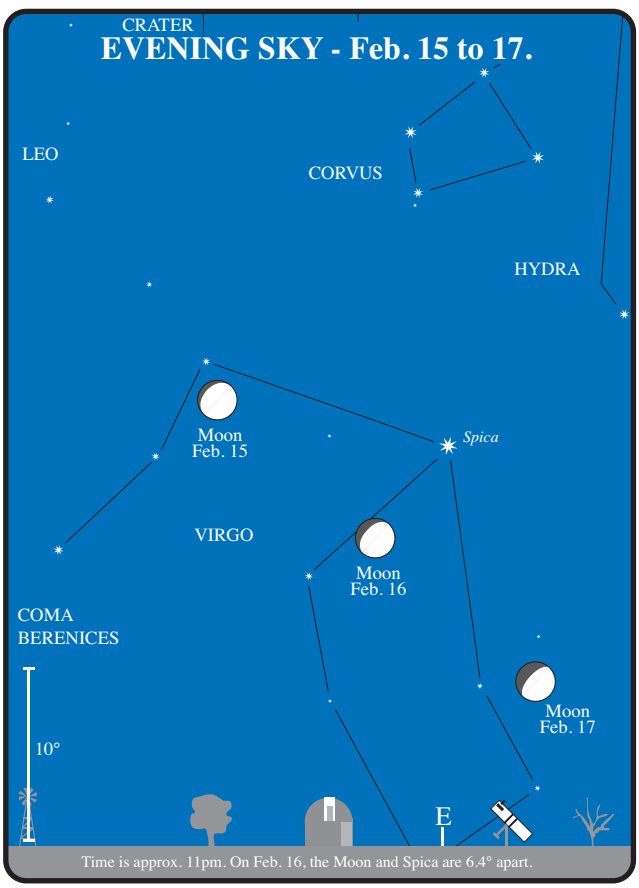
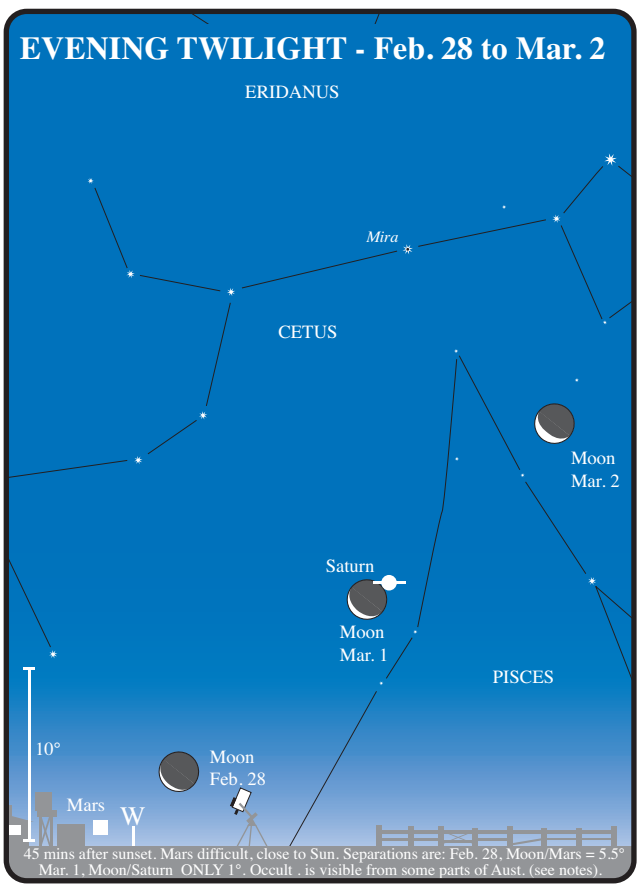
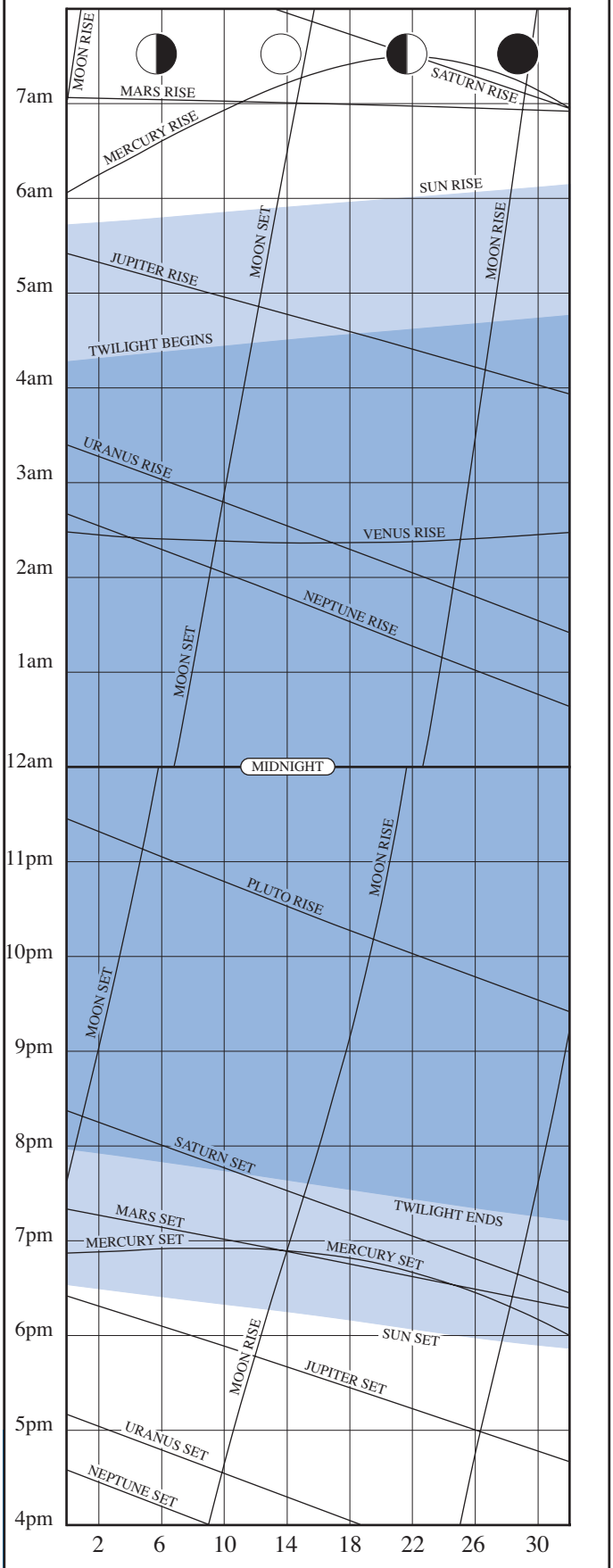




MARCH

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

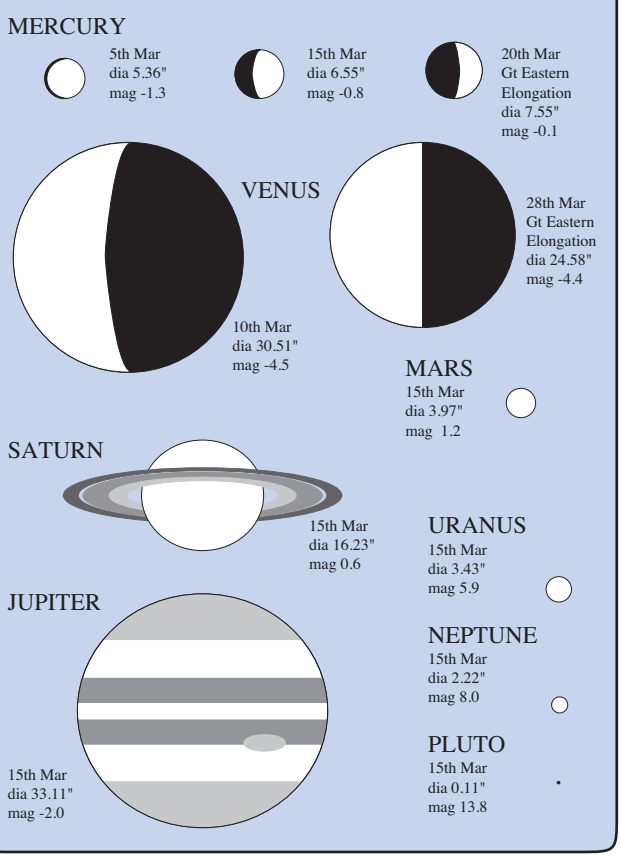
MARCH HIGHLIGHTS

- Mercury is close to the Sun. low in the western evening twilight sky.
- Venus is prominent in morning sky; occultation by Moon on 25th.
- Mars in evening twilight sky, difficult to observe, close to the Sun.
- Jupiter returns to the morning sky.
- Saturn low in the early evening twilight sky. An occultation with the Moon is seen on 1st.

THE MOON

1st	Occultation of Saturn by the Moon. See Saturn text for details.
5th	First Quarter
5th	Occultation of Aldebaran by the Moon. Not visible from Australia. From eastern Australia, the pair can be seen about 5° apart in the evening sky (see Sky View).
13th	Full Moon
13th	Penumbral Eclipse of the Moon. Not visible from Australia.
15th	Moon at apogee (furthest from Earth - 410,350 km distant, angular size 29.1 arc minutes).
21st	Last Quarter
25th	Occultation of Venus by the Moon. Only visible from N.E. Australia.
26th	Occultation of Jupiter by the Moon. Not visible from Australia.
28th	New Moon
28th	Moon at perigee (closest to Earth - 355,595 km distant, angular size 33.6 arc minutes).

APPEARANCE of the PLANETS



THE PLANETS

MERCURY reaches its greatest elongation (19º) east of the Sun on the 20th. Despite the elongation the planet will be difficult to observe as it sets in the twilight soon after the Sun. The best period for evening observation of the planet will be late June to early August, when the angular separation from the Sun will be greater. Mercury and Mars appear within 1° on the 11th. Mercury, Saturn and Mars all appear close on the 30th. Binoculars may assist in finding the planets during these early evening twilight events.

VENUS is very prominent in the morning eastern sky, reaching its greatest elongation (47°) west of the Sun on the 28th. The planet begins the month in Sagittarius, then moves into Capricornus, Aquarius and back into Capricornus. Venus passes less than 4° from two of the Solar System's most distant worlds this month, Neptune on the 7th and Uranus on the 19th. Venus also has close encounters with three deep sky objects in Aquarius. On the 19th to the 21st the planet will be within 2° of the globular cluster M72 and the open star cluster M73. On the 22nd it will be within 3° of NGC7009, the Saturn Nebula. On the 25th there is an occultation of Venus by the 26 day old crescent Moon, the event is only visible from N.E. Australia, but the two bodies appear close from anywhere in Australia (see Sky View). The occultation is visible from the northern parts of Queensland, from Cape York down to around Bundaberg. Townsville sees a reappearance about 30 minutes after moonrise; Rockhampton, 50 minutes. The further down the eastern coast the more the distance between the Moon and Venus increases. Closest approach occurs around 3am soon after Venus rises.

MARS is lost in the evening twilight, setting soon after the Sun. The planet is moving towards conjunction in May. Thereafter it reappears in the morning sky where it remains for the rest of the year. Those keen for a last look may try the interesting, but difficult, planetary conjunctions mentioned in the Mercury section.

JUPITER, after being in conjunction with the Sun last month, reappears in the morning sky about mid-March. On the 26th and 27th Jupiter appears near the crescent Moon (see Sky View). An occultation occurs on the 26th, but this is not visible from southern latitudes.

SATURN is occulted by the dark limb of the 3 day old Moon on the 1st. Visible from parts of Australia as detailed below, the event occurs low in the western sky in the evening twilight. Adelaide, occultation occurs at 7:37pm with reappearance from the bright limb just as Saturn sets at 8:39pm. Brisbane and Darwin, no occultation. Canberra has a disappearance at 8:13pm (sets at 8.30pm). Hobart, occultation begins at 7:58pm, Saturn sets at 8:30pm. Melbourne. occultation begins at 8:06pm with Saturn setting at 8:42pm. Sydney does not see the event, but in the early twilight Saturn and the Moon are about 1º apart (see Sky View in February section). The distance decreases to about 0.3° before Saturn sets at about 8:40pm

URANUS & **NEPTUNE** rise around 2am mid-month in Capricornus. Venus passes less than 4° from both worlds, Uranus on the 19th and Neptune on the 7th.

PLUTO now rises late in the evening sky as it moves toward opposition in May.

CONSTELLATION of the MONTH — HYDRA (Hya)

Hydra, The Water Snake, in area is the largest of the constellations. It is also the longest, extending almost 100 degrees across the sky. It is so long that it could be the Constellation of the Month for March, April, May or June, as some part of it is always on the meridian at 9pm during this period. It is not an obvious constellation, the easiest section to recognise is the snake's head, which is a small grouping of stars above Cancer. From this group the body can be traced to Alphard (the beast's heart), the constellation's brightest star at 2nd magnitude. From here it makes a sinuous path of faint stars to the end of its tail near Libra and Centaurus. In classical mythology. Apollo banished Corvus (the Crow), and Crater (the Cup) together with Hydra to the heavens. The Egyptians saw it as the heavenly counterpart to the river Nile. It is also known as the many headed serpent that Hercules slew in his second labour.

Hydra, while not abounding in bright objects, does have a fair share of the interesting and unusual. There are many double and multiple stars, lots of faint galaxies, a handful of variables, a couple of globulars, two planetaries and one open star cluster.

The 8th magnitude globular M68 (NGC4590) is very rich and compact, and seen at its best with a 150mm telescope. In contrast, Hydra's other globular NGC5694, is one of the most distant (over 100,000 light years away). It is 11th magnitude, tiny, and unresolvable in amateur instruments. The strange thing about NGC5694 is that its speed relative to our galaxy exceeds the escape velocity. This would indicate that the globular has at some time in the past been influenced by a large body (the Large Magellanic Cloud?) and flung out of the Milky Way. Or could it be just a distant visitor wandering through space and just passing through?

Hydra's only open cluster is worth a look. Known as M48 or NGC2548, it is about 30 are minutes in diameter and consists of many faint and bright stars which form arcs. Three of its members are yellow stars, showing a pretty contrast against the main white population. M48 is bright enough to be seen with the unaided eye under dark skies.

The best of the two planetary nebulae is known as the "Ghost of Jupiter" or NGC3242. It is visible in small instruments, but long

Galaxy M83. Taken with an ST-6 CCD camera on 250mm Meade LX200 telescope. Composite of 5 x / minute exposures

exposure photographs show the nebula to look like an eye. The constellation also has an irregular variable star known as V Hydrae which is considered to be the reddest star known. At maximum the star is about 6.5 magnitude and varies by 1 or 2 magnitudes over a 530 day period. It has been known to fluctuate down to about 12th every 18 years.

The most famous of Hydra's galaxies, indeed one of the best known of all galaxies, is M83 or NGC5236. This 8th magnitude spiral galaxy appears nearly face on and measures 10 by 8 arc minutes. It is one of the 25 brightest galaxies in the sky, and one of the southern hemisphere's showpieces. Interestingly. M83 has generated five supernovae since 1923, a remarkably high rate. We now move from M83's symmetrical beauty to a galaxy known as NGC3109. This galaxy is thought to be close, being just outside our local group of galaxies. Astronomers have resolved its brighter stars in long exposure photographs. In large amateur telescopes this 10th magnitude irregular galaxy appears roughly cigar shaped, about 11 are minutes long.

MARCH

MINOR PLANETS. 3 Juno is at opposition on 20th at magnitude 9.1 in Virgo.

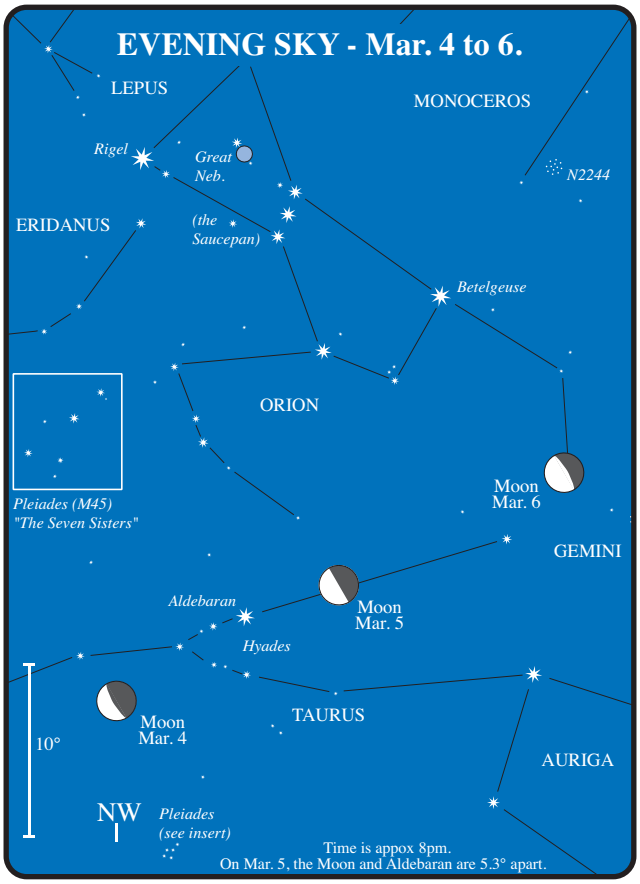
COMETS

Hale-Bopp: Slowly moving northward, Hale-Bopp will spend most of this month in Dorado, initially at a brightness of magnitude 7.8. By month's end, the magnitude 8.2 comet will be moving into Pictor, and observations will be best suited in the evening.

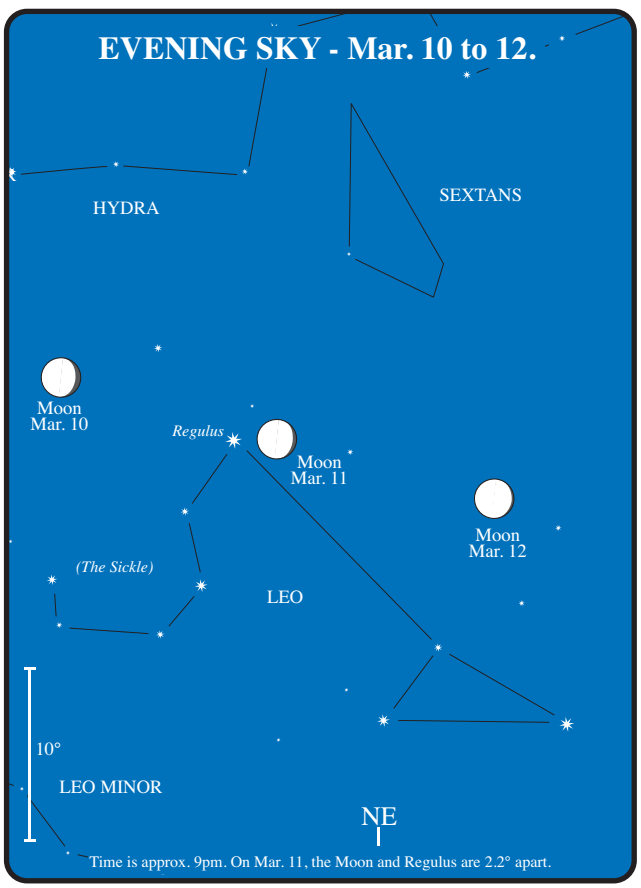
Hartley 2: March sees this comet initially in Taurus, setting before 11:30 pm at magnitude 8.8. Hartley 2 will move into Orion, passing near Gamma Orionis, before ending the month near Betelgeuse, at which time it will be setting before 11 pm and will have faded to 12.1 magnitude..

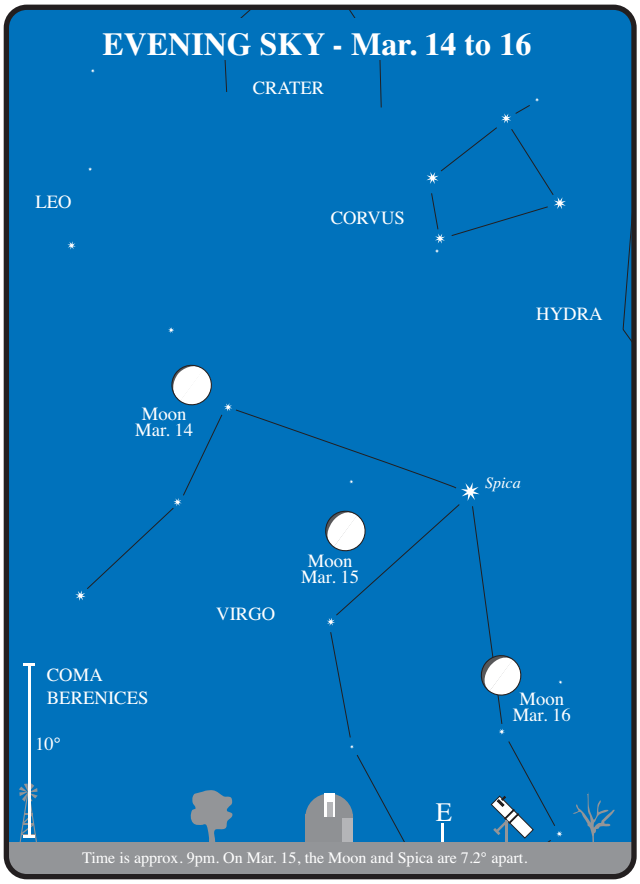
DIARY OF EVENTS

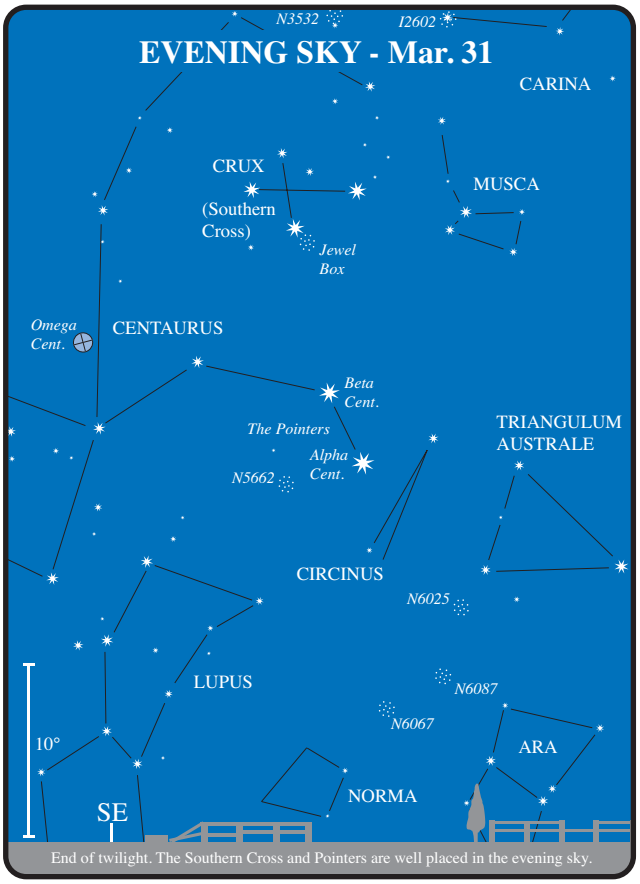
1st		m.p. 63 Ausonia 1.3°N of Comet 37P/Forbes
1st	8 PM	Regulus 0.2°S of Moon; Occn.
2nd	4:58 PM	Full Moon
3rd		m.p. 3 Juno 0.7°NW of Pluto
3rd	11 PM	Mercury greatest elong. E. (18°)
7th		Mercury 4°NW of Jupiter
7th	Noon	Mars 3°S of Moon
8th		Comet 37P/Forbes 1°N of M54 (GC) in Sagittarius
8th	3 PM	Moon at apogee
9th		Pluto 2°S of Comet Tempel 2
10th		Comet 37P/Forbes 0.5°NW of Zeta Sagittarii
10th	8 AM	Mercury stationary
10th	6:40 PM	Last Quarter Moon
11th		Mercury at greatest latitude North
12th		m.p. 3 Juno 1.3°S of Comet 10P/Tempel-2
14th		Comet C/1995 O1 (Hale-Bopp) 1.1°W of NGC 1786 (GC in LMC) in Dorado
14th	9 AM	Neptune 1.4°S of Moon
15th		m.p. 40 Harmonia 0.8°S of NGC 2903 (SG) in Leo
15th	6 AM	Uranus 1.3°S of Moon
15th	Noon	Pluto stationary
17th		Venus at ascending node
18th	4:48 AM	New Moon
18th	8 PM	Mars stationary
18th	9 PM	Jupiter 3°N of Moon
19th		m.p. 14 Irene 0.4°SE of NGC 676 (SG) in Pisces
20th	5 AM	Mercury in inferior conjunction
20th	11 AM	Moon at perigee
20th	11 AM	Venus 5°N of Moon
20th	1 PM	Saturn 3°N of Moon
21st	7 AM	Venus 3°N of Saturn
21st	Noon	Equinox
23rd	2 AM	Aldebaran 0.6°S of Moon Occn
24th	8:18 PM	First Quarter Moon
24th	9 PM	Vesta stationary
25th		Jupiter at greatest latitude South
29th	2 AM	Regulus 0.3°S of Moon; Occn.



All times are AEST. For daylight saving add 1 hour.







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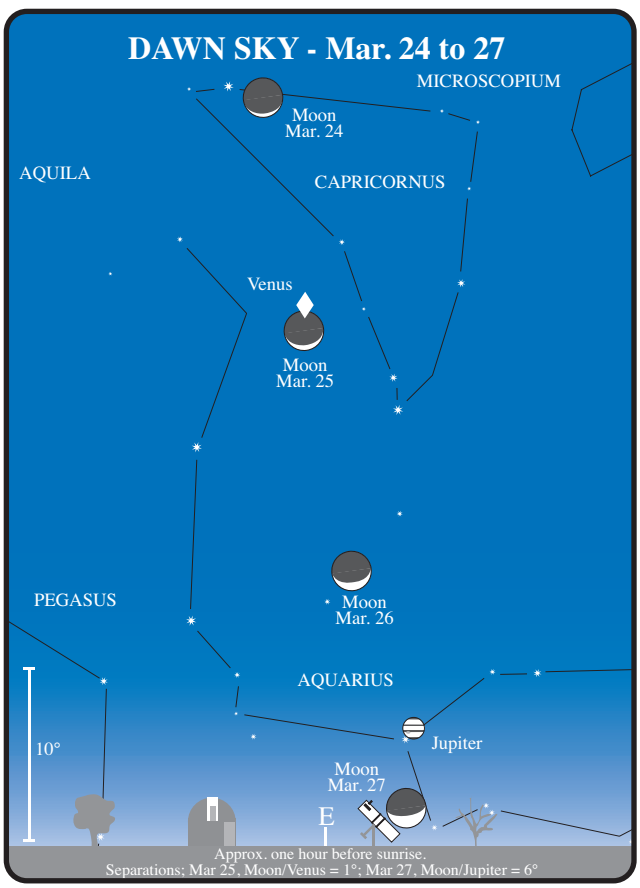
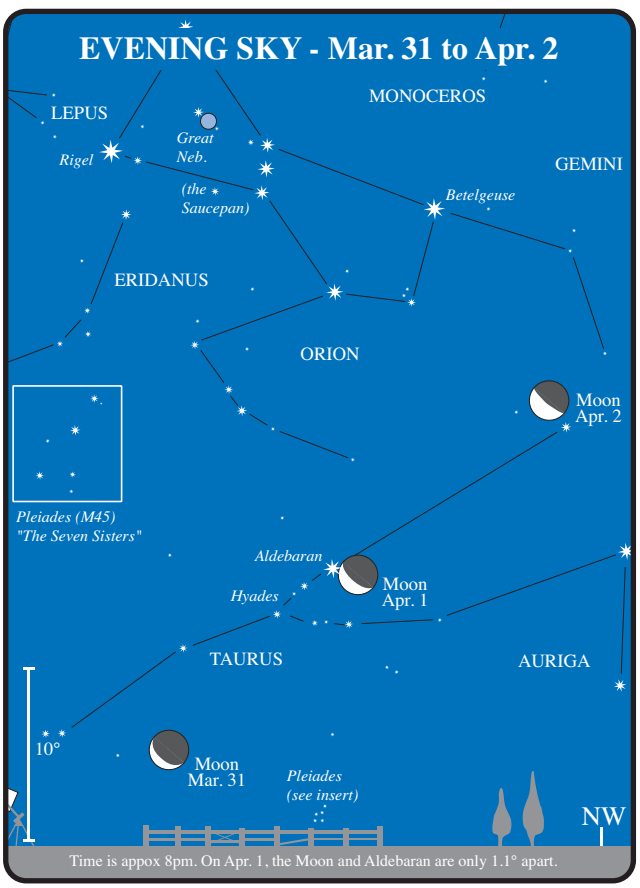
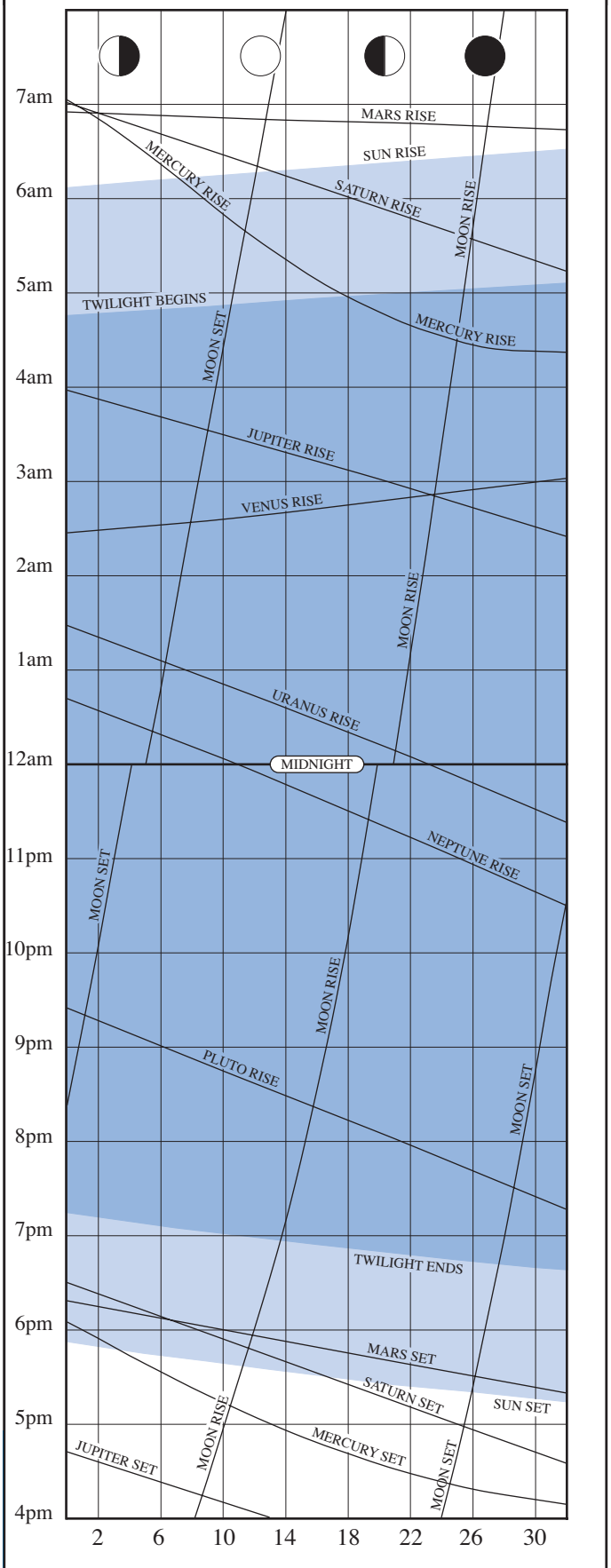




APRIL

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

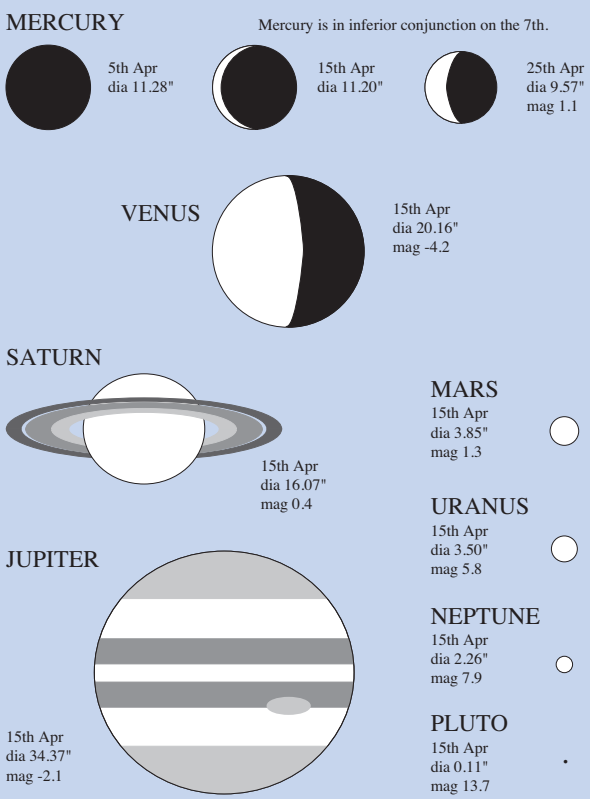
APRIL HIGHLIGHTS

- Mercury returns to the morning sky.
- Venus and Jupiter close together on 25th. Not to be missed!
- Mars in evening twilight sky. too close to Sun to observe.
- Jupiter in morning sky, rising around 3am.
- Saturn reappears in the dawn morning sky towards the end of April.

THE MOON

1st	Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach from the eastern states is approximately 1° (see Sky View for March).
4th	First Quarter
11th	Moon at apogee (furthest from Earth - 412,590 km distant, angular size 29.0 arc minutes).
12th	Full Moon
20th	Last Quarter
23rd	Occultation of Venus by the Moon. Not visible from Australia.
23rd	Occultation of Jupiter by the Moon. Not visible from Australia.
25th	Occultation of Mercury by the Moon. Not visible from Australia.
26th	Moon at perigee (closest to Earth - 361,280 km distant, angular size 33.1 arc minutes).
26th	New Moon

APPEARANCE of the PLANETS



29th Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach from the eastern states is approximately 7° (see Sky View).

THE PLANETS

MERCURY returns to the morning sky after inferior conjunction (between the Earth and the Sun) on the 7th. The planet rises rapidly as it heads towards greatest elongation early next month. From late April to mid-May, the planet is at its best in the morning sky for the year. An occultation of Mercury by the Moon on the 25th is not visible from our latitudes, but the pair can be seen close together in the morning sky (see Sky View).

VENUS. Throughout the month Venus (magnitude -4.2) and Jupiter (magnitude -2.1) move toward each other, creating a dazzling sight in the eastern dawn sky. By the 23rd, the pair are extremely close, at only 0.3° (see Sky View). The brightness and closeness will no doubt generate the usual UFO reports! To further enhance this morning display the crescent Moon appears above the pair on the 23rd and below on the 24th. If you are not in the habit of getting up early for only a conjunction, do yourself a favour and make this one the exception! As mentioned in the Moon section (above), an occultation of both Venus and Jupiter takes place but this is not visible from Australia. From some parts of Africa, Arabia and India, both planets will be simultaneously concealed by the Moon; an exceedingly rare event.

MARS remains close to the Sun, and remains invisible until it appears in the early morning June twilight.

JUPITER features in the fine conjunction detailed in the Venus section. It should be remembered that Venus is the brighter object. There is not much more to be said about Jupiter's movements that has not been detailed above, except a reminder to get up early for the conjunction of the year!

SATURN is in conjunction with the Sun on the 13th, and reappears in the eastern morning twilight sky at the end of April. Saturn's return to the dawn sky is shown on the Sky View for the 30th with Saturn, Mercury, Venus and Jupiter appearing in a 36° line rising above the horizon.

URANUS & **NEPTUNE** both rise around midnight mid-month. The Moon appears near the planets on the 20th and 21st.

MINOR PLANETS at opposition this month include: 25 Phocaea on 24th at magnitude 10.5 in Virgo and 32 Pomona on 30th at magnitude 10.3 in Libra.

COMETS

Hale-Bopp: Located in Pictor for the entire month, Hale-Bopp will fade from magnitude 8.2 to 8.7. Observations will be best suited during the evening, as the comet will be below the horizon for much of the morning.

Meunier-Dupouy: This 11th magnitude comet will be found in Pegasus during April, rising before Sam at the beginning of the month, and rising after 3am by month's end.

CONSTELLATIONS OF THE MONTH - CORVUS (Crv), CRATER (Crt) and SEXTANS (Sex)

Corvus (The Crow), Crater (The Cup) and Sextans (The Sextant) are three small constellations that are situated just above (south) the celestial equator and bounded on the south side by Hydra. These three neighbours do not abound in interesting objects and have been grouped together for convenience. Corvus is the most readily identifiable and is located west of Spica in Virgo, its main four 3rd magnitude stars form a trapezoid. Further west of Corvus is Crater, its main four 4th magnitude stars also form a fainter trapezoid. Still moving westward we come across Sextans, a very undistinguished grouping of 5th magnitude stars. Its brightest members form an equilateral triangle with Regulus (in Leo) and Alpha Hydrae (in Hydrus).

In classical mythology the crow was sent by Apollo to bring back the water of life in a cup. The crow, unable to resist the fruit of a fig tree, dropped the cup and began feasting, Realising he had lingered too long, the crow hastily picked up the cup in its beak and a water snake (Hydra) in its claws. On his return the crow blamed the snake for his delay. Apollo was not fooled by this deception, and banished the three of them into the sky. Sextans however does not have such an interesting past, it was created by Hevelius in 1690 to fill in some empty space between the constellations.

Situated near the Virgo Galaxy Cluster, Corvus too has its share of galaxies. Most however are faint; the remarkable exception is the Antennae galaxy (NGC4038 and 4039). These two galaxies are undergoing a collision, and long exposure images show two fine tails (or antennae) being thrown radially out from the centre. The Antennae has a fairly high surface brightness and is easily seen in telescopes 150mm and larger.

One of the brightest of the large planetary nebulae can be found within the trapezium of Corvus. Known as NGC4361, the planetary appears as a round 80 are second diameter nebulae with a 13th

Colliding Galaxies NGC 4038/39 (The "Antennae" is not visible). Taken with an ST-6 camera on 250mm Meade LX200 telescope. Composite of 5 x / minute exposures.

magnitude central star. There is also a double star and two triple stars worth looking at in Corvus. The double, Delta, appears as a 3rd and 8th magnitude pair with good colour contrast. Struve 1604 is a 6th magnitude star with two wide 9th magnitude companions. Lastly, two evenly matched close 6th magnitude stars and a wide 10th magnitude star form Struve 1669.

Crater has a few faint galaxies best suited for larger telescopes and a few average double stars. Sextans similarly is lacking in good objects with the exception of a galaxy known as the *Spindle Nebula" or NGC3115. The galaxy is unusual for it appears to be a flattened elliptical type. Its surface brightness is high and makes an easy target for a small telescope.

APRIL

Howell: Observers will find this comet in Virgo during April, visible all night for most of April until month's end when it is setting around 5am. During this time, the comet will brighten from magnitude 13.7 to 12.9.

Hartley 2: Beginning the month at magnitude 12.1, Comet Hartley 2 will be found in Orion near Betelgeuse, setting before 11pm. During the month, the comet will move through Monoceros, passing near the Cone Nebula, before ending the month in Canis Major, when it will be nearly 14th magnitude.

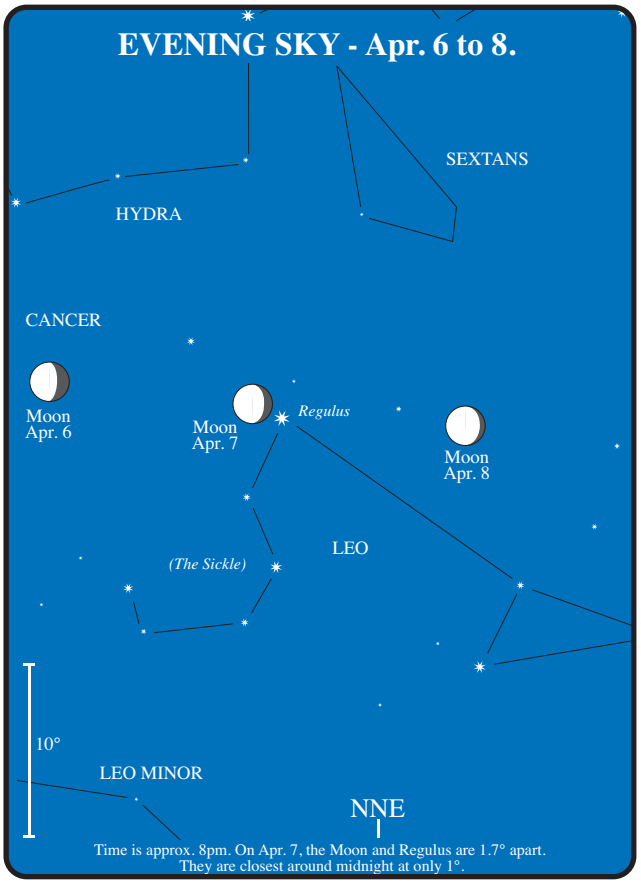
METEOR SHOWERS

The **Lyrids** are a northern shower, but can be observed south of the equator. They are best seen from 2am to dawn from the 16th to 25th April, with maximum on the 22nd. Maximum rates may only last an hour or so, and typically the zenith hourly rate is around 15. The Lyrids have occasionally produced higher rates and because of this erratic nature, they are a shower to be watched. In 1982 American observers recorded a short peak of 90 per hour.

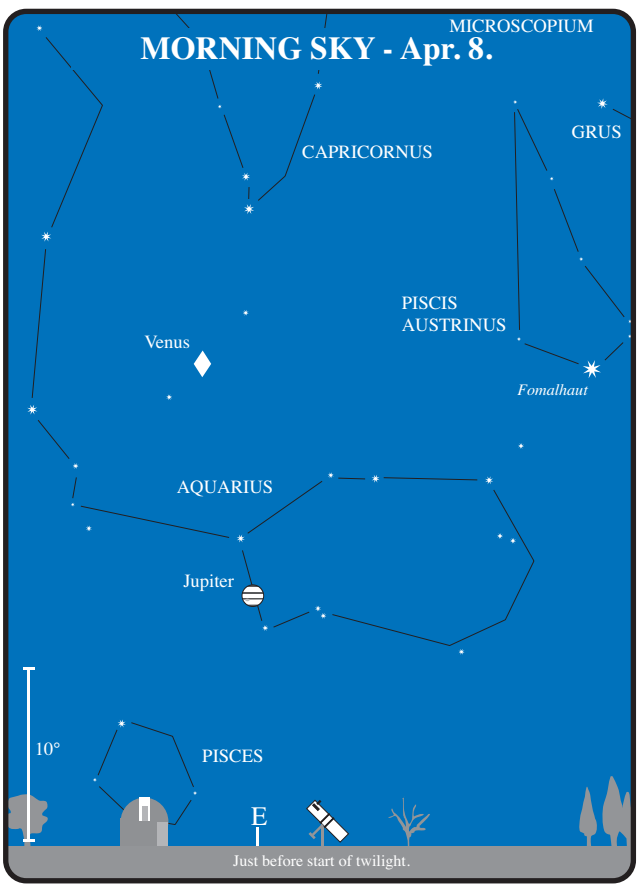
The **pi-Puppids** or **Grigg-Skjellerupids** (named after the short period comet that produced the stream), is a very young southern shower first observed in 1972. It is best seen in the evening sky from 15th to 28th April, with maximum activity on the 23rd. Leading up to and after maximum the rates are low and difficult to separate from sporadic meteors. The peak can vary greatly in intensity. It is sometimes nil and occasionally 3 to 4 per hour or more (13 in 1983, 40 in 1982 and 1977). The Pi Puppids are noted for their very slow speed, brightness, persistent trains, large proportion of yellow meteors and occasional fireballs.

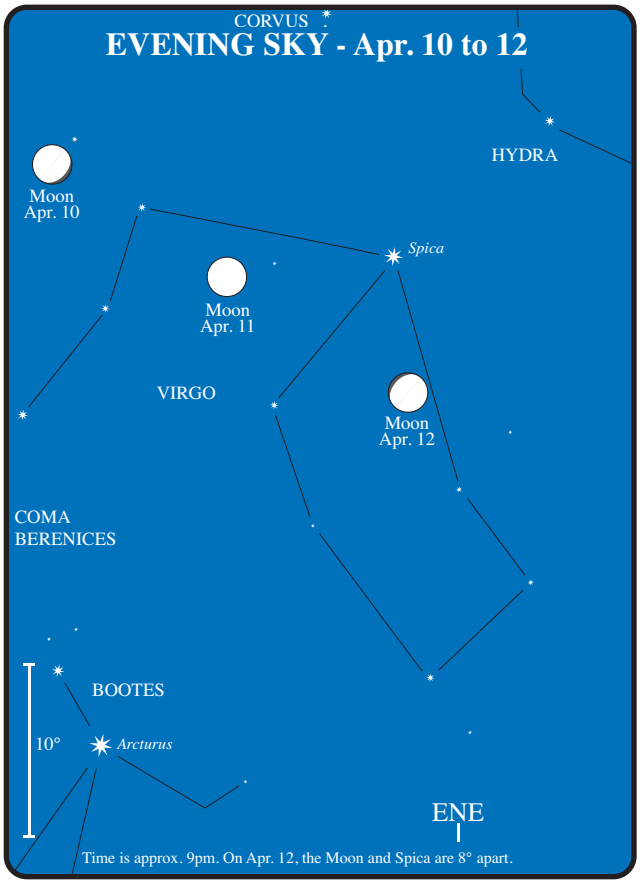
DIARY OF EVENTS

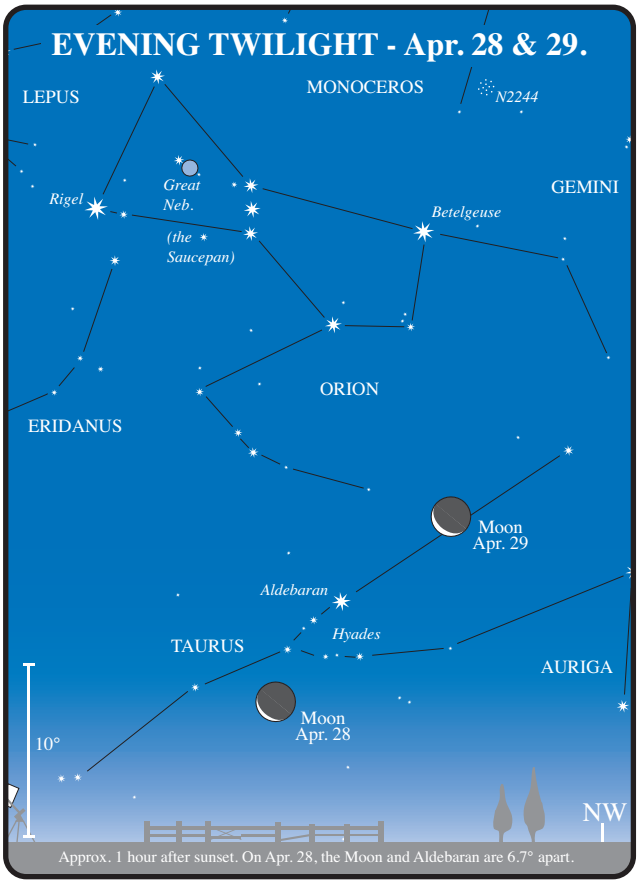
1st	6 PM	Aldebaran 0.2°S of the Moon; Occn.
4th	6:18 AM	First quarter Moon.
5th		m.p. 29 Amphitrite 0.2°S of NGC 6907 (SG) in Capricornus.
7th	3 AM	Mercury in inferior conjunction.
8th		m.p. 6 Hebe 0.6°NW of NGC 6366 (GC) in Ophiuchus.
9th	9 AM	Ceres in conjunction with the Sun.
11th	Noon	Moon at apogee.
12th	8:23 AM	Full Moon.
13th		Mercury at descending node.
13th	10 PM	Saturn in conjunction with the Sun.
14th		Comet Meunier-Dupouy 0.7°SW of NGC 7217 (SG) in Pegasus.
16th		Mercury at descending node.
19th		Saturn at greatest latitude S (heliocentric).
19th	Noon	Mercury stationary.
20th	5:53 AM	Last quarter Moon.
20th	Noon	Neptune 3°S of the Moon.
21st	6 AM	Uranus 3°S of the Moon.
23rd		m.p. 7 Isis 1.6°N of m.p. 43 Ariadne.
23rd	Noon	Venus 0.3°N of Jupiter.
23rd	5 PM	Jupiter 0.2°S of the Moon; Occn.
23rd	6 PM	Venus 0.08°N of the Moon; Occn.
25th	5 AM	Mercury 0.9°N of the Moon; Occn.
26th		Mercury at aphelion.
26th	4 AM	Moon at perigee.
26th	9:41 PM	New Moon.
29th		m.p. 18 Melpomene 1°SW of NGC 6517 (GC) in Ophiuchus.
29th	4 AM	Aldebaran 0.4°S of the Moon; Occn.



All times are AEST. For daylight saving add 1 hour.







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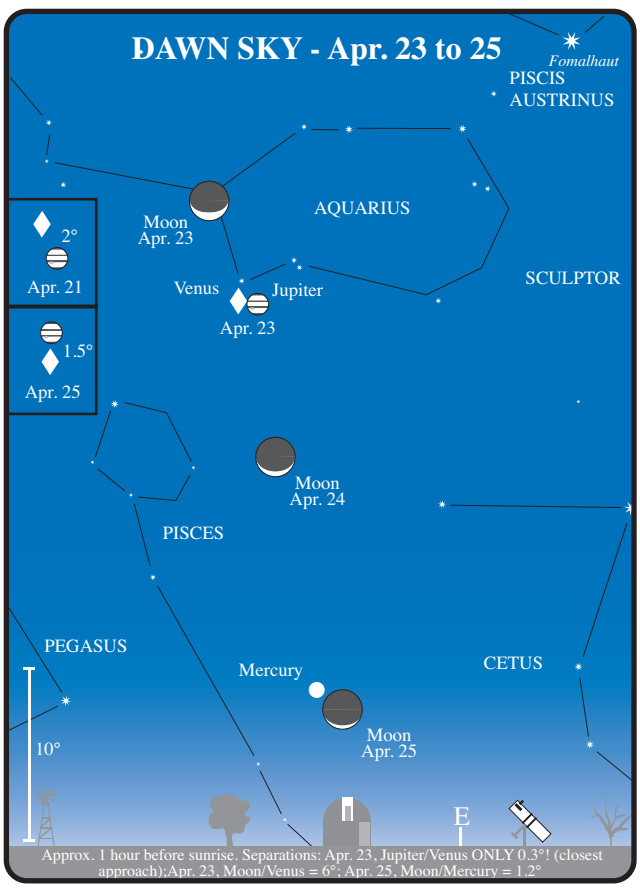
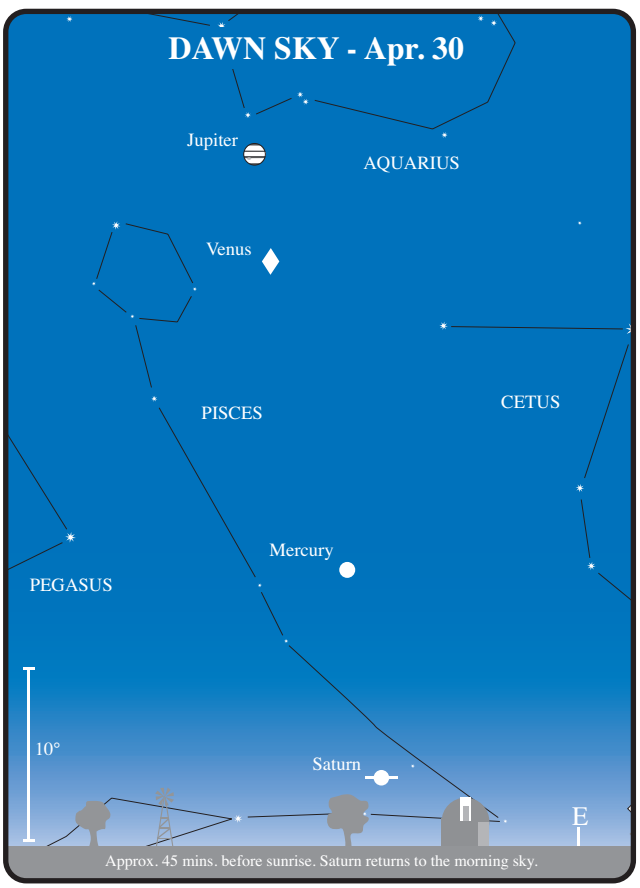
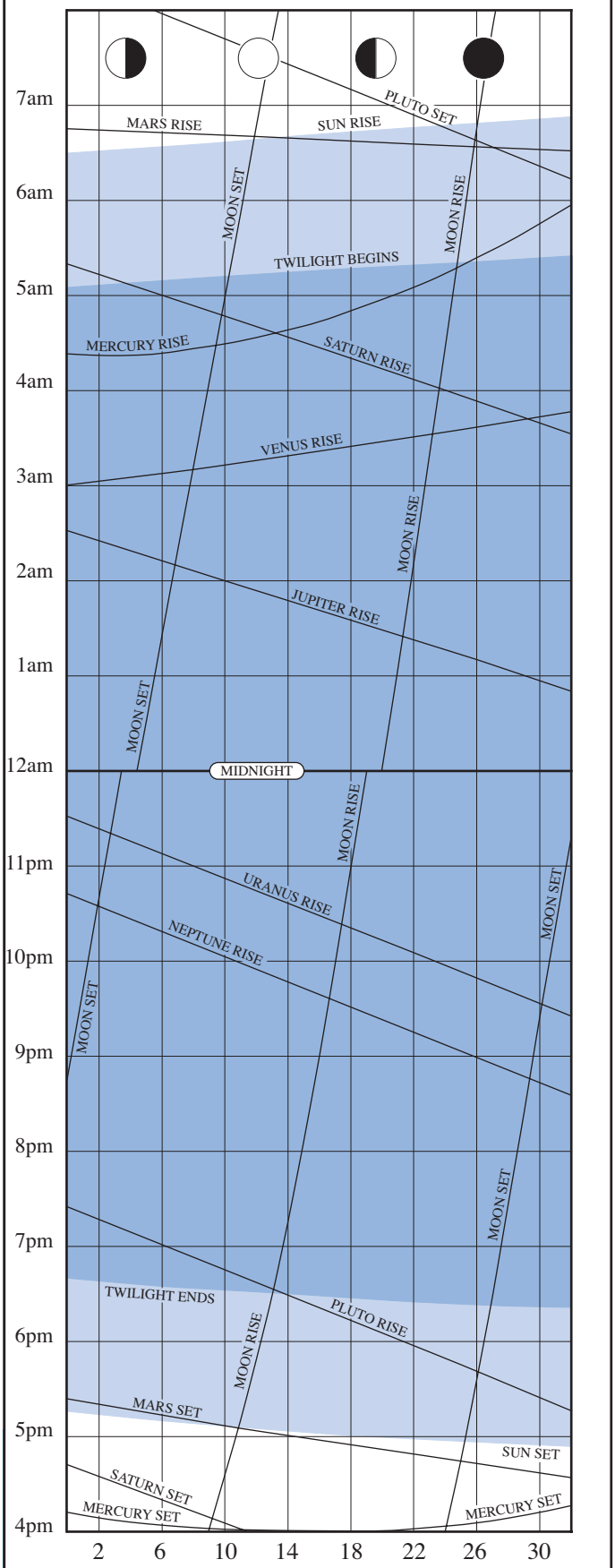




MAY

RISE/SET CHART



All times are AEST.

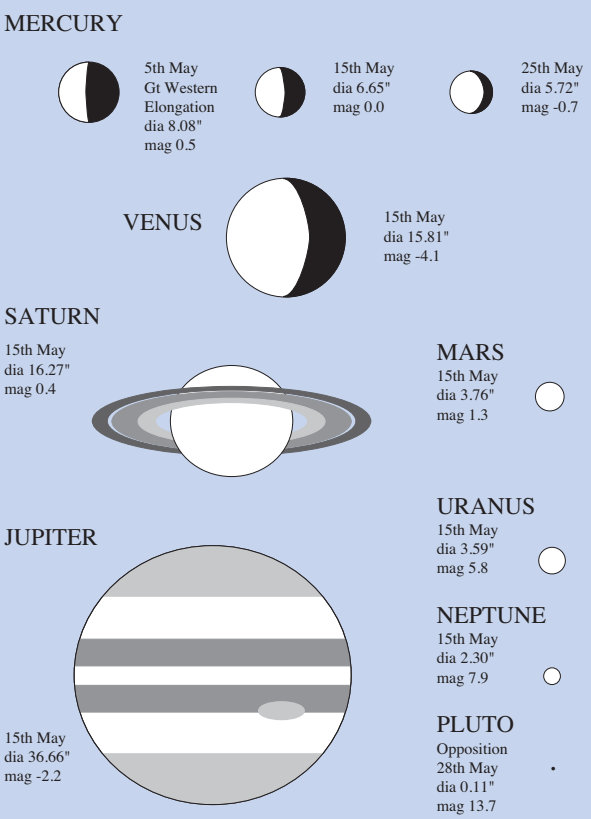
MAY HIGHLIGHTS

- Mercury. Best view in the morning sky for 1998.
- Mercury and Saturn have a close conjunction, on the 13th, in the dawn sky.
- Jupiter, Venus, Mercury and Saturn together in the eastern pre-dawn sky.
- Venus and Saturn are close together on 29th.
- Jupiter, daylight occultation on 21st, for some Aussie locations

THE MOON

3rd	First Quarter
8th	Moon at apogee (furthest from Earth - 401,670 km distant, angular size 29.7 arc minutes).
12th	Full Moon
19th	Last Quarter
21st	Occultation of Jupiter by the Moon. Daytime event, see Jupiter notes (next page).
24th	Moon at perigee (closest to Earth - 358,440 km distant, angular size 33.3 arc minutes).
26th	New Moon

APPEARANCE of the PLANETS



THE PLANETS

MERCURY reaches its greatest elongation (27°) west of the Sun on the 5th. The planet then remains in a good position for early morning observers for most of May. From the beginning of the month, Mercury and Saturn gradually approach each other, and on the 13th the pair are at their closest at 0.8° apart (see Sky View).

VENUS is in Pisces for most of the month, shining brilliantly in the early morning eastern sky. On the 23rd, Venus and the 26 day old crescent Moon appear 1.5° from each other, with Saturn below (see Sky View). On the 29th, Venus and Saturn appear very close at 0.3° apart (see Sky View).

MARS is in conjunction with the Sun on the 13th, and will appear in the morning twilight next month.

JUPITER can be seen high in the early morning eastern sky. Situated in Aquarius until the end of the month, it then moves into Pisces where it will remain for the next three months. The 24 day old Moon appears 2.5° above Jupiter in the morning sky on the 21st (see Sky View), in some parts of Australia there will be a daylight occultation. Just like Venus, Jupiter can be seen with the unaided eye in broad daylight. You just need to know where to look! Even if no occultation occurs from your area, it is still worth the challenge to try to locate Jupiter in the daylight (binoculars may help when the planet is still some distance from the lunar limb). The times listed below are only approximations and you should start looking well in from the bright limb side. From Hobart (9:40am), Melbourne (9:40am), Canberra (9:50am) and Sydney (10:00am), Jupiter just skims past the lunar limb. These times are for closest approach. Other capital cities will see the Moon pass in front of Jupiter. The times are: Adelaide, Jupiter disappears (D) at 8:33am and reappears (R) at 9:21am, Brisbane D 9:42am & R 10:24am, Darwin D 8:36am & R 9:51am and for Perth D 6:10am & R 7:32am (dawn sky).

SATURN in Pisces can be seen rising up to meet Mercury and Venus in the early morning sky. On the 13th, Saturn comes within 0.8° of Mercury (see Sky View). On the 29th, Saturn is only 0.3° from the brightest of the planets, Venus.

URANUS appears stationary on the 18th and thereafter begins its western motion across the sky, continuing until October. It then returns to its west-to-east track (see discussion on retrograde motion page 68 and the Uranus finder chart in Part II).

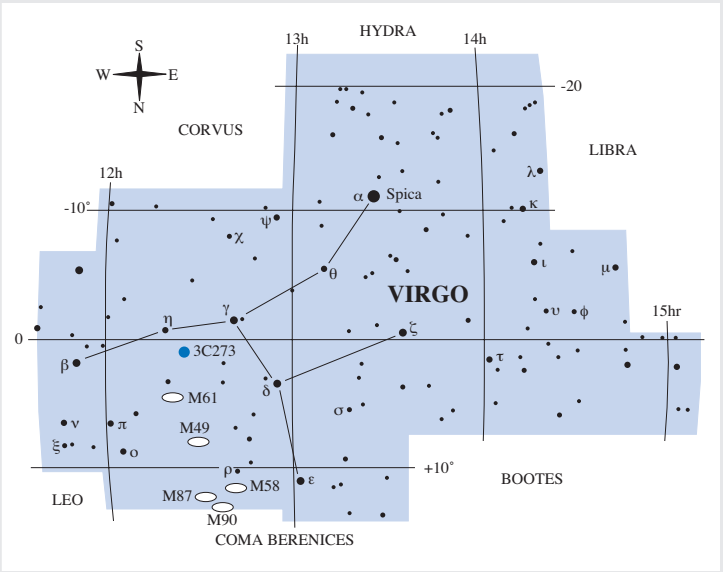
NEPTUNE appears stationary on the 4th. Like Uranus, it then begins its western motion across the sky, continuing until October.

PLUTO is at opposition on the 28th. Unlike some of the closer planets, opposition means little to this tiny distant member of the Solar System. Any difference in angular size or magnitude from conjunction to opposition is insignificant.

MINOR PLANETS 16 Psyche is at opposition on 9th at magnitude 10.4 in Libra.

CONSTELLATION of the MONTH — VIRGO (Vir)

Virgo, the Virgin, is a zodiacal constellation that culminates in late May around 9pm. Just beaten by Hydra, Virgo ranks as the second largest of the constellations. It is an ancient constellation that has generally been depicted as a beautiful maiden and goddess of the harvest. The constellation's brightest star Spica represents an ear of corn held in her left hand (the Latin name Spica, in fact means 'ear of corn'). The Arabs did not depict a human form, but rather the whole constellation was represented as a sheaf of wheat. Through the ages many women have been associated with the constellation. Astraca (the Greek goddess of Justice) Minerva (the Roman goddess), Isis (the Egyptian goddess) and even the Virgin Mary (by the medieval Christians).



In the 1920s Edwin Hubble described the region of Virgo near the Coma Berenices border as the "Realm of the Nebulae" Hubble's work however proved that these "nebulae" were in fact island universes millions of light years away. At a distance of about fifty million light years, the Virgo Cluster of galaxies is the nearest group of many such clusters. The Virgo Cluster is even thought to be the centre of a larger grouping known as the Virgo Supercluster. To date astronomers have identified about 3000 members of the cluster, and amateurs with relatively modest equipment can observe dozens of the brighter members. In fact, many amateurs search these clusters of galaxies to try and find rare and elusive supernovae.

The fact that Charles Messier in the 1700s used telescopes no larger than an 80mm refractor, to observe nine of these galaxies, attests to their brightness. Dark skies and telescopes larger than 150mm will give the most pleasant and detailed views. With so many galaxies we can only briefly cover a few here: M49 (NGC4472) an elliptical, M58 (NGC4579) a barred spiral, M61 (NGC4303) a face on spiral and M90 (NGC4569) a spiral, are some of the brightest. M87 (NGC4486), an elliptical, is the brightest member of the Virgo group and intrinsically one of the brightest galaxies known. M87 is a curious galaxy, it is surrounded by many thousands of globular star clusters (compared with the 110 or so known to belong to our own Milky Way galaxy). It has a bright jet of material apparently ejected from its nucleus. The jet extends about 5000 light years, and is visible in large amateur telescopes and on photographs. M87 also emits intense radio signals, and is known to radio astronomers as "Virgo A". M104 (NGC4594), also known as the famous "Sombrero Galaxy" is one of the largest galaxies known. It appears as an edge on spiral with a dark lane. The dark lane can be seen visually in amateur telescopes, but is particularly prominent in photographs.

Within Virgo's boundaries is the most distant object in the universe that an amateur is likely to see visually - the Quasar known as 3C273. Thought to be the nucleus of a young galaxy. 3C273, is one of the most luminous objects known at a distance of 3.000 million light years. 3C273 is about 13.5 magnitude and through the telescope it appears stellar and no different from many other faint stars in the field. The challenge is to track it down.

MAY

COMETS

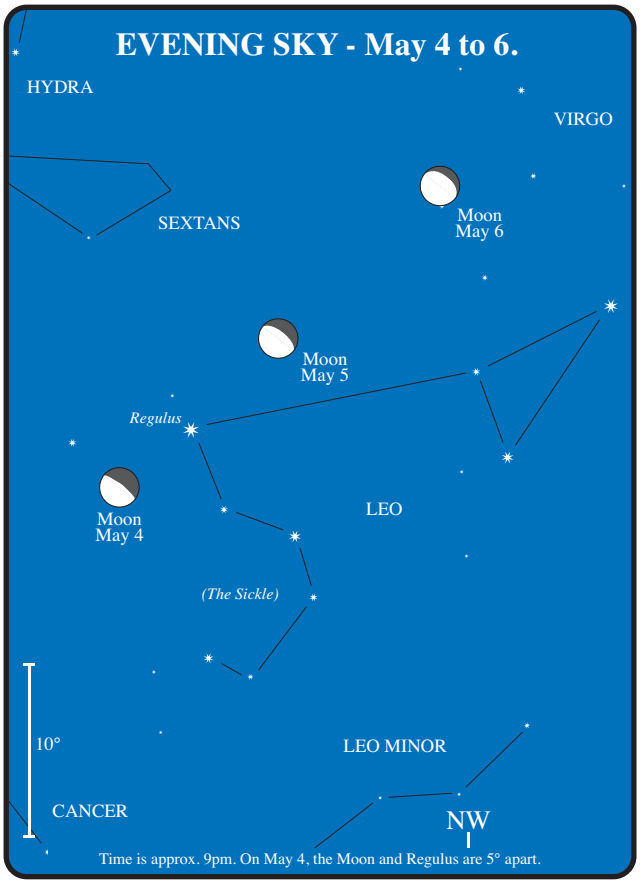
Hale-Bopp: Still located in Pictor, Hale-Bopp will be best observed early in the evening or just before dawn. During the month, the comet will fade from magnitude 8.7 to 9.0.

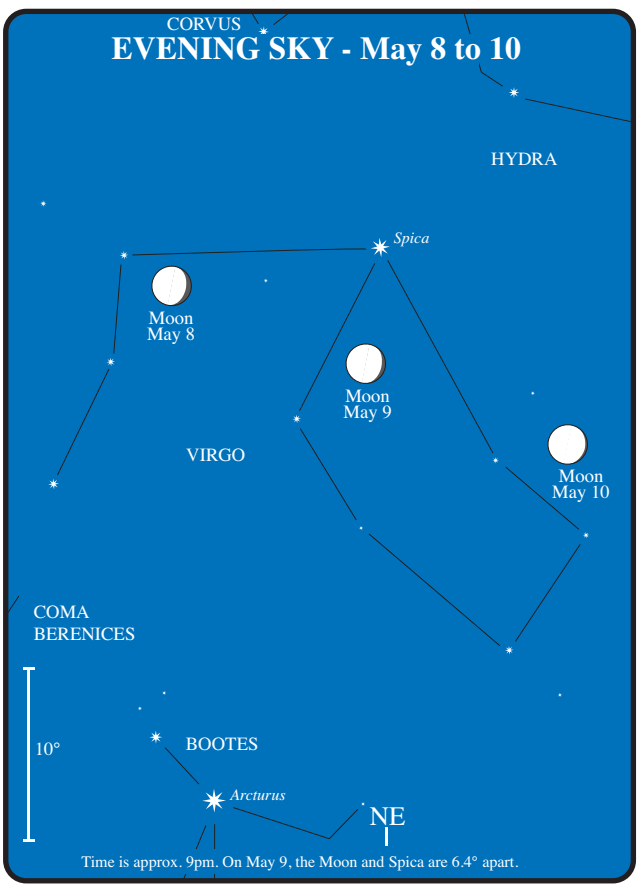
Meunier-Dupouy: Located in Pegasus, this 11th magnitude comet will rise after 3am at the beginning of the month, while by month's end it will be rising around 1:30 am.

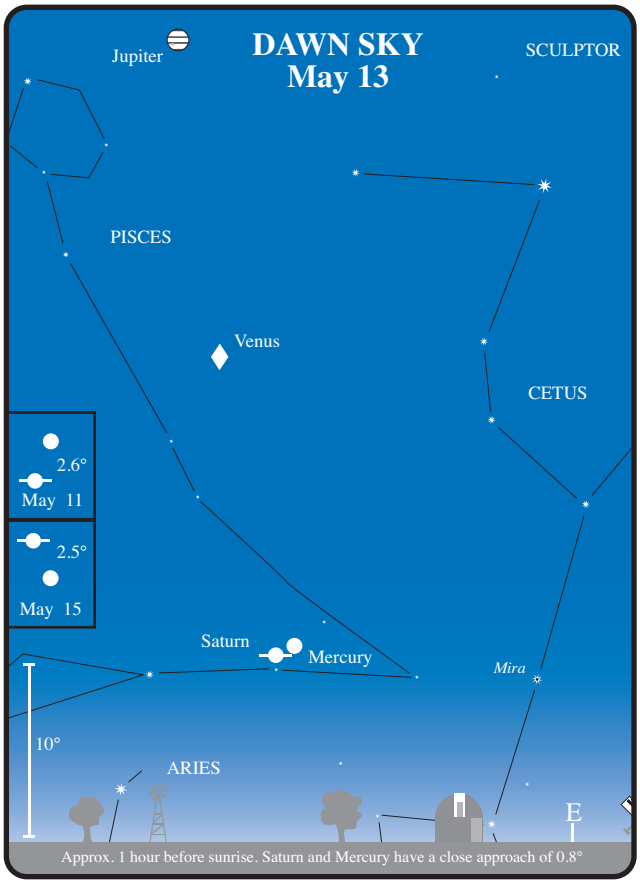
Howell: Remaining in Virgo, and initially setting around 5am, the comet will brighten from magnitude 12.9 to 12.2 by month's end, at which time it will be setting around 2:30 am.

DIARY OF EVENTS

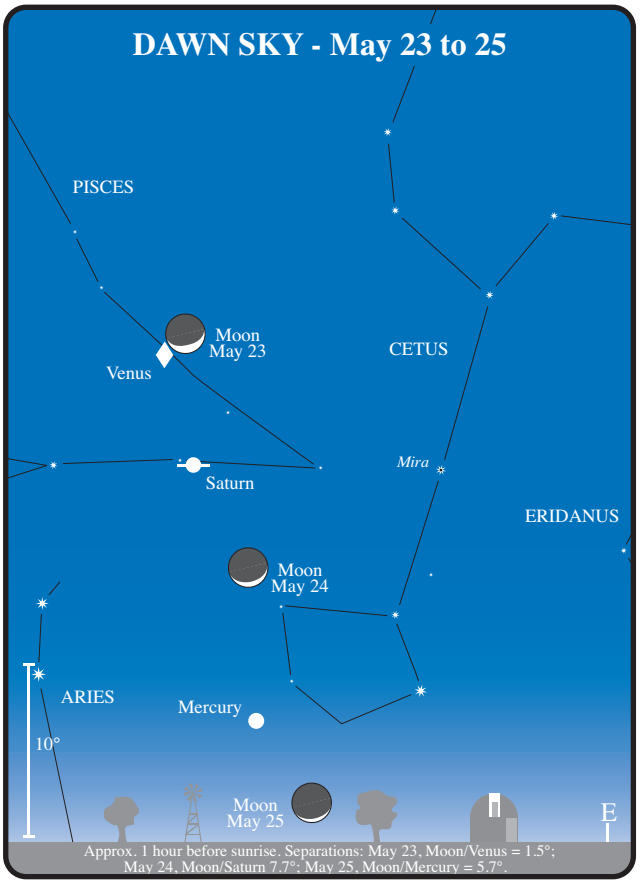
1st		Venus 0.3°NW of m.p. 44 Nysa.
2nd		m.p. 5 Astraea 0.2°SE of NGC 488 (SG) in Pisces.
3rd	8:04 PM	First quarter Moon.
4th	9 PM	Neptune stationary.
5th	3 AM	Mercury greatest elongation W.(27°).
6th		Venus 1.2°SE of m.p. 20 Massalia.
8th		Mercury 0.1°W of NGC 448 (SG) in Pisces.
8th		Mars at ascending node.
8th	7 PM	Moon at apogee.
9th	4 AM	Juno stationary.
11th		Mercury 0.4°W of m.p. 5 Astraea .
12th		m.p. 25 Phocaea 0.2°W of NGC 5339 (SG) in Virgo.
12th	12:29 AM	Full Moon.
13th	2 AM	Mercury 0.8°S of Saturn.
13th	6 AM	Mars in conjunction with the Sun.
16th		m.p. 1 Ceres 0.7°NW of NGC 864 (SG) in Cetus.
17th		Mercury at greatest latitude S (heliocentric).
17th	5 PM	Neptune 3°S of the Moon.
18th		Venus at aphelion.
18th	6 AM	Uranus stationary.
18th	1 PM	Uranus 3°S of the Moon.
19th	2:35 PM	Last quarter Moon.
20th		m.p. 20 Massalia 0.6°NW of NGC 128 (SG) in Pisces.
20th		Saturn 1°NW of m.p. 5 Astraea.
21st	9 AM	Jupiter 0.4°N of the Moon; Occn.
22nd		Venus 1.7°NW of NGC 488 (SG) in Pisces.
23rd	8 AM	Venus 1.7°N of the Moon.
23rd	6 PM	Saturn 1.7°N of the Moon.
24th	10 AM	Moon at perigee.
24th	9 PM	Mercury 3°N of the Moon.
25th		Neptune 0.5°S of m.p. 43 Ariadne.
26th	5:32 AM	New Moon.
28th		m.p. 230 Athamantis 0.1°NW of NGC 2775 (SG) in Cancer.
28th	3 PM	Pluto at opposition.
29th	Noon	Venus 0.3°N of Saturn.



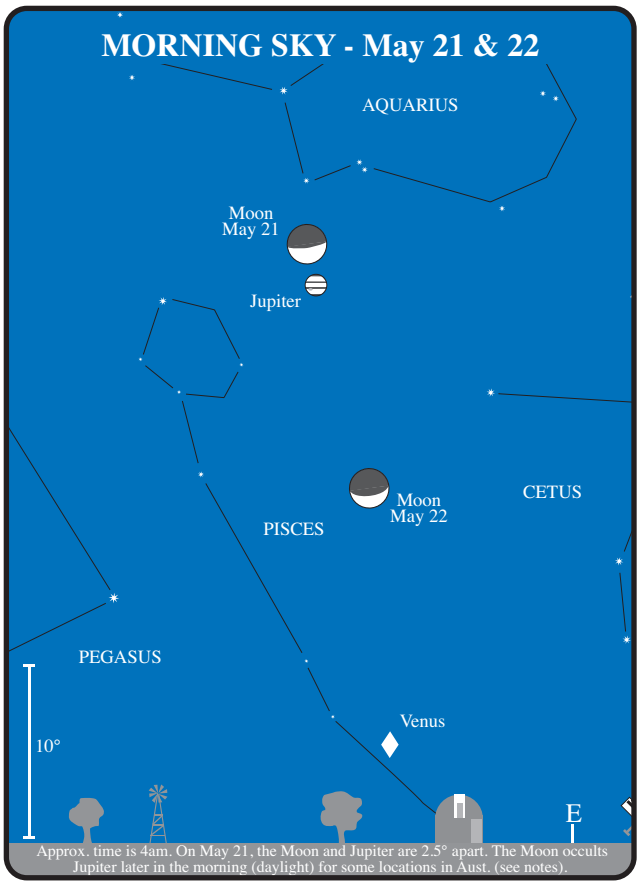




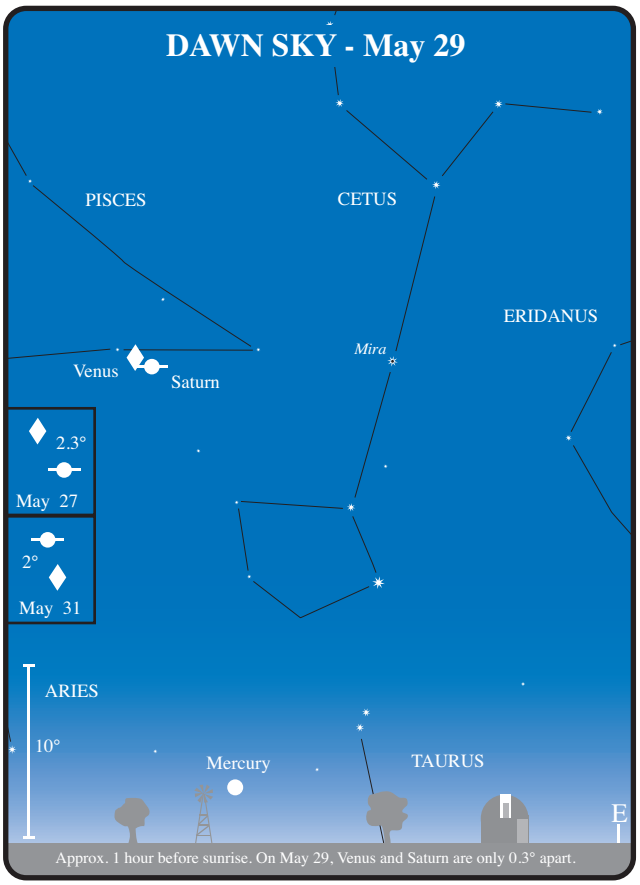
Approx. 1 hour before sunrise. Saturn and Mercury have a close approach of 0.8°



Approx. 1 hour before sunrise. Separations: May 23, Moon/Venus = 1.5°; May 24, Moon/Saturn 7.7°; May 25, Moon/Mercury = 5.7°.



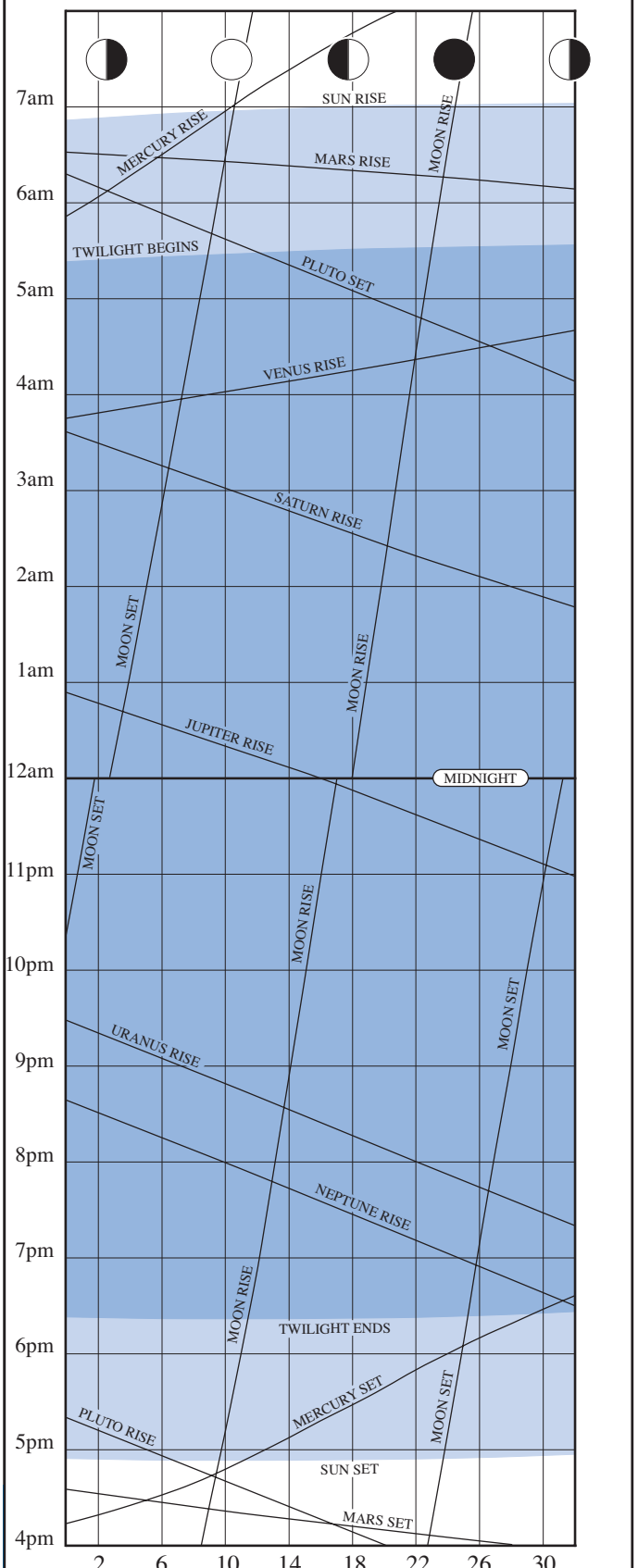
Approx. time is 4am. On May 21, the Moon and Jupiter are 2.5° apart. The Moon occults Jupiter later in the morning (daylight) for some locations in Aust. (see notes).



Approx. 1 hour before sunrise. On May 29, Venus and Saturn are only 0.3° apart.

JUNE

RISE/SET CHART



All times are AEST.

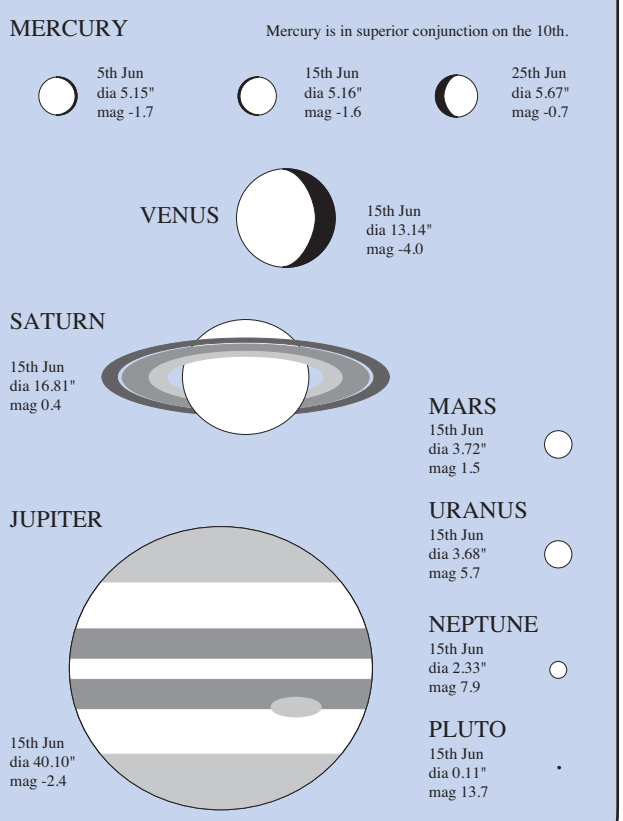
JUNE HIGHLIGHTS

- Mercury. Visible in evening twilight sky from late June.
- Venus and Saturn are in the eastern morning sky.
- Jupiter is dominant in the early morning NE sky, rising around midnight.
- Saturn and the Moon are close together in the dawn sky on 20th.
- Mars in morning dawn sky, too close to Sun to observe.

THE MOON

1st	Occultation of Regulus by the Moon. Visible from New Zealand and the end from Hobart at about 12:35pm (Moon just above horizon, daylight event), see Sky View for evening aspect. This is the first in a series of 19 occultations with Regulus which ends in October 1999.
2nd	First Quarter
5th	Moon at apogee (furthest from Earth - 409,450 km distant, angular size 29.2 arc minutes).
10th	Full Moon
17th	Occultation of Jupiter by the Moon. Not visible from Australia, the closest approach, as seen from eastern Australia, is approximately 3° (see Sky View).
17th	Last Quarter
21st	Moon at perigee (closest to Earth - 367,115 km distant, angular size 32.6 arc minutes).
22nd	Occultation of Aldebaran by the Moon. Not visible from Australia.
24th	New Moon

APPEARANCE of the PLANETS



28th Occultation of Regulus by the Moon. Not visible from Australia, the closest approach, as seen from eastern Australia, is approximately 2° (see Sky View).

THE PLANETS

MERCURY moves from the morning to the evening sky, after superior conjunction (opposite side of the Sun to the Earth) on the 10th. From late June to early August is the most favourable time of the year to view the planet during the evening. An interesting and challenging alignment occurs on the 25th. Mercury appears in a line with the young (17 hours old) slender crescent Moon to the South and the 1st magnitude star Pollux (Beta Geminorum) to the North (see Sky View). Binoculars are recommended to help overcome the evening twilight glow.

VENUS appears 3° below the much fainter Saturn at the beginning of June. The two separate as Venus moves closer to the Sun. On the 22nd, the 27 day old crescent Moon appears 4° from Venus. Towards month's end Venus passes within 5° of the Pleiades in Taurus, and on the 30th will be 5º from 1st magnitude Aldebaran (Alpha Tauri).

MARS rises in the morning twilight, but is still too close to the Sun for observation.

JUPITER in Pisces, rises around midnight, and by the beginning of morning twilight the planet can be seen high in the northern sky. On the 17th, Jupiter is occulted by the Last Quarter Moon. This event is not visible from Australia; the closest approach from "down under" being 3° on the 18th (see Sky View).

SATURN appears 3° above the brilliant Venus at the beginning of the month. The separation increases as the month progresses. Saturn gains altitude as Venus drops toward the Sun. On 20th, the 25 day old Moon and Saturn can be seen at a close 1.5° separation (see Sky View).

PLUTO. While Pluto is visible the entire night, it is a good opportunity to try and find this faint outer world. For this challenge, you will need a telescope of at least 200mm aperture, a good dark sky, and our finder chart in Part II. Since the planet will appear similar to any other 14th magnitude star in the neighbourhood, it is a good idea to sketch (or photograph) the field twice, about 2 weeks apart. The one that moves is Pluto!

MINOR PLANETS at opposition this month include: 18 Melpomene on 14th at magnitude 9.7 in Ophiuchus and 6 Hebe on 6th at magnitude 9.4 in Ophiuchus.

CONSTELLATION of the MONTH - BOOTES (Boo)

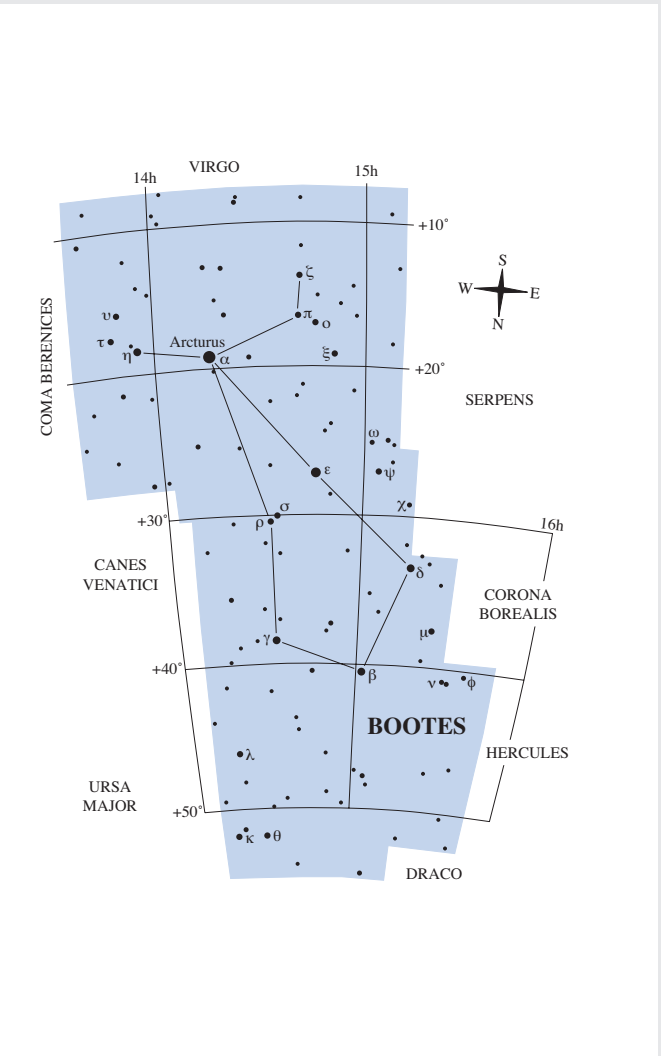
Bootes, the Herdsman, is a large constellation that is high in the northern sky at 9pm mid month. It is west of the Northern Crown i.e., the constellation of Corona Borealis. Homer mentions Bootes in the Odyssey as the Bear Driver, pursuing the Great Bear (Ursa Major) and the Small Bear (Ursa Minor) across the sky. Southern observers can only see a small portion of Ursa Major, and being north circumpolar Ursa Minor is never seen. Old constellation drawings show Bootes with two hunting dogs (Canes Venatici), apparently ready to be unleashed on the Great Bear.

An easy way to recognise Bootes is to picture the outline of an upside down kite formed by the stars Beta, Gamma, Delta and Epsilon. Arcturus, the constellation's brightest star, is midway along the kite's tail that curves westward.

Bootes contains no open star clusters, planetary or diffuse nebulae, and only one dim globular cluster. There are many galaxies, most of which are faint and disappointing even in fairly large amateur telescopes. This seemingly uninteresting constellation has one saving grace for the telescope user, scores of double stars!

Two good doubles are Kappa (magnitude 4.6 & 6.6, separation 13.4 are seconds) and Iota Bootis (4.9 & 7.5 magnitude, separation 2.8"). If you are looking for colour. Pi Bootis is a neat yellow pair (4.9 & 5.8 magnitude, separation 5.6"). For colour contrast, Epsilon Bootis is considered one of the finest in the sky (2.5 & 4.9 magnitude, separation 2.8"). Its primary is yellowish orange with the companion a bluish green. Xi Bootis also has excellent contrast with a yellow primary and reddish orange secondary.

Arcturus (Alpha Bootis), at magnitude -0.04 is the brightest star north of the celestial equator and the fourth brightest star in the sky. Only Sirius, Canopus, & Rigil Kent are Arcturus' seniors and all have negative declinations. Areturus has a large annual proper motion of 2.28 are seconds, and 3,000 years ago was situated about two degrees north east of its present position. Its course is towards the constellation of Virgo. Of the first magnitude stars, only Rigil Kent (Alpha Centauri) with a 3.68 are second annual proper motion exceeds that of Arcturus.



JUNE

COMETS

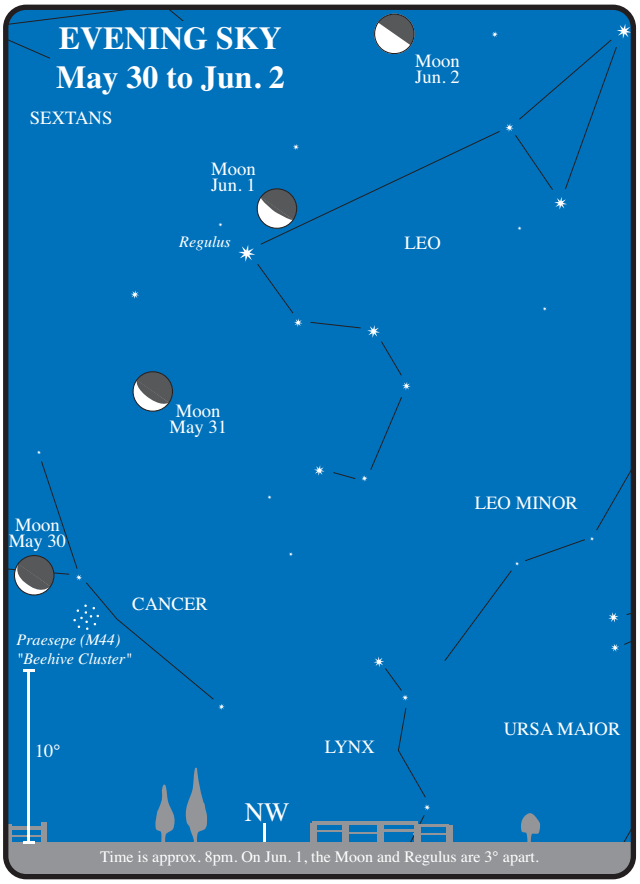
Hale-Bopp: This comet begins the month in Pictor at 9th magnitude. During the month, it moves through Puppis, ending the month on the Puppis / Carina border, only a few degrees north of Canopus, and will have faded to magnitude 9.3. It will be best observed in the pre-dawn sky.

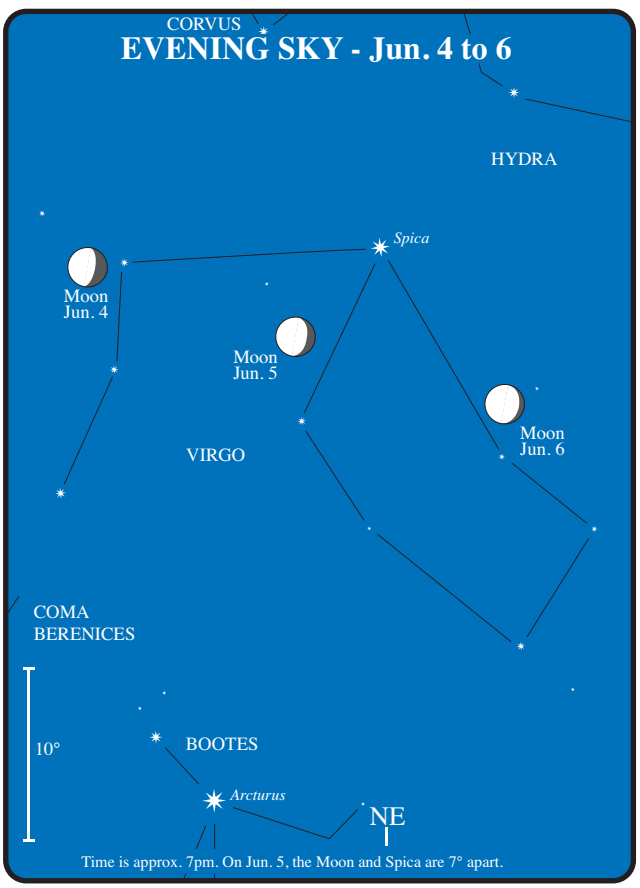
Meunier-Dupouy: Located in Pegasus, this 11th magnitude comet will rise around 1:30am at the beginning of the month, while by month's end it will be rising around 11pm.

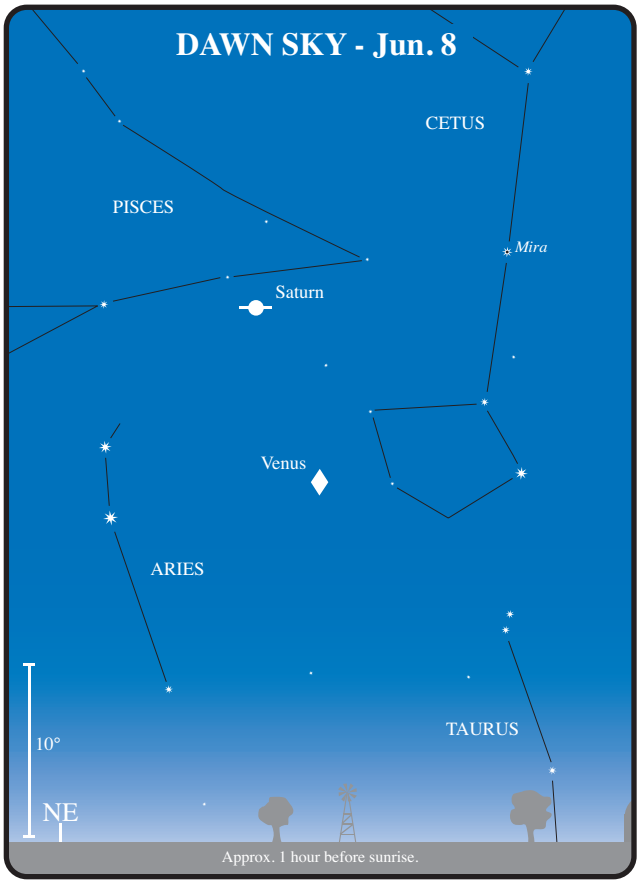
Howell: This comet remains in Virgo during June. Initially setting around 2:30am at magnitude 12.2, the comet will end the month near Theta Virginis, setting around lam at magnitude 11.8..

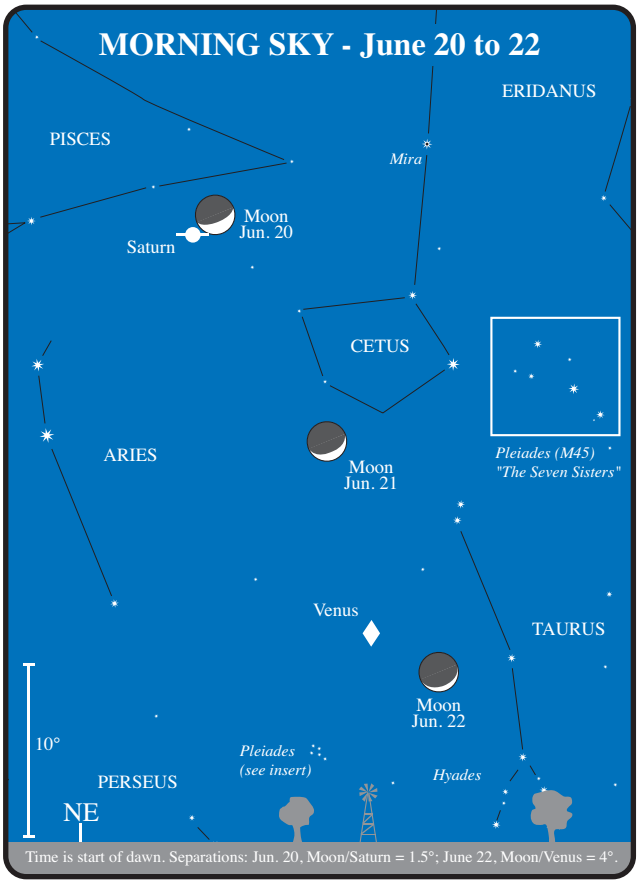
DIARY OF EVENTS

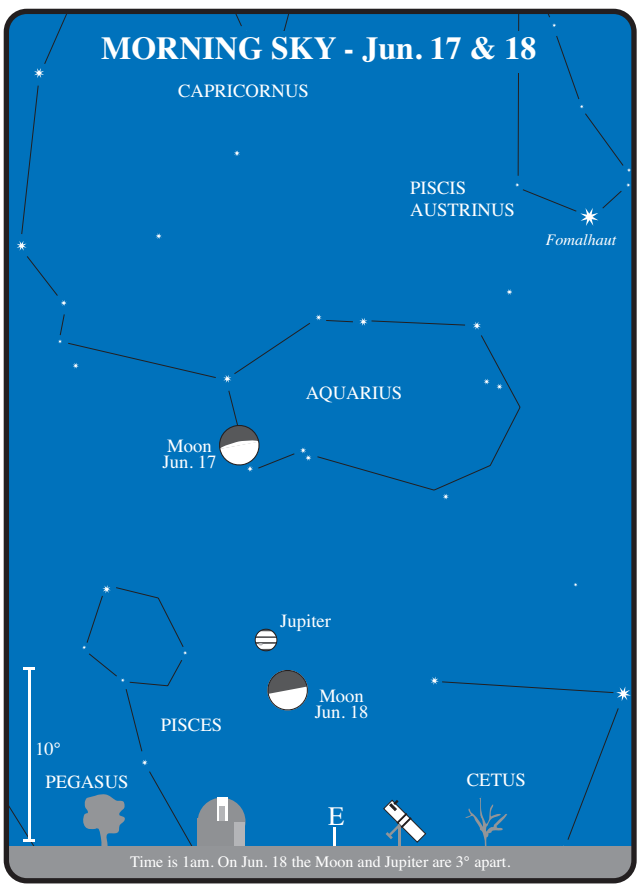
1st	2 PM	Regulus 1.0°N of the Moon; Occn.
2nd		Venus 0.4°SW of NGC 821 (EG) in Aries.
2nd	11:45 AM	First quarter Moon.
5th		Mercury at ascending node.
5th	10 AM	Moon at apogee.
9th		Venus at greatest latitude S (heliocentric).
9th		Mercury at perihelion.
10th	5 AM	Vesta in conjunction with the Sun.
10th	2:18 PM	Full Moon.
10th	5 PM	Mercury in superior conjunction.
13th	10 PM	Neptune 2°S of the Moon.
14th		m.p. 30 Urania 1.9°SW of Regulus.
14th	6 PM	Uranus 3°S of the Moon.
16th		m.p. 6 Hebe 0.7°N of M12 (GC) in Ophiuchus.
17th	8:38 PM	Last quarter Moon.
17th	9 PM	Jupiter 0.8°N of the Moon; Occn.
20th		Mercury at greatest latitude N (heliocentric).
20th	6 AM	Saturn 2°N of the Moon.
21st	3 AM	Moon at perigee.
21st	Midnight	Solstice.
21st	Midnight	Venus 3°N of the Moon.
22nd	Midnight	Aldebaran 0.4°S of the Moon; Occn.
24th	1:50 PM	New Moon.
25th	11 PM	Mercury 5°N of the Moon.
27th	9 PM	Mercury 5°S of Pollux.
28th	10 PM	Regulus 0.8°N of the Moon; Occn.
30th		m.p. 20 Massalia 0.3°SE of NGC 524 (EG) in Pisces.
30th		m.p. 230 Athamantis 1°SW of UGC 5373 (IG) in Sextans.
30th		Venus 0.8°NW of NGC 1554 (Nebula) in Taurus.

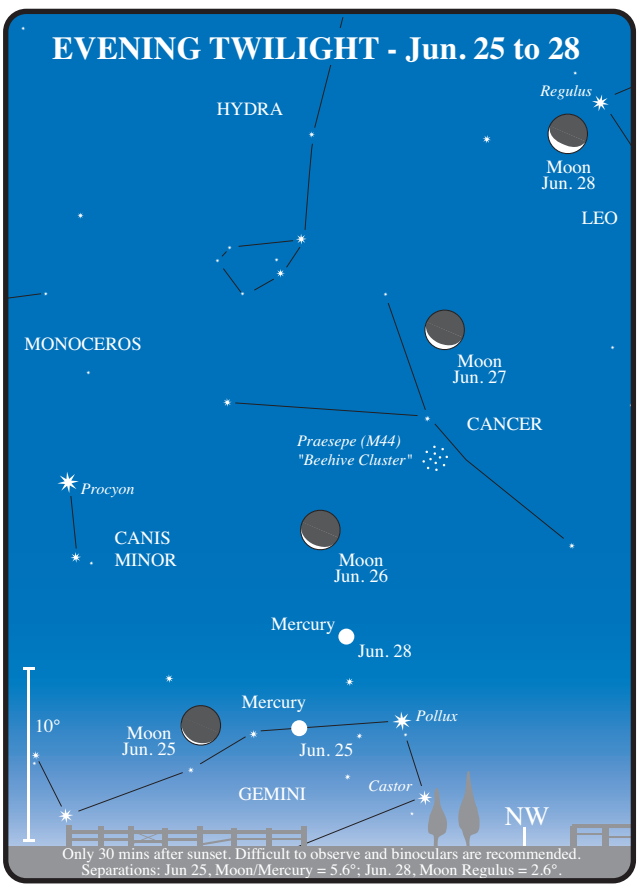





DAWN SKY - Jun. 8
CETUS
PISCES
Mira
Saturn
Venus
ARIES
TAURUS
10°
NE
Approx. 1 hour before sunrise.

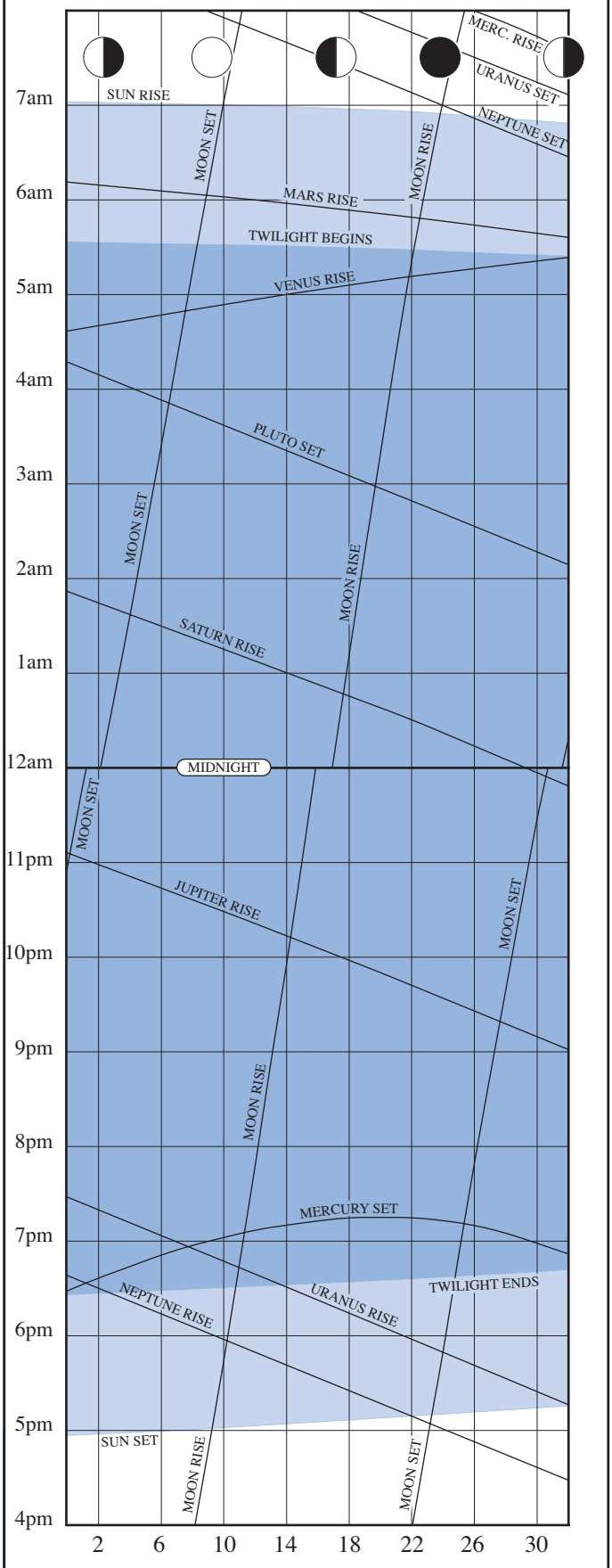

MORNING SKY - June 20 to 22
ERIDANUS
PISCES
Mira
Moon
Jun. 20
Saturn
CETUS
ARIES
Moon
Jun. 21
Pleiades (M45)
"The Seven Sisters"
Venus
TAURUS
Moon
Jun. 22
10°
Pleiades
(see insert)
Hyades
PERSEUS
NE
Time is start of dawn. Separations: Jun. 20, Moon/Saturn = 1.5°; June 22, Moon/Venus = 4°.


MORNING SKY - Jun. 17 & 18
CAPRICORNUS
PISCIS
AUSTRINUS
Fomalhaut
AQUARIUS
Moon
Jun. 17
Jupiter
Moon
Jun. 18
PISCES
10°
PEGASUS
CETUS
E
Time is 1am. On Jun. 18 the Moon and Jupiter are 3° apart.


EVENING TWILIGHT - Jun. 25 to 28
HYDRA
Regulus
Moon
Jun. 28
LEO
MONOCEROS
Moon
Jun. 27
CANCER
Praesepe (M44)
"Beehive Cluster"
Procyon
CANIS
MINOR
Moon
Jun. 26
Mercury
Jun. 28
Mercury
Pollux
10°
Moon
Jun. 25
Jun. 25
GEMINI
Castor
NW
Only 30 mins after sunset. Difficult to observe and binoculars are recommended.
Separations: Jun 25, Moon/Mercury = 5.6°; Jun. 28, Moon Regulus = 2.6°.

JULY

RISE/SET CHART



All times are AEST.

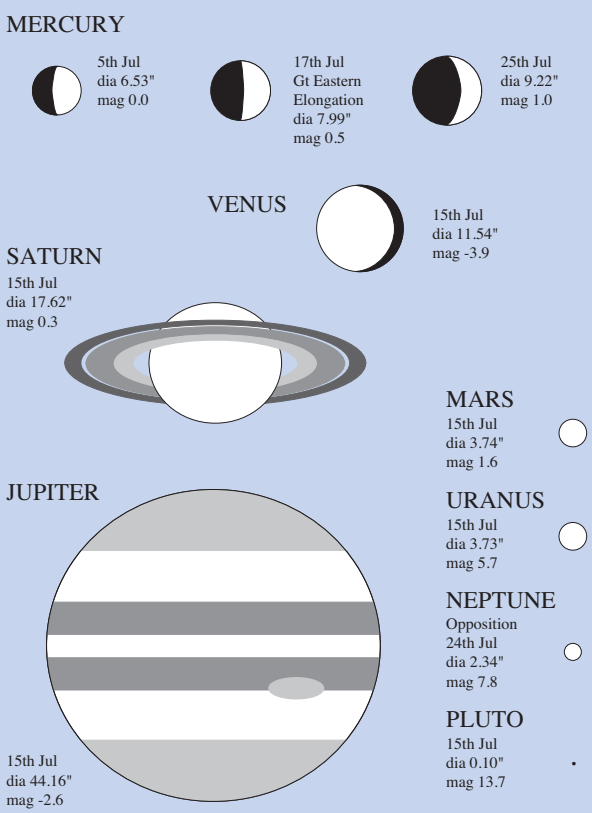
JULY HIGHLIGHTS

- Mercury. July is the best month to observe this planet in the evening sky.
- Venus is in the eastern pre-dawn sky.
- Mars returns to the morning sky. It is low in the eastern dawn sky late in the month.
- Jupiter moves into the evening sky, rising approximately 10pm. It has a close encounter with the Moon on 15th.
- Saturn is in the morning sky, rising around 1am.

THE MOON

2nd	First Quarter
3rd	Moon at apogee (furthest from Earth - 407,060 km distant, angular size 29.4 arc minutes).
10th	Full Moon
15th	Occultation of Jupiter by the Moon. Not visible from Australia, the closest approach from the eastern states is 0.4° (see Sky View).
16th	Moon at perigee (closest to Earth - 369,800 km distant, angular size 32.3 arc minutes).
17th	Last Quarter
20th	Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach from the eastern states is 1° (see Sky View).
23rd	New Moon
26th	Occultation of Regulus by the Moon. Not visible from Australia, see Sky View for our perspective on the 25th and 26th.

APPEARANCE of the PLANETS



30th Moon at apogee (furthest from Earth - 402,420 km distant, angular size 29.7 arc minutes).

31st First Quarter

THE PLANETS

MERCURY is in a very favourable position for observation this month to early August. On the 17th the planet reaches its greatest eastern elongation from the Sun (27°). This large angular distance means the planet will still be at a reasonable altitude as the western evening sky begins to darken. Mercury spends the first half of the month in Cancer, before crossing the border into Leo. On the 5th (see Sky View), the planet will be found on the outskirts of the open star cluster M44 (the Beehive or Praesepe). M44 is a large grouping of about 50 stars that cover an area of about 1º. It is visible as a fuzzy patch to the unaided eye under dark skies and is also a good binocular object. In Leo, on the 25th, Mercury is the centre of an interesting alignment with the 2 day old thin crescent Moon and 1st magnitude Regulus (see Sky View).

VENUS makes its closest approach of 4° to 1st magnitude Aldebaran on the 3rd. This will make the Hyades star cluster in Taurus look a little strange (see Sky View). On the 15th, Venus passes within 0.3° of the famous supernova remnant known as M1 (the Crab Nebula). On the 22nd, just 45 minutes before sunrise, Venus will be 6° north of the thin crescent Moon, with Mars only a few degrees above the horizon (see Sky View).

MARS rises about one hour before the Sun and is visible in the morning twilight, low in the eastern sky.

JUPITER is occulted by the 20 day old waning gibbous Moon on the 15th (see Sky View), the event is only visible from New Zealand to Antarctica. From Australia, we will see Jupiter and the Moon close together in the late evening sky (on the 14th). The distance decreases throughout the night, and just prior to the beginning of astronomical twilight (on the 15th) the pair will be very close. From Adelaide and Brisbane the distance of Jupiter from the lunar limb will be about 0.2°, from Melbourne and Sydney 0.1°, from Hobart it will be extremely close at 0.04°, and from Darwin about 0.5°. Jupiter appears stationary on the 19th and thereafter begins its westerly motion across the sky. continuing until November. It then returns to its west-to-east track (see discussion on retrograde motion on page 68).

SATURN can be seen in the early morning sky in Pisces. Half-way through the month the planet moves into Cetus where it meanders until early September. The first quarter Moon appears nearby Saturn on two consecutive days, on the 17th, 7° away and on the 18th, 8° (see Sky View).

NEPTUNE is at opposition on the 24th, and is visible the entire night.

MINOR PLANETS at opposition this month include: 7 Iris on 10th at magnitude 8.7 in Sagittarius and 43 Ariadne on 20th at magnitude 9.3 in Sagittarius.

COMETS

Hale-Bopp: Comet Hale-Bopp will move slowly through Carina this month, remaining near Canopus. It will fade from magnitude 9.3 to 9.6, and observations will be best suited to the morning hours.

Meunier-Dupouy: Located in Pegasus, this 11th magnitude comet will rise around 11pm at the beginning of the month, while by month's end it will be rising around 8pm.

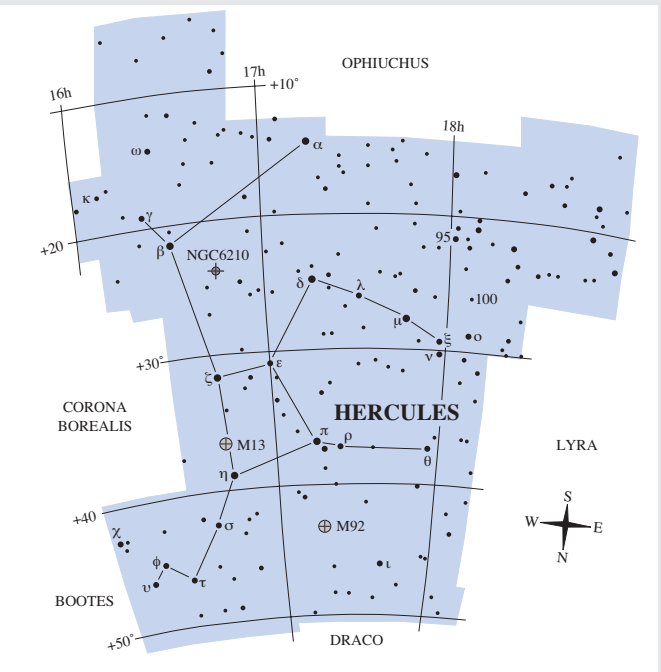
Howell: Beginning the month near Theta Virginis, Comet Howell will be setting around 1am. During the month, as it brightens from magnitude 11.8 to 11.3, the comet will pass near Spica. By month's end it will be setting around midnight.

CONSTELLATION of the MONTH — HERCULES (Her)

It is in the constellation of Hercules that this legendary hero and superman of Greek mythology is immortalised. The great grandson of Perseus (the famous hero who rescued Andromeda from the sea monster), Hercules had a reputation for performing impossible tasks and enormous feats of strength. Hercules is typically shown kneeling with one foot on the head of the dragon, Draco. whom he slew in his eleventh labour. In area, it is the fifth largest of the constellations and is high in the northern sky late in the month at 9pm. Interestingly, for southern observers. Hercules appears the right way up (unlike Orion) and it is relatively easy to trace the kneeling figure out. Some northern observers see and identify the constellation shape as that of a butterfly.

One of the most celebrated objects in the northern sky. the Great Globular Star Cluster M13 (NGC6205), resides in Hercules. This showpiece is one of the finest globulars in the sky, and although low in the north for southern observers, we still obtain a reasonable view. The cluster is located between Eta and Zeta Herculis, and can be seen by the unaided eye under dark skies. Small telescopes can resolve stars in this very rich compressed cluster and larger scopes reveal three dark lanes that apparently are areas of fewer stars. From a subjective viewpoint the globular clusters 47 Tucanae and Omega Centauri are probably the best examples of this class of object and both are about twice the diameter of M13. Even M22 in Sagittarius, and NGC6752 in Pavo would give MI3 a run for their money (a bit of southern bias here). Another globular in Hercules, bearing a Messier number, is worth a look, M92 or NGC6341. It is located about nine degrees northeast of M13 (even lower in the sky). It is smaller than M13, but almost as bright and easily resolved into stars in medium instruments.

Hercules contains a few scattered galaxies that are of no real interest. There are also the very distant and consequently very faint galaxy clusters known as Abell 2151 and Abell 2199. The planetary nebula known as NGC6210 is an easier target for small telescopes and is located about four degrees north east of Beta Herculis. The nebula appears bluish and bright, slightly oval (about 16 by 20 arc seconds in size), with a 12th magnitude central star.



The constellation contains some fine binary stars suitable for all apertures, the stars listed below are relatively easy in small telescopes.

Alpha Herculis, a nice bright pair, orange and white, separation 4.7". magnitude 3.2 and 5.4.

Rho Herculis, a fine pair of white stars, sep 4.1" magnitude 4.6 and 5.6.

95 Herculis, very nice, yellow and deep yellow, sep 6.3" mag. 5.0 and 5.1.

100 Herculis, attractive equal white pair, sep 14.2" mag 5.9 and 6.0.

JULY

METEOR SHOWERS

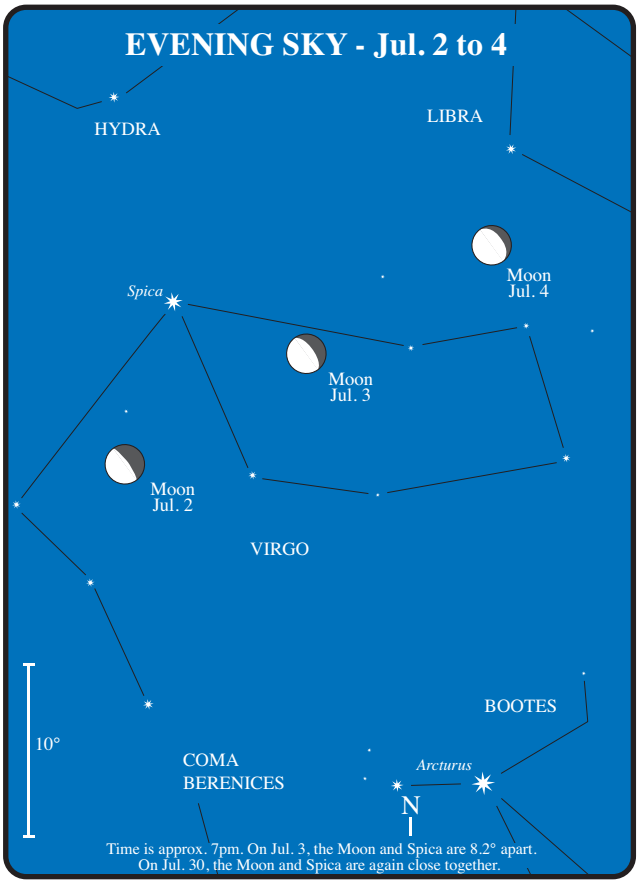
The **Piscis Austrinids** are visible from the 15th July to 10th August. The shower generally provides 1 or 2 meteors per hour and on occasion 3 or 4. The zenith hourly rate (ZHR) increases to 8 or 10 meteors on the 28th of this month: however this can vary from as little as 5 to as many as 15 per hour. Visible from about 8pm to the beginning of morning twilight the Piscis Austrinids are generally blue, white or yellow in colour, with some leaving trains.

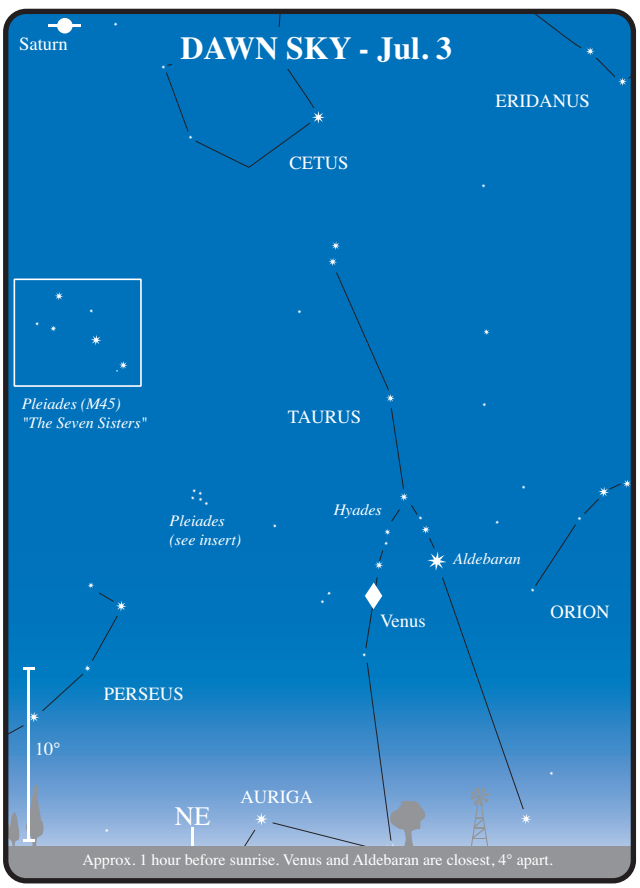
The **Southern delta-Aquarids** are one of the strongest and most consistent of the southern showers, visible late evening until dawn. The range of activity of these medium speed meteors extends from 12th July through to 19th August, with maximum this month on the 28th, with a ZHR of 20. The delta Aquarids are generally faint (bright meteors are the exception), typically white with some blue members, and occasionally leaving trains.

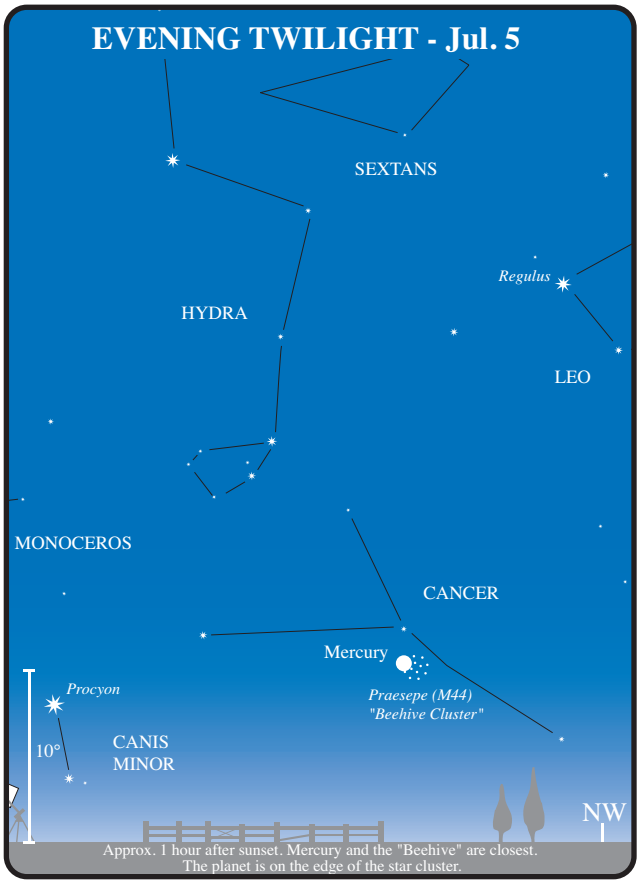
The **alpha-Capricornids** are noted for their bright, slow meteors with long paths and frequent fireballs. The shower is visible late evening until dawn, from 3rd July through to 15th August. Maximum activity occurs this month on the 30th, when a ZHR of 4 can be expected. Low hourly rates over the period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

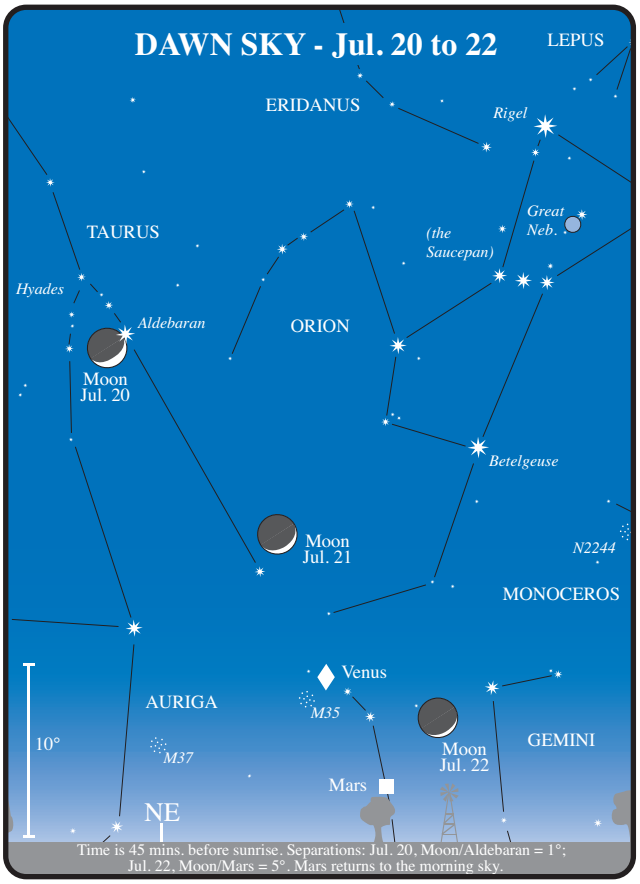
DIARY OF EVENTS

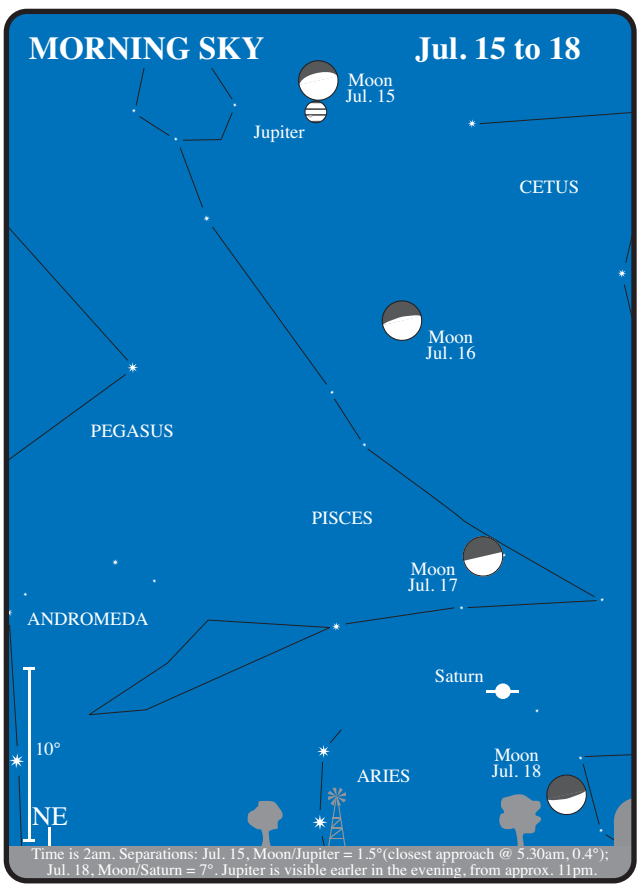
2nd	4:43 AM	First quarter Moon.
3rd	3 AM	Moon at apogee.
3rd	3 PM	Venus 4°N of Aldebaran.
4th	10 AM	Earth at aphelion.
5th		Mercury 0.5°W of the Beehive Cluster in Cancer.
10th		m.p. 230 Athamantis 0.1°W of NGC 3166 (SG) in Sextans.
10th		m.p. 44 Nysa 0.3°N of NGC 488 (SG) in Pisces.
10th	2:01 AM	Full Moon.
11th	4 AM	Neptune 2°S of the Moon.
11th	11 PM	Uranus 3°S of the Moon.
12th		Comet Hale-Bopp 1.7°NE of Canopus.
13th		Mercury at descending node.
15th		Venus 0.3°N of M1 (Nebula) in Taurus.
15th	5 AM	Jupiter 1.0°N of the Moon; Occn.
16th	Midnight	Moon at perigee.
17th	1:13 AM	Last quarter Moon.
17th	1 PM	Mercury greatest elongation E. (27°).
17th	3 PM	Saturn 2°N of the Moon.
19th		m.p. 30 Urania 0.1°E of NGC 3423 (SG) in Sextans.
19th	4 AM	Jupiter stationary.
19th	9 AM	Ceres 1.1°S of the Moon; Occn.
20th		Venus 0.5°S of NGC 2129 (OC) in Gemini.
20th	7 AM	Aldebaran 0.3°S of the Moon; Occn.
21st	10 PM	Venus 4°N of the Moon.
22nd	1 PM	Mars 5°N of the Moon.
23rd		m.p. 3 Juno 0.5°SW of M61 (SG) in Virgo.
23rd		Mercury at aphelion.
23rd	11:44 PM	New Moon.
24th	6 AM	Neptune at opposition.
25th	Midnight	Mercury 2°S of the Moon.
26th		Mercury 4°SW of Regulus.
26th	7 AM	Regulus 0.7°N of the Moon; Occn.
26th	11 PM	Pallas stationary.
27th		Venus 1°N of m.p. 4 Vesta.
30th		m.p. 3 Juno 0.3°SW of NGC 4457 (SG) in Virgo.
30th		Saturn 0.7°S of NGC 821 (EG) in Aries.
30th	3 PM	Mercury stationary.
30th	10 PM	Moon at apogee.
31st	10:05 PM	First quarter Moon.

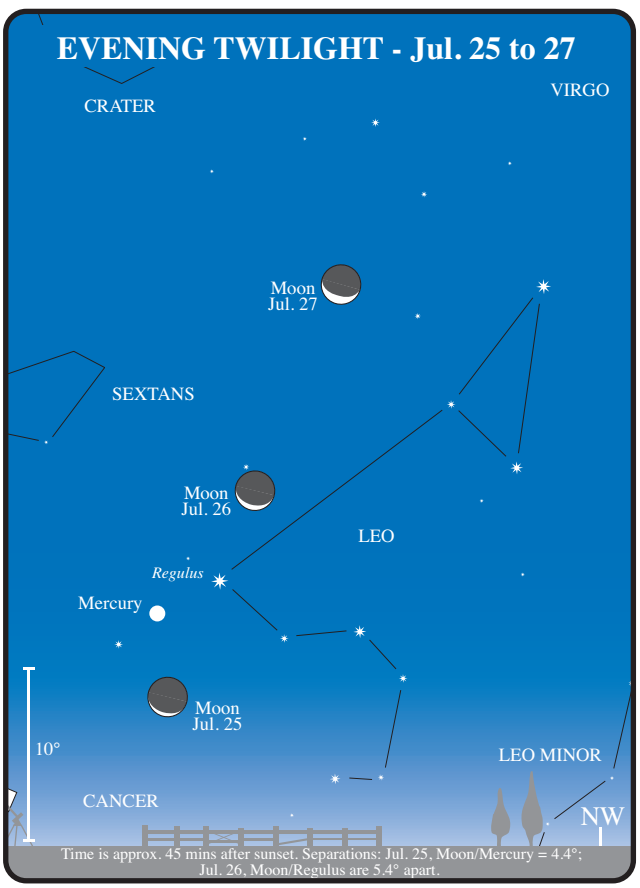





EVENING TWILIGHT - Jul. 5
SEXTANS
Regulus
HYDRA
LEO
MONOCEROS
CANCER
Mercury
Procyon
Praesepe (M44)
"Beehive Cluster"
10°
CANIS
MINOR
NW
Approx. 1 hour after sunset. Mercury and the "Beehive" are closest.
The planet is on the edge of the star cluster.

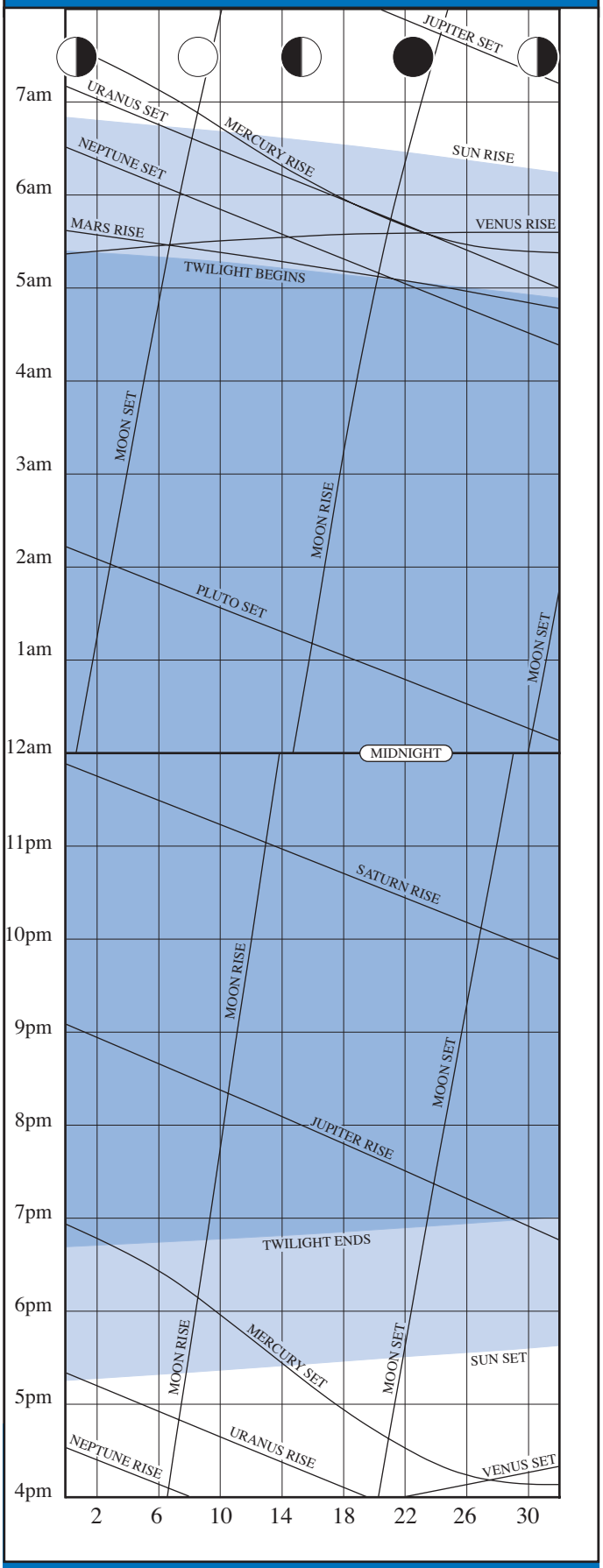

DAWN SKY - Jul. 20 to 22
LEPUS
ERIDANUS
Rigel
TAURUS
Great
Neb.
(the
Saucepan)
Hyades
Aldebaran
ORION
Moon
Jul. 20
Betelgeuse
Moon
Jul. 21
N2244
MONOCEROS
Venus
AURIGA
M35
M37
10°
Moon
Jul. 22
GEMINI
Mars
NE
Time is 45 mins. before sunrise. Separations: Jul. 20, Moon/Aldebaran = 1°;
Jul. 22, Moon/Mars = 5°. Mars returns to the morning sky.


MORNING SKY
Jul. 15 to 18
Moon
Jul. 15
Jupiter
CETUS
Moon
Jul. 16
PEGASUS
PISCES
Moon
Jul. 17
ANDROMEDA
Saturn
10°
ARIES
Moon
Jul. 18
NE
Time is 2am. Separations: Jul. 15, Moon/Jupiter = 1.5°(closest approach @ 5.30am, 0.4°);
Jul. 18, Moon/Saturn = 7°. Jupiter is visible earler in the evening, from approx. 11pm.


EVENING TWILIGHT - Jul. 25 to 27
CRATER
VIRGO
Moon
Jul. 27
SEXTANS
Moon
Jul. 26
LEO
Regulus
Mercury
Moon
Jul. 25
10°
LEO MINOR
CANCER
NW
Time is approx. 45 mins after sunset. Separations: Jul. 25, Moon/Mercury = 4.4°;
Jul. 26, Moon/Regulus are 5.4° apart.

AUGUST

RISE/SET CHART



All times are AEST.

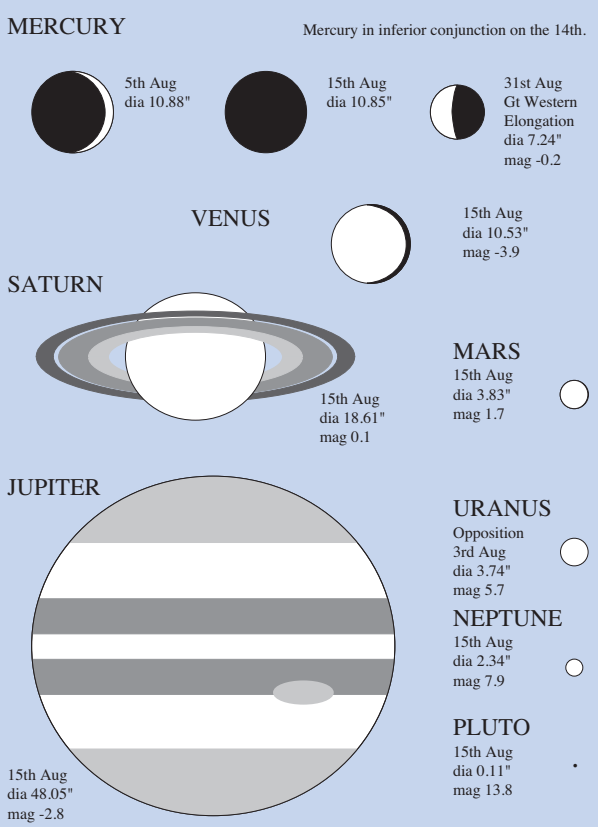
AUGUST HIGHLIGHTS

- Partial eclipse of the Sun for Australia on 22nd.
- Mercury moves from the evening to the morning sky.
- Venus and Mars are close together in the dawn sky on 5th.
- Mars in the morning sky, rising around start of dawn.
- Jupiter prominent in the late evening sky, rising around 8pm.
- Saturn returns to the evening sky, rising around 11pm.

THE MOON

8th	Full Moon
8th	Penumbral eclipse of the Moon. This eclipse is not visible from Australia, or for that matter anywhere else in the world as only a very small fraction of the Moon is immersed in the Earth's penumbral shadow.
11th	Moon at perigee (closest to Earth - 365,020 km distant, angular size 32.7 arc minutes).
11th	Occultation of Jupiter by the Moon. Not visible from Australia, see Jupiter section (next page).
15th	Last Quarter
16th	Occultation of Aldebaran by the Moon. Visible only from Africa, Asia and Japan. From Australia, the closest approach is about 4° (see Sky View).
22nd	New Moon
22nd	Annular eclipse of the Sun. Visible from Sumatra, Borneo and the Pacific Ocean. Partial phases visible from Australia. See eclipse section in Part II.
27th	Moon at apogee (furthest from Earth - 400,175 km distant, angular size 29.9 are minutes).
30th	First Quarter

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is visible in Leo early in the month in the western twilight sky (see Sky View for 4th). It then rapidly loses altitude as it moves toward the Sun and inferior conjunction (between the Earth and the Sun) on the 14th. Reappearing in the morning twilight sky, Mercury reaches its greatest elongation (18°) west of the Sun on the 31st. This is not a good elongation and the planet will be only a little better in the morning skies from mid-December. Mercury and Venus appear 3° apart in the last week of August, rising in the morning twilight only 45 minutes before the Sun.

VENUS. August will be the last month to view Venus in the morning sky as the planet moves toward the Sun and superior conjunction in October. Venus and Mars are close companions in the first week of the month, their closest approach being on the 5th (see Sky View).

MARS rises in the morning sky, rising around the start of dawn (about 1.5 hours before the Sun).

JUPITER is occulted by the 18 day old Moon on the 11th, the event is not visible from Australia. On the 11th the Moon appears about 7° from Jupiter in the eastern evening sky, and 9° on the 12th. Jupiter is only one month from opposition and now presents a large 48 arc second diameter disc for observers.

SATURN appears stationary on the 17th and thereafter begins its western motion across the sky, this retrograde motion continues until the end of December. It then returns to its west-to-east track (see discussion on retrograde motion and the Saturn finder chart in Part II). On the 14th, Saturn will be approximately 3° from the 21 day old Moon (see Sky View).

URANUS is at opposition on the 3rd and is visible the entire night.

PLUTO is high in the early evening sky, setting around 1am.

MINOR PLANETS 29 Amphitrite is at opposition on 2nd at magnitude 9.3 in Capricornus.

COMETS

Hale-Bopp: Carina once again hosts Hale-Bopp during August, as the comet fades from magnitude 9.6 to 9.8. By month's end, the comet will once again be circumpolar for many observers, though morning observations will be favoured.

Meunier-Dupouy: This 11th magnitude comet begins the month in Pegasus, rising around 8pm. In late August, it will pass near M15 before ending the month in Equuleus, at which time it will be setting around 4:30am.

CONSTELLATION OF THE MONTH — AQUILA (Aql)

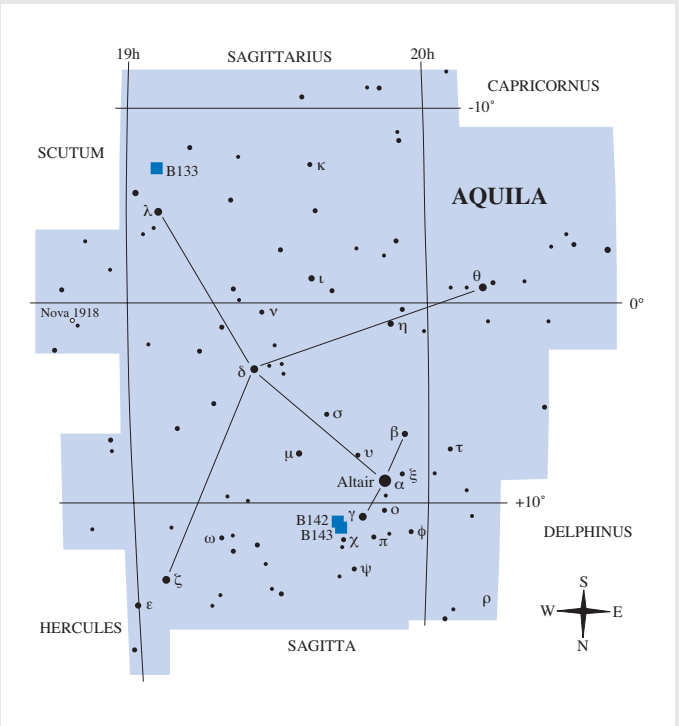
Aquila, The Eagle, has been identified as a bird for thousands of years by many cultures. but not always as an eagle. In Roman mythology, Aquila is said to be the eagle that was sent by Jupiter to return Ganymede to Mount Olympus to be the cup bearer for the gods. Interestingly the Australian aborigines Eagle was the star Sirius. To these Aussie natives, the constellation Aquila depicted one of their mythical people "Totyarguil". who was killed by a fish while bathing. Aquila is high in the sky at 9pm late in the month. It sits on the equator in the northern sky, with the Milky Way running through it. The constellation is readily identifiable by its brightest star, Altair (its Arabic name meaning "the flying eagle"), which at 0.77 magnitude is the 12th brightest star in the night sky.

At a distance of 16 light years, Altair is one of the closest bright stars, and is noted for its very high rotational period of 6.5 hours (compared with about 25 days for our own Sun). The rapid rotation, which was detected by astronomers studying the star's spectrum, has been estimated to distort the star so much that its equatorial diameter is twice that of the polar diameter.

Another of Aquila's stars known as Van Biesbroeck's Star, also has an unusual claim to fame. It is a companion to a 9th magnitude star that lies 19 light years from us. Van Biesbroeck's Star has the lowest measured luminosity known for any star. If it replaced the Sun it would appear not much brighter than a full moon!

For binocular users, under a dark sky, the Milky Way area from Cygnus low in the north up through Aquila, Sagittarius and Scorpius, and onto Crux is stunning. Huge dark clouds of interstellar dust obscure and divide our galaxy throughout this entire region, and they are very prominent in Aquila. The best known example of dark nebulae, and most familiar with southern observers, is the "Coal Sack" in Crux. In Aquila, there is a smaller (around one degree in area) dark nebula known as B 143 (from Barnard's catalogue of dark nebulae, published in 1919). There is another close to the south called B142. Both B143 and B142 are visible to the unaided eye, but for greatest effect they are best viewed in binoculars (or a rich field telescope). Located just north of Gamma Aquilae, they have the appearance of a shapeless dark area with three "fingers" extending into the star field. Situated two degrees south of Lambda Aquilae is another prominent dark nebulae known as B133. Its 10 x 3 are minute size is best viewed with a small telescope.

About 1,300 years ago a star in Aquila went nova, by the time the light from this outburst reached the Earth it was the 8th June 1918. Nova



Aquilae 1918, reaching magnitude -1.4 (almost as bright as Sirius) and was the brightest nova since Kepler's Nova in 1604AD (-2.5 magnitude). For a brief period, the star's actual luminosity was over 400,000 times that of our own Sun! For a few years astronomers could detect an expanding shell of material ejected from the star, just like a typical planetary nebula. Today, Nova Aquilae 1918 has returned to its pre outburst magnitude of around 2.

While the constellation is certainly not a gold mine of objects for small telescopes, there are some good binary stars that may be of interest; Struve 2404 is a fine example. For owners of 20 cm telescopes and larger there are ten planetary nebulae that may be interesting with a few challenges.

AUGUST

Giacobini-Zinner: Evening observers will find this comet in Hercules, setting after midnight. Brightening from magnitude 13.3 to 12.2, the comet will end the month near Beta Herculis, at which time it will be setting before 11pm.

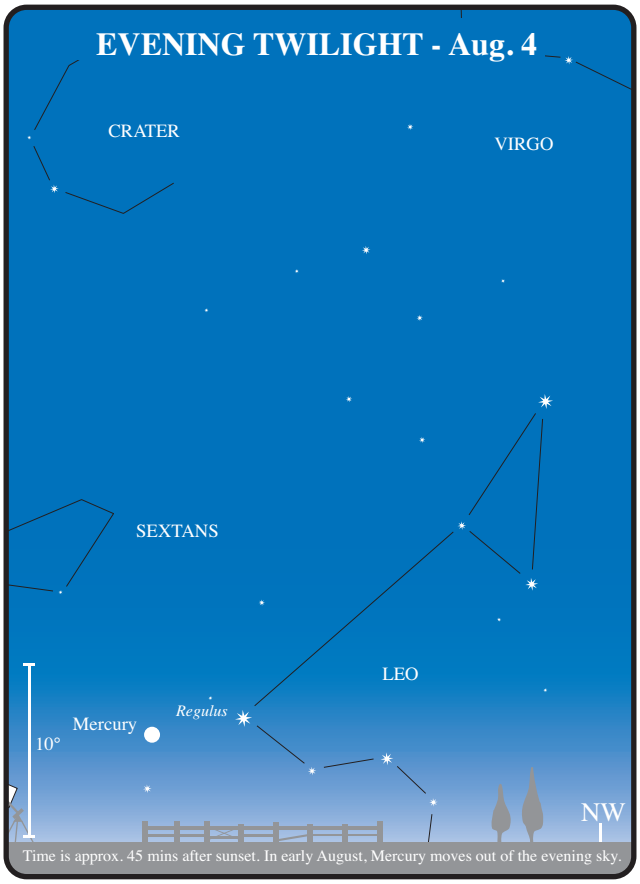
Howell: Brightening from magnitude 11.3 to 11.0, Howell will begin the month in Virgo, setting around midnight. By month's end the comet will have moved into Libra, setting around 11:30pm.

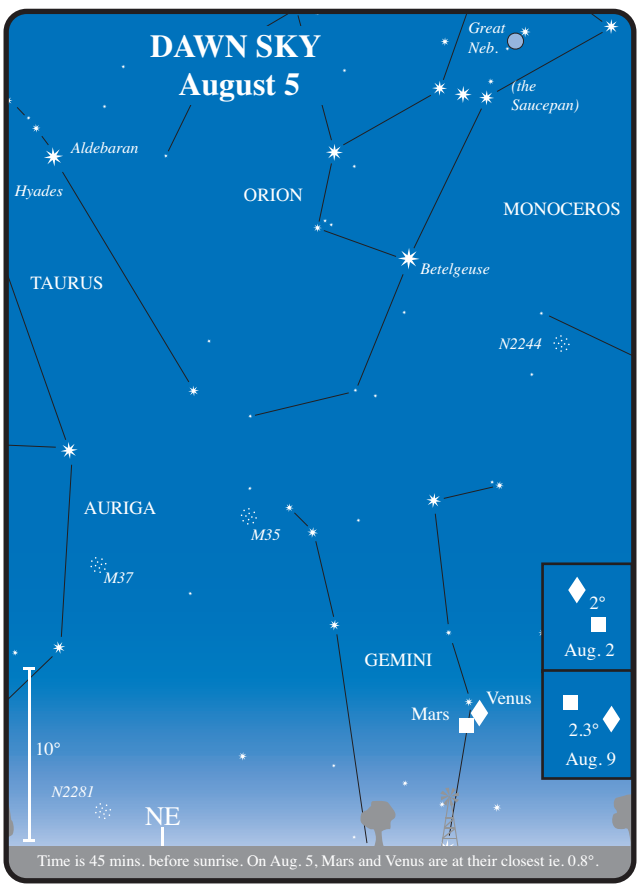
METEOR SHOWERS

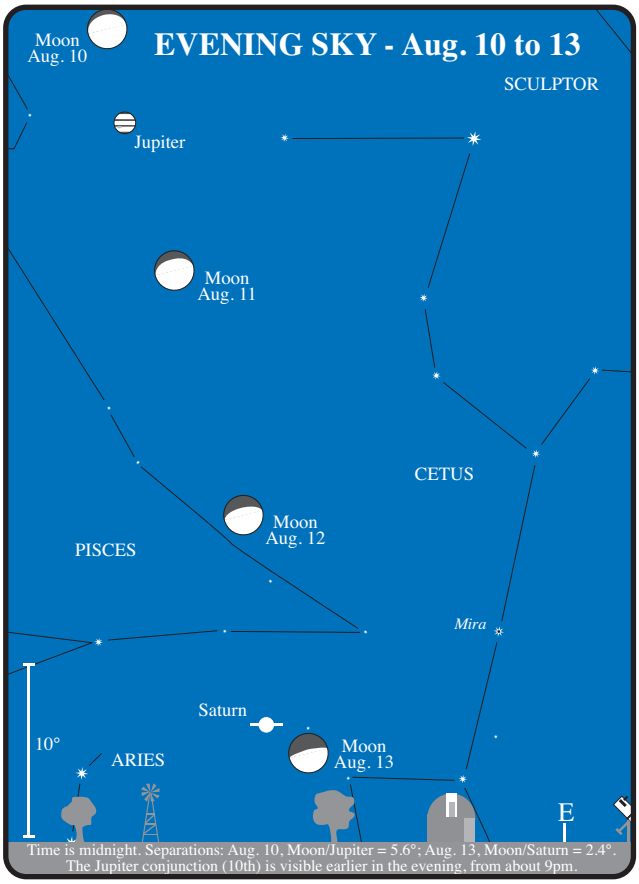
The Northern iota-Aquarids are active from 11th through to the 31st August, with maximum activity on 20th. The hourly rate is 3, and the shower is visible from late evening in the eastern sky until dawn in the west.

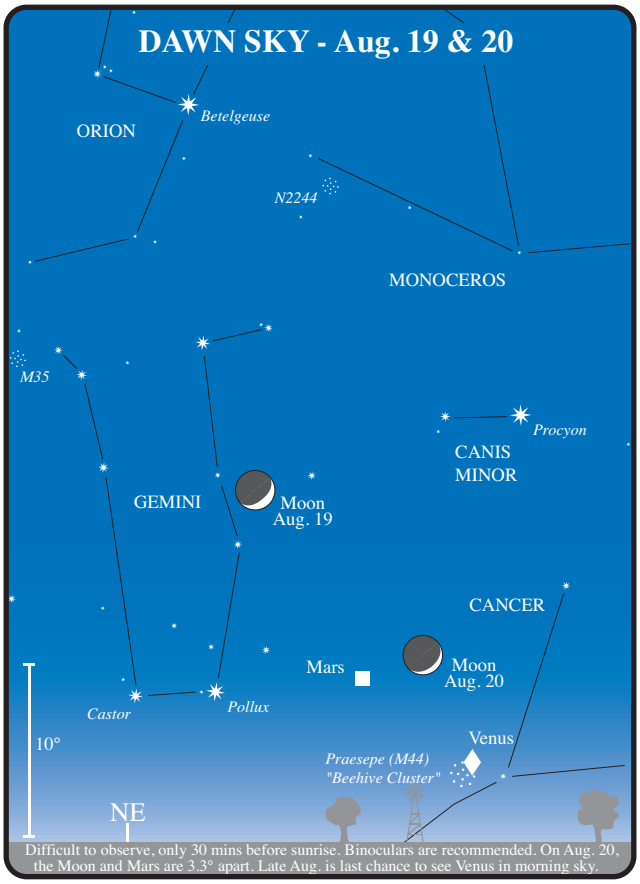
DIARY OF EVENTS

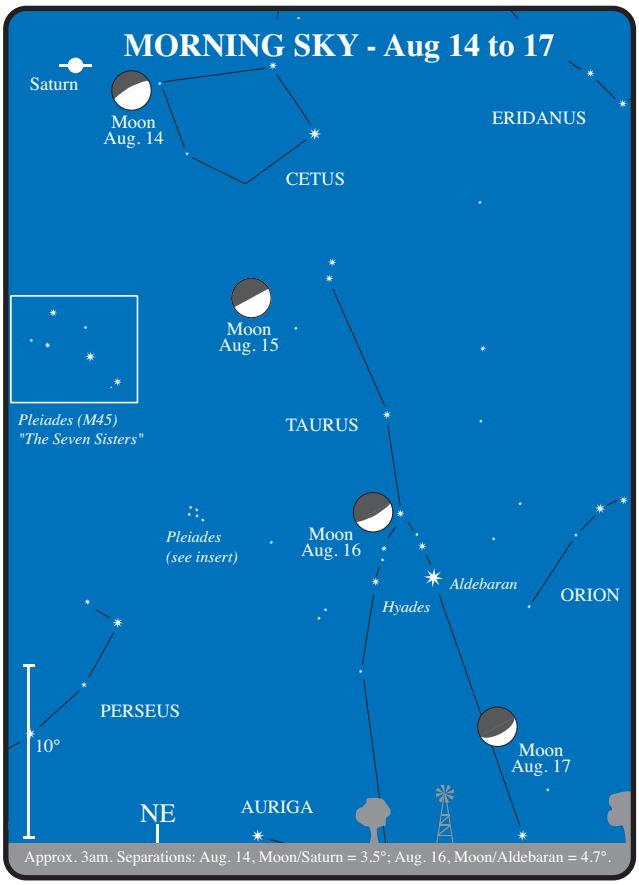
3rd	5 PM	Uranus at opposition.
4th		Venus at ascending node.
5th		m.p. 3 Juno 0.1°N of NGC 4527 (SG) in Virgo.
5th	1 PM	Venus 0.8°S of Mars.
6th		m.p. 52 Europa 1.1°S of Aldebaran.
7th		m.p. 30 Urania 0.5°SW of NGC 3640 (EG) in Leo.
7th	11 AM	Neptune 2°S of the Moon.
8th	5 AM	Uranus 3°S of the Moon.
8th	12:10 PM	Full Moon; Penumbral Eclipse.
9th	4 AM	Venus 7°S of Pollux.
10th		Mars 0.8°N of NGC 2420 (OC) in Gemini.
11th		m.p. 230 Athamantis 0.9°S of NGC 3521 (SG) in Leo.
11th	10 AM	Jupiter 0.9°N of the Moon; Occn.
11th	10 PM	Moon at perigee.
12th	7 AM	Mars 6°S of Pollux.
13th		m.p. 3 Juno 0.1°SW of NGC 4643 (SG) in Virgo.
13th		Mercury at greatest latitude S (heliocentric).
13th	10 PM	Saturn 2°N of the Moon.
14th	10 AM	Mercury in inferior conjunction.
15th	5:48 AM	Last quarter Moon.
16th	5 AM	Ceres 0.9°S of the Moon; Occn.
16th	1 PM	Aldebaran 0.2°S of the Moon; Occn.
17th	2 AM	Saturn stationary.
19th	5 AM	Pluto stationary.
20th		Comet Meunier-Dupouy 1°E of M15 (GC) in Pegasus.
20th	6 AM	Mars 4°N of the Moon.
20th	Midnight	Venus 3°N of the Moon.
21st		m.p. 16 Psyche 0.2°N of m.p. 32 Pomona.
22nd	12:03 PM	New Moon; eclipse.
23rd	3 PM	Mercury stationary.
25th		m.p. 4 Vesta 0.2°NE of NGC 2392 (Eskimo Nebula) in Gemini.
26th	9 AM	Mercury 3°S of Venus.
27th	4 PM	Moon at apogee .
29th		m.p. 29 Amphitrite 0.2°S of Comet Giacobini-Zinner.
30th		m.p. 4 Vesta 0.8°S of NGC 2420 (OC) in Gemini.
30th		m.p. 6 Hebe 0.4°NE of Zeta Ophiuchi.
30th	3:06 PM	First quarter Moon.
31st	7 PM	Mercury greatest elongation W.(18°).

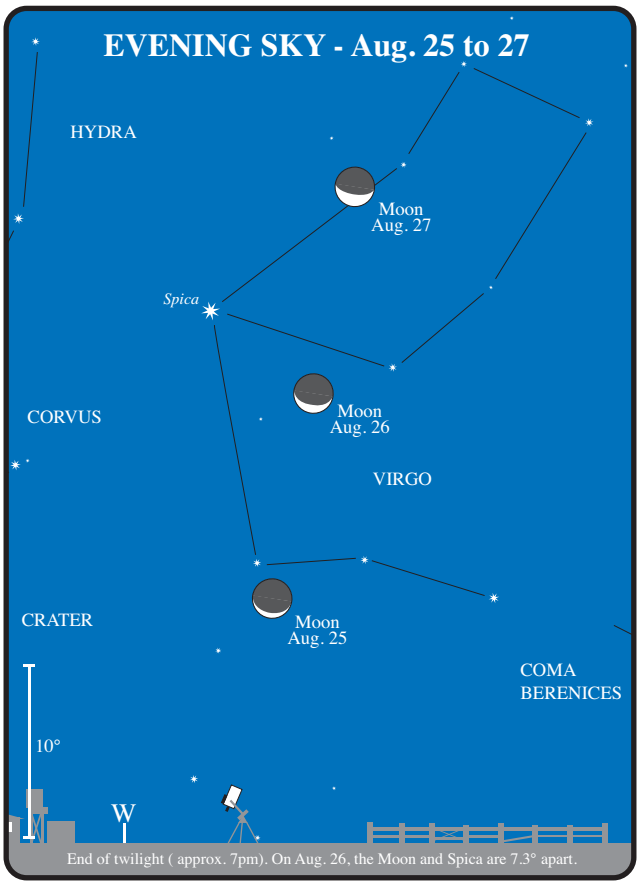





EVENING SKY - Aug. 10 to 13
Moon Aug. 10
SCULPTOR
Jupiter
Moon Aug. 11
CETUS
Moon Aug. 12
PISCES
Mira
Saturn
10°
ARIES
Moon Aug. 13
E
Time is midnight. Separations: Aug. 10, Moon/Jupiter = 5.6°; Aug. 13, Moon/Saturn = 2.4°. The Jupiter conjunction (10th) is visible earlier in the evening, from about 9pm.

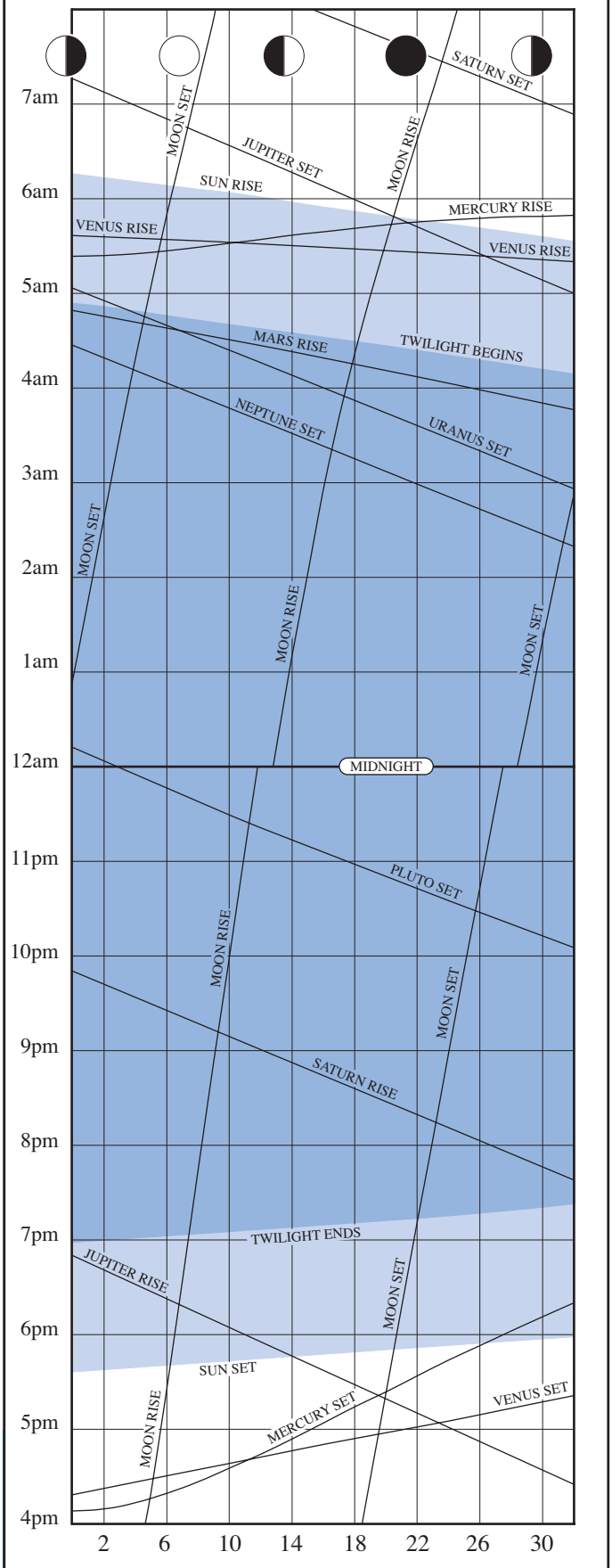

DAWN SKY - Aug. 19 & 20
Betelgeuse
ORION
N2244
MONOCEROS
M35
Procyon
CANIS MINOR
GEMINI
Moon Aug. 19
CANCER
Mars
Moon Aug. 20
Castor
Pollux
10°
Venus
Praesepe (M44) "Beehive Cluster"
NE
Difficult to observe, only 30 mins before sunrise. Binoculars are recommended. On Aug. 20, the Moon and Mars are 3.3° apart. Late Aug. is last chance to see Venus in morning sky.


MORNING SKY - Aug 14 to 17
Saturn
Moon Aug. 14
ERIDANUS
CETUS
Moon Aug. 15
Pleiades (M45) "The Seven Sisters"
TAURUS
Pleiades (see insert)
Moon Aug. 16
Aldebaran
Hyades
ORION
PERSEUS
10°
Moon Aug. 17
NE
AURIGA
Approx. 3am. Separations: Aug. 14, Moon/Saturn = 3.5°; Aug. 16, Moon/Aldebaran = 4.7°.


EVENING SKY - Aug. 25 to 27
HYDRA
Moon Aug. 27
Spica
Moon Aug. 26
CORVUS
VIRGO
Moon Aug. 25
CRATER
COMA BERENICES
10°
W
End of twilight (approx. 7pm). On Aug. 26, the Moon and Spica are 7.3° apart.

SEPTEMBER

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

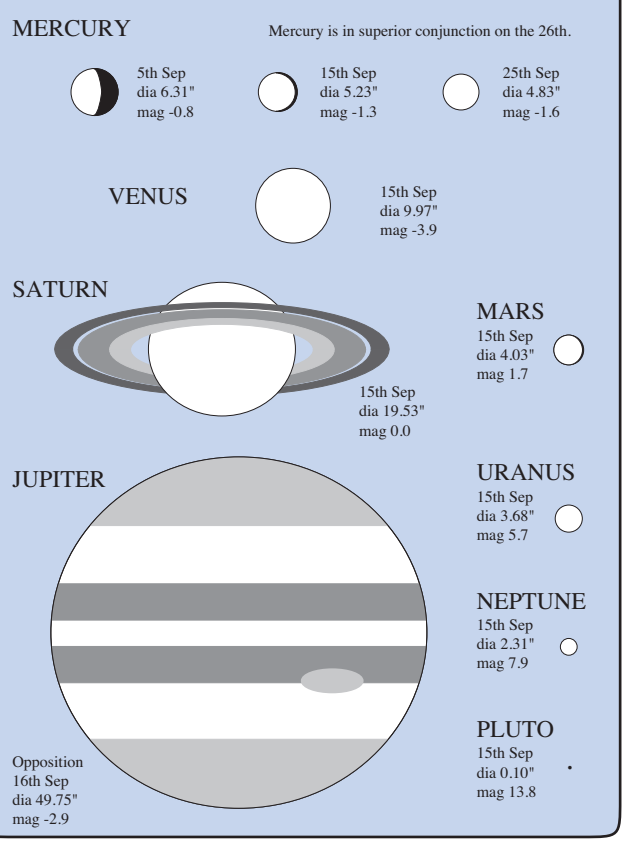
SEPTEMBER HIGHLIGHTS

- Mercury and Venus are close to the Sun. They may be glimpsed in the late dawn sky early in September.
- Mars rises just before dawn in the eastern morning sky.
- Mars on 1st, is close to the Beehive cluster.
- Jupiter is at opposition and visible the whole night.
- Saturn, rising around 9pm, is visible in the late evening sky.

THE MOON

6th	Full Moon
6th	Penumbral eclipse of the Moon. Visible from Australia, refer to eclipse section in Part II.
7th	Occultation of Jupiter by the Moon. Only visible from South America and parts of Africa, the closest approach from Australia is about 5° (see Sky View).
8th	Moon at perigee (closest to Earth - 365,620 km distant, angular size 32.7 arc minutes).
12th	Occultation of Aldebaran by the Moon. Not visible from Australia, but the Moon appears near Aldebaran on the 12th and 13th (see Sky View).
13th	Last Quarter
18th	Occultation of Regulus by the Moon. Not visible from Australia, see Sky View for the Australian appearance in the dawn sky.
21st	New Moon
24th	Moon at apogee (furthest from Earth - 405,710 km distant, angular size 29.4 arc minutes).
29th	First Quarter

APPEARANCE of the PLANETS



THE PLANETS

MERCURY reached its greatest elongation (18°) west of the Sun last month on the 31st. This is not a good elongation and the planet will present a little better view in the morning skies from mid-December, when it will be further from the Sun. On the 11th, Mercury and Venus will be less than 0.5° apart, with the pair rising only 30 minutes before the Sun. Mercury is at superior conjunction on the 26th (opposite side of the Sun to the Earth), and thereafter moves into the evening twilight sky. It is best to wait until the end of October and November to look at Mercury in the evening sky.

VENUS now rises just prior to the Sun in the morning twilight. The planet is at superior conjunction next month and will remain unobservable until its reappearance in the evening sky at the end of 1998.

MARS now rises just prior to the beginning of astronomical twilight in the eastern morning sky. On the 1st and 2nd the planet will be on the edge of the Beehive Cluster (M44 in Cancer). Unfortunately the brightening dawn sky spoils this view (Mercury also paid M44 an earlier visit this year - see July). On two consecutive mornings the crescent Moon will be seen near the planet, on the 17th, 7.5° away and on the 18th closer at 5° (see Sky View). In the second half of the month, Mars moves from Cancer into Leo where it slowly approaches 1st magnitude Regulus (Alpha Leonis). At the end of September, the pair will be 4° apart.

JUPITER is at opposition this month on the 16th, and is visible the entire night. Although Jupiter is good at any time of the year in small telescopes, this is a good time to observe this gas giant while the planet presents a large disc (almost 50 arc seconds across the equator). Jupiter will be seen about 11° below the penumbrally eclipsed Moon on the 6th in the evening sky. On the following evening, the planet will be about 5° below the Moon (see Sky View).

SATURN, in Cetus, moves into Pisces mid-month where it will remain for the rest of the year. On the 9th, Saturn will be 4° below the 18 day old Moon (see Sky View). Saturn is moving towards opposition next month and can be best seen late in the evening sky.

URANUS & NEPTUNE are both now well past their oppositions and set in the early morning sky.

PLUTO, setting around 11pm, is best observed in the early evening.

MINOR PLANETS 2 Pallas is at opposition on 16th at magnitude 8.3 in Pisces.

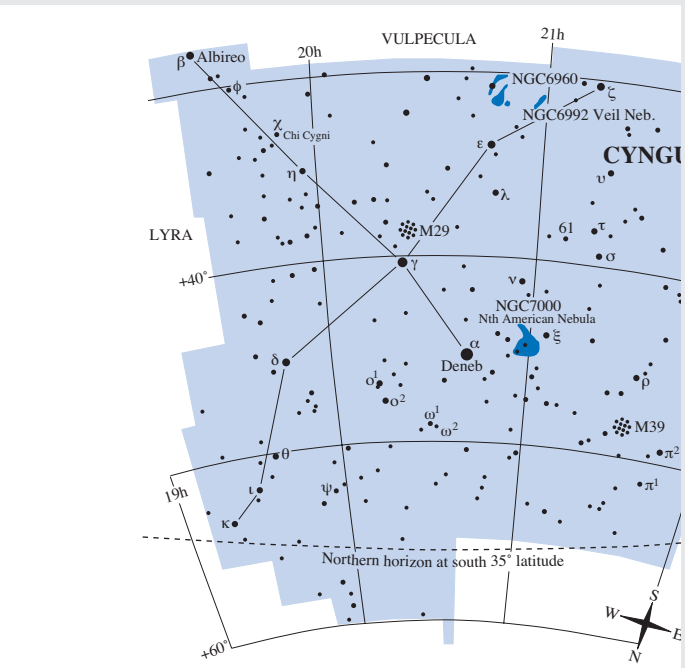
CONSTELLATION OF THE MONTH — CYGNUS (Cyg)

Cygnus, The Swan, is a large and ancient constellation that represents a swan flying along the Milky Way. Cygnus culminates low in the northern sky at 9pm mid month and can be seen in its entirety from Brisbane and further north. The further south you go the less you see, although from mid latitudes (-35°). only a small portion is lost over the horizon. Visible from all of Australia it is also known as "The Northern Cross". This large cross has more meaning north of the equator than down here. At Christmas time, in the northern hemisphere, the starry cross can be seen standing over the northwestern horizon in the evening sky. Another pattern, again better known in the northern hemisphere, is the Summer Triangle (a bit out of season down under in September!). The triangle is formed from three bright stars in different constellations. They are: Deneb (magnitude 1.25. in Cygnus), Vega (magnitude 0.03, in Lyra), and Altair (magnitude 0.77, in Aquila).

Situated directly in a region of Milky Way known as "The Cygnus Star Cloud", the constellation is a virtual treasure trove of binary and variable stars, open star clusters, planetary nebulae, and nebulosity. The dark dust clouds known as the Great Rift (or the Northern Coalsack), begin at Cygnus and effectively split the Milky Way into two streams. These "clouds" obscure large sections of our galaxy all the way down to Centaurus. This region is a "must" for binocular users under dark skies.

The Cygnus area is bathed in nebulosity and two of the best known are visible in binoculars, assuming good dark skies. The North American Nebula (NGC7000, about 3° east of Deneb) has a shape which looks extraordinarily similar to its terrestrial counterpart, including the Gulf of Mexico. As the nebula is about two degrees across, binoculars are best. but small telescopes at low magnification do quite well. More difficult to observe is the Great Cygnus Loop (NGC6960 & NGC6992), between Epsilon Cygni and the Vulpecula border. This is a vast expanding cloud like bubble, the remains of a supernova. The bright portion known as the Veil Nebula (NGC6992), is visible in binoculars, but the full beauty seen in photographs requires a very large amateur telescope equipped with a nebula filter. The authors were fortunate to see this nebula in a pair of 20 inch Dobsonian binoculars from the northern hemisphere in 1995. The view, at an altitude of 2100m, was breathtaking as we slowly moved the telescope through the region, allowing the fine delicate filament-like structure to unfold before us. The cover photograph of this publication shows a section of the Veil.

There are a number of open clusters within the constellation, most require medium sized telescopes to see them at their best. The two that bear Messier numbers are rather sparse, but with a number of bright stars they appear good in small instruments, M29 (NGC6913) is located near Gamma Cygni. and M39 (NGC7092) is below and east of Deneb (which could be too low for some southern observers).



Considered by many to be one of the finest binary stars in the sky is Albireo (Beta Cygni). This is a real gem in small telescopes and set in a good field. The stars have good colour contrast and appear yellow and blue. Their magnitudes are 3.1 and 5.1 and the separation is a wide 34 are seconds. Another double is 61 Cygni. These are two red dwarf stars with magnitudes of 5.2 & 6.0, separated by 30 are seconds. 61 Cygni was the first star to have its parallax measured (in 1838), from these measures the star was found to be close by at only 11 light years (the 15th closest star to our solar system). From its motion it is thought that the brighter of the two stars has at least one body (about 8 times the mass of Jupiter) in orbit.

Chi Cygni is a Mira type variable star (the most common type), which varies from 14.2 magnitude at minimum, to about 4.5 at maximum (it has at times reached 3.5 mag). This red star, which varies in brightness with a period of 408 days, will reach maxima in the last week of October this year. Why not try to follow its rise? Binoculars are all that is needed. Chi Cygni is the second brightest of the Mira variables. The most famous is Mira the constellation of Cetus (see also Astronomy 1996 - December constellation of the month).

SEPTEMBER

COMETS

Hale-Bopp: Observers will find 10th magnitude Hale-Bopp in Carina during September, as the comet continues its trek among the southern stars. It is best viewed in the late morning sky.

Meunier-Dupouy: Beginning the month in Equuleus and setting around 4:30am, 11th magnitude Meunier-Dupouy will move into Aquarius by month's end. At that time it will have faded to magnitude 11.5 and will be setting after 2:30am.

Giacobini-Zinner: Brightening from 12th to 11th magnitude during September, the comet will initially be found in Hercules, setting before 11pm. By month's end, it will have crossed the border into Ophiuchus and will be setting after 10pm.

Howell: Reaching its peak brightness of 11th magnitude during September, Comet Howell begins the month in Libra, setting around 11:30pm. During the month, it moves into Scorpius, passing near Antares and M4.

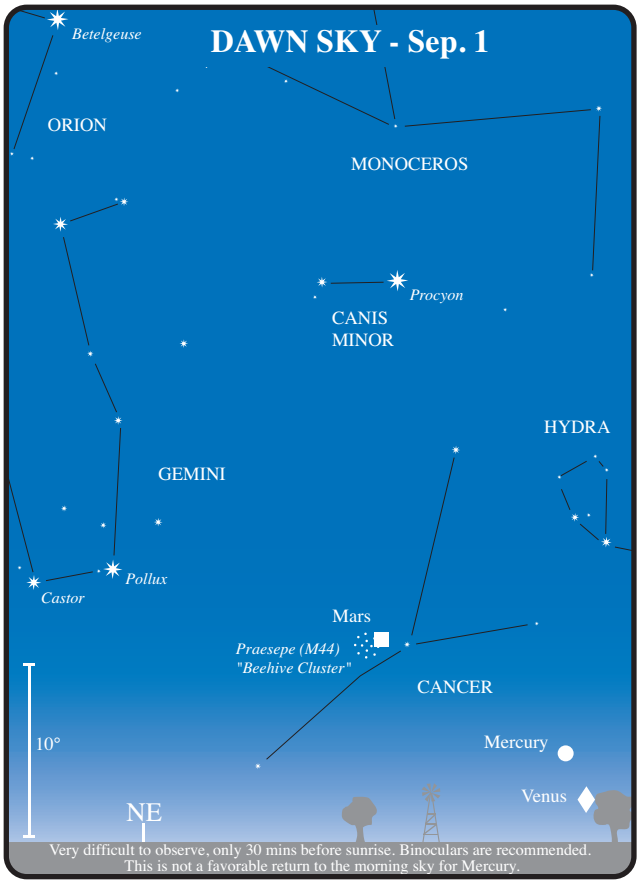
Lovas 1: Rising around 1am during the month, this comet will initially be found in Perseus near the California Nebula at magnitude 13.8. During the month, it crosses into Auriga, brightening to magnitude 13.3.

METEOR SHOWER

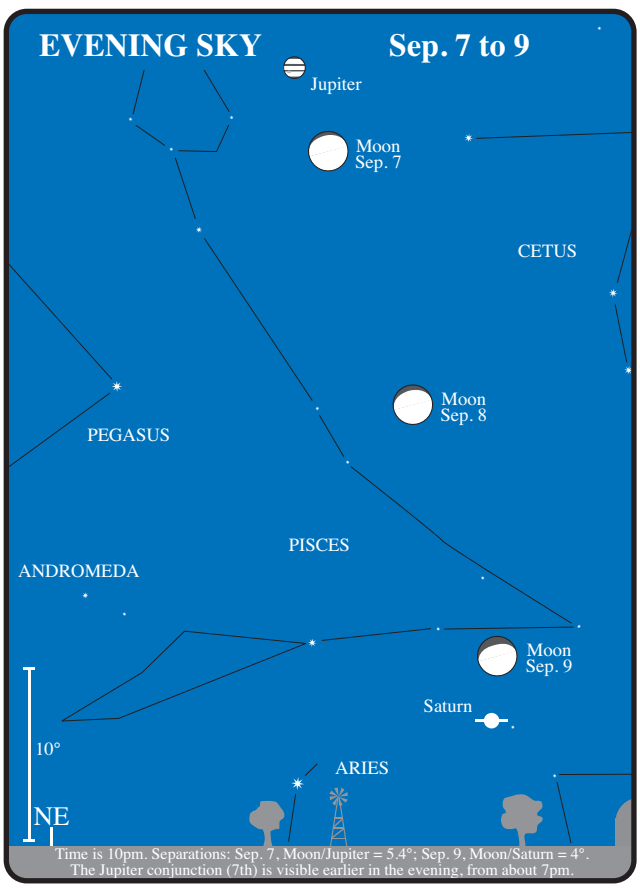
The **Piscids** are a minor shower that little is known about. They are active from 1st to 30th September, with a zenith hourly rate of three. The date of maximum (if there is one) is thought to be on the 20th.

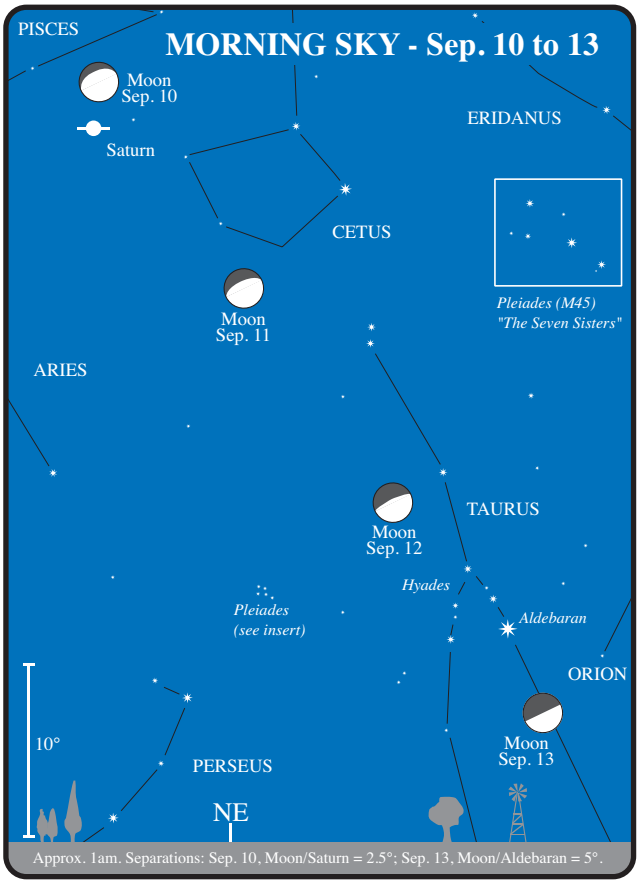
DIARY OF EVENTS

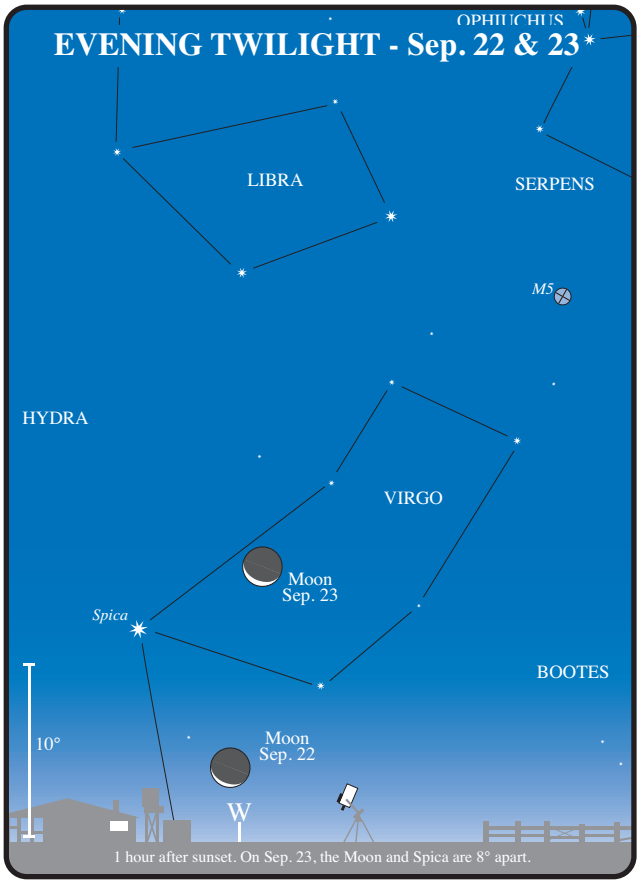
1st		Mars 0.5°S of Beehive Cluster (M44) in Cancer.
1st		Mercury at ascending node.
3rd	8 PM	Neptune 2°S of the Moon.
4th	1 PM	Uranus 3°S of the Moon.
5th		m.p. 1 Ceres 0.7°S of Aldebaran.
5th		Mercury at perihelion.
6th		m.p. 52 Europa 1°S of NGC 1817 (OC) in Taurus.
6th	8 PM	Venus 0.8°N of Regulus.
6th	9:21 PM	Full Moon; Penumbral Eclipse.
7th		Venus at perihelion.
7th	2 PM	Jupiter 0.5°N of the Moon; Occn.
8th		m.p. 18 Melpomene 1.2°NE of Eta Ophiuchi.
8th	5 AM	Mercury 0.8°N of Regulus.
8th	4 PM	Moon at perigee.
10th	4 AM	Saturn 2°N of the Moon.
11th		m.p. 14 Irene 0.4°SW of NGC 337 (SG) in Cetus.
11th	10 AM	Mercury 0.4°N of Venus.
12th	6 PM	Aldebaran 0.3°S of the Moon; Occn.
12th	9 PM	Ceres 0.9°S of the Moon; Occn.
13th	11:58 AM	Last quarter Moon.
16th		Mercury at greatest latitude N (heliocentric).
16th	1 PM	Jupiter at opposition.
16th	3 PM	Pallas at opposition.
17th		m.p. 44 Nysa 0.4°SE of NGC 676 (SG) in Pisces.
17th	10 PM	Mars 2°N of the Moon.
18th	9 PM	Regulus 0.6°N of the Moon; Occn.
21st	3:01 AM	New Moon.
23rd	4 PM	Equinox.
24th		Jupiter 1°E of m.p. 2 Pallas.
24th	8 AM	Moon at apogee.
26th	6 AM	Mercury in superior conjunction.
29th		Venus at greatest latitude N (heliocentric).
29th	7:11 AM	First quarter Moon.



All times are AEST. For daylight saving add 1 hour.







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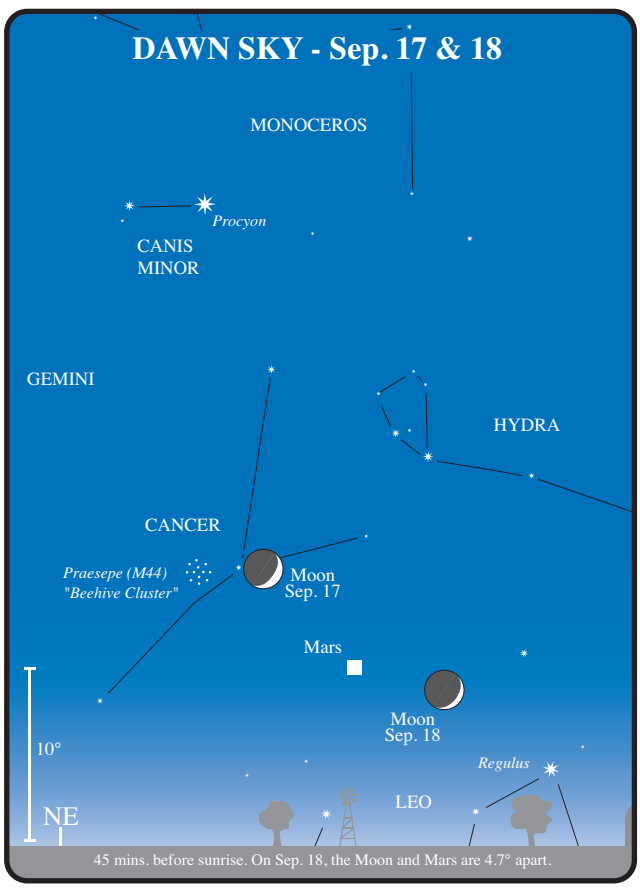
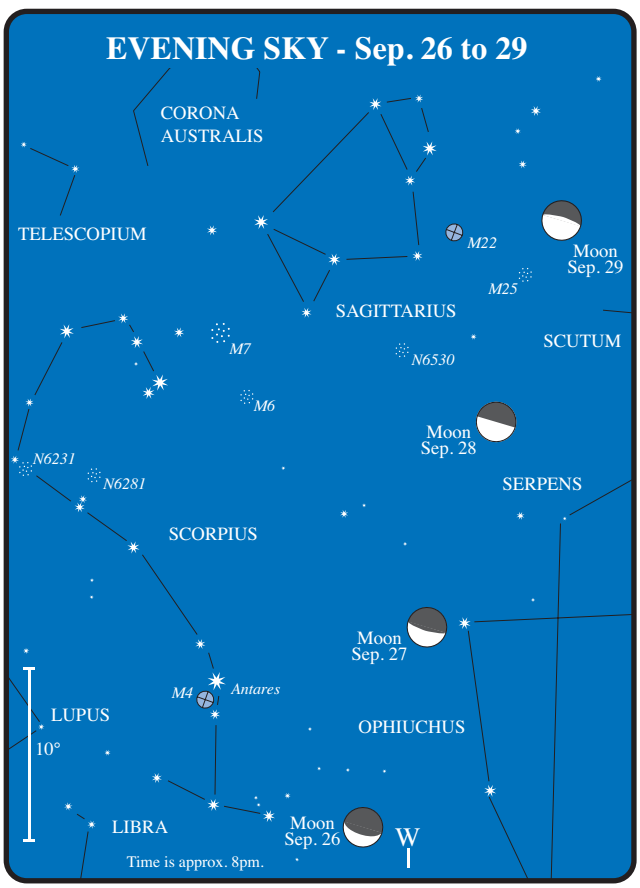
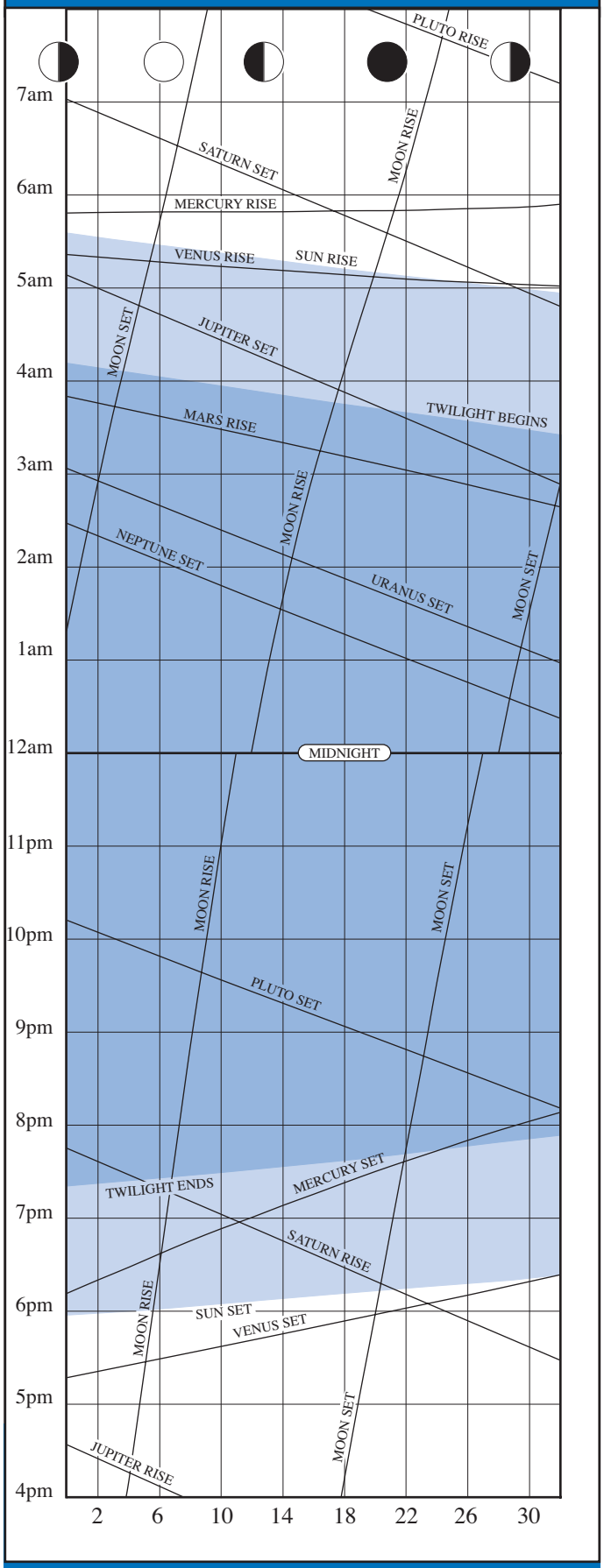




OCTOBER

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

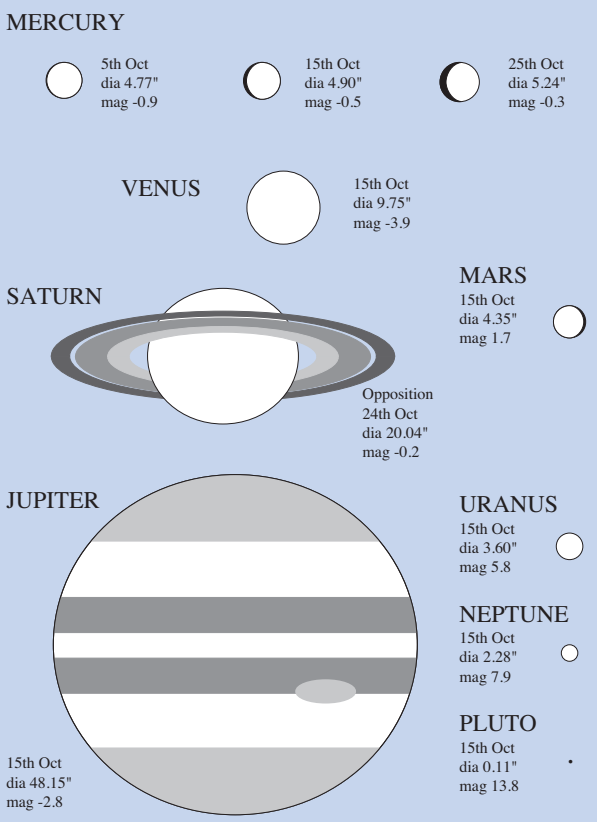
OCTOBER HIGHLIGHTS

- Daylight occultation of Jupiter on 4th.
- Mercury reappears in the western evening twilight sky in the latter half of October.
- Venus is not visible - too close to Sun.
- Mars rises just before the start of dawn.
- Jupiter is still visible most of the night, setting around the start of dawn.
- Saturn is at opposition, at its brightest, visible all night

THE MOON

4th	Occultation of Jupiter by the Moon. Daytime event visible from New Zealand and most of Australia (see Jupiter Notes).
6th	Full Moon
6th	Moon at perigee (closest to Earth - 353,050 km distant, angular size 33.8 arc minutes).
10th	Occultation of Aldebaran by the Moon. Visible from Japan, China and parts of America, the closest approach from Australia is about 1° (see Sky View).
12th	Last Quarter
16th	Occultation of Regulus by the Moon. Not visible from Australia, see Sky View for the down under view on 16th.
16th	Occultation of Mars by the Moon. Only visible from Antarctica, see Sky View on 16th for the Australian view.
20th	New Moon
21st	Moon at apogee (furthest from Earth - 402,120 km distant, angular size 29.7 arc minutes).
28th	First Quarter

APPEARANCE of the PLANETS



THE PLANETS

MERCURY after superior conjunction at the end of last month, returns to the evening twilight sky. Moving from Virgo into Libra mid-month, the planet will be best seen toward the later part of the month. On the 22nd, the 2 day old thin crescent Moon will be 7° from the planet (see Sky View).

VENUS is at superior conjunction (opposite side of the Sun from the Earth) on the 30th and remains unobservable until it reappears in the evening twilight sky in late December.

MARS, in the pre-dawn eastern morning sky, begins the month 4° from 1st magnitude Regulus (Alpha Leonis). The two get closer until they are only 0.9° apart on 7th (see Sky View). This distance increases to 5° by the 16th, when the 25 day old crescent Moon will be seen between the two (see Sky View). Mars passes about 2° from two well known galaxies, M95 and M96 in Leo, on the 22nd.

JUPITER. The 13 day old (almost Full) Moon appears below Jupiter in the early eastern evening sky on the 4th (see Sky View). With the exception of a western portion of our continent, a daylight occultation can be seen in the late afternoon (a similar event occurred in May). Just like Venus, Jupiter can be seen with the unaided eye in broad daylight, you just need to know where to look! It can be a challenge to see Jupiter in daylight and binoculars can be a big help. The reappearance of the planet will be easier to see because it happens in twilight after sunset. The times listed below, for various locations, are only approximations and one should begin looking well in advance. A good low eastern horizon is essential as the Moon will be just above the horizon when Jupiter disappears. Times of the event are:

Adelaide	Jupiter disappears (D) at 5:07pm (Moon altitude 6°) and reappears (R) at 6.01pm
Brisbane	(D) 5:38pm (alt 19°), (R) 6:40pm.
Hobart	(D) 5:51pm (alt 15°), (R) 6:31pm.
Melbourne	(D) 5:41pm (alt 12°), (R) 6:34pm.
Sydney	(D) 5:39pm (alt 17°), (R) 6:39pm.

The event is not seen in Darwin, with Jupiter just missing the lunar limb at moonrise (5:25pm). Perth also misses out on the event, with the occultation happening before the Moon and Jupiter rise.

SATURN is at opposition on the 24th, rising in the east as the Sun sets, and visible the entire night. It is an ideal time to observe this beautiful planet. Not only is it at its brightest (-0.2 magnitude) and largest angular diameter (20 arc seconds), but its rings are near their maximum opening for the year. The Moon can be seen near the planet on two consecutive evenings, on the 6th about 9° above, and on the 7th, 5.4° below (see Sky View).

URANUS & NEPTUNE both having been in retrograde motion since May, return to their west-to-east path across the sky.

MINOR PLANETS at opposition this month include: 14 Irene on 4th at magnitude 10.6 in Cetus, 20 Massalia on 25th at magnitude 8.9 in Aries and 44 Nysa on 17th at magnitude 9.8 on Cetus/Pisces border.

COMETS

Hale-Bopp: October sees this 10th magnitude circumpolar comet move from Carina into Volans, passing near Delta Volantis by month's end. The best views are in the morning sky.

Meunier-Dupouy: Located in Aquarius for the entire month, the magnitude 11.5 comet will initially be setting around 2:30am. By month's end, having passed near NGC 7009 (the Saturn nebula), it will have faded to magnitude 12.1 and can be found near M72 and M73, setting around 1am.

Giacobini-Zinner: Beginning the month in Ophiuchus, where it is 11th magnitude and setting after 10pm, the comet moves through Serpens Cauda. It ends the month in Aquila where it is setting around 10:30 pm and has brightened to magnitude 9.3.

Howell: Observers will find 11th magnitude Comet Howell initially in Scorpius near M19, setting around 11:30pm. It fades to magnitude 11.5 as it moves into Sagittarius, where it ends the month near Phi Sagittarii.

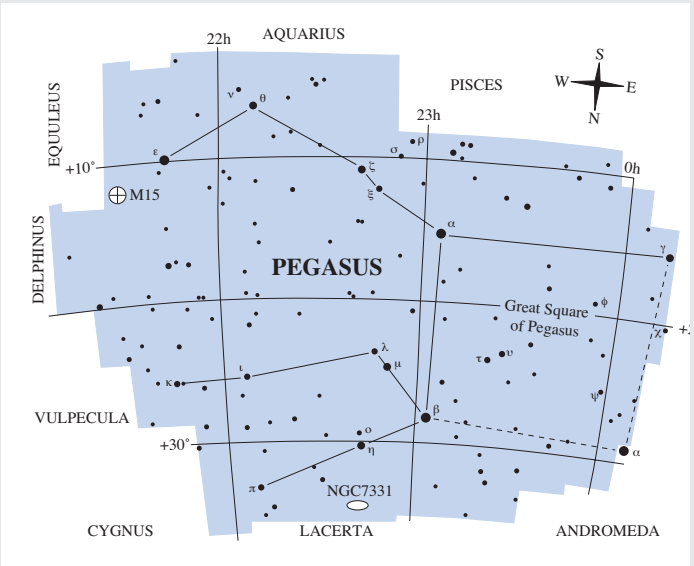
Lovas 1: Auriga hosts this 13th magnitude comet during October, which initially can be found rising before lam. During the month, the comet passes a few degrees south of Beta Aurigae, and ends the month rising after midnight.

CONSTELLATION OF THE MONTH — PEGASUS (Peg)).

Pegasus, the winged horse from classical mythology, is quite distinctive, high in the northern evening sky, mid month. The outline of a winged horse is difficult to picture, even from the northern hemisphere. The 'Great Square of Pegasus' is the body of the horse. and the easiest way to identify the constellation. The Great Square is formed by three stars of Pegasus and one in Andromeda (Alpha, Beta, and Gamma Pegasi, plus Alpha Andromedae). The square is large and unmistakable, its sides varying in length from about 13 to 17 degrees. Alpha Andromedae was formerly associated with Pegasus, but now marks the head of the chained maiden, Andromeda.

There are well over one hundred fine double and multiple stars in the constellation, many of which are ideally suited to small apertures. Charles Messier observed only one of the deep sky treasures of Pegasus, the only globular in the constellation, M15. It is a very rich and tightly compacted globular in a good field. Small telescopes will have trouble resolving individual stars, but the view is still grand. It was discovered in 1975 that M15 was a strong X-ray emitter, leading astronomers to speculate on the existence of black holes at the centre of some of these globulars.

Many galaxies reside in Pegasus, including the famed Stephan's Quintet, a cluster of five galaxies. The members of the group appear to be interacting with faint tidal streamers, which are visible in photographs. An enigma of Stephan's Quintet is that not all the galaxies share the same red shift, as would be expected of galaxies in the same neighbourhood. To view Stephan's Quintet, a large amateur telescope is required and even then only three or four may be detected.



If you wish to picture how our own Milky Way galaxy would appear from intergalactic space, NGC7331 is worth checking out. It is one of Pegasus' brighter deep sky objects and is a good example of a spiral galaxy of similar form and size to our own. This deep sky splendour appears tilted, about twenty degrees from being edge-on.

OCTOBER

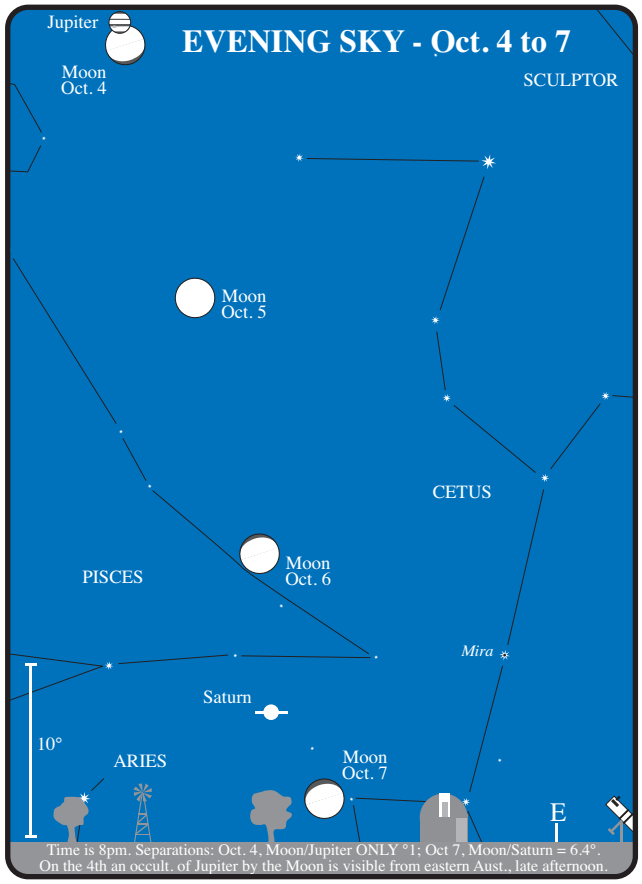
METEOR SHOWERS

The **epsilon-Geminids** are a weak minor shower that is active from 14th to 27th October with maximum on the 18th. A low hourly rate of 2 can be expected. As this shower is near the Orionids, which 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. There are many sub-maxima and good rates have been seen between 20th to 24th October (in 1993, high rates were recorded on the 17th and 18th, 4 days before the predicted peak). The Orionids provide a prominent display that generally reach an intensity of 25 meteors per hour. They are typically very swift, bright and sometimes leave trains. The shower was first recorded by Chinese observers in 288 AD, and is associated with Halley's Comet.

DIARY OF EVENTS

1st		m.p. 6 Hebe 1.3°NE of Eta Ophiuchi.
1st	5 AM	Neptune 2°S of the Moon.
1st	10 PM	Uranus 3°S of the Moon.
4th	5 PM	Pallas 1.0°S of the Moon; Occn.
4th	7 PM	Jupiter 0.2°N of the Moon; Occn.
6th		Comet Giacobini-Zinner 0.8°NE of NGC 6384 (SG) in Ophiuchus.
6th	6:12 AM	Full Moon.
6th	11 PM	Moon at perigee.
7th	2 AM	Mars 0.9°N of Regulus.
7th	11 AM	Saturn 1.8°N of the Moon.
8th		m.p. 4 Vesta 1.4°S of Beehive cluster (OC) in Cancer.
9th		Mercury at descending node.
10th		m.p. 2 Pallas 0.5°E of NGC 7606 (SG) in Aquarius.
10th	2 AM	Aldebaran 0.4°S of the Moon; Occn.
10th	8 AM	Ceres 0.9°S of the Moon; Occn.
11th	3 AM	Ceres stationary.
11th	9 PM	Neptune stationary.
12th		m.p. 18 Melpomene 1.2°NE of M23 (OC) in Sagittarius.
12th	9:11 PM	Last quarter Moon.
15th		m.p. 4 Vesta 0.8°S of NGC 2672 (EG) in Cancer.
16th	3 AM	Regulus 0.5°N of the Moon; Occn.
16th	2 PM	Mars 1.0°N of the Moon; Occn.
19th		Mercury at aphelion.
19th	11 AM	Uranus stationary.
20th		m.p. 18 Melpomene 0.6°N of NGC 6567 (PN) in Sagittarius.
20th	8:09 PM	New Moon.
21st	3 PM	Moon at apogee.
22nd		m.p. 18 Melpomene 0.3°SW of M24 (OC) in Sagittarius.
22nd	4 AM	Mercury 7°S of the Moon.
24th	5 AM	Saturn at opposition.
26th		Comet Meunier-Dupouy 1.3°W of NGC 7009 (Saturn Nebula) in Aquarius.
27th		Mercury 1°NE of NGC 5897 (GC) in Libra.
28th	11 AM	Juno in conjunction with the Sun.
28th	1 PM	Neptune 2°S of the Moon.
28th	9:46 PM	First quarter Moon.
29th		m.p. 6 Hebe 1.7°N of M23 (OC) in Sagittarius.
29th	6 AM	Uranus 2°S of the Moon.
30th		m.p. 18 Melpomene 0.3°NE of M25 (OC) in Sagittarius.
30th	2 PM	Venus in superior conjunction .



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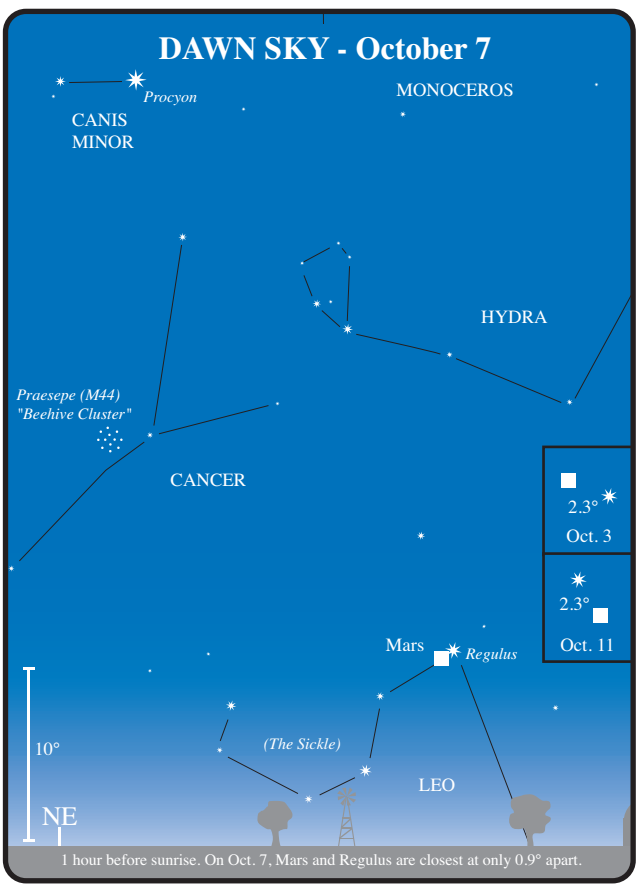
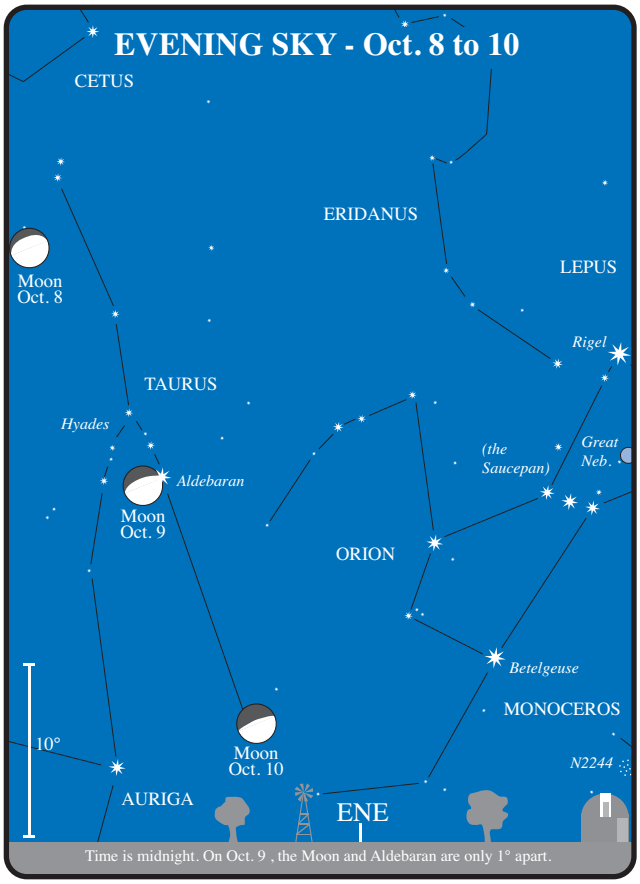
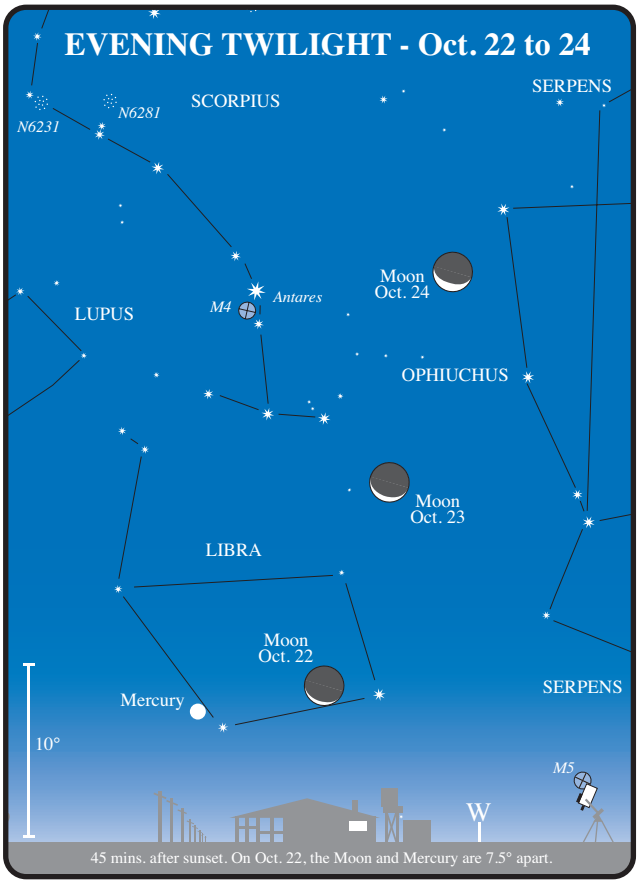


OCTOBER





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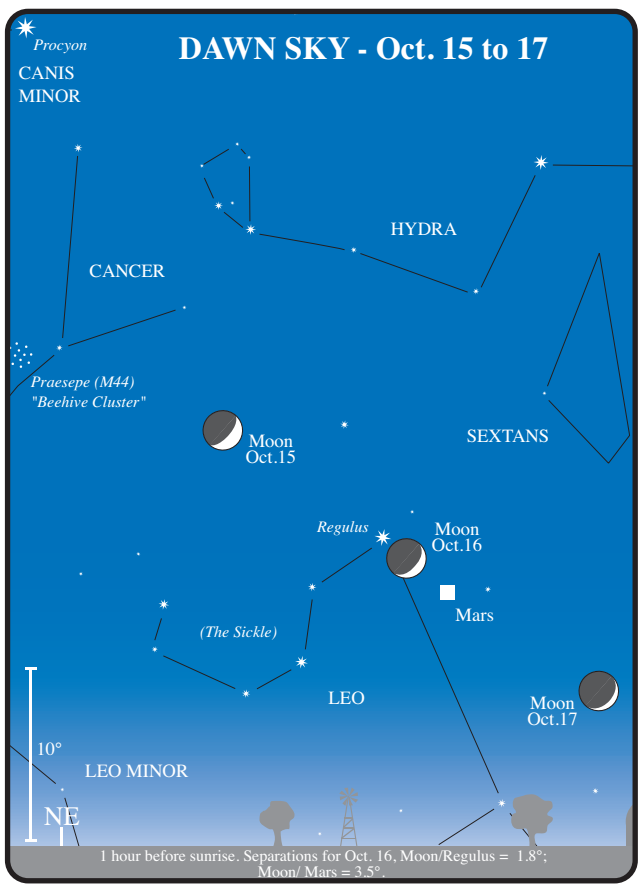
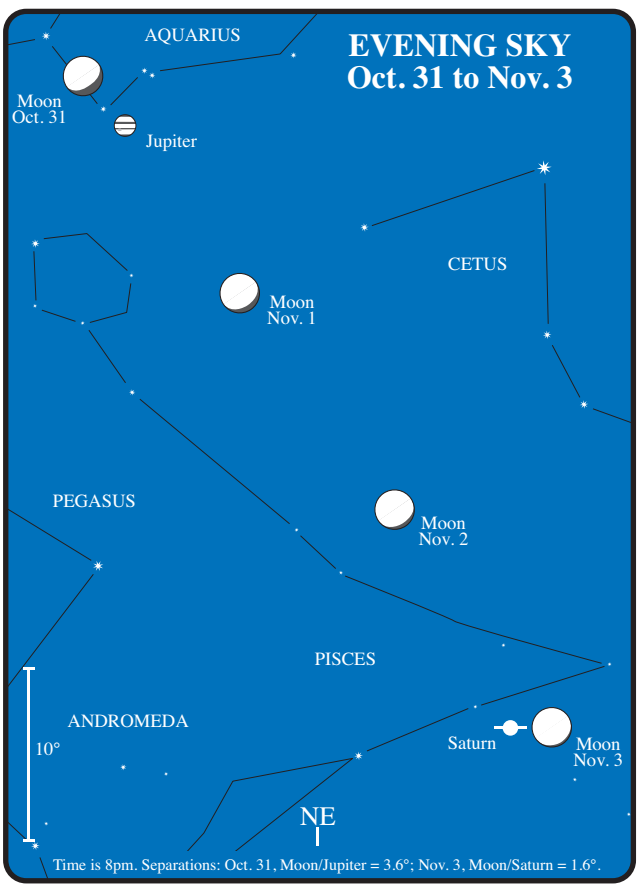
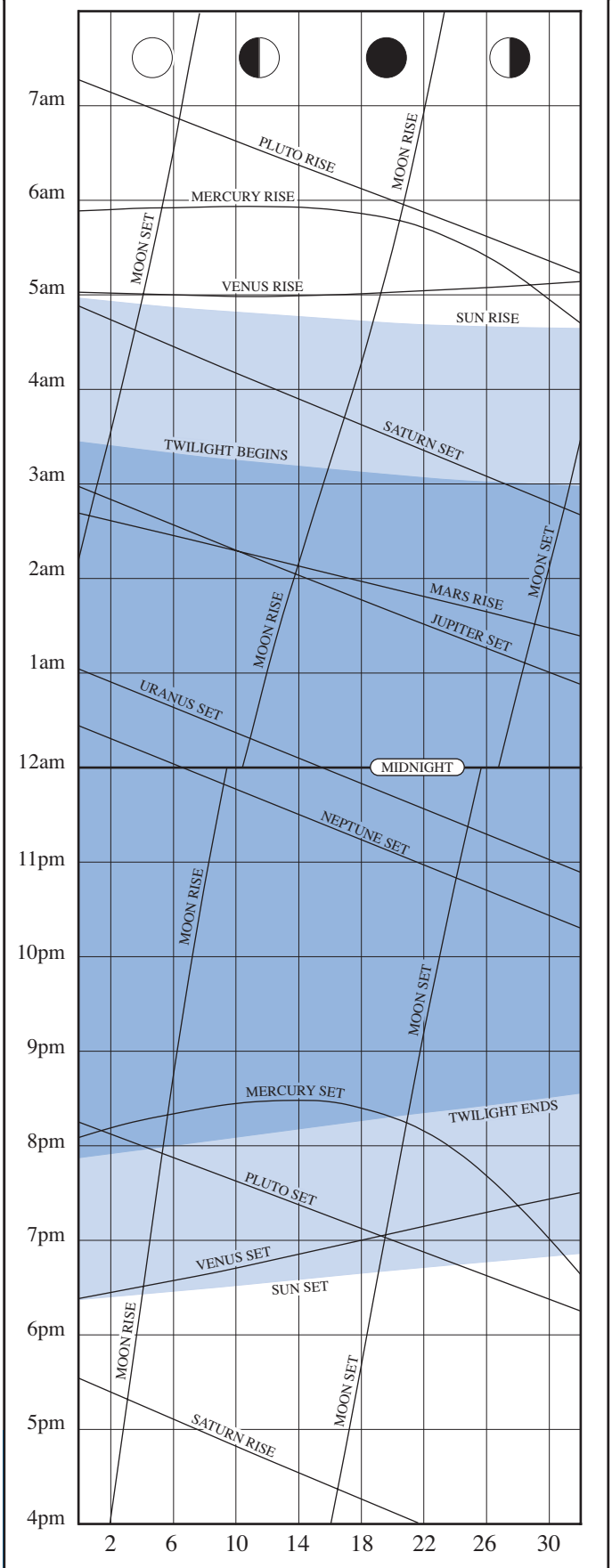




NOVEMBER

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

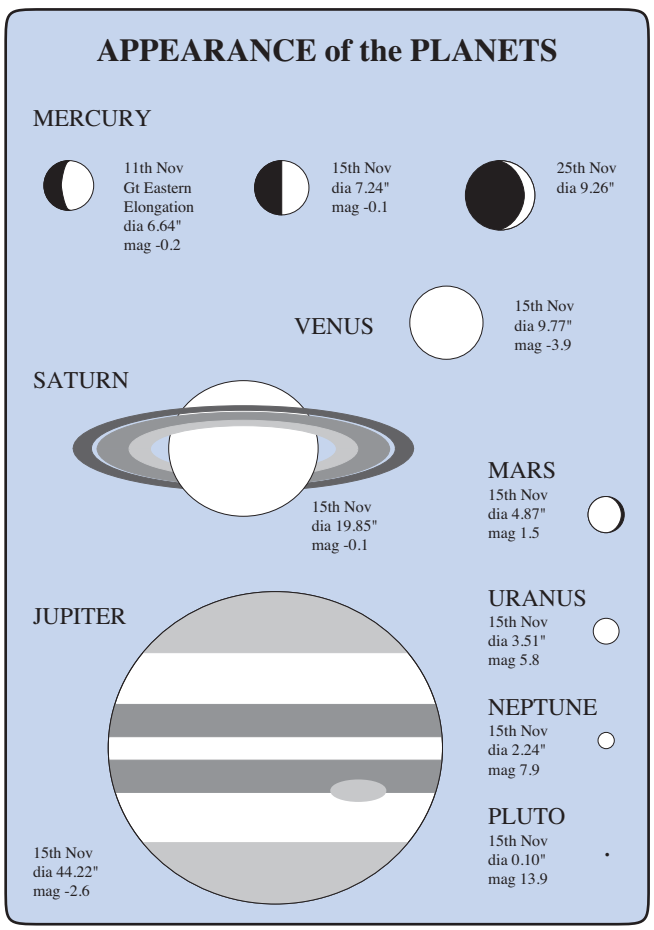
NOVEMBER HIGHLIGHTS

- Look for the Leonids meteor shower!
- Early in the month there is a good view of Mercury in the early western evening sky.
- Mars in the morning sky, rising around 2am.
- Jupiter is well placed in the evening sky, setting about 2am.
- Saturn, early in NE evening sky, visible most of the night.

THE MOON

1st	Occultation of Jupiter by the Moon. Not visible from Australia, see Jupiter text and October 31st Sky View.
4th	Full Moon
4th	Moon at perigee (closest to Earth - 362,475 km distant, angular size 33.0 arc minutes).
6th	Occultation of Aldebaran by the Moon. Visible only from the northern hemisphere, see Sky View.
11th	Last Quarter
12th	Occultation of Regulus by the Moon. This is a daytime event from some parts of eastern Australia (see Lunar Occultation section under your nearest city pages 85-91). See also the Sky View for the night sky aspect.
14th	Occultation of Mars by the Moon. Visible only from northern hemisphere, see Sky View for the closest approach from Australia.
17th	Moon at apogee (furthest from Earth - 405,560 km distant, angular size 29.5 arc minutes).
19th	New Moon
27th	First Quarter
28th	Occultation of Jupiter by the Moon. Visible only from South America (see Sky View).

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is at its best in the evening sky this month. It reaches its greatest elongation east (23°) from the Sun on the 11th. From early in the month Mercury moves through Scorpius towards 1st magnitude Antares (Alpha Scorpii) and on the 9th the pair will be 2° apart (see Sky View). On the 21st the 2 day old Moon will be 8.3° from Mercury (see Sky View). Towards the end of the month Mercury rapidly loses altitude in the western sky and is soon lost in the glow of the Sun.

VENUS, having just past superior conjunction, returns to the evening sky. The rising of the planet, away from the Sun, is gradual and Venus will be unobservable until late December.

MARS has a fairly quiet month in the early morning sky, spending the first half in Leo before crossing over into Virgo. On the 14th, the 25 day old crescent Moon appears 1.2° from the planet (see Sky View), an occultation takes place in east Asia and North America.

JUPITER is occulted by the 11 day old Moon, on the 1st, from some parts of Africa and Asia. The closest we see the pair is when they set around 3am less than 1° apart (see Sky View on 31st October for an evening view). Towards the end of the month Jupiter again encounters the Moon, but not so close. On the 27th, the First Quarter Moon appears 8.3° south of Jupiter, and on the 28th, 5.6° to the north (see Sky View). Jupiter has been in retrograde motion since July, and this month returns to its normal west-to-east path across the sky (see discussion on retrograde motion on page 68).

SATURN, high in the north eastern sky after sunset, has two encounters with the Moon this month. On the 3rd, the Full Moon will be 1.6° from Saturn, and on the 30th an 11 day old Moon is 4° away (see Sky View).

PLUTO is in conjunction with the Sun on the 30th, and will not be visible again until it moves into the morning sky in early January 1999.

MINOR PLANETS at opposition this month include: 1 Ceres on 29th at magnitude 7.1 in Taurus, 5 Astraea on 26th at magnitude 9.8 in Taurus and 15 Eunomia on 5th at magnitude 7.9 in Cetus.

COMETS

Hale-Bopp: The 10th magnitude comet remains in Volans during November, during which time it passes near Gamma Volantis.

Giacobini-Zinner: Initially located in Aquila, setting around 10:30pm, Comet Giacobini-Zinner will move into Capricornus. Brightening from magnitude 9.3 to its peak of 8.9, late November will see the comet pass Uranus, M72, and Comet Meunier-Dupouy. By month's end, the comet will be near Theta Capricorni, setting around 11:30pm.

Howell: Beginning the month in Sagittarius near Phi Sagittarii, and setting before 11:30pm, the comet will fade from magnitude 11.5 to 12.2. Month's end will see the comet move into Capricornus, where it will be near Neptune and M75, setting before 11pm.

METEOR SHOWERS

The **Leonids**. Up until the early 1800s, scientists believed that meteors were purely an atmospheric event. The Leonids "storm", of unbelievable intensity in 1833, was responsible for a change in the scientific world's attitude. The shower is associated with the periodic Comet Tempel-Tuttle and puts on its best display about every 33 years when the comet returns to perihelion. The Leonids generally provide showers of low to moderate activity each year (10 to 20 meteors per hour), and are active from 14th to 21st November, with maximum on the 17th/18th. It is expected that storms might occur again this year and possibly in 1999. The radiant is in the star pattern known as the Sickle or Head of Leo, and will be visible to southern observers in the morning

CONSTELLATIONS OF THE MONTH - FORNAX (For) and SCULPTOR (Scl).

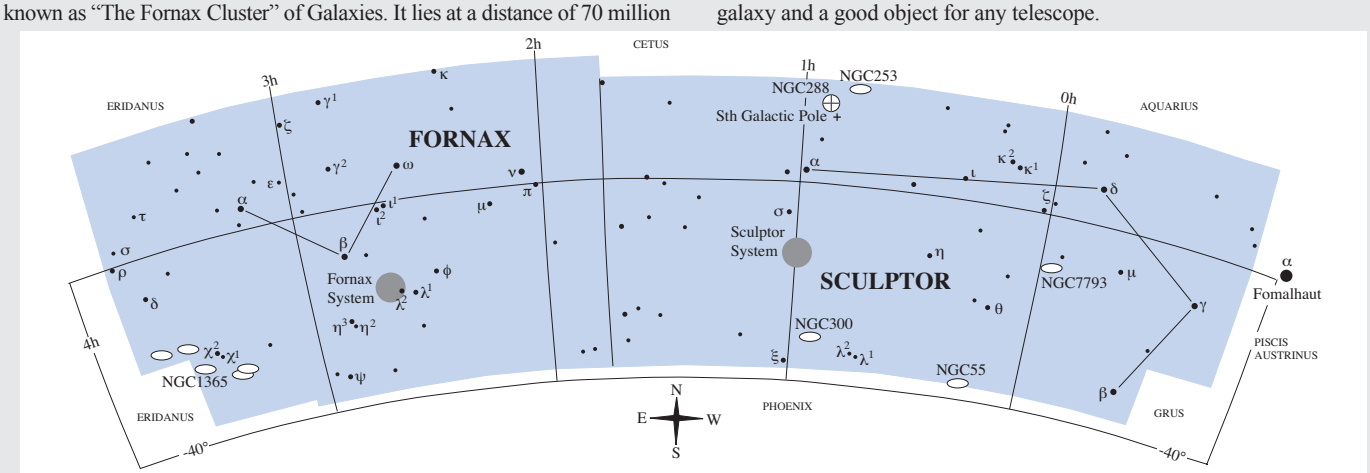
These two faint southern constellations were created by the French astronomer Nicolas Louis de Lacaille in 1752. Both are indistinct with stars no brighter than 4th magnitude. The chief interest is their galaxies.

Fornax, The Furnace, was originally named by Lacaille as "The Chemical Furnace". Near the star Beta Fornacis is the Fornax System, an elliptically shaped galaxy that is a member of our local group of galaxies (at a distance of 424,000 light years from the Milky Way). This loose dwarf galaxy, made up of very faint stars that cover over 1° of sky, does not appear to have any central condensation or nebulosity. There are several globular clusters connected with the Fornax System: the brightest of these appears as a fuzzy. almost stellar 13th magnitude object in large amateur instruments. The galaxy itself is difficult to photograph, let alone trying to observe it. The Fornax and Sculptor Systems (see below) were discovered in 1938. Since that time several other dwarf ellipticals have been detected in our local group. If the Fornax System and other similar dwarf galaxies were beyond our local group of galaxies they may never have been discovered. It seems reasonable to expect that this type of galaxy is fairly common in the Universe, most of them are just too faint to see.

A grouping of eighteen bright and many fainter galaxies makes up what is known as "The Fornax Cluster" of Galaxies. It lies at a distance of 70 million light years. This aggregation spills over a little into neighbouring Eridanus. Some of the galaxies lie close together and it is possible to view up to nine in a 1° field with a 20cm telescope. Within the cluster is one of the showpieces of the southern skies, the barred spiral NGC1365.

Sculptor, The Sculptor's Workshop, contains the South Galactic Pole of our own Galaxy. Ironically Sculptor, like its neighbour Fornax, also boasts a dwarf galaxy and a cluster of galaxies. Each contains some of the best southern galaxies and two of the hardest to observe. The Sculptor System. at a distance of some 277.000 light years is a member of our local group and covers and area of about 1°. Burnham, in his Celestial Handbooks, suggests that they are akin to a globular cluster like Omega Centauri, expanded 50 times, with 99% of its stars removed. We would then have a galaxy that resembles these elliptical dwarfs.

The Sculptor Group of Galaxies (or the South Galactic Pole Group) are the closest cluster of galaxies outside of our own group. The members include NGC45 (in Cetus), NGC55, NGC247 (in Cetus), NGC300, NGC253 and NGC7793. One of the best of the Sculptor galaxies for small telescopes is NGC 55. This is an irregular, elongated galaxy that is much brighter toward one end. NGC253, the Silver Coin galaxy, is a stunning edge-on galaxy and a good object for any telescope.



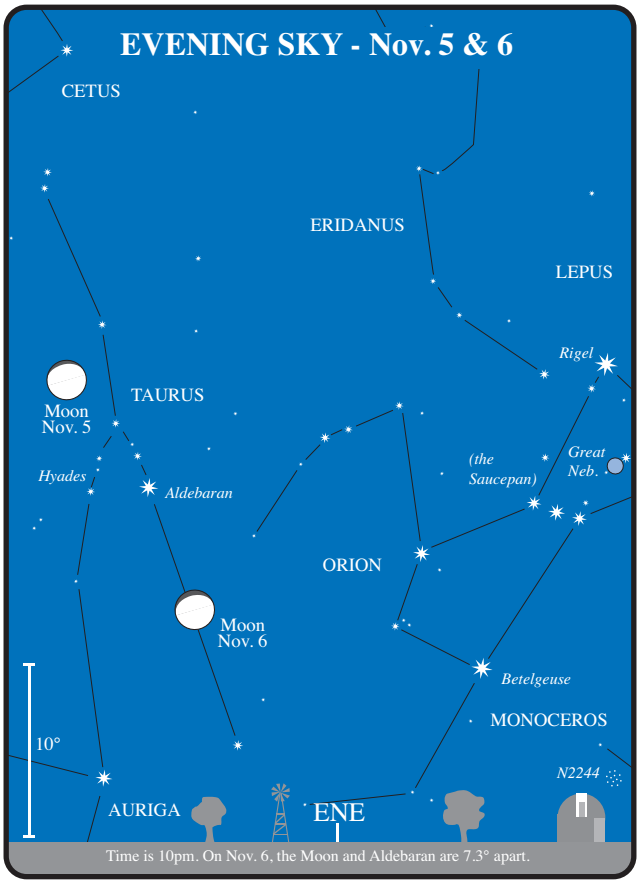
NOVEMBER

sky. While there are no guarantees that a meteor storm will occur, it might be worth missing some sleep on the 17th just in case. After all, are you prepared to wait another 33 years to witness one of the most spectacular heavenly shows.

The **alpha-Monocerotids** are a minor shower, with unusual short lived bursts of high rates. Active from 15th to 25th November, they peak on the 21st and are best seen during the late evening. 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, but who knows about this year? e Sun's disc. Transits of Mercury are fairly rare and occur

DIARY OF EVENTS

1st	2 AM	Jupiter 0.2°N of the Moon; Occn.
2nd		Comet Meunier-Dupouy 0.3°E of M73 (OC) in Aquarius.
3rd		Mercury 0.5°SW of Delta Scorpii.
3rd	7 PM	Saturn 1.7°N of the Moon.
4th		Comet Hale-Bopp 1.4°NW of NGC 2442 (SG) in Volans.
4th		m.p. 44 Nysa 0.3°NW of NGC 428 (SG) in Cetus.
4th	11 AM	Moon at perigee.
4th	3:18 PM	Full Moon.
6th		Mercury 1°SW of M80 (GC) in Scorpius.
6th	Noon	Aldebaran 0.6°S of the Moon; Occn.
6th	2 PM	Ceres 0.3°S of the Moon; Occn.
7th		m.p. 43 Ariadne 1°S of M72 (GC) in Aquarius.
7th		m.p. 7 Isis 1.8°S of NGC 6822 (IG) in Sagittarius.
7th	9 AM	Pallas stationary.
9th		m.p. 6 Hebe 0.3°NW of M24 (OC) in Sagittarius.
9th		Mars at greatest latitude N (heliocentric).
9th		Mercury at greatest latitude S (heliocentric).
9th	7 PM	Mercury 1.9°N of Antares.
10th		m.p. 43 Ariadne 0.6°S of M73 (OC) in Aquarius.
11th		Comet Giacobini-Zinner 1.2°N of NGC 6814 (SG) in Aquila.
11th		m.p. 43 Ariadne 1.2°NW of Comet Meunier-Dupouy.
11th	10:28 AM	Last quarter Moon.
11th	7 PM	Mercury greatest elongation E (23°).
12th	8 AM	Regulus 0.3°N of the Moon; Occn.
13th		m.p. 1 Ceres 0.5°N of Aldebaran.
13th		m.p. 32 Pomona 0.3°S of NGC 6342 (GC) in Ophiuchus.
14th	4 AM	Mars 0.5°S of the Moon; Occn.
14th	11 AM	Jupiter stationary.
17th		m.p. 6 Hebe 0.8°N of M25 (OC) in Sagittarius.
17th	4 PM	Moon at apogee.
19th	2:27 PM	New Moon.
21st	7 AM	Mercury 7°S of the Moon.
21st	Midnight	Mercury stationary.
22nd		m.p. 15 Eunomia 0.5°NE of NGC 925 (SG) in Triangulum.
24th		Venus at descending node.
24th	7 PM	Neptune 1.9°S of the Moon.
25th	1 PM	Uranus 2°S of the Moon.
27th	10:23 AM	First quarter Moon.
28th		Comet Giacobini-Zinner 1.1°SW of Comet Meunier-Dupouy.
28th		m.p. 7 Isis 0.3°SW of Beta Capricorni.
28th		Mercury at ascending node.
28th	11 AM	Jupiter 0.6°N of the Moon; Occn.
29th		m.p. 29 Amphitrite 0.9°S of NGC 6907 (SG) in Capricornus.
29th	8 AM	Ceres at opposition.
30th	6 PM	Pluto in conjunction with the Sun.



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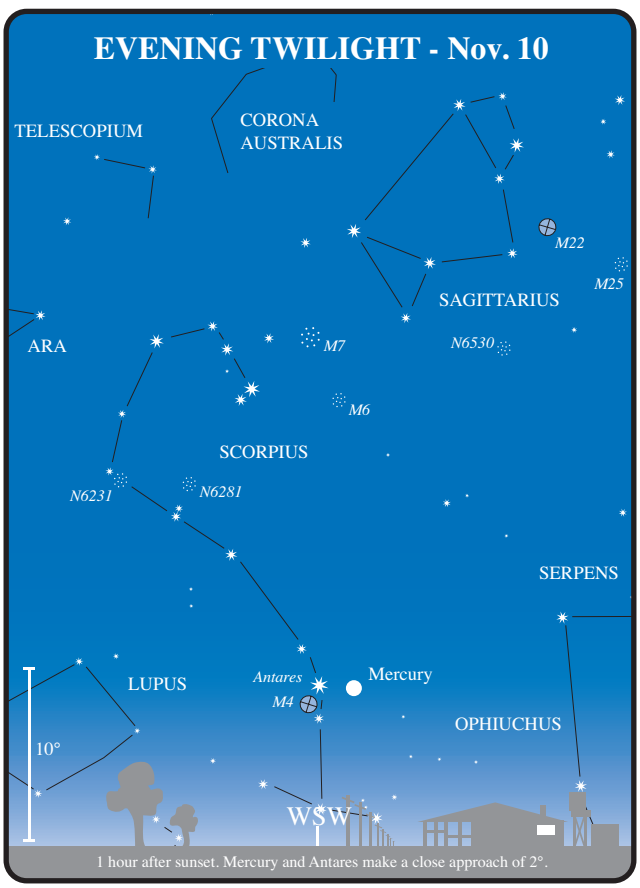

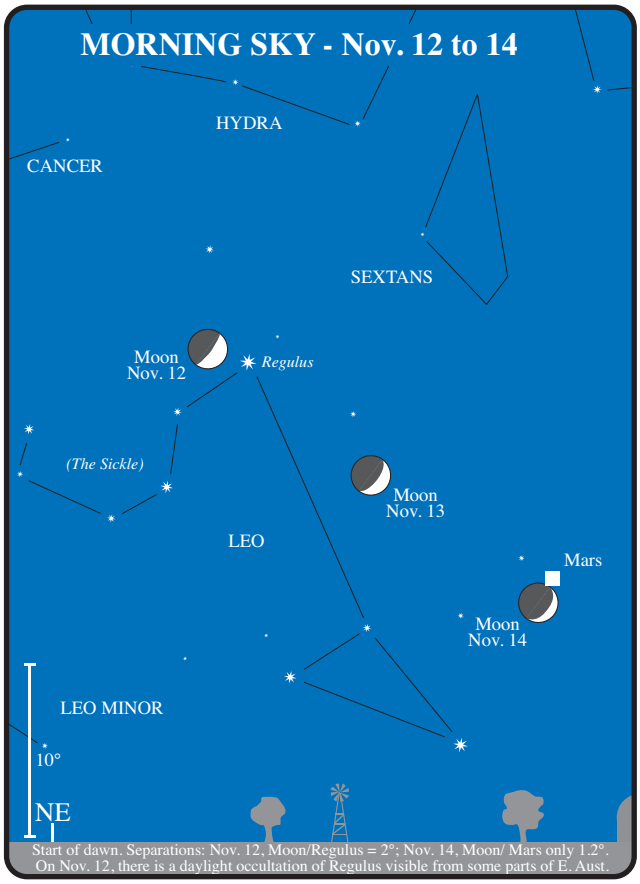

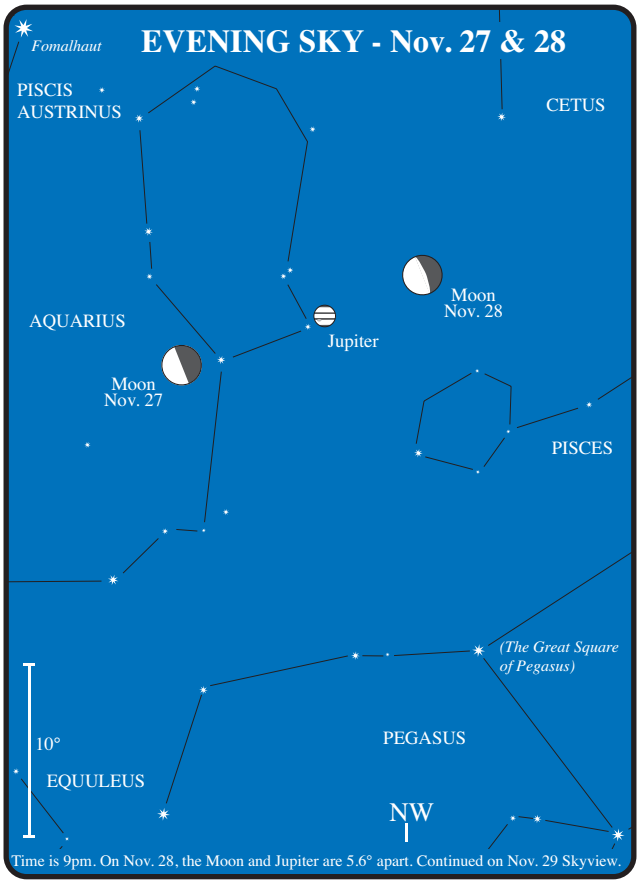

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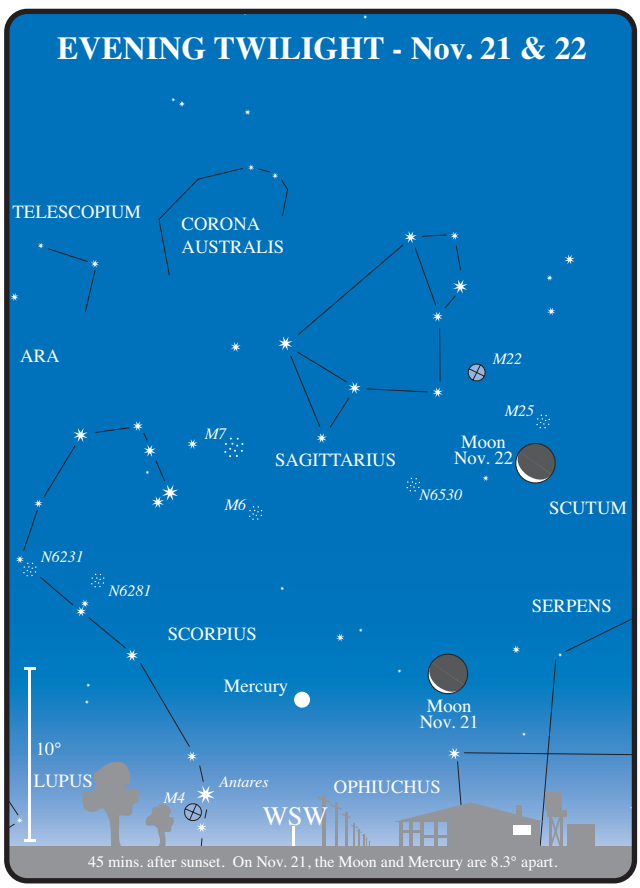
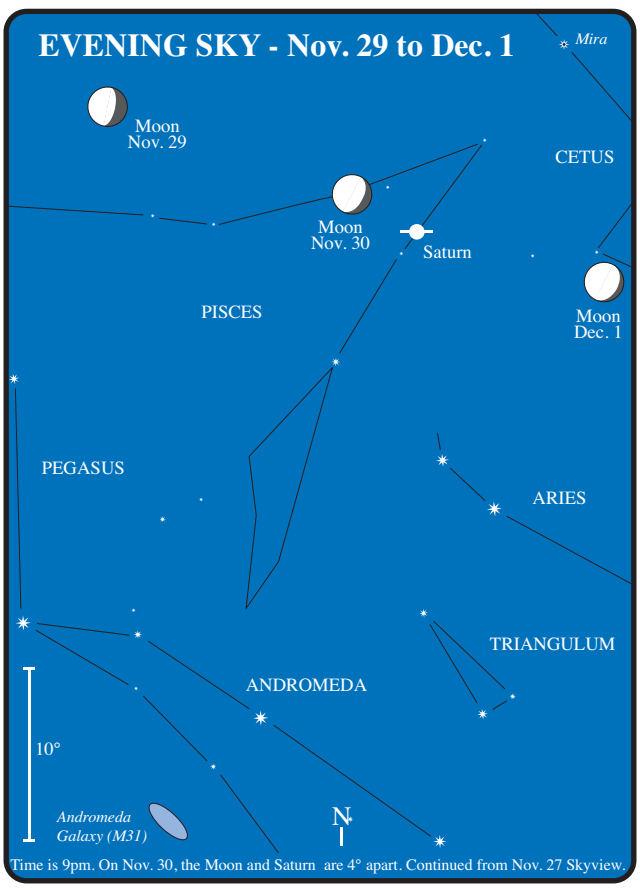
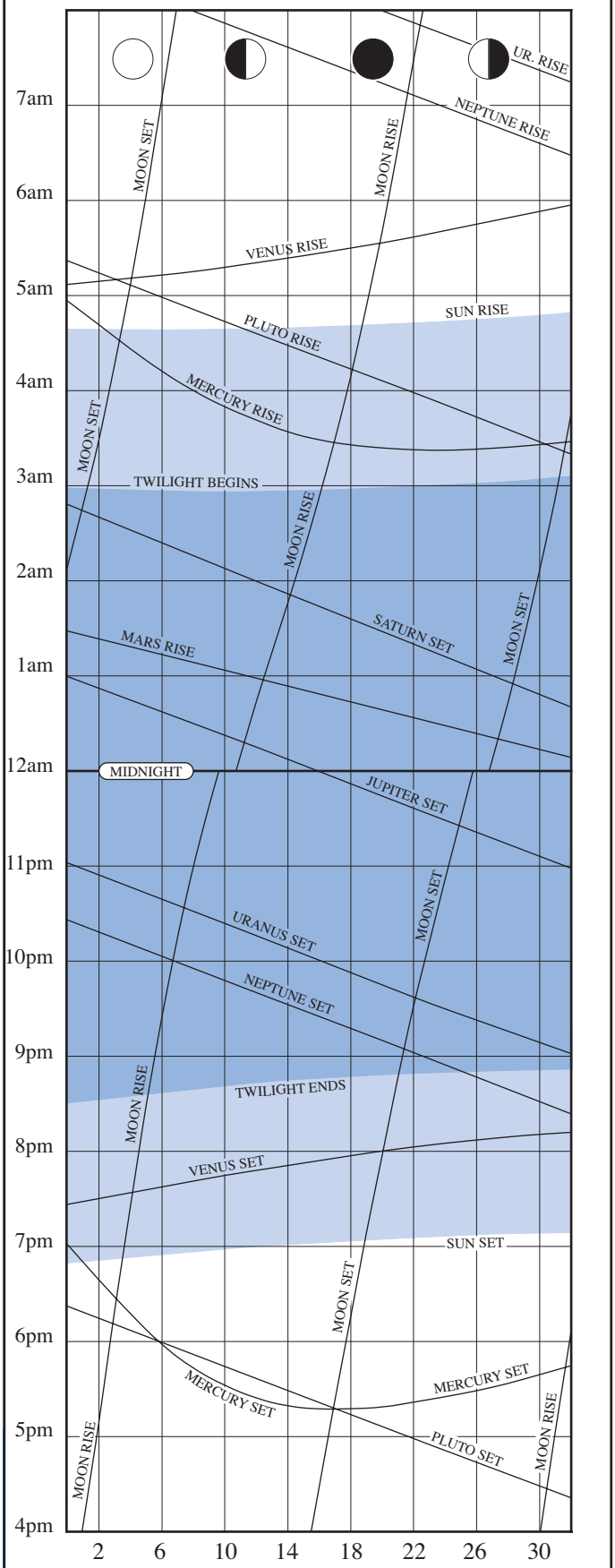




DECEMBER

RISE/SET CHART



All times are AEST. For daylight saving add 1 hour.

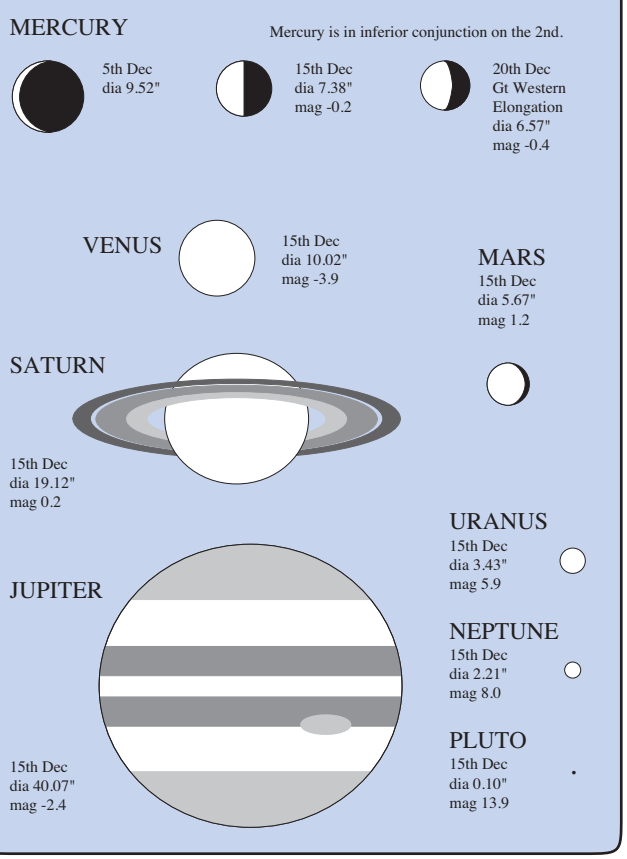
DECEMBER HIGHLIGHTS

- Jupiter on the 25th has a close encounter with the Moon.
- Mercury in the eastern dawn sky for the later half of December.
- Venus is low in the western evening twilight sky towards the end of the month.
- Mars is in the morning sky, rising around 1am.
- Jupiter is in the evening sky. setting around midnight.
- Saturn is high in the early evening northern sky.

THE MOON

2nd	Moon at perigee (closest to Earth - 354,700 km distant, angular size 33.7 arc minutes).
3rd	Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach from mid "Aussie" latitudes is 1.2° (see Sky View).
4th	Full Moon
9th	Occultation of Regulus by the Moon. Not visible from Australia, see Sky View for our perspective on the 9th and 10th.
11th	Last Quarter
15th	Moon at apogee (furthest from Earth - 404,810 km distant, angular size 29.5 arc minutes).
19th	New Moon
25th	Occultation of Jupiter by the Moon. Visible only from eastern Antarctica, but the Moon comes very close to Jupiter from some parts of Australia (see Sky View).
26th	First Quarter

APPEARANCE of the PLANETS



31st Moon at perigee (closest to Earth - 365,170 km distant, angular size 32.7 arc minutes).

31st Occultation of Aldebaran by the Moon. Not visible from Australia, but on the 30th and 31st the Moon will be about 8° from the first magnitude star.

THE PLANETS

MERCURY is in inferior conjunction (between the Sun and Earth) on the 2nd, it then moves west of the Sun to become a morning object. It can be observed in the dawn twilight from about the 10th. On the 17th, the thin crescent Moon appears 4° to the north of the planet in the dawn sky (see Sky View). Mercury reaches its greatest elongation west (22") on the 20th, and thereafter begins its journey back closer to the Sun.

VENUS makes its debut in the evening twilight this month, moving from Ophiuchus into Sagittarius. While in Sagittarius, Venus passes extremely close to two well known deep sky objects, M8 (Lagoon Nebula) and M22 (globular cluster), however these objects will be lost in the twilight glow. On the 20th, the thin crescent Moon will be 6° to the north of Venus (very low on the WSW horizon, only 30 mins after sunset) .

MARS, in Virgo, rises around 1am. On 12th, the 23 day old Moon will be 8° from the planet and on the following morning, 5° (see Sky View). By month's end, Mars can be seen in the eastern morning sky 8° north of 1st magnitude Spica (Alpha Virginis).

JUPITER is occulted by the 6 day old Moon on the 25th over Antarctica. From Australia we are treated to a very close approach from most areas (see Sky View). The following gives the approximate local time and minimum distance from the lunar limb from each capital; Adelaide, separation 0.15° at 9:40pm, Brisbane, 0.2° at 10:25pm, Canberra, 0.1° at 10:15pm, Darwin, 0.5° at 10:00pm. Hobart, 0.05° at 10:05pm. Melbourne, 0.1° at 10:10pm. Perth 0.3° at 7:40pm. Sydney, 0.15° at 10:20pm. Jupiter spends the month in Aquarius, close to the border of Pisces, setting around midnight. Next month will be the last opportunity to see the planet in the evening sky.

SATURN is in an ideal position for evening viewing this month, transiting the meridian around 8pm. On the 27th, the 8 day old Moon appears 8° from the planet, and on the following evening 6.3° away (see Sky View). Saturn has been in retrograde motion since August, and this month returns to its normal west-to-east path across the sky (see discussion on retrograde motion on page 68).

URANUS & NEPTUNE. December is the last month to catch a glimpse of these two distant worlds as they set in the early evening sky. Early next year they will be in conjunction with the Sun.

PLUTO, in conjunction since late last month, reappears in the morning sky in January.

MINOR PLANETS. 52 Europa is at opposition on 11th at magnitude 10.3 in Orion.

CONSTELLATION OF THE MONTH - ERIDANUS (Eri)

Eridanus, the River, is a large southern constellation that begins at the celestial equator, west of Orion, and ends down near the bright star, Achernar. Northern observers, south of about +35° latitude, can see the constellation in its entirety. From the 3rd magnitude star Cursa (near Rigel in Orion), the River can be traced to Achernar via a meandering string of many faint stars (a dark night away from city lights will help). In area, Eridanus ranks as the sixth largest of the constellations and is the second longest (Hydra wins the dual title of being the largest and longest of the constellations).

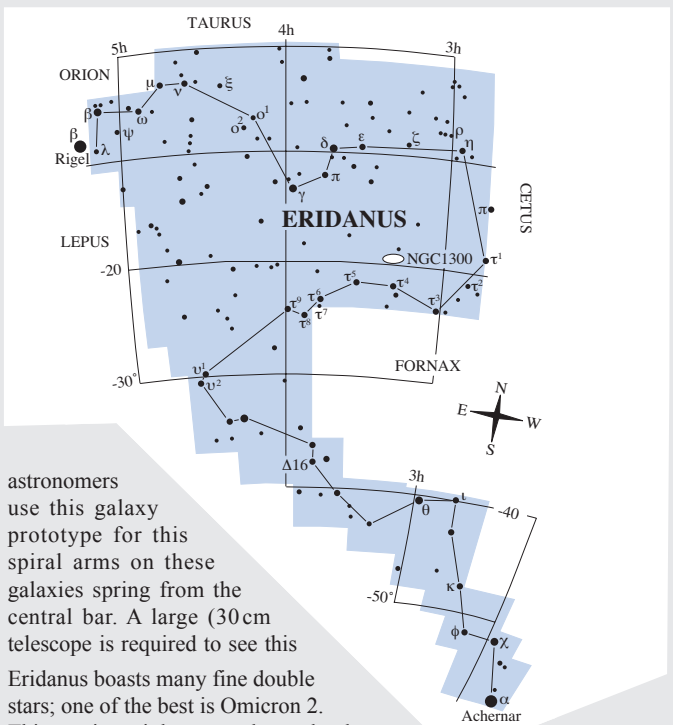
In classical mythology Eridanus was the river into which Phaethon fell after being struck dead by a thunderbolt from Zeus. Phaethon, it seems, upset Zeus by some bad driving! The tale goes something like this. Phaethon was the son of Helios the Sun God. He relentlessly pestered his father to allow him to drive the chariot that carried the Sun across the sky. Helios knew his son could not take on such a responsibility, but alas Helios finally relented.

When Phaethon took the reins he could not control the horses. The chariot went too high and the Earth became cold. He then drove it too low and scorched the Barth. Zeus decided to intervene and dispatched Phaethon to his watery grave. Phaethon's sisters, who encouraged him, were turned into poplar trees on the banks of the river.

It is not certain just which river Eridanus represents. It could be the Tigris. Euphrates or the Nile; perhaps even the more modern Po of Italy. It may originally have been mythical, like Homer's "Ocean Stream" that flowed around the Earth. Originally the river ended with its southern-most star Acamar (Theta Eridani). Because of its southern declination the ancients could not see Achernar (Alpha Eridani). However, modern day astronomers have moved the boundary further south to include this star (both star names mean "the end of the river").

Achernar is a blue supergiant star that lies at a distance of 142 light years and at 0.46 magnitude it is the 9th brightest star in the sky. The star Epsilon Bridani is the 10th closest star to our solar system. After Alpha Centauri and Sirius, this star is the 3rd nearest naked eye star (although at 4th magnitude. it doesn't compete with the other two). From observations made in 1973, it is thought that Epsilon Eridani could have at least one Jupiter sized planet in orbit.

There are many galaxies in the constellation but the real classic is NGC1300. It belongs to a classification of galaxies known as barred astronomers use this galaxy prototype for this spiral arms on these galaxies spring from the central bar. A large (30cm telescope is required to see this



Eridanus boasts many fine double stars; one of the best is Omicron 2. This star is a triple system located only 15.9 light years away, Omicron 2 appears as a wide double in the telescope, but the fainter star is also a double consisting of two dwarf stars. The brighter of this pair (only 27000 kilometres in diameter) is considered the easiest white dwarf visible in amateur telescopes. Other fine doubles include

- p Eridani, two deep yellow stars in a fine field.
- Theta Eridani, a pair of white gems that some consider one of the finest of the southern doubles.
- Dunlop 16, two yellow stars in a good field.

DECEMBER

COMETS

Hale-Bopp: Comet Hale-Bopp moves back into Dorado this month, and fades to about magnitude 10.7. By the end of 1998, it will lie close to the Large Magellanic Cloud. The comet is visible the entire night.

Giacobini-Zinner: The comet begins the month in Capricornus at magnitude 9.0, near Theta Capricorni and setting around 11:30pm. During December, it moves through Aquarius, passing near the Helix Nebula, and ends the month in Cetus at 10th magnitude, setting after midnight.

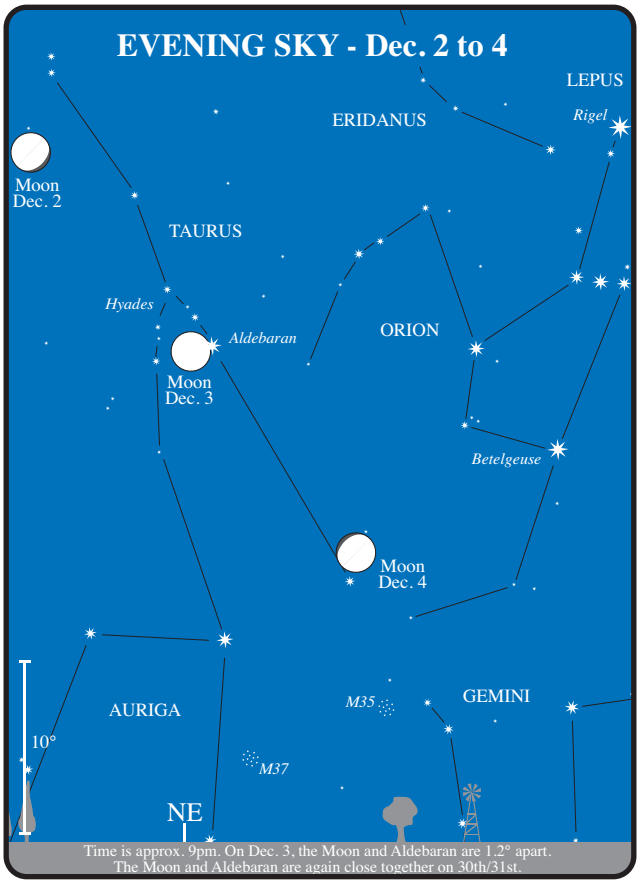
Howell: Observers will initially find 12th magnitude Comet Howell in Capricornus, setting before 11pm. Passing near Comet Meunier-Dupouy, Eta Capricorni and Delta Capricorni, the comet will end 1998 moving into Aquarius, setting after 10pm.

METEOR SHOWERS

The **Geminids** are one of the best annual showers, but for southern observers the radiant is below or low on the horizon until after midnight. Visible from the 7th to 17th, with maximum on the 14th, the Geminids produce often bright, medium speed meteors. The zenith hourly rate is variable but around 110 is normal. They are worth watching for in the morning hours, even though our northern counterparts will see the best of the Geminids.

DIARY OF EVENTS

1st	3 AM	Saturn 1.8°N of the Moon.
2nd		m.p. 29 Amphitrite 1.4°SE of Comet Meunier-Dupouy.
2nd		Mars 0.7°S of NGC 4179 (SG) in Virgo.
2nd		Mercury at perihelion.
2nd	1 AM	Mercury in inferior conjunction.
2nd	10 PM	Moon at perigee.
3rd	4 PM	Ceres 1.2°N of the Moon; Occn.
3rd	11 PM	Aldebaran 0.6°S of the Moon; Occn.
4th	1:19 AM	Full Moon.
8th		Comet Giacobini-Zinner 0.2°SE of NGC 7184 (SG) in Aquarius.
9th	4 PM	Regulus 0.01°N of the Moon; Occn.
11th	3:53 AM	Last quarter Moon.
11th	4 PM	Mercury stationary.
12th	6 PM	Mars 1.8°S of the Moon.
13th		Mercury at greatest latitude N (heliocentric).
15th		Neptune 1.2°S of m.p. 18 Melpomene.
15th	3 AM	Moon at apogee.
16th		m.p. 7 Isis 0.6°S of M72 (GC) in Aquarius.
17th	10 AM	Mercury 3°S of the Moon.
19th		m.p. 44 Nysa 0.4°SE of IC 1613 (IG) in Cetus.
19th		m.p. 7 Isis 0.2°E of M73 (OC) in Aquarius.
19th	8:42 AM	New Moon.
20th		Mars 0.2°N of NGC 4691 (SG) in Virgo.
20th	2 PM	Mercury greatest elongation W. (22°).
22nd	2 AM	Neptune 1.7°S of the Moon.
22nd	Noon	Solstice.
22nd	4 PM	Mercury 7°N of Antares.
22nd	9 PM	Uranus 1.8°S of the Moon.
23rd	9 AM	Vesta stationary.
25th	9 PM	Jupiter 1.2°N of the Moon; Occn.
26th	8:46 PM	First quarter Moon.
28th	9 AM	Saturn 2°N of the Moon.
29th		Mars 0.7°N of NGC 4941 (SG) in Virgo.
31st		m.p. 2 Pallas 0.4°S of NGC 7723 in Aquarius.
31st	2 AM	Saturn stationary.
31st	4 AM	Moon at perigee.
31st	9 AM	Aldebaran 0.6°S of the Moon; Occn.



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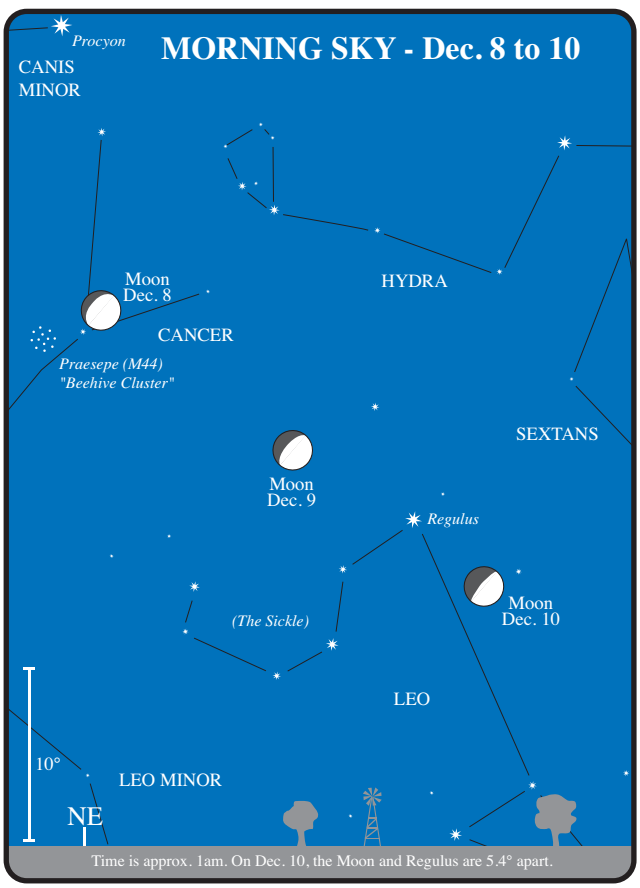
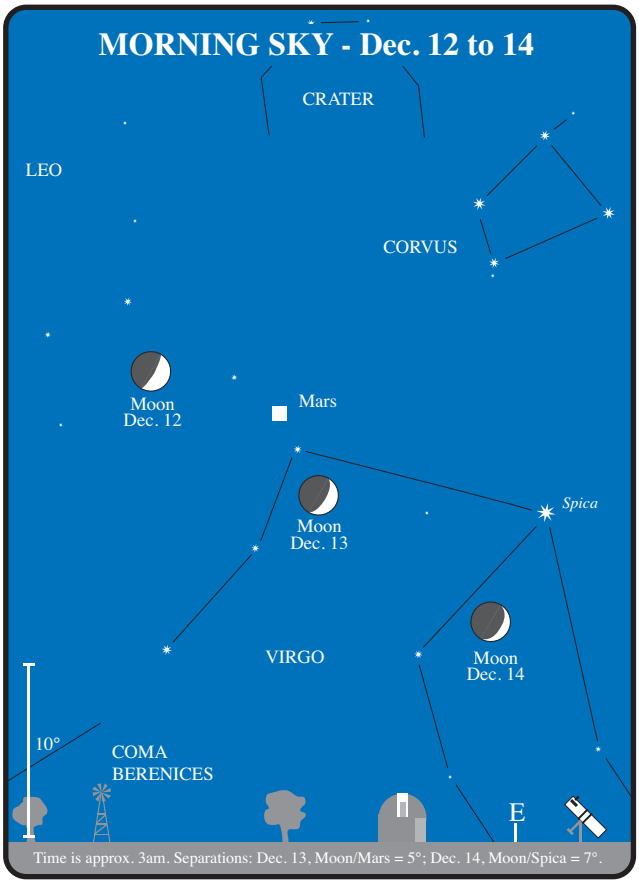
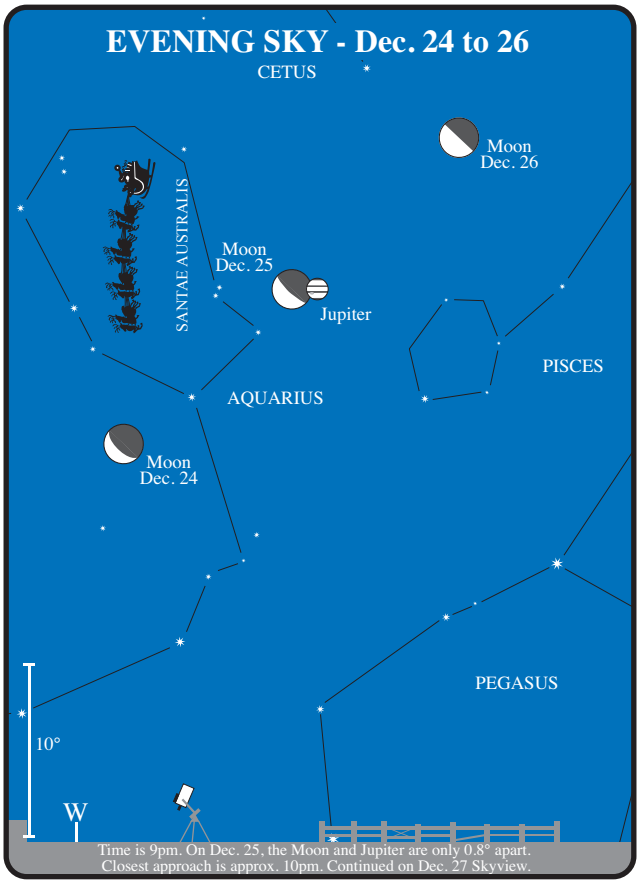
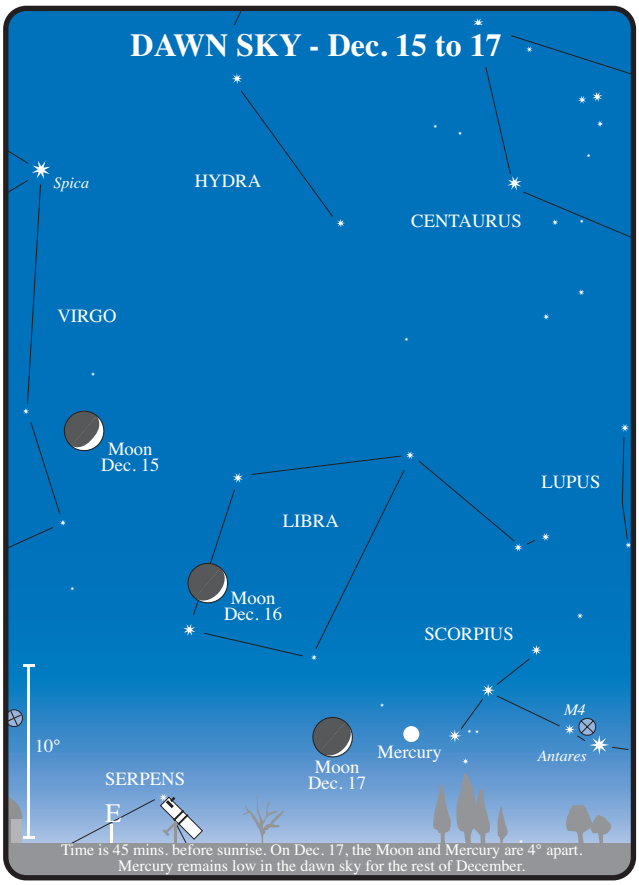
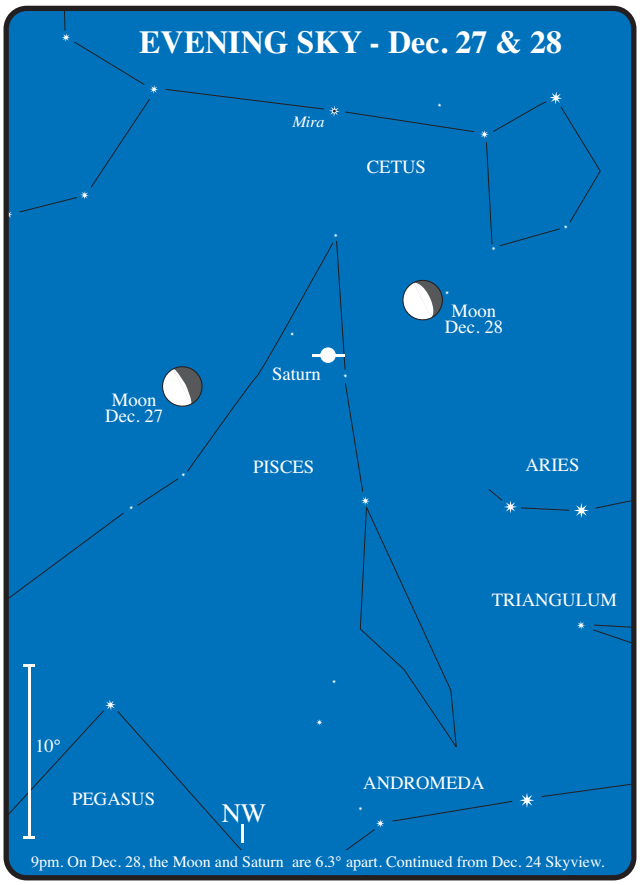






All times are AEST. For daylight saving add 1 hour.





PART II
THE SOLAR SYSTEM

GENERAL COMMENTS

Time. There are three time zones used in Part II of this book. They are Australian Eastern Standard Time (AEST) as used in Part I, Australian Central Standard Time (ACST) and Universal Time (UT). ACST is used only in data which has been specifically generated for Adelaide or Darwin i.e., the rise and set times (see the individual Sun, Moon and planet sections) and lunar occultation tables (pp. 86-91) for these cities. The 24 hr clock is often used in astronomy e.g., 16:00 hr is equal to 4:00pm. This avoids having to distinguish between 'am' and 'pm'. The 24hr approach is used a lot in Part II of this book, e.g., for rise/set times. In some areas, it is convenient to use decimal hours. e.g., 5.3hr is the same as 5hr 18 min or 5:18hr. The satellite data for Saturn, Uranus and Neptune use decimal hours.

Universal Time, or UT, is the mean time for the meridian of Greenwich, England, reckoned from midnight. AEST is 10 hours ahead of UT (ACST is 9.5 hours ahead). For example, midnight UT, or 0 hr, is equal to 10:00hr or 10:00am AEST.

Locations. Rise/Set times and Lunar Occultation data are given for specific cities. The latitudes and longitudes used are:

Adelaide	34° 58' S 138° 38' 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
Sydney	33° 54' S 151° 15' E	Townsville	19° 16' S 146° 48' E

Astronomical Co-ordinates or Positions. The astronomical positions are given as equatorial co-ordinates. These are Right Ascension (RA) and Declination (Dec) which are analogous to longitude and latitude for finding places on the 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, south are negative (-).

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°. The 'Northern 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 partners.

Position Tables. Right Ascension and Declination have been calculated for 0 hr UT on the date listed (Epoch 2000). 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. The Sun, Moon, Venus and Mercury are daily.

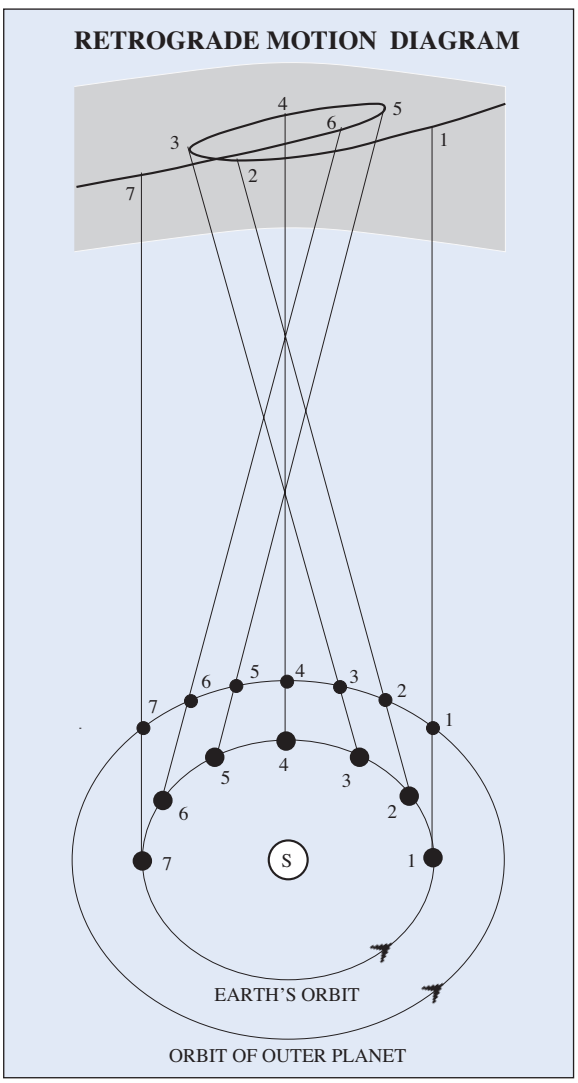
Rise and Set Times. The rise and set times for various objects are given in AEST, except Adelaide and Darwin which use ACST (see above). The times given are when the upper limb of the object is coincident with the theoretical horizon. The data is adjusted for atmospheric refraction. The intervals used for rise/sets are weekly and the dates correspond to Saturdays. The only exception is the Moon which is presented for every day.

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, over many years 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) will be in the year 2000. This epoch has now been adopted by all modern star atlases. On the secondhand market there may still be atlases around which use epoch 1950.0 and it is important to check your atlas before using (or buying) it to ensure it is epoch 2000.0. The precession over this 50 year period can cause a shift of up to one degree in the apparent position of a Solar System object relative to the background stars. This may not be a problem when looking for the brighter planets, but high precision may be necessary to track down a 12th magnitude comet. The calculations to convert (or 'precess') positions from one epoch to another are not complicated, considering the power of today's calculators and computers. Suggested references are 'Practical Astronomy with a Calculator' (Duffett-Smith), 'Astronomical Formulae for Calculators' (Meeus) or 'Astronomical Algorithms' (Meeus).

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 of north (in the sky east and west are opposite to what is seen on terrestrial maps). Telescope systems that use odd numbers of reflecting surfaces will 'mirror' (or 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.

Planet Finder Charts. No finder charts are presented for the Moon, Venus or Mercury. 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'.

Retrograde Motion. The finder charts for the outer planets have one thing in common - an apparent motion with a 'loop' shape. This puzzled astronomers for centuries until it was finally recognised that the Earth



orbited the Sun. This was just like any of the other 'wanderers' or planets. Unfortunately, the Earth could no longer be looked upon as the centre of the Universe. The diagram below illustrates the combined effects of the orbital motions of Earth and an outer planet to explain this 'loop'. This only applies to the period during opposition. All the outer planets reach opposition each year, except for Mars which is every 26 months. Mars does not reach opposition this year and you will notice there is no 'loop' in its finder charts (p. 97) as seen for the other outer planets. Returning to the 'Retrograde Motion Diagram', the shaded area represents the path of an outer planet against the celestial sphere. 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 or 'S-bend' 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 moves from east to west instead of from west to east. At position 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' shape. An 'S' shape will happen if it is near one of its nodes (the points where a planet crosses the plane of the Earth's orbit), at the time of opposition. During 1998, none of the outer planets, reaching opposition, cross a node and hence all show a 'loop' (see the finder charts).

SECTION EXPLANATION

The following is a brief explanation of the data in Part II of this book. Some sections are not mentioned, or only briefly described, when there are more detailed discussions presented on the relevant pages.

Declination of the Sun and Planets (p. 72) In general, the further south a planet is (negative declination), the higher in the northern sky it is, as seen from 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.

Planetary Angular Size (p. 72) The 'Y' axis of this diagram is arc seconds. It is interesting that Venus, in mid January, grows to an angular exceeding to 1 are minute. There have been rare reports of people having the ability to see the crescent of Venus, with the naked eye, when the planet is close to 1 are minute in size. It is certainly worthwhile trying to observe Venus' crescent in binoculars (it helps to keep the binoculars steady by using a tripod). Looking during twilight can often help. There is less glare and the planet is higher in the sky. The exact time of maximum angular size occurs when Venus is at inferior conjunction when the planet is closest to the Sun and shows the smallest crescent. It may be best to try a week or two either side of conjunction, i.e., at the beginning of January in the evening sky, or towards the end of the month in the morning sky. See Part I for the expected crescent shape.

Planet Illumination (p. 73) This graph gives an indication of how much of the planet's disc, visible from Earth, is lit by the Sun. A figure of 100% means the whole disc is bright, presenting a 'full moon' like appearance. 50% would be like a first (or third) quarter Moon. The inner planets show the largest change in phase. For example, as Venus approaches inferior conjunction (directly between the Sun and the Earth), the phase shrinks as more of the 'night side' becomes visible. It is obvious from the drawing that Venus will reach inferior conjunction in mid January.

Moon - Rise/Set Data (pp. 80-83). Looking at this data you will see there are some days where the Moon appears not to rise or set (represented by 'DNR' for Does Not Rise or 'DNS' Does Not Set). 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. (making it an event for the 3rd).

JUPITER AND SATURN

Jupiter's Moons (pp. 99-104). Jupiter is like a miniature solar system with 16 moons orbiting the planet. Also, like the planets, these moons all lie in a similar plane. This plane is also very close to the plane of the Earth's orbit. Therefore, as seen from Earth, the moons appear to move from side-to-side (east-west) of Jupiter, occasionally passing across (transiting) or behind (occulting) the planet. The diagrams on pp. 102-104 show the patterns the four major moons of Jupiter make as they move from side-to-side. Each complete period represents one orbit of the satellite. Each horizontal date line represents midnight AEST (14hr 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. 100-101). The same can be done with the occultation times i.e., when the line disappears behind Jupiter.

These four moons (Io, Europa, Ganymede and Callisto) are bright enough to be seen in binoculars (7X power 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 every 8 days approximately; an example would be the evening of January 7. 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.

Eclipse Positions of Jupiter's Moons (bottom of p. 99) shows the positions of the eclipse events for each satellite for the month, relative to Jupiter. An eclipse is when the moon passes into (disappearance or 'd') or out of (reappearance or 'r') Jupiter's shadow.

Jupiter - Longitudes of Central Meridian. (p. 105) Unlike Mars, Jupiter (and Saturn) are 'Gas Giants' and they only allow us to view their upper atmospheric features. Only a small telescope (even a 50mm instrument) is required to view the equatorial belts and the Great Red Spot. When 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.

The longitude can be worked out from the 'Longitude of Central' Meridian tables (p. 105). All the times on the main tables are calculated for 0hrs UT (10:00am AEST) of date. You will need to add multiple hours/minutes from the small 'Increase in Longitude' tables. For example the longitude of central meridian for Jupiter (system I) for June 21 at 2:20am AEST would be calculated as follows:

The longitude on June 20 is 281.7°. To this add an adjustment for the 16 hours since 10am (0hr UT) which is 225.3° and finally for the 20 mins add 12.2°. This equals 519.2°; subtracting 360° gives a final answer of 159.2°.

Saturn's Rings. (p. 108) The 'Appearance of the Planets' diagrams in Part I show how 'open' the rings are for 1998. The plane of the rings is tilted, with respect to the plane of the ecliptic, by 28°. The planet's year is 29.5 (Earth) years. During this period the Earth can be up to 28° 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 early in 1996. During 1998, the rings are in the process of opening up.

Satellites of Saturn (pp. 108-109). To estimate the configuration or positions of the satellites, the 'Apparent Orbits' diagram (p. 108) and the times of 'Greatest Eastern Elongation' are needed. For each satellite, take the previous (most recent) date of greatest eastern elongation and work out the period that has elapsed (in days/hours) since this time. Locate this time on the relevant orbit on the diagram (p. 108) and that gives the moon's position directly.

SOLAR SYSTEM DATA — THE PLANETS

NAME	MEAN DISTANCE FROM SUN ($x\ 10^3$ km)	MEAN DISTANCE FROM SUN (Earth = 1)	MAG at OPP	EQUATORIAL DIAMETER (km).	FLATTENING [1]	No of MOONS	MASS ($x10^{24}$ kg)	MASS (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	16	1898.8	317.900
Saturn	1425983	9.540	0.67	120536	0.097962	18	568.50	95.200
Uranus	2867760	19.180	5.52	51118	0.022927	15	86.625	14.500
Neptune	4492800	30.700	7.84	49528	0.017081	8	102.78	17.400
Pluto	5745000	39.670	13.7	2302	0	1	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 the equatorial and polar radii to the 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 The 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.

PART II - THE SOLAR SYSTEM ... continued

URANUS / NEPTUNE / PLUTO

Satellites of Uranus (p. 111). Titania (III) and Oberon (IV) are the easiest to observe visually. However, at least a 20cm telescope, under 'dark skies', is needed to glimpse these distant bodies. The inner satellites, Ariel and Umbriel, are harder to observe and they would be a real test for a 40cm telescope. The orbits of the satellites are half face-on as seen from Earth (see diagram p. 111). The orbits' apparent minor axis (running east/west) is 59% of the apparent major axis (north/south). For example, Oberon, at opposition, has a maximum elongation of 44' (p. 71). Its minimum elongation would be 59% of this or 26'. To locate the approximate position angle (degrees east of north) for a satellite, at your time of observation:

1. Work out how long since the satellite's most recent greatest northern elongation.
2. Express this as a fraction of the sidereal orbital period. Satellites II, III, and IV have periods of 4.14, 8.71 and 13.46 days respectively.
3. Multiply the result by 360°.

Satellites of Neptune (p. 111). With typical amateur telescopes, Triton (I) is the only observable moon. To find Triton, use the approach as described above for the satellites of Uranus. Note that in this case, the apparent major axis is in the east/west direction. Like Uranus, the orbits of the Neptunian satellites are currently relatively open (see diagram p. 111). In 1998, Triton's apparent orbit as seen from Earth is an ellipse with the minor axis being 76% of the major axis. Therefore Triton, at opposition, varies from 17' (p. 71) down to 13'. To find the approximate position angle of Triton, the same approach is used as above for Uranus. The sidereal orbital period for Triton is 5.88 days and after step 3 add 90° to get the position angle from north. If greater than 360°, subtract 360°.

Pluto (pp. 113-115). The pointer chart (p. 114) is designed to help people find the general area for Pluto. The main finder chart shows stars down to approximately magnitude 14.5. This is necessary to pick out the faint star-like image of Pluto (magnitude 13.7) from other numerous faint stars in the field. Commonly available star atlases do not include stars down to anywhere near this magnitude.

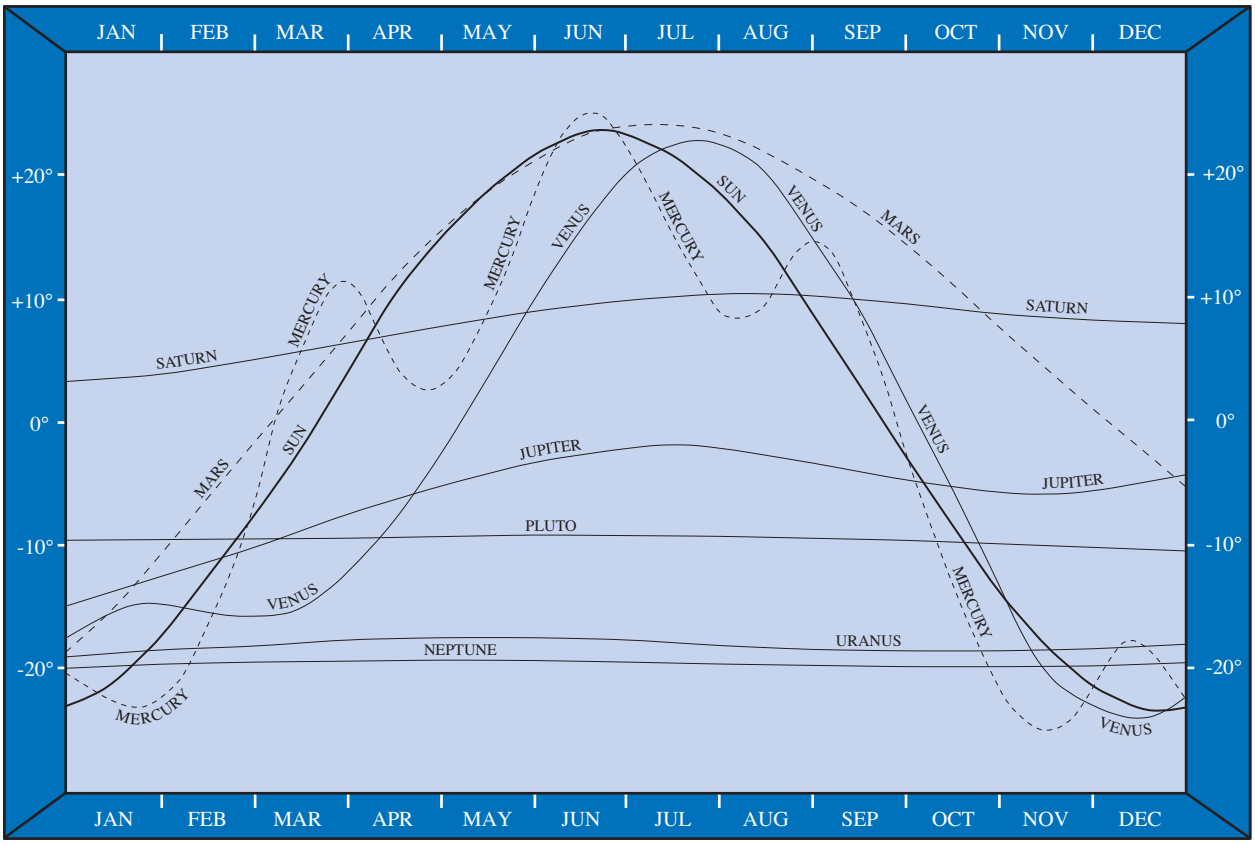
Minor Planets (pp. 120-121). As well as the 9 planets, their moons and the comets, the Solar System contains numerous smaller bodies known as the 'minor planets' or 'asteroids'. There are now some 5000 such bodies catalogued! Their sizes vary from around a thousand kilometres down to a few hundred metres. 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. Most need to be found by photographing 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 60 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 20 of the minor planets (all returning to opposition, except for Vesta) expected to reach magnitude 10 or brighter this year.

SOLAR SYSTEM DATA — SATELLITES

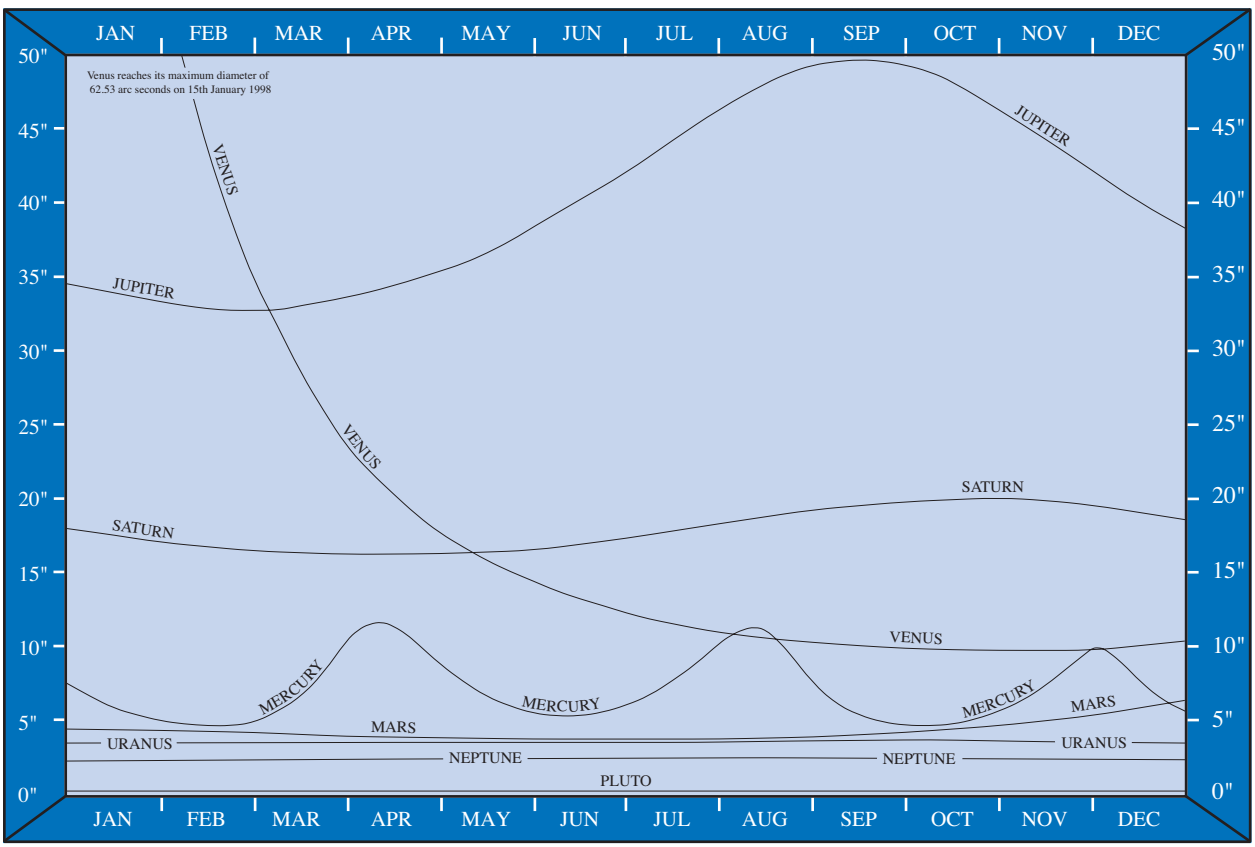
PLANET / SATELLITE		ORBITAL [1] PERIOD (days) (R=retrograde)	MAX. ELONG AT MEAN OPPOSITION	SEMIMAJOR AXIS ($x10^3$ km)	ORBITAL ECCENTRICITY	INCLINATION TO PLANET'S EQUATOR (°)	MASS (1/PLANET)	RADIUS (km)	SIDEREAL PERIOD OF ROTATION (days) [4]	MAGNITUDE AT OPPOSITION
Earth										
Moon		27.321661		384.400	0.054900489	18.28-28.58	0.01230002	1737.4	S	-12.74
Mars										
Phobos	I	0.31891023	25"	9.378	0.015	1.0	$1.65x10^{-8}$	13.4x11.2x9.2	S	11.3
Deimos	II	1.2624407	1' 02"	23.459	0.0005	0.9-2.7	$3.71x10^{-9}$	7.5x6.1x5.2	S	12.40
Jupiter										
Metis	XVI	0.294780	0' 42"	128			$0.5x10^{-10}$	20	S	17.5
Adrastea	XV	0.29826	0' 42"	129			$0.1x10^{-10}$	13x10x8	S	19.1
Amalthea	V	0.49817905	0' 59"	181	0.003	0.40	$38x10^{-10}$	131x73x67	S	14.1
Thebe	XIV	0.6745	1' 13"	222	0.015	0.8	$4x10^{-10}$	55x45	S	15.7
Io	I	1.769137786	2' 18"	422	0.004	0.04	$4.70x10^{-5}$	1830x1819x1815	S	5.29
Europa	II	3.551181041	3' 40"	671	0.009	0.47	$2.53x10^{-5}$	1565	S	5.29
Ganymede	III	7.15455296	5' 51"	1070	0.002	0.21	$7.80x10^{-5}$	2634	S	4.61
Callisto	IV	16.6890184	10' 18"	1883	0.007	0.51	$5.67x10^{-5}$	2403	S	5.65
Leda	XIII	238.72	1° 00' 39"	11094	0.14762	26.07	$0.03x10^{-10}$	5		20.2
Himalia	VI	250.5662	1° 02' 46"	11480	0.15798	27.63	$50x10^{-10}$	85	0.4	14.84
Lysithea	X	259.22	1° 04' 04"	11720	0.107	29.02	$0.4x10^{-10}$	12	0.533	18.4
Elara	VII	259.6528	1° 04' 10"	11737	0.20719	24.77	$4x10^{-10}$	40		16.77
Ananke	XII	631. R	1° 55' 52"	21200	0.16870	147	$0.2x10^{-10}$	10	0.35	18.9
Carme	XI	692. R	2° 03' 31"	22600	0.20678	164	$0.5x10^{-10}$	15	0.433	18.0
Pasiphae	VIII	735. R	2° 08' 26"	23500	0.378	145	$1x10^{-10}$	18		17.03
Sinope	IX	758. R	2° 09' 31"	23700	0.275	153	$0.4x10^{-10}$	14	0.548	18.3
Saturn										
Pan	XVIII	0.5750	0' 21"	133.583				10		
Atlas	XV	0.6019	0' 22"	137.670	0.000	0.3		18.5x17.2x13.5		18
Prometheus	XVI	0.6130	0' 23"	139.353	0.003	0.0		74x50x34		16
Pandora	XVII	0.6285	0' 23"	141.700	0.004	0.0		55x44x31		16
Epimetheus	XI	0.6942	0' 24"	151.422	0.009	0.34	$9.5x10^{-10}$	69x55x55	S	15
Janus	X	0.6945	0' 24"	151.472	0.007	0.14	$3.38x10^{-9}$	97x95x77	S	14
Mimas	I	0.942421813	0' 30"	185.52	0.0202	1.53	$6.60x10^{-8}$	209x196x191	S	12.9
Enceladus	II	1.370217855	0' 38"	238.02	0.00452	0.00	$1x10^{-7}$	256x247x245	S	11.7
Telesto	XIII	1.8878	0' 48"	294.66				15x12.5x7.5		18.5
Tethys	III	1.887802160	0' 48"	294.66	0.00000	1.86	$1.10x10^{-6}$	536x528x526	S	10.2
Calypso	XIV	1.8878	0' 48"	294.66				15x8x8		18.7
Helene	XII	2.7369	1' 01"	377.40	0.005	0.0		18x16x15		18
Dione	IV	2.736914742	1' 01"	377.40	0.002230	0.02	$1.93x10^{-6}$	560	S	10.4
Rhea	V	4.517500436	1' 25"	527.04	0.00100	0.35	$4.06x10^{-6}$	764	S	9.7
Titan	VI	15.94542068	3' 17"	1221.83	0.029192	0.33	$2.37x10^{-4}$	2575	S	8.28
Hyperion	VII	21.2766088	3' 59"	1481.1	0.104	0.43	$4x10^{-8}$	180x140x113		14.19
Iapetus	VIII	79.3301825	9' 35"	3561.3	0.02828	14.72	$2.8x10^{-6}$	718	S	11.1
Phoebe	IX	550.48 R	34' 51"	12952	0.16326	177 [2]	$7x10^{-10}$	110	0.4	16.45
Uranus										
Cordelia	VI	0.3350338	0' 04"	49.77	0.00026	0.08		13		24.1
Ophelia	VII	0.376400	0' 04"	53.79	0.0099	0.10		15		23.8
Bianca	VIII	0.43457899	0' 04"	59.17	0.009	0.19		21		23.0
Cressida	IX	0.46356960	0' 05"	61.78	0.0004	0.01		31		22.2
Desdemona	X	0.47364960	0' 05"	62.68	0.00013	0.11		27		22.5
Juliet	XI	0.49306549	0' 05"	64.35	0.00066	0.07		42		21.5
Portia	XII	0.51319592	0' 05"	66.09	0.0000	0.06		54		21.0
Rosalind	XIII	0.55845953	0' 05"	69.94	0.0001	0.28		27		22.5
Belinda	XIV	0.62352747	0' 06"	75.26	0.00007	0.03		33		22.1
Puck	XV	0.76183287	0' 07"	86.01	0.00012	0.32		77		20.2
Miranda	V	1.41347925	0' 10"	129.39	0.0027	4.2	$0.08x10^{-5}$	240x234x233	S	16.3
Ariel	I	2.52037935	0' 14"	191.02	0.0034	0.3	$1.55x10^{-5}$	581x578x578	S	14.16
Umbriel	II	4.1441772	0' 20"	266.30	0.0050	0.36	$1.35x10^{-5}$	585	S	14.81
Titania	III	8.7058717	0' 33"	435.91	0.0022	0.14	$4.06x10^{-5}$	789	S	13.73
Oberon	IV	13.4632389	0' 44"	583.52	0.0008	0.10	$3.47x10^{-5}$	761	S	13.94
Caliban	XVI	579R	8' 56"	7,169	0.082	139.7 [2]		30		22.4
Sycorax	XVII	1289R	15' 26"	12,214	0.509	152.7 [2]		60		20.9
Neptune										
Naiad	III	0.294396	0' 02"	48.23	0.000	4.74		29		24.7
Thalassa	IV	0.311485	0' 02"	50.07	0.000	0.21		40		23.8
Despina	V	0.334655	0' 02"	52.53	0.000	0.07		74		22.6
Galatea	VI	0.428745	0' 03"	61.95	0.000	0.05		79		22.3
Larissa	VII	0.554654	0' 03"	73.55	0.00139	0.20		104x89		22.0
Proteus	VIII	1.122315	0' 06"	117.65	0.0004	0.55		218x208x201	S	20.3
Triton	I	5.8768541 R	0' 17"	354.76	0.000016	157.345	$2.09x10^{-4}$	1353	S	13.47
Nereid	II	360.13619	4' 21"	5513.4	0.7512	27.6 [3]	$2x10^{-7}$	170		18.7
Pluto										
Charon	I	6.38725	<1"	19.6	<0.001	99 [3]	0.125	593	S	16.8

Notes: **1** - Sidereal periods, except tropical periods are given for Saturn. **2** - Relative to the ecliptic plane. **3** - Referred to the equator of 1950.0
4 - S = Synchronous, rotation period same as orbital period. i.e., keeps the same section of its surface facing its planet.

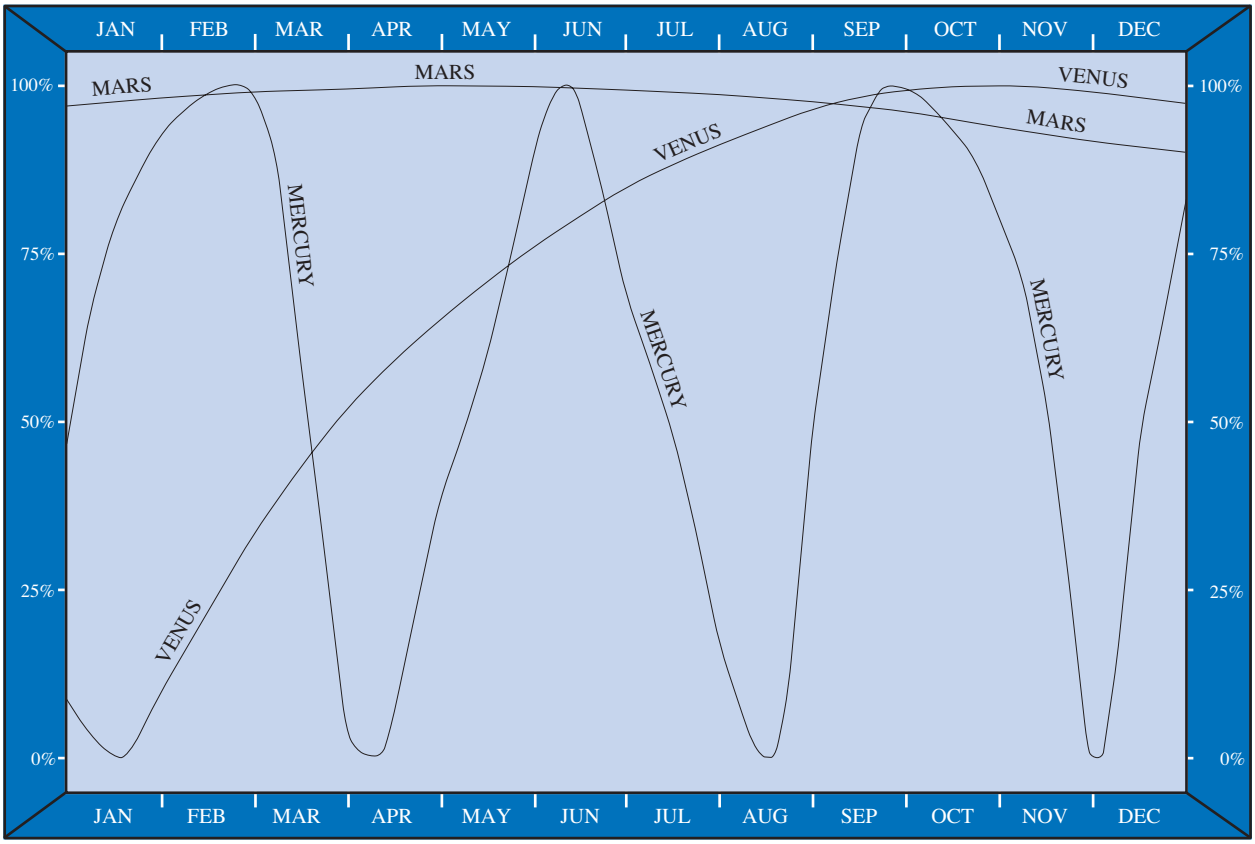
DECLINATIONS of the SUN and PLANETS



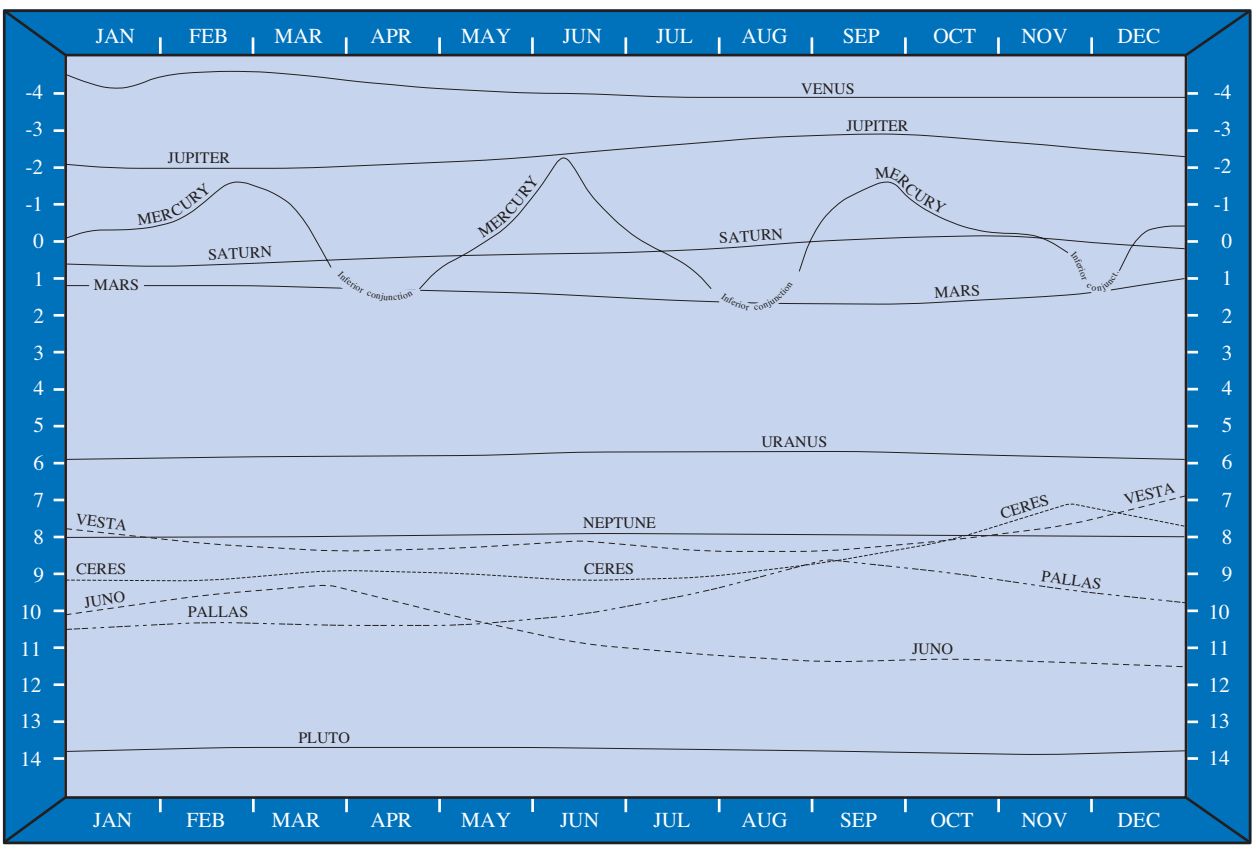
PLANETARY ANGULAR SIZE



PLANET ILLUMINATION

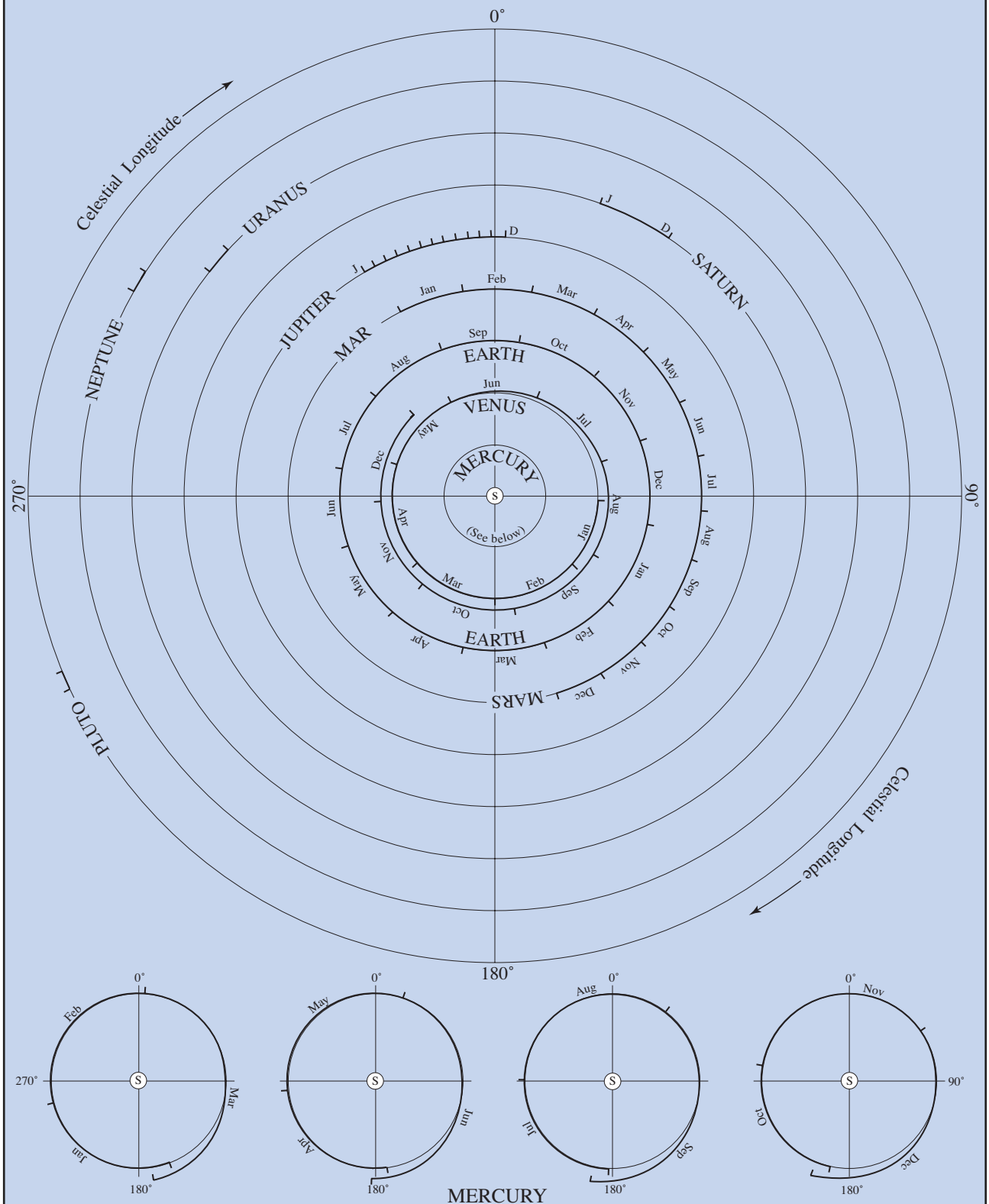


MAGNITUDES of the PLANETS and MAJOR ASTEROIDS



PLANET POSITIONS

This diagram illustrates the relative positions of the planets during the course of their orbits in 1998. The illustration clearly shows the relationship between the solar system bodies. For example, this year's opposition of Saturn occurs in October when the Earth appears closest to that planet. The diagram is drawn as viewed from below (South of) the solar system. The drawing has been simplified in that the orbits are not shown as ellipses and the sun and planet distances are not drawn to scale. It should also be noted that Pluto, with its highly elliptical orbit, is at present inside the orbit of Neptune. This situation continues until 1999.



SUN

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

SUN RISE, SUN SET AND ASTRONOMICAL TWILIGHT

AEST (Adelaide & Darwin ACST)

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

SUN RISE, SUN SET AND ASTRONOMICAL TWILIGHT

AEST

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

ORIENTATION OF THE SUN

DATE (0hr UT)		P°	B_o°	L_o°
Jan	3	1.17	-3.25	256.81
	10	-2.21	-4.03	164.62
	17	-5.51	-4.74	072.44
	24	-8.69	-5.39	340.27
	31	-11.69	-5.95	248.11
Feb	7	-14.47	-6.41	155.95
	14	-17.00	-6.78	063.78
	21	-19.26	-7.05	331.60
	28	-21.23	-7.20	239.40
Mar	7	-22.89	-7.25	147.19
	14	-24.24	-7.19	054.95
	21	-25.25	-7.02	322.67
	28	-25.93	-6.75	230.37
Apr	4	-26.26	-6.38	138.03
	11	-26.24	-5.92	045.65
	18	-25.86	-5.38	313.22
	25	-25.11	-4.76	220.76
May	2	-24.01	-4.08	128.26
	9	-22.56	-3.35	035.73
	16	-20.77	-2.57	303.16
	23	-18.66	-1.76	210.56
	30	-16.26	-0.92	117.95
Jun	6	-13.61	-0.08	025.31
	13	-10.75	0.76	292.66
	20	-7.73	1.60	200.00
	27	-4.61	2.41	107.34
Jul	4	-1.44	3.18	014.69
	11	1.73	3.92	282.04
	18	4.84	4.60	189.41
	25	7.85	5.22	096.80
Aug	1	10.73	5.77	004.21
	8	13.42	6.25	271.64
	15	15.92	6.63	179.09
	22	18.19	6.93	086.58
	29	20.22	7.13	354.09
Sep	5	21.99	7.24	261.62
	12	23.47	7.24	169.18
	19	24.66	7.14	076.77
	26	25.54	6.93	344.37
Oct	3	26.09	6.63	252.00
	10	26.29	6.23	159.64
	17	26.14	5.73	067.30
	24	25.61	5.15	334.98
	31	24.71	4.50	242.66
Nov	7	23.42	3.77	150.36
	14	21.75	2.98	058.07
	21	19.70	2.15	325.80
	28	17.31	1.28	233.53
Dec	5	14.61	0.39	141.28
	12	11.65	-0.50	049.04
	19	8.48	-1.39	316.82
	26	5.16	-2.26	224.61
		1.78	-3.10	132.41

VARIATION OF L_o

DAILY

1	13.18
2	26.37
3	39.55
4	52.73
5	65.91
6	79.10

HOURLY

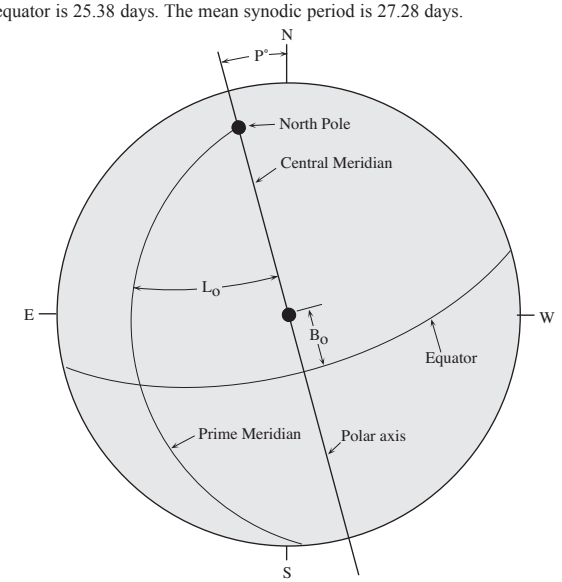
1	0.55
2	1.10
3	1.65
4	2.20
5	2.75
6	3.30
7	3.84
8	4.39
9	4.94
10	5.49
11	6.04
12	6.59
13	7.14
14	7.69
15	8.24
16	8.79
17	9.34
18	9.89
19	10.43
20	10.98
21	11.53
22	12.08
23	12.63
24	13.18

SYNODIC ROTATION NUMBERS (UT)

		d.dd
1932	Jan	22.50
1933	Feb	18.85
1934	Mar	18.17
1935	Apr	14.46
1936	May	11.70
1937	Jun	7.91
1938	Jul	5.11
1939	Aug	1.32
1940	Aug	28.56
1941	Sep	24.82
1942	Oct	22.10
1943	Nov	18.41
1944	Dec	15.72

P° Position angle of Polar Axis. (+ when pole east of north point, - if west)
Bo° Heliocentric Latitude of centre of Sun
Lo° Heliocentric Longitude of centre of Sun

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



SOLAR AND LUNAR ECLIPSES

During 1998 there are five eclipses, two of the Sun and three of the Moon. One solar eclipse is total and the other annular. All the lunar eclipses are penumbral. From Australia the partial phases of the annular solar eclipse, and the penumbral lunar eclipse of 6th September are visible.

26th February TOTAL ECLIPSE of the SUN

This eclipse is visible from the eastern parts of the USA, Canada, Mexico and Central America, northern part of South America and the West Indies. The maximum duration of totality is 4 minutes and 8 seconds.

13th March PENUMBRAL ECLIPSE of the MOON

Visible from the Americas, west Africa and the UK.

5th August PENUMBRAL ECLIPSE of the MOON

This eclipse, although real, is not considered observable as only a very small portion of the Moon is immersed in the outer penumbral shadow.

22nd August ANNULAR ECLIPSE of the SUN

Annular path visible from Sumatra, Borneo and north of New Guinea. From Australia and New Zealand the partially eclipsed Sun is visible, see next page for detail.

6th September PENUMBRAL ECLIPSE of the MOON

This eclipse will be visible from Australia, although twilight interferes with the early stages of the eclipse from Western Australia. Many people would debate whether it is worthwhile viewing such an event. The change in the Moon's brightness can be subtle. See next page for detail.

	Stage	AEST
Moon enters penumbra	P1	19h 14.3m
Middle of eclipse	Mid	21h 10.0m
Moon leaves penumbra	P4	23h 06.2m

MOON PHASES (AEST)

Lunation	New Moon d h:m	First Quarter d h:m	Full Moon d h:m	Last Quarter d h:m
928		Jan 06 00:18	Jan 13 03:24	Jan 21 05:40
929	Jan 28 16:01	Feb 04 08:53	Feb 11 20:23	Feb 20 01:27
930	Feb 27 03:26	Mar 05 18:41	Mar 13 14:34	Mar 21 17:38
931	Mar 28 13:14	Apr 04 06:18	Apr 12 08:23	Apr 20 05:53
932	Apr 26 21:41	May 03 20:04	May 12 00:29	May 19 14:35
933	May 26 05:32	Jun 02 11:45	Jun 10 14:18	Jun 17 20:38
934	Jun 24 13:50	Jul 02 04:43	Jul 10 02:01	Jul 17 01:13
935	Jul 23 23:44	Jul 31 22:05	Aug 08 12:10	Aug 15 05:48
936	Aug 22 12:03	Aug 30 15:07	Sep 06 21:21	Sep 13 11:58
937	Sep 21 03:01	Sep 29 07:11	Oct 06 06:12	Oct 12 21:11
938	Oct 20 20:09	Oct 28 21:46	Nov 04 15:18	Nov 11 10:28
939	Nov 19 14:27	Nov 27 10:23	Dec 04 01:19	Dec 11 03:54
940	Dec 19 08:42	Dec 26 20:46		

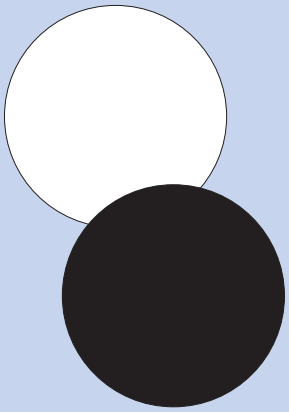
MOON DISTANCE (AEST)

APOGEE d hh		APOGEE d hh		PERIGEE d hh		PERIGEE d hh	
Jan	19 07	Jul	30 22	Jan	3 19	Jul	17 00
Feb	16 01	Aug	27 16	Jan	31 00	Aug	11 22
Mar	15 11	Sep	24 08	Feb	28 06	Sep	8 16
Apr	11 12	Oct	21 15	Mar	27 17	Oct	6 23
May	8 19	Nov	17 16	Apr	26 04	Nov	4 11
Jun	5 10	Dec	15 03	May	24 10	Dec	2 22
Jul	3 03			Jun	21 03	Dec	31 04

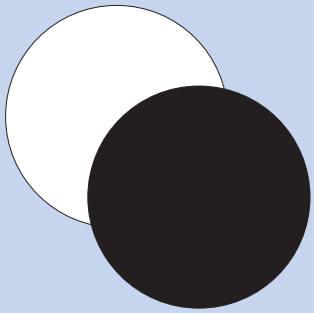
ANNULAR SOLAR ECLIPSE of 22nd August 1998

The diagrams show the appearance of the Sun at the approximate local time of mid eclipse. North is up.
Above each city is the beginning and end times. All times are correct to within a few minutes.

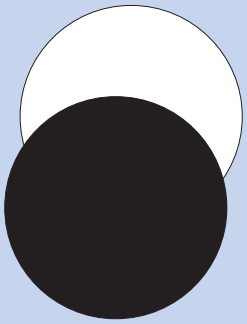
ADELAIDE at Noon ACST
Begin 11.00am, end 1.00pm



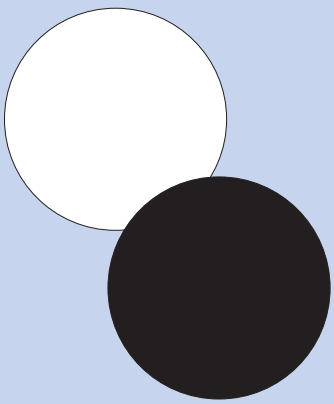
BRISBANE at 1.00pm AEST
Begin 11.30am, end 2.30pm



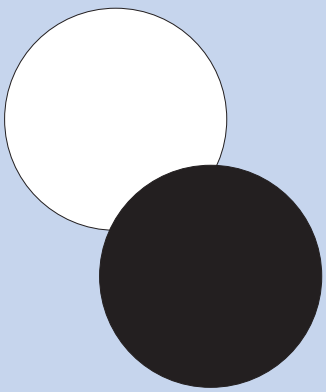
DARWIN at 11.15am ACST
Begin 9.30am, end 12.55pm



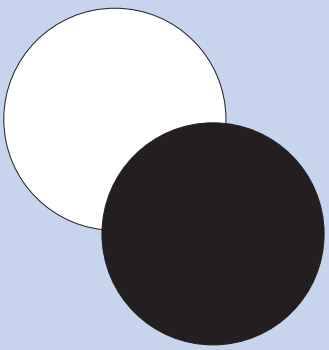
HOBART at 12.55pm AEST
Begin 12.10pm, end 1.40pm



MELBOURNE at 12.50pm AEST
Begin 11.50am, end 1.50pm

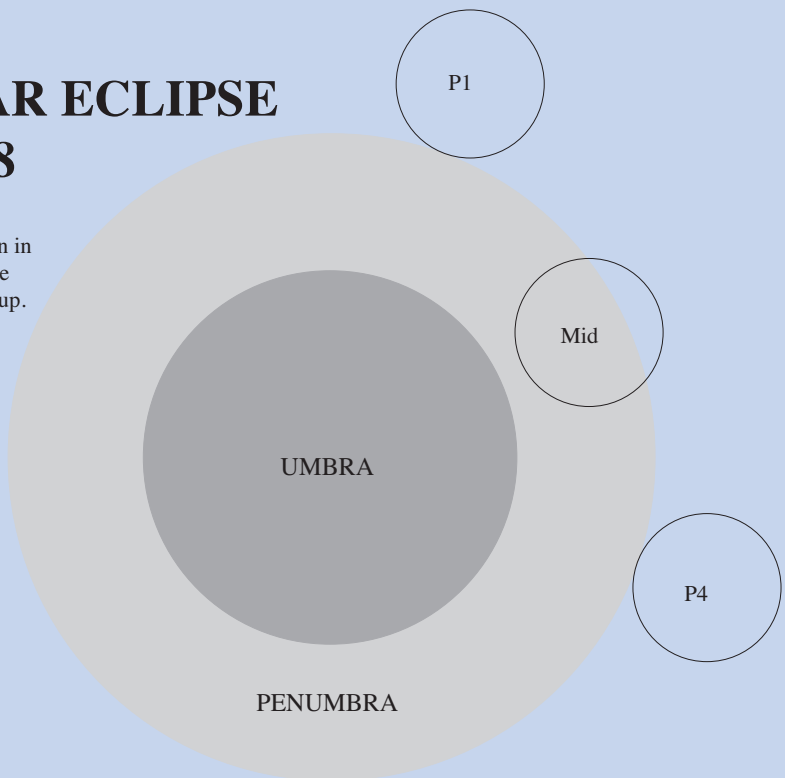


SYDNEY at 1.00pm AEST
Begin 11.45am, end 2.15pm



PENUMBRAL LUNAR ECLIPSE of 6th September 1998

The diagram shows the relative position of the Moon in relation to the Earth's shadow at various stages of the eclipse (times given in table are in AEST). North is up. FromWestern Australia the eclipse begins with the Moon below the horizon, twilight then interferes until about mid-eclipse.



Moon enters penumbra (P1) 19h 14.3m
Middle of eclipse (Mid) 21h 10.0m
Moon leaves penumbra (P4) 23h 6.2m

MOON RISE AND SET

ADELAIDE — ACST

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:33	21:25	09:44	22:06	08:34	20:41	10:45	21:32
2	08:38	22:08	10:51	22:46	09:43	21:23	11:48	22:23
3	09:44	22:49	11:57	23:26	10:51	22:06	12:45	23:17
4	10:49	23:27	13:01	DNS	11:56	22:51	13:36	DNS
5	11:55	DNS	14:04	00:08	12:58	23:39	14:22	00:12
6	13:00	00:06	15:04	00:53	13:56	DNS	15:03	01:08
7	14:04	00:44	16:00	01:42	14:50	00:30	15:40	02:03
8	15:08	01:25	16:53	02:33	15:38	01:23	16:15	02:58
9	16:10	02:08	17:40	03:27	16:22	02:18	16:47	03:53
10	17:10	02:55	18:23	04:23	17:02	03:13	17:18	04:46
11	18:07	03:45	19:02	05:19	17:39	04:08	17:49	05:40
12	18:58	04:39	19:38	06:15	18:12	05:03	18:21	06:33
13	19:45	05:35	20:11	07:10	18:45	05:58	18:54	07:27
14	20:27	06:32	20:43	08:04	19:16	06:51	19:30	08:21
15	21:04	07:28	21:14	08:58	19:47	07:45	20:08	09:15
16	21:39	08:24	21:46	09:51	20:19	08:38	20:51	10:10
17	22:11	09:19	22:18	10:45	20:53	09:32	21:38	11:03
18	22:43	10:13	22:53	11:38	21:29	10:26	22:30	11:55
19	23:14	11:06	23:31	12:33	22:09	11:20	23:26	12:45
20	23:46	12:00	DNR	13:28	22:54	12:14	DNR	13:33
21	DNR	12:54	00:14	14:23	23:43	13:08	00:26	14:18
22	00:19	13:49	01:01	15:18	DNR	14:00	01:30	15:00
23	00:56	14:45	01:55	16:12	00:38	14:51	02:36	15:41
24	01:37	15:41	02:54	17:03	01:38	15:39	03:44	16:22
25	02:23	16:38	03:58	17:51	02:42	16:24	04:54	17:03
26	03:15	17:34	05:05	18:36	03:49	17:08	06:04	17:45
27	04:12	18:27	06:14	19:19	04:58	17:50	07:15	18:30
28	05:15	19:17	07:24	20:00	06:09	18:31	08:24	19:19
29	06:21	20:03			07:20	19:14	09:31	20:11
30	07:29	20:46			08:30	19:57	10:33	21:05
31	08:37	21:27			09:39	20:43		

	MAY		JUNE		JULY		AUGUST	
1	11:28	22:02	12:16	23:38	11:55	DNS	12:02	00:43
2	12:18	22:59	12:51	DNS	12:26	00:11	12:39	01:37
3	13:02	23:56	13:23	00:33	12:57	01:05	13:19	02:32
4	13:41	DNS	13:54	01:27	13:29	01:59	14:04	03:27
5	14:17	00:52	14:24	02:20	14:04	02:53	14:54	04:21
6	14:49	01:47	14:56	03:14	14:43	03:48	15:49	05:14
7	15:21	02:41	15:30	04:08	15:25	04:44	16:50	06:05
8	15:52	03:34	16:06	05:03	16:13	05:39	17:54	06:53
9	16:23	04:28	16:46	05:58	17:06	06:33	18:59	07:37
10	16:55	05:21	17:31	06:54	18:03	07:25	20:06	08:19
11	17:30	06:16	18:20	07:48	19:04	08:14	21:13	08:58
12	18:08	07:10	19:14	08:41	20:08	08:59	22:20	09:37
13	18:49	08:05	20:12	09:30	21:12	09:41	23:27	10:16
14	19:35	09:00	21:13	10:17	22:18	10:21	DNR	10:56
15	20:25	09:53	22:16	11:00	23:23	10:59	00:33	11:39
16	21:20	10:44	23:20	11:40	DNR	11:36	01:37	12:25
17	22:18	11:32	DNR	12:19	00:28	12:15	02:39	13:15
18	23:20	12:16	00:25	12:56	01:34	12:56	03:38	14:09
19	DNR	12:59	01:30	13:35	02:40	13:40	04:32	15:05
20	00:23	13:39	02:37	14:15	03:44	14:28	05:21	16:03
21	01:28	14:18	03:44	14:57	04:46	15:20	06:05	17:01
22	02:35	14:57	04:51	15:44	05:45	16:16	06:45	17:59
23	03:43	15:37	05:56	16:35	06:38	17:14	07:21	18:56
24	04:52	16:19	06:59	17:30	07:26	18:13	07:54	19:52
25	06:01	17:05	07:56	18:29	08:09	19:12	08:26	20:46
26	07:09	17:55	08:48	19:28	08:47	20:10	08:57	21:40
27	08:14	18:49	09:33	20:27	09:22	21:06	09:28	22:34
28	09:15	19:46	10:14	21:26	09:55	22:01	10:01	23:27
29	10:09	20:45	10:50	22:22	10:26	22:55	10:36	DNS
30	10:57	21:44	11:23	23:17	10:57	23:49	11:14	00:21
31	11:39	22:41			11:29	DNS	11:56	01:15

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	12:42	02:09	13:15	02:31	15:16	03:15	16:21	03:07
2	13:35	03:02	14:18	03:17	16:25	03:54	17:32	03:49
3	14:32	03:53	15:23	04:01	17:36	04:35	18:43	04:35
4	15:34	04:42	16:32	04:43	18:48	05:17	19:51	05:27
5	16:39	05:28	17:41	05:24	19:59	06:02	20:53	06:23
6	17:47	06:11	18:52	06:04	21:08	06:51	21:50	07:22
7	18:56	06:52	20:03	06:46	22:12	07:45	22:39	08:24
8	20:05	07:33	21:13	07:29	23:10	08:42	23:22	09:26
9	21:14	08:13	22:21	08:15	DNR	09:41	DNR	10:26
10	22:22	08:54	23:25	09:05	00:01	10:41	00:00	11:24
11	23:29	09:37	DNR	09:58	00:45	11:40	00:34	12:21
12	DNR	10:23	00:24	10:54	01:24	12:37	01:06	13:16
13	00:33	11:12	01:17	11:52	02:00	13:33	01:37	14:10
14	01:33	12:05	02:04	12:49	02:32	14:28	02:07	15:03
15	02:29	13:00	02:45	13:47	03:03	15:22	02:39	15:57
16	03:19	13:57	03:23	14:43	03:34	16:16	03:12	16:51
17	04:04	14:55	03:57	15:39	04:05	17:10	03:48	17:45
18	04:44	15:52	04:29	16:33	04:37	18:04	04:27	18:39
19	05:21	16:48	05:00	17:27	05:11	18:58	05:11	19:32
20	05:55	17:44	05:31	18:21	05:49	19:52	06:00	20:23
21	06:27	18:39	06:02	19:15	06:29	20:45	06:52	21:10
22	06:58	19:33	06:35	20:09	07:15	21:36	07:49	21:55
23	07:29	20:27	07:11	21:02	08:04	22:25	08:48	22:36
24	08:01	21:20	07:49	21:56	08:57	23:11	09:48	23:14
25	08:35	22:14	08:31	22:48	09:54	23:54	10:51	23:51
26	09:11	23:07	09:17	23:38	10:53	DNS	11:54	DNS
27	09:51	DNS	10:08	DNS	11:55	00:34	12:58	00:28
28	10:35	00:00	11:03	00:26	12:59	01:12	14:04	01:05
29	11:23	00:52	12:02	01:12	14:04	01:50	15:12	01:44
30	12:17	01:43	13:04	01:55	15:12	02:28	16:20	02:26
31			14:09	02:36			17:28	03:13

Note: DNR means Moon does not rise on that day, DNS means Moon does not set. See explanation page 69.

BRISBANE — AEST

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:14	20:45	09:15	21:38	08:03	20:15	10:03	21:16
2	08:17	21:32	10:18	22:21	09:08	21:00	11:04	22:08
3	09:20	22:15	11:20	23:04	10:12	21:46	12:00	23:02
4	10:22	22:57	12:22	23:50	11:15	22:34	12:52	23:57
5	11:24	23:39	13:22	DNS	12:15	23:24	13:40	DNS
6	12:25	DNS	14:20	00:37	13:12	DNS	14:23	00:51
7	13:26	00:21	15:16	01:26	14:06	00:15	15:02	01:44
8	14:27	01:04	16:09	02:18	14:55	01:08	15:39	02:36
9	15:28	01:50	16:57	03:12	15:41	02:01	16:15	03:28
10	16:26	02:39	17:42	04:06	16:23	02:55	16:49	04:19
11	17:22	03:30	18:24	05:00	17:02	03:48	17:22	05:09
12	18:14	04:24	19:02	05:53	17:38	04:40	17:57	06:00
13	19:02	05:19	19:38	06:46	18:13	05:32	18:33	06:51
14	19:46	06:14	20:13	07:37	18:47	06:23	19:11	07:42
15	20:27	07:09	20:47	08:28	19:21	07:13	19:51	08:34
16	21:04	08:02	21:21	09:19	19:56	08:04	20:35	09:27
17	21:39	08:54	21:56	10:09	20:32	08:55	21:23	10:19
18	22:13	09:45	22:33	11:01	21:11	09:46	22:14	11:11
19	22:47	10:36	23:14	11:53	21:53	10:39	23:10	12:02
20	23:22	11:26	23:58	12:46	22:38	11:31	DNR	12:51
21	23:58	12:17	DNR	13:40	23:28	12:24	00:08	13:38
22	DNR	13:10	00:46	14:34	DNR	13:16	01:09	14:23
23	00:37	14:03	01:39	15:28	00:22	14:08	02:12	15:08
24	01:20	14:58	02:37	16:20	01:20	14:58	03:16	15:52
25	02:07	15:54	03:39	17:11	02:22	15:46	04:22	16:36
26	02:59	16:49	04:44	17:59	03:26	16:33	05:29	17:22
27	03:56	17:44	05:50	18:46	04:32	17:18	06:36	18:11
28	04:57	18:36	06:56	19:31	05:39	18:04	07:43	19:02
29	06:01	19:25			06:46	18:49	08:47	19:55
30	07:06	20:11			07:53	19:36	09:48	20:51
31	08:11	20:55			08:59	20:25		

	MAY		JUNE		JULY		AUGUST	
1	10:44	21:47	11:39	23:15	11:25	23:42	11:42	00:05
2	11:35	22:43	12:16	DNS	11:58	DNS	12:20	00:57
3	12:21	23:37	12:51	00:08	12:32	00:32	13:02	01:50
4	13:02	DNS	13:25	00:59	13:08	01:23	13:48	02:43
5	13:40	00:31	13:59	01:49	13:45	02:15	14:39	03:37
6	14:16	01:23	14:33	02:40	14:25	03:07	15:34	04:30
7	14:50	02:14	15:09	03:31	15:10	04:01	16:33	05:22
8	15:24	03:05	15:48	04:23	15:58	04:55	17:34	06:11
9	15:58	03:55	16:30	05:16	16:51	05:48	18:37	06:58
10	16:33	04:46	17:16	06:10	17:47	06:41	19:41	07:43
11	17:10	05:38	18:06	07:04	18:47	07:31	20:44	08:27
12	17:50	06:30	18:59	07:56	19:47	08:19	21:47	09:09
13	18:33	07:23	19:56	08:47	20:49	09:04	22:50	09:51
14	19:20	08:16	20:55	09:35	21:51	09:47	23:53	10:35
15	20:10	09:08	21:54	10:21	22:52	10:28	DNR	11:21
16	21:04	10:00	22:55	11:04	23:54	11:10	00:55	12:09
17	22:01	10:49	23:56	11:46	DNR	11:52	01:55	13:00
18	23:00	11:36	DNR	12:27	00:57	12:35	02:53	13:54
19	DNR	12:21	00:58	13:09	01:59	13:22	03:48	14:50
20	00:00	13:04	02:01	13:52	03:01	14:12	04:38	15:46
21	01:02	13:46	03:05	14:38	04:02	15:05	05:24	16:42
22	02:05	14:29	04:09	15:27	05:00	16:01	06:06	17:38
23	03:09	15:12	05:13	16:20	05:54	16:58	06:45	18:32
24	04:15	15:58	06:14	17:16	06:44	17:56	07:21	19:24
25	05:21	16:47	07:11	18:13	07:29	18:52	07:56	20:16
26	06:26	17:39	08:04	19:12	08:10	19:47	08:30	21:07
27	07:30	18:34	08:52	20:09	08:48	20:41	09:04	21:58
28	08:30	19:31	09:35	21:04	09:23	21:33	09:40	22:49
29	09:25	20:29	10:14	21:58	09:57	22:24	10:17	23:40
30	10:14	21:26	10:50	22:50	10:31	23:14	10:57	DNS
31	10:59	22:22			11:06	DNS	11:40	00:32

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	12:28	01:25	12:59	01:48	14:49	02:42	15:44	02:43
2	13:20	02:17	13:59	02:36	15:54	03:25	16:52	03:28
3	14:16	03:09	15:01	03:23	17:01	04:08	17:59	04:17
4	15:16	03:59	16:06	04:08	18:09	04:54	19:05	05:11
5	16:19	04:48	17:12	04:52	19:17	05:43	20:08	06:08
6	17:23	05:34	18:18	05:36	20:23	06:35	21:05	07:08
7	18:28	06:19	19:26	06:21	21:27	07:30	21:56	08:08
8	19:33	07:03	20:33	07:08	22:25	08:27	22:42	09:08
9	20:39	07:47	21:38	07:57	23:17	09:26	23:23	10:06
10	21:44	08:31	22:41	08:49	DNR	10:24	DNR	11:01
11	22:48	09:17	23:39	09:44	00:04	11:21	00:00	11:55
12	23:50	10:06	DNR	10:39	00:46	12:16	00:35	12:47
13	DNR	10:57	00:33	11:36	01:24	13:09	01:09	13:38
14	00:49	11:50	01:21	12:32	02:00	14:01	01:42	14:28
15	01:44	12:45	02:05	13:27	02:34	14:52	02:16	15:19
16	02:35	13:41	02:45	14:21	03:07	15:43	02:52	16:11
17	03:22	14:37	03:22	15:14	03:41	16:34	03:30	17:03
18	04:05	15:31	03:57	16:05	04:16	17:25	04:12	17:55
19	04:44	16:25	04:31	16:56	04:52	18:17	04:57	18:47
20	05:21	17:18	05:05	17:47	05:32	19:09	05:46	19:38
21	05:56	18:10	05:39	18:38	06:14	20:00	06:38	20:27
22	06:30	19:01	06:15	19:29	07:00	20:51	07:32	21:13
23	07:04	19:51	06:52	20:21	07:50	21:40	08:29	21:56
24	07:39	20:42	07:33	21:12	08:42	22:28	09:27	22:38
25	08:15	21:34	08:16	22:03	09:37	23:13	10:26	23:18
26	08:53	22:25	09:03	22:53	10:34	23:56	11:26	23:58
27	09:35	23:17	09:53	23:42	11:33	DNS	12:27	DNS
28	10:20	DNS	10:47	DNS	12:33	00:37	13:29	00:39
29	11:09	00:08	11:44	00:29	13:35	01:18	14:33	01:21
30	12:02	00:59	12:44	01:15	14:39	02:00	15:38	02:06
31			13:45	01:59			16:44	02:56

CANBERRA

AEST

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:18	21:12	09:30	21:53	08:20	20:28	10:32	21:18
2	08:23	21:56	10:37	22:32	09:29	21:09	11:34	22:09
3	09:29	22:36	11:43	23:12	10:37	21:52	12:32	23:03
4	10:35	23:14	12:48	23:55	11:42	22:37	13:23	23:58
5	11:41	23:52	13:51	DNS	12:45	23:25	14:09	DNS
6	12:46	DNS	14:51	00:40	13:43	DNS	14:50	00:54
7	13:51	00:31	15:47	01:28	14:37	00:16	15:28	01:49
8	14:55	01:11	16:40	02:19	15:26	01:09	16:02	02:44
9	15:57	01:54	17:28	03:13	16:10	02:04	16:34	03:39
10	16:57	02:41	18:11	04:08	16:50	02:59	17:05	04:33
11	17:54	03:31	18:50	05:05	17:26	03:54	17:36	05:26
12	18:45	04:25	19:25	06:01	18:00	04:49	18:08	06:20
13	19:32	05:21	19:59	06:56	18:32	05:44	18:41	07:14
14	20:14	06:17	20:30	07:50	19:03	06:38	19:16	08:08
15	20:52	07:14	21:01	08:44	19:34	07:31	19:55	09:02
16	21:26	08:10	21:33	09:38	20:06	08:25	20:37	09:57
17	21:59	09:05	22:05	10:31	20:40	09:19	21:24	10:50
18	22:30	09:59	22:40	11:25	21:16	10:13	22:15	11:42
19	23:01	10:53	23:18	12:20	21:56	11:07	23:12	12:32
20	23:32	11:46	DNR	13:15	22:40	12:01	DNR	13:20
21	DNR	12:40	00:00	14:10	23:29	12:55	00:12	14:05
22	00:06	13:35	00:47	15:05	DNR	13:47	01:15	14:47
23	00:43	14:31	01:40	15:59	00:24	14:38	02:22	15:28
24	01:23	15:28	02:39	16:50	01:23	15:26	03:30	16:09
25	02:09	16:25	03:43	17:38	02:27	16:11	04:40	16:49
26	03:00	17:21	04:51	18:23	03:34	16:55	05:50	17:32
27	03:58	18:14	06:00	19:06	04:44	17:37	07:01	18:17
28	05:00	19:04	07:10	19:47	05:55	18:18	08:11	19:05
29	06:06	19:50			07:06	19:00	09:18	19:57
30	07:14	20:33			08:16	19:44	10:20	20:51
31	08:23	21:14			09:26	20:29		

	MAY		JUNE		JULY		AUGUST	
1	11:16	21:48	12:04	23:24	11:42	23:58	11:49	00:29
2	12:05	22:45	12:38	DNS	12:13	DNS	12:25	01:24
3	12:49	23:42	13:10	00:19	12:44	00:52	13:05	02:19
4	13:28	DNS	13:41	01:13	13:16	01:45	13:50	03:14
5	14:04	00:38	14:11	02:07	13:51	02:40	14:40	04:08
6	14:37	01:33	14:43	03:01	14:29	03:35	15:35	05:01
7	15:08	02:27	15:16	03:55	15:11	04:30	16:35	05:52
8	15:39	03:21	15:53	04:50	15:59	05:26	17:39	06:40
9	16:10	04:14	16:33	05:45	16:51	06:20	18:45	07:24
10	16:42	05:08	17:17	06:41	17:49	07:12	19:52	08:06
11	17:16	06:02	18:06	07:35	18:50	08:01	20:59	08:45
12	17:54	06:57	19:00	08:28	19:54	08:46	22:06	09:24
13	18:35	07:52	19:58	09:18	20:58	09:28	23:13	10:03
14	19:21	08:47	20:59	10:04	22:04	10:08	DNR	10:43
15	20:11	09:40	22:02	10:47	23:09	10:46	00:19	11:26
16	21:06	10:31	23:06	11:27	DNR	11:23	01:24	12:11
17	22:04	11:19	DNR	12:06	00:15	12:02	02:26	13:01
18	23:05	12:04	00:11	12:43	01:20	12:42	03:25	13:55
19	DNR	12:46	01:16	13:21	02:26	13:26	04:19	14:51
20	00:09	13:26	02:23	14:01	03:31	14:14	05:08	15:49
21	01:14	14:04	03:30	14:44	04:33	15:06	05:52	16:47
22	02:21	14:43	04:37	15:30	05:32	16:01	06:32	17:45
23	03:29	15:23	05:43	16:21	06:25	17:00	07:08	18:42
24	04:38	16:06	06:46	17:16	07:13	17:59	07:41	19:38
25	05:47	16:51	07:43	18:14	07:56	18:58	08:13	20:32
26	06:56	17:41	08:35	19:14	08:34	19:56	08:44	21:27
27	08:01	18:35	09:20	20:13	09:09	20:52	09:15	22:20
28	09:02	19:32	10:01	21:11	09:42	21:47	09:48	23:14
29	09:56	20:31	10:37	22:08	10:13	22:42	10:22	DNS
30	10:44	21:29	11:10	23:04	10:44	23:35	11:00	00:08
31	11:26	22:27			11:15	DNS	11:42	01:02

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	12:28	01:56	13:01	02:19	15:02	03:02	16:08	02:54
2	13:20	02:49	14:03	03:05	16:11	03:41	17:18	03:36
3	14:18	03:40	15:09	03:48	17:22	04:21	18:29	04:22
4	15:20	04:29	16:17	04:30	18:34	05:03	19:37	05:12
5	16:25	05:15	17:27	05:10	19:46	05:48	20:40	06:08
6	17:33	05:58	18:38	05:51	20:54	06:37	21:37	07:08
7	18:42	06:39	19:49	06:32	21:59	07:30	22:26	08:10
8	19:51	07:20	21:00	07:15	22:57	08:27	23:09	09:11
9	21:00	07:59	22:08	08:01	23:48	09:26	23:47	10:12
10	22:09	08:40	23:12	08:51	DNR	10:26	DNR	11:10
11	23:16	09:23	DNR	09:44	00:32	11:25	00:21	12:07
12	DNR	10:09	00:11	10:40	01:12	12:23	00:53	13:02
13	00:20	10:58	01:04	11:37	01:47	13:20	01:24	13:56
14	01:20	11:51	01:51	12:35	02:20	14:15	01:54	14:50
15	02:16	12:46	02:33	13:33	02:51	15:09	02:25	15:44
16	03:06	13:43	03:10	14:29	03:21	16:03	02:58	16:38
17	03:51	14:41	03:44	15:25	03:52	16:56	03:34	17:32
18	04:31	15:38	04:16	16:20	04:24	17:51	04:14	18:26
19	05:08	16:35	04:47	17:14	04:58	18:45	04:57	19:19
20	05:42	17:30	05:18	18:08	05:35	19:39	05:46	20:10
21	06:14	18:25	05:49	19:02	06:16	20:32	06:38	20:58
22	06:45	19:19	06:22	19:56	07:01	21:23	07:34	21:42
23	07:16	20:13	06:57	20:49	07:50	22:12	08:33	22:23
24	07:48	21:07	07:35	21:43	08:43	22:58	09:34	23:01
25	08:21	22:01	08:17	22:35	09:40	23:41	10:36	23:38
26	08:58	22:54	09:03	23:25	10:39	DNS	11:40	DNS
27	09:37	23:47	09:54	DNS	11:41	00:21	12:45	00:14
28	10:21	DNS	10:49	00:13	12:45	01:00	13:51	00:51
29	11:09	00:40	11:48	00:59	13:50	01:37	14:58	01:30
30	12:03	01:30	12:50	01:42	14:58	02:15	16:07	02:12
31			13:55	02:23			17:15	02:59

Note: DNR means Moon does not rise on that day, DNS means Moon does not set. See explanation page 69.

ACST

DARWIN

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	08:37	21:30	10:18	22:42	09:03	21:23	10:45	22:40
2	09:35	22:21	11:16	23:31	10:02	22:14	11:43	23:35
3	10:33	23:10	12:12	DNS	11:01	23:05	12:38	DNS
4	11:29	23:58	13:09	00:20	11:59	23:56	13:31	00:29
5	12:25	DNS	14:05	01:09	12:56	DNS	14:20	01:22
6	13:21	00:45	15:00	02:00	13:51	00:49	15:06	02:13
7	14:17	01:33	15:54	02:52	14:44	01:42	15:49	03:03
8	15:13	02:21	16:47	03:45	15:34	02:34	16:31	03:51
9	16:09	03:12	17:37	04:38	16:22	03:26	17:10	04:38
10	17:05	04:04	18:25	05:30	17:07	04:17	17:49	05:24
11	18:00	04:57	19:09	06:20	17:50	05:06	18:28	06:10
12	18:53	05:51	19:52	07:10	18:31	05:54	19:07	06:56
13	19:43	06:44	20:32	07:58	19:10	06:41	19:47	07:42
14	20:30	07:37	21:12	08:45	19:49	07:27	20:29	08:29
15	21:14	08:28	21:50	09:30	20:28	08:13	21:13	09:18
16	21:56	09:17	22:29	10:16	21:07	08:58	22:00	10:07
17	22:35	10:04	23:09	11:02	21:48	09:45	22:49	10:58
18	23:14	10:50	23:51	11:49	22:31	10:32	23:41	11:49
19	23:53	11:36	DNR	12:37	23:16	11:21	DNR	12:41
20	DNR	12:22	00:35	13:27	DNR	12:11	00:35	13:32
21	00:32	13:08	01:22	14:19	00:04	13:02	01:30	14:23
22	01:13	13:56	02:12	15:12	00:55	13:55	02:27	15:13
23	01:56	14:46	03:06	16:07	01:48	14:48	03:25	16:03
24	02:43	15:38	04:03	17:02	02:45	15:41	04:23	16:53
25	03:33	16:33	05:02	17:56	03:43	16:33	05:23	17:44
26	04:26	17:28	06:02	18:49	04:42	17:25	06:24	18:36
27	05:23	18:24	07:03	19:41	05:42	18:17	07:25	19:30
28	06:22	19:19	08:03	20:32	06:43	19:08	08:26	20:25
29	07:22	20:12			07:44	20:00	09:27	21:21
30	08:21	21:04			08:44	20:53	10:26	22:18
31	09:20	21:54			09:45	21:46		

	MAY		JUNE		JULY		AUGUST	
1	11:22	23:13	12:27	DNS	12:24	DNS	12:58	00:55
2	12:14	DNS	13:08	00:30	13:03	00:43	13:41	01:43
3	13:03	00:07	13:48	01:17	13:41	01:29	14:26	02:32
4	13:48	00:58	14:26	02:03	14:21	02:15	15:14	03:22
5	14:30	01:48	15:05	02:49	15:03	03:02	16:06	04:15
6	15:10	02:35	15:44	03:35	15:47	03:51	17:01	05:08
7	15:49	03:22	16:25	04:21	16:35	04:41	17:57	06:01
8	16:27	04:07	17:08	05:09	17:25	05:33	18:55	06:54
9	17:06	04:53	17:53	05:59	18:18	06:26	19:53	07:45
10	17:46	05:39	18:42	06:50	19:13	07:19	20:51	08:35
11	18:28	06:26	19:33	07:42	20:10	08:12	21:48	09:24
12	19:11	07:14	20:26	08:34	21:06	09:03	22:45	10:13
13	19:57	08:04	21:21	09:26	22:03	09:53	23:42	11:01
14	20:46	08:55	22:16	10:17	22:58	10:41	DNR	11:50
15	21:37	09:46	23:11	11:06	23:54	11:28	00:40	12:41
16	22:30	10:38	DNR	11:55	DNR	12:15	01:37	13:33
17	23:25	11:29	00:07	12:42	00:50	13:03	02:35	14:27
18	DNR	12:19	01:02	13:29	01:47	13:52	03:31	15:21
19	00:20	13:08	01:58	14:17	02:44	14:44	04:25	16:16
20	01:16	13:56	02:55	15:06	03:42	15:37	05:17	17:10
21	02:12	14:44	03:53	15:57	04:41	16:32	06:06	18:03
22	03:09	15:33	04:53	16:51	05:38	17:28	06:52	18:54
23	04:07	16:23	05:53	17:46	06:32	18:24	07:35	19:43
24	05:06	17:14	06:52	18:43	07:24	19:19	08:17	20:30
25	06:07	18:08	07:49	19:40	08:12	20:11	08:56	21:17
26	07:08	19:04	08:43	20:36	08:58	21:01	09:35	22:03
27	08:09	20:02	09:34	21:30	09:40	21:50	10:14	22:49
28	09:08	20:59	10:20	22:21	10:20	22:37	10:54	23:36
29	10:03	21:55	11:04	23:10	10:59	23:23	11:35	DNS
30	10:55	22:49	11:45	23:57	11:38	DNS	12:19	00:23
31	11:42	23:40			12:17	00:09	13:05	01:13

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	13:54	02:03	14:23	02:28	15:56	03:36	16:36	03:53
2	14:47	02:55	15:19	03:19	16:55	04:25	17:38	04:44
3	15:42	03:47	16:17	04:09	17:55	05:16	18:41	05:39
4	16:39	04:40	17:16	05:00	18:57	06:08	19:44	06:37
5	17:37	05:32	18:15	05:50	20:00	07:02	20:45	07:36
6	18:36	06:24	19:16	06:41	21:03	07:59	21:43	08:36
7	19:35	07:14	20:17	07:32	22:04	08:57	22:37	09:35
8	20:34	08:04	21:18	08:25	23:02	09:55	23:26	10:31
9	21:33	08:54	22:19	09:19	23:56	10:53	DNR	11:25
10	22:32	09:45	23:19	10:15	DNR	11:49	00:11	12:15
11	23:31	10:36	DNR	11:11	00:46	12:42	00:53	13:03
12	DNR	11:29	00:17	12:07	01:31	13:32	01:33	13:50
13	00:30	12:23	01:11	13:02	02:14	14:21	02:11	14:36
14	01:27	13:18	02:02	13:55	02:54	15:08	02:50	15:22
15	02:22	14:12	02:49	14:46	03:33	15:53	03:29	16:08
16	03:14	15:06	03:33	15:35	04:12	16:39	04:09	16:55
17	04:03	15:58	04:14	16:23	04:50	17:25	04:52	17:44
18	04:50	16:49	04:54	17:10	05:30	18:12	05:36	18:34
19	05:33	17:38	05:33	17:56	06:11	19:00	06:24	19:24
20	06:14	18:26	06:12	18:42	06:54	19:48	07:13	20:15
21	06:54	19:12	06:51	19:28	07:40	20:38	08:05	21:05
22	07:33	19:58	07:31	20:15	08:27	21:28	08:58	21:54
23	08:12	20:44	08:12	21:03	09:17	22:18	09:51	22:41
24	08:52	21:31	08:56	21:51	10:09	23:07	10:45	23:28
25	09:32	22:18	09:42	22:41	11:01	23:55	11:38	DNS
26	10:14	23:06	10:30	23:31	11:55	DNS	12:32	00:14
27	10:59	23:55	11:21	DNS	12:49	00:42	13:27	00:59
28	11:46	DNS	12:13	00:20	13:43	01:29	14:24	01:46
29	12:36	00:46	13:07	01:10	14:39	02:16	15:22	02:34
30	13:28	01:36	14:02	01:59	15:37	03:03	16:22	03:25
31			14:58	02:48			17:23	04:20

MOON RISE AND SET

HOBART AEST

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:11	21:33	09:38	21:59	08:30	20:32	10:56	21:09
2	08:20	22:13	10:49	22:34	09:44	21:09	12:00	21:59
3	09:30	22:49	11:59	23:11	10:56	21:48	12:58	22:53
4	10:40	23:23	13:08	23:49	12:04	22:30	13:49	23:49
5	11:50	23:57	14:14	DNS	13:09	23:16	14:33	DNS
6	12:59	DNS	15:16	00:32	14:09	DNS	15:12	00:47
7	14:08	00:32	16:14	01:18	15:03	00:06	15:46	01:45
8	15:16	01:08	17:06	02:09	15:51	00:59	16:17	02:43
9	16:21	01:48	17:52	03:03	16:33	01:55	16:46	03:41
10	17:23	02:32	18:33	04:00	17:10	02:52	17:14	04:38
11	18:20	03:21	19:09	04:59	17:44	03:51	17:41	05:35
12	19:11	04:14	19:42	05:58	18:14	04:49	18:09	06:32
13	19:56	05:11	20:12	06:57	18:43	05:47	18:39	07:30
14	20:35	06:10	20:40	07:55	19:10	06:44	19:11	08:27
15	21:10	07:10	21:08	08:52	19:38	07:41	19:47	09:24
16	21:41	08:09	21:36	09:49	20:07	08:38	20:28	10:21
17	22:10	09:07	22:05	10:46	20:37	09:36	21:14	11:16
18	22:38	10:05	22:36	11:43	21:11	10:33	22:05	12:09
19	23:05	11:02	23:11	12:41	21:48	11:30	23:03	12:58
20	23:34	11:59	23:51	13:39	22:30	12:26	DNR	13:43
21	DNR	12:57	DNR	14:36	23:19	13:21	00:05	14:25
22	00:04	13:55	00:37	15:31	DNR	14:13	01:12	15:04
23	00:38	14:54	01:30	16:24	00:14	15:03	02:22	15:41
24	01:16	15:53	02:30	17:13	01:15	15:48	03:35	16:17
25	02:00	16:51	03:36	17:59	02:22	16:30	04:49	16:53
26	02:50	17:47	04:47	18:40	03:33	17:10	06:05	17:31
27	03:48	18:39	06:01	19:19	04:47	17:47	07:20	18:12
28	04:52	19:26	07:16	19:56	06:02	18:24	08:33	18:57
29	06:01	20:09			07:18	19:02	09:43	19:47
30	07:13	20:48			08:33	19:41	10:46	20:41
31	08:26	21:24			09:46	20:23		

	MAY		JUNE		JULY		AUGUST	
1	11:42	21:38	12:22	23:23	11:51	DNS	11:46	00:47
2	12:30	22:37	12:53	DNS	12:18	00:06	12:19	01:44
3	13:12	23:36	13:21	00:22	12:46	01:03	12:57	02:42
4	13:48	DNS	13:49	01:19	13:15	02:01	13:40	03:39
5	14:21	00:35	14:16	02:17	13:47	02:59	14:29	04:35
6	14:50	01:33	14:44	03:14	14:22	03:57	15:25	05:28
7	15:18	02:31	15:14	04:12	15:02	04:55	16:27	06:17
8	15:45	03:28	15:47	05:10	15:48	05:52	17:34	07:02
9	16:13	04:25	16:25	06:08	16:41	06:47	18:44	07:43
10	16:42	05:23	17:07	07:06	17:39	07:38	19:55	08:21
11	17:13	06:21	17:56	08:02	18:43	08:25	21:06	08:56
12	17:48	07:19	18:50	08:54	19:50	09:07	22:18	09:31
13	18:27	08:16	19:49	09:43	20:58	09:46	23:29	10:05
14	19:11	09:12	20:53	10:27	22:08	10:21	DNR	10:41
15	20:01	10:06	21:59	11:07	23:18	10:55	00:39	11:20
16	20:56	10:57	23:07	11:44	DNR	11:28	01:47	12:03
17	21:56	11:43	DNR	12:18	00:28	12:03	02:52	12:51
18	23:00	12:26	00:16	12:51	01:38	12:39	03:52	13:44
19	DNR	13:04	01:26	13:25	02:47	13:20	04:46	14:41
20	00:08	13:40	02:37	14:01	03:55	14:05	05:33	15:41
21	01:17	14:15	03:49	14:39	04:59	14:55	06:15	16:42
22	02:28	14:50	05:00	15:23	05:59	15:51	06:51	17:43
23	03:41	15:25	06:08	16:11	06:51	16:50	07:24	18:43
24	04:54	16:03	07:12	17:05	07:37	17:52	07:54	19:43
25	06:08	16:45	08:10	18:04	08:17	18:54	08:22	20:41
26	07:20	17:32	09:00	19:05	08:52	19:55	08:49	21:39
27	08:27	18:24	09:43	20:07	09:24	20:55	09:17	22:36
28	09:29	19:21	10:21	21:09	09:53	21:54	09:46	23:33
29	10:22	20:21	10:54	22:09	10:20	22:52	10:18	DNS
30	11:08	21:22	11:23	23:08	10:48	23:49	10:53	00:30
31	11:48	22:23			11:16	DNS	11:33	01:27

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	12:18	02:22	12:53	02:44	15:07	03:15	16:24	02:56
2	13:10	03:15	13:58	03:27	16:21	03:50	17:39	03:33
3	14:08	04:06	15:07	04:07	17:37	04:25	18:54	04:15
4	15:13	04:53	16:20	04:45	18:53	05:03	20:04	05:03
5	16:22	05:36	17:35	05:21	20:08	05:44	21:08	05:57
6	17:33	06:15	18:50	05:57	21:20	06:29	22:03	06:56
7	18:47	06:52	20:06	06:34	22:26	07:20	22:51	08:00
8	20:01	07:28	21:21	07:13	23:24	08:16	23:31	09:04
9	21:15	08:04	22:32	07:55	DNR	09:16	DNR	10:08
10	22:27	08:40	23:39	08:42	00:13	10:18	00:05	11:10
11	23:38	09:19	DNR	09:33	00:55	11:20	00:36	12:10
12	DNR	10:02	00:38	10:29	01:31	12:21	01:04	13:09
13	00:45	10:49	01:30	11:28	02:03	13:21	01:31	14:07
14	01:47	11:40	02:15	12:28	02:32	14:19	01:57	15:04
15	02:43	12:35	02:54	13:28	03:00	15:17	02:25	16:02
16	03:32	13:34	03:28	14:28	03:26	16:15	02:55	16:59
17	04:14	14:34	03:59	15:27	03:54	17:12	03:28	17:56
18	04:52	15:35	04:28	16:26	04:22	18:10	04:05	18:52
19	05:25	16:35	04:55	17:24	04:53	19:07	04:47	19:46
20	05:56	17:34	05:22	18:21	05:27	20:03	05:34	20:37
21	06:24	18:33	05:50	19:19	06:06	20:58	06:27	21:23
22	06:52	19:30	06:20	20:16	06:50	21:50	07:25	22:05
23	07:19	20:28	06:52	21:12	07:39	22:39	08:27	22:43
24	07:48	21:25	07:27	22:08	08:33	23:23	09:31	23:18
25	08:18	22:22	08:07	23:01	09:31	DNS	10:37	23:51
26	08:51	23:18	08:53	23:52	10:34	00:03	11:45	DNS
27	09:28	DNS	09:43	DNS	11:39	00:40	12:54	00:23
28	10:11	00:13	10:40	00:39	12:47	01:15	14:05	00:55
29	10:59	01:06	11:41	01:23	13:58	01:48	15:17	01:30
30	11:53	01:56	12:46	02:03	15:10	02:21	16:29	02:08
31			13:55	02:40			17:40	02:51

Note: DNR means Moon does not rise on that day, DNS means Moon does not set. See explanation page 69.

MELBOURNE AEST

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:31	21:33	09:48	22:09	08:38	20:44	10:54	21:30
2	08:37	22:15	10:56	22:47	09:49	21:24	11:57	22:21
3	09:44	22:54	12:03	23:26	10:58	22:05	12:55	23:14
4	10:52	23:32	13:09	DNS	12:04	22:50	13:46	DNS
5	11:58	DNS	14:13	00:07	13:07	23:37	14:31	00:10
6	13:05	00:08	15:13	00:52	14:06	DNS	15:12	01:06
7	14:11	00:46	16:10	01:39	15:00	00:27	15:48	02:03
8	15:16	01:25	17:03	02:30	15:48	01:20	16:21	02:59
9	16:19	02:07	17:50	03:25	16:32	02:15	16:52	03:54
10	17:20	02:53	18:32	04:21	17:11	03:12	17:22	04:49
11	18:17	03:43	19:10	05:18	17:46	04:08	17:52	05:44
12	19:08	04:36	19:45	06:14	18:19	05:04	18:23	06:38
13	19:54	05:32	20:17	07:11	18:50	05:59	18:55	07:33
14	20:35	06:30	20:48	08:06	19:20	06:54	19:29	08:29
15	21:12	07:27	21:18	09:01	19:50	07:49	20:07	09:24
16	21:45	08:24	21:48	09:56	20:21	08:44	20:49	10:19
17	22:17	09:20	22:19	10:51	20:53	09:39	21:35	11:13
18	22:47	10:16	22:53	11:46	21:29	10:34	22:27	12:05
19	23:17	11:10	23:30	12:41	22:08	11:29	23:23	12:55
20	23:47	12:05	DNR	13:37	22:51	12:24	DNR	13:42
21	DNR	13:00	00:12	14:33	23:40	13:18	00:24	14:26
22	00:20	13:56	00:59	15:28	DNR	14:10	01:29	15:07
23	00:55	14:53	01:52	16:21	00:35	15:00	02:37	15:47
24	01:35	15:51	02:51	17:12	01:35	15:48	03:46	16:26
25	02:20	16:48	03:56	17:59	02:40	16:32	04:58	17:05
26	03:12	17:44	05:04	18:43	03:49	17:14	06:10	17:46
27	04:09	18:36	06:15	19:25	05:00	17:55	07:22	18:30
28	05:12	19:25	07:27	20:04	06:12	18:35	08:33	19:17
29	06:19	20:10			07:24	19:15	09:40	20:08
30	07:29	20:52			08:37	19:57	10:43	21:02
31	08:38	21:32			09:47	20:42		

	MAY		JUNE		JULY		AUGUST	
1	11:39	21:59	12:24	23:38	11:59	DNS	12:02	00:49
2	12:28	22:57	12:57	DNS	12:29	00:15	12:38	01:45
3	13:11	23:55	13:28	00:35	12:59	01:10	13:17	02:41
4	13:49	DNS	13:58	01:30	13:30	02:05	14:01	03:36
5	14:24	00:52	14:27	02:25	14:04	03:00	14:51	04:31
6	14:55	01:48	14:58	03:20	14:41	03:56	15:47	05:24
7	15:25	02:43	15:30	04:15	15:23	04:53	16:47	06:15
8	15:55	03:38	16:05	05:11	16:10	05:49	17:52	07:01
9	16:25	04:32	16:45	06:07	17:03	06:43	18:59	07:45
10	16:56	05:27	17:28	07:03	18:01	07:35	20:08	08:25
11	17:30	06:23	18:17	07:58	19:02	08:23	21:16	09:03
12	18:06	07:19	19:12	08:51	20:07	09:07	22:25	09:41
13	18:47	08:14	20:10	09:40	21:13	09:48	23:33	10:18
14	19:32	09:10	21:12	10:26	22:20	10:26	DNR	10:57
15	20:22	10:03	22:16	11:08	23:26	11:03	00:40	11:38
16	21:17	10:54	23:21	11:47	DNR	11:39	01:46	12:23
17	22:16	11:41	DNR	12:24	00:34	12:16	02:49	13:13
18	23:18	12:25	00:27	13:00	01:41	12:56	03:48	14:06
19	DNR	13:06	01:34	13:37	02:48	13:38	04:42	15:02
20	00:23	13:45	02:42	14:15	03:53	14:25	05:31	16:01
21	01:30	14:22	03:51	14:57	04:56	15:17	06:14	17:00
22	02:38	15:00	04:59	15:42	05:55	16:13	06:53	17:59
23	03:47	15:38	06:06	16:33	06:48	17:11	07:27	18:57
24	04:58	16:19	07:09	17:27	07:36	18:11	08:00	19:54
25	06:09	17:04	08:06	18:26	08:17	19:11	08:30	20:50
26	07:18	17:53	08:57	19:26	08:55	20:10	09:00	21:45
27	08:24	18:46	09:42	20:26	09:28	21:08	09:30	22:40
28	09:25	19:43	10:22	21:25	10:00	22:04	10:02	23:35
29	10:19	20:42	10:57	22:23	10:30	23:00	10:35	DNS
30	11:06	21:42	11:29	23:20	10:59	23:55	11:12	00:30
31	11:47	22:41			11:30	DNS	11:53	01:24

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	12:40	02:19	13:13	02:41	15:18	03:21	16:28	03:09
2	13:32	03:12	14:16	03:26	16:29	03:59	17:40	03:49
3	14:29	04:03	15:23	04:09	17:42	04:37	18:52	04:34
4	15:32	04:51	16:33	04:49	18:55	05:18	20:00	05:24
5	16:39	05:36	17:44	05:28	20:08	06:01	21:04	06:19
6	17:48	06:18	18:57	06:07	21:17	06:49	22:00	07:19
7	18:58	06:58	20:09	06:47	22:22	07:42	22:49	08:21
8	20:09	07:37	21:21	07:29	23:20	08:38	23:31	09:24
9	21:20	08:15	22:30	08:14	DNR	09:38	DNR	10:25
10	22:29	08:55	23:35	09:03	00:10	10:38	00:07	11:25
11	23:38	09:37	DNR	09:55	00:54	11:38	00:40	12:23
12	DNR	10:21	00:34	10:51	01:32	12:37	01:11	13:19
13	00:43	11:10	01:27	11:49	02:07	13:35	01:40	14:14
14	01:43	12:02	02:13	12:48	02:38	14:31	02:10	15:09
15	02:39	12:57	02:54	13:46	03:08	15:26	02:40	16:04
16	03:29	13:55	03:30	14:44	03:37	16:21	03:12	16:59
17	04:13	14:53	04:03	15:40	04:07	17:16	03:47	17:55
18	04:52	15:52	04:34	16:36	04:38	18:11	04:25	18:49
19	05:28	16:49	05:04	17:32	05:11	19:06	05:09	19:42
20	06:01	17:46	05:34	18:27	05:47	20:01	05:57	20:33
21	06:32	18:42	06:04	19:22	06:27	20:55	06:49	21:20
22	07:01	19:37	06:36	20:17	07:12	21:46	07:46	22:04
23	07:31	20:32	07:10	21:11	08:01	22:35	08:46	22:44
24	08:02	21:27	07:47	22:05	08:54	23:20	09:48	23:21
25	08:35	22:22	08:29	22:58	09:52	DNS	10:52	23:57
26	09:10	23:16	09:15	23:48	10:52	00:02	11:56	DNS
27	09:49	DNS	10:05	DNS	11:55	00:42	13:02	00:32
28	10:32	00:10	11:01	00:36	13:00	01:19	14:10	01:07
29	11:21	01:03	12:00	01:21	14:07	01:55	15:19	01:44
30	12:14	01:53	13:03	02:03	15:17	02:31	16:29	02:25
31			14:10	02:43			17:38	03:11

MOON RISE AND SET

SYDNEY — AEST

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:12	21:02	09:22	21:45	08:11	20:20	10:21	21:12
2	08:16	21:45	10:28	22:24	09:20	21:02	11:23	22:03
3	09:22	22:26	11:33	23:05	10:27	21:45	12:20	22:57
4	10:27	23:06	12:37	23:48	11:31	22:31	13:12	23:52
5	11:32	23:44	13:39	DNS	12:33	23:19	13:58	DNS
6	12:36	DNS	14:39	00:33	13:32	DNS	14:40	00:48
7	13:40	00:23	15:36	01:22	14:25	00:10	15:17	01:43
8	14:44	01:04	16:28	02:13	15:14	01:03	15:52	02:37
9	15:46	01:48	17:16	03:07	15:59	01:57	16:25	03:31
10	16:46	02:35	18:00	04:02	16:39	02:52	16:56	04:24
11	17:42	03:25	18:39	04:58	17:16	03:47	17:28	05:17
12	18:34	04:19	19:15	05:54	17:50	04:42	18:00	06:10
13	19:21	05:15	19:49	06:48	18:23	05:36	18:33	07:04
14	20:03	06:11	20:21	07:42	18:54	06:29	19:09	07:57
15	20:41	07:07	20:53	08:35	19:26	07:22	19:48	08:51
16	21:16	08:03	21:25	09:28	19:58	08:15	20:31	09:45
17	21:49	08:57	21:58	10:21	20:33	09:08	21:18	10:39
18	22:21	09:51	22:33	11:15	21:09	10:02	22:09	11:31
19	22:52	10:44	23:11	12:09	21:49	10:56	23:05	12:21
20	23:25	11:37	23:54	13:04	22:34	11:50	DNR	13:09
21	23:59	12:30	DNR	13:59	23:23	12:43	00:05	13:54
22	DNR	13:25	00:41	14:54	DNR	13:36	01:08	14:37
23	00:36	14:20	01:34	15:47	00:18	14:27	02:14	15:19
24	01:17	15:17	02:33	16:38	01:17	15:15	03:22	16:00
25	02:03	16:13	03:37	17:27	02:20	16:01	04:31	16:41
26	02:54	17:09	04:44	18:13	03:27	16:45	05:41	17:24
27	03:52	18:02	05:52	18:56	04:36	17:28	06:51	18:10
28	04:54	18:53	07:02	19:38	05:46	18:10	08:00	18:58
29	06:00	19:40			06:56	18:52	09:06	19:51
30	07:07	20:23			08:06	19:36	10:08	20:45
31	08:15	21:05			09:15	20:23		

	MAY		JUNE		JULY		AUGUST	
1	11:04	21:42	11:53	23:17	11:33	23:49	11:42	00:19
2	11:54	22:39	12:28	DNS	12:04	DNS	12:18	01:13
3	12:38	23:35	13:01	00:11	12:36	00:42	12:59	02:07
4	13:18	DNS	13:32	01:05	13:09	01:35	13:44	03:02
5	13:54	00:31	14:03	01:58	13:44	02:29	14:34	03:56
6	14:27	01:25	14:35	02:51	14:22	03:24	15:29	04:50
7	14:59	02:19	15:09	03:45	15:05	04:19	16:29	05:41
8	15:30	03:12	15:46	04:39	15:53	05:14	17:32	06:29
9	16:02	04:05	16:26	05:34	16:46	06:08	18:38	07:14
10	16:35	04:58	17:11	06:29	17:43	07:00	19:44	07:56
11	17:10	05:52	18:00	07:24	18:44	07:50	20:51	08:36
12	17:48	06:46	18:54	08:16	19:47	08:35	21:57	09:15
13	18:29	07:41	19:52	09:06	20:51	09:18	23:03	09:55
14	19:15	08:35	20:52	09:53	21:55	09:58	DNR	10:36
15	20:05	09:28	21:55	10:36	23:00	10:37	00:08	11:19
16	21:00	10:19	22:58	11:17	DNR	11:15	01:12	12:05
17	21:58	11:07	DNR	11:56	00:05	11:54	02:14	12:55
18	22:58	11:53	00:02	12:35	01:10	12:35	03:13	13:49
19	DNR	12:35	01:07	13:13	02:15	13:19	04:07	14:45
20	00:01	13:16	02:13	13:54	03:19	14:08	04:57	15:43
21	01:06	13:55	03:20	14:37	04:22	15:00	05:41	16:41
22	02:12	14:35	04:26	15:24	05:20	15:56	06:21	17:38
23	03:19	15:15	05:32	16:15	06:14	16:54	06:58	18:34
24	04:28	15:59	06:34	17:10	07:02	17:53	07:32	19:29
25	05:37	16:45	07:31	18:08	07:45	18:51	08:04	20:24
26	06:45	17:35	08:23	19:08	08:24	19:49	08:36	21:17
27	07:50	18:29	09:09	20:07	08:59	20:44	09:08	22:10
28	08:50	19:26	09:50	21:04	09:33	21:39	09:41	23:03
29	09:44	20:25	10:27	22:01	10:04	22:33	10:16	23:57
30	10:33	21:23	11:01	22:55	10:36	23:26	10:54	DNS
31	11:15	22:21			11:08	DNS	11:36	00:51

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	12:22	01:44	12:55	02:07	14:54	02:53	15:57	02:46
2	13:14	02:37	13:57	02:54	16:02	03:32	17:08	03:28
3	14:12	03:28	15:02	03:38	17:12	04:13	18:18	04:15
4	15:13	04:17	16:09	04:20	18:23	04:56	19:25	05:06
5	16:18	05:04	17:18	05:01	19:34	05:41	20:28	06:02
6	17:25	05:48	18:29	05:42	20:43	06:31	21:25	07:02
7	18:33	06:30	19:39	06:24	21:47	07:25	22:15	08:04
8	19:42	07:11	20:49	07:08	22:45	08:21	22:58	09:05
9	20:50	07:51	21:56	07:55	23:36	09:20	23:37	10:05
10	21:58	08:33	23:00	08:45	DNR	10:20	DNR	11:03
11	23:05	09:16	23:59	09:38	00:21	11:19	00:12	11:59
12	DNR	10:03	DNR	10:34	01:01	12:16	00:44	12:53
13	00:08	10:52	00:53	11:31	01:37	13:12	01:15	13:47
14	01:09	11:45	01:40	12:29	02:10	14:06	01:46	14:40
15	02:04	12:40	02:22	13:26	02:42	15:00	02:18	15:33
16	02:55	13:37	03:00	14:22	03:13	15:53	02:52	16:27
17	03:40	14:34	03:35	15:17	03:44	16:46	03:28	17:21
18	04:21	15:31	04:07	16:11	04:16	17:40	04:08	18:15
19	04:58	16:27	04:39	17:05	04:51	18:34	04:52	19:07
20	05:32	17:22	05:10	17:58	05:29	19:27	05:40	19:58
21	06:05	18:16	05:42	18:51	06:10	20:20	06:32	20:46
22	06:37	19:10	06:15	19:45	06:55	21:11	07:28	21:31
23	07:08	20:03	06:51	20:38	07:44	22:00	08:27	22:12
24	07:40	20:57	07:29	21:31	08:37	22:47	09:27	22:51
25	08:14	21:50	08:11	22:23	09:33	23:30	10:29	23:29
26	08:51	22:43	08:58	23:13	10:32	DNS	11:31	DNS
27	09:31	23:36	09:48	DNS	11:34	00:11	12:35	00:06
28	10:15	DNS	10:43	00:02	12:37	00:50	13:41	00:43
29	11:03	00:28	11:41	00:48	13:42	01:28	14:48	01:23
30	11:57	01:18	12:43	01:31	14:49	02:06	15:56	02:05
31			13:47	02:12			17:03	02:52

Note: DNR means Moon does not rise on that day, DNS means Moon does not set. See explanation page 69.

TOWNSVILLE — AEST

	JANUARY		FEBRUARY		MARCH		APRIL	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:52	21:01	09:41	22:05	08:27	20:44	10:17	21:54
2	08:52	21:50	10:41	22:51	09:29	21:32	11:16	22:48
3	09:51	22:37	11:40	23:38	10:30	22:21	12:12	23:42
4	10:50	23:22	12:39	DNS	11:30	23:11	13:04	DNS
5	11:49	DNS	13:37	00:25	12:28	DNS	13:53	00:35
6	12:47	00:07	14:33	01:15	13:24	00:02	14:38	01:28
7	13:45	00:52	15:28	02:05	14:18	00:55	15:20	02:19
8	14:43	01:39	16:21	02:58	15:08	01:47	15:59	03:09
9	15:42	02:27	17:10	03:51	15:55	02:40	16:37	03:58
10	16:39	03:17	17:57	04:44	16:39	03:32	17:13	04:46
11	17:34	04:10	18:40	05:36	17:20	04:23	17:50	05:34
12	18:27	05:04	19:21	06:27	17:59	05:13	18:27	06:22
13	19:16	05:58	20:00	07:17	18:36	06:01	19:05	07:10
14	20:02	06:52	20:37	08:06	19:13	06:50	19:46	07:59
15	20:44	07:44	21:14	08:54	19:50	07:38	20:28	08:49
16	21:24	08:35	21:50	09:42	20:27	08:25	21:14	09:40
17	22:02	09:24	22:28	10:30	21:06	09:14	22:02	10:32
18	22:39	10:13	23:08	11:19	21:47	10:03	22:54	11:23
19	23:15	11:00	23:50	12:08	22:30	10:53	23:48	12:14
20	23:52	11:48	DNR	13:00	23:17	11:44	DNR	13:04
21	DNR	12:37	00:36	13:52	DNR	12:36	00:45	13:54
22	00:31	13:27	01:25	14:46	00:08	13:28	01:44	14:42
23	01:13	14:18	02:19	15:40	01:01	14:21	02:44	15:29
24	01:57	15:11	03:16	16:34	01:59	15:12	03:45	16:17
25	02:46	16:06	04:16	17:27	02:58	16:03	04:47	17:05
26	03:39	17:02	05:19	18:18	04:00	16:53	05:50	17:55
27	04:36	17:57	06:22	19:08	05:02	17:42	06:54	18:46
28	05:36	18:50	07:25	19:56	06:05	18:30	07:58	19:39
29	06:37	19:42			07:09	19:20	09:00	20:34
30	07:39	20:31			08:12	20:10	10:00	21:30
31	08:41	21:19			09:15	21:01		

	MAY		JUNE		JULY		AUGUST	
1	10:56	22:26	11:57	23:48	11:49	DNS	12:16	00:24
2	11:48	23:21	12:36	DNS	12:25	00:07	12:56	01:13
3	12:35	DNS	13:14	00:38	13:02	00:55	13:40	02:04
4	13:19	00:14	13:50	01:26	13:40	01:43	14:28	02:56
5	13:59	01:05	14:27	02:14	14:20	02:32	15:19	03:48
6	14:37	01:55	15:04	03:02	15:02	03:22	16:14	04:42
7	15:14	02:43	15:43	03:50	15:48	04:14	17:11	05:34
8	15:51	03:31	16:24	04:40	16:38	05:07	18:11	06:26
9	16:27	04:19	17:08	05:31	17:31	06:00	19:11	07:15
10	17:05	05:07	17:55	06:23	18:26	06:53	20:11	08:03
11	17:45	05:56	18:46	07:16	19:24	07:45	21:11	08:50
12	18:27	06:46	19:39	08:08	20:22	08:34	22:11	09:36
13	19:11	07:37	20:34	08:59	21:21	09:22	23:10	10:21
14	19:59	08:28	21:31	09:49	22:19	10:08	DNR	11:08
15	20:50	09:20	22:29	10:37	23:18	10:53	00:10	11:57
16	21:44	10:12	23:26	11:23	DNR	11:37	01:09	12:47
17	22:39	11:02	DNR	12:08	00:16	12:22	02:08	13:40
18	23:36	11:51	00:24	12:53	01:15	13:09	03:05	14:34
19	DNR	12:38	01:23	13:38	02:15	13:59	03:59	15:29
20	00:33	13:24	02:22	14:24	03:15	14:51	04:51	16:24
21	01:32	14:10	03:23	15:13	04:14	15:45	05:38	17:19
22	02:32	14:55	04:24	16:05	05:12	16:41	06:23	18:11
23	03:32	15:43	05:26	16:59	06:06	17:37	07:04	19:02
24	04:34	16:32	06:26	17:56	06:57	18:33	07:43	19:52
25	05:37	17:23	07:23	18:53	07:44	19:27	08:21	20:41
26	06:40	18:18	08:17	19:50	08:27	20:20	08:58	21:29
27	07:42	19:14	09:06	20:45	09:08	21:10	09:35	22:17
28	08:42	20:11	09:51	21:38	09:46	21:59	10:12	23:06
29	09:37	21:08	10:33	22:29	10:23	22:48	10:52	23:55
30	10:28	22:04	11:12	23:19	11:00	23:36	11:34	DNS
31	11:14	22:57			11:37	DNS	12:19	00:46

	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	13:07	01:37	13:37	02:01	15:17	03:03	16:04	03:13
2	13:59	02:29	14:35	02:51	16:19	03:49	17:08	04:02
3	14:55	03:21	15:35	03:39	17:22	04:37	18:13	04:54
4	15:53	04:13	16:36	04:28	18:27	05:26	19:17	05:50
5	16:54	05:03	17:38	05:15	19:32	06:18	20:19	06:48
6	17:55	05:53	18:41	06:03	20:36	07:13	21:17	07:48
7	18:56	06:41	19:45	06:52	21:38	08:09	22:10	08:48
8	19:58	07:28	20:49	07:42	22:36	09:08	22:57	09:46
9	21:00	08:15	21:52	08:34	23:29	10:06	23:41	10:41
10	22:02	09:03	22:53	09:28	DNR	11:02	DNR	11:34
11	23:03	09:53	23:51	10:24	00:18	11:57	00:21	12:24
12	DNR	10:43	DNR	11:20	01:02	12:50	00:58	13:13
13	00:03	11:36	00:45	12:15	01:43	13:40	01:35	14:01
14	01:01	12:30	01:35	13:10	02:21	14:29	02:11	14:49
15	01:56	13:25	02:20	14:02	02:58	15:18	02:48	15:37
16	02:48	14:20	03:03	14:54	03:34	16:05	03:26	16:27
17	03:36	15:13	03:42	15:44	04:11	16:53	04:07	17:17
18	04:21	16:06	04:20	16:32	04:48	17:42	04:50	18:07
19	05:02	16:57	04:57	17:20	05:28	18:31	05:37	18:59
20	05:42	17:47	05:33	18:08	06:09	19:22	06:26	19:49
21	06:20	18:36	06:10	18:57	06:53	20:12	07:18	20:39
22	06:57	19:24	06:49	19:45	07:40	21:02	08:11	21:26
23	07:33	20:12	07:28	20:35	08:30	21:52	09:06	22:12
24	08:11	21:00	08:11	21:25	09:22	22:40	10:02	22:57
25	08:49	21:49	08:55	22:15	10:15	23:27	10:58	23:40
26	09:30	22:39	09:43	23:05	11:10	DNS	11:54	DNS
27	10:13	23:29	10:33	23:54	12:06	00:13	12:51	00:23
28	10:59	DNS	11:26	DNS	13:03	00:57	13:50	01:07
29	11:49	00:20	12:22	00:43	14:02	01:41	14:51	01:53
30	12:41	01:10	13:18	01:30	15:02	02:26	15:53	02:42
31			14:17	02:17			16:56	03:34

MOON

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

LUNAR OCCULTATIONS 1998

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 apparent 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 the Sun does.
2. The rapid motion of the Moon across the sky. It completes one revolution about every 28 days.
3. With it moving approximately in the plane of the ecliptic, as do all Solar System bodies, the Moon monthly moves across 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 degrees. 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 will 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 will disappear on the bright limb and reappear on the dark limb. There is no dark limb at the time of 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 1998 as predicted for **Adelaide**, **Brisbane, Canberra, Darwin, Hobart, Melbourne** 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 (e.g. 1194) 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 of within 0.2 seconds is not unusual for the experienced observer.

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 worthwhile contacting your local astronomical society (p. 132).

LUNAR OCCULTATION TABLES

The faintest stars, which have occultation predictions on the following pages, are approximately 8th 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

AEST	Is the date and time of the occultation. Hr & min are in AEST for all except Adelaide and Darwin which are ACST	
OBJECT	nnnn	ZC catalogue no.
	nnnnn or nnnnnn	SAO catalogue number
	X nnnnn	USNO XZ catalogue no.
	Name of planet or satellite.	
PD	This is the event which consists of one or 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.	
Mag	is the magnitude of the star.	
Elg	is the elongation or separation of the Moon from the Sun as measured in degrees.	
Alt.	Is the altitude of the Moon during the occultation.	
P.A.	Position Angle is the position the event occurs on the limb of the Moon (measured as degrees east of true 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 calculation 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 x n) + (B x p)

where 'n' and 'p' is 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 ZC995 on March 1 for their location in Albury (NSW) (146° 55' E, 36° 05' S), see page 133. 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 20:13 AEST and the values of A and B are 0.2 and 2.0 respectively.

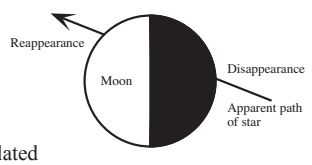
Therefore the equation becomes:-

20:13 + (0.2 * –2°.22) + (2.0 * –0°.83)

= 20:13 + (–0.44) + (–1.66)

= 20:13 – 2 = 20:11

The event will be visible from Albury approximately 2 mins earlier than Canberra, i.e., about 8:11pm (AEST) on March 1st.



Lunar occultation predictions were calculated using Occult version 4.02 by D.Herald, PO Box 254 Woden ACT 2606.

heraldd@canberra.DIALix.oz.au

ADELAIDE (34° 58' S, 138° 38'E)

ACST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 08 21:45	93524	DD	6.5	128	38	12	1.3	3.8
Jan 09 21:28	94015	DD	7.8	140	37	49	1.9	1.2
Jan 10 21:40	94634	DD	7.7	153	35	67	2.1	0.3
Jan 11 00:32	94694	DD	7.8	154	29	126	1.6	-0.4
Jan 12 01:13	95852	DD	6.9	166	30	74	2.2	1.2
Jan 16 01:16	98931	RD	7.0	146	39	333	1.6	-2.8
Jan 19 04:03	119399	RD	7.7	112	54	215	9.9	9.9
Feb 03 20:17	92932	RB	5.5	83	32	264	1.7	1.1
Feb 05 23:35	93900	DD	5.7	110	13	154	**	-2.5
Feb 06 21:48	94431	DD	7.5	122	33	136	2.0	-1.3
Feb 07 22:17	95402	DD	7.7	134	34	85	2.3	0.6
Feb 07 23:07	95432	DD	5.2	135	30	122	1.7	-0.3
Feb 08 00:06	95461	DD	7.8	135	23	143	0.9	-1.0
Feb 08 00:27	95475	DD	7.3	135	20	155	0.3	-1.9
Feb 10 00:14	97545	DD	7.7	159	35	70	2.6	1.3
Feb 11 00:11	98247	DD	5.2	170	40	108	2.3	-0.4
Feb 12 22:25	118355	DB	3.8	167	30	157	1.2	-3.3
Feb 12 23:24	118355	RD	3.8	167	38	245	2.6	0.3
Feb 15 01:54	119245	RD	6.1	144	51	15	-2.4	-8.9
Feb 16 23:10	139428	RD	5.8	123	16	266	0.5	-1.2
Feb 21 02:40	160171	RD	6.5	77	28	276	0.6	-1.3
Feb 22 03:44	160879	RD	7.7	65	31	237	1.2	0.1
Feb 24 03:56	162980	RD	6.7	39	11	225	0.5	0.4
Mar 01 19:39	Saturn	DD	0.7	37	11	44	0.5	2.1
Mar 01 19:42	Titan	DD	8.3	37	11	47	0.5	2.0
Mar 01 20:30	Saturn	RB	0.7	38	1	281	0.1	0.8
Mar 03 20:25	93276	DD	5.8	65	18	84	1.0	1.2
Mar 08 22:52	97268	DD	7.6	128	31	34	4.2	5.6
Mar 09 21:41	98007	DD	7.8	139	39	108	2.3	-0.6
Mar 10 22:22	98617	DD	7.6	151	42	111	2.3	-0.8
Mar 15 00:59	138889	RD	7.2	164	55	295	2.2	-1.2
Mar 15 02:32	138917	DB	2.9	164	53	175	0.4	-4.3
Mar 15 02:32	X54027	DB	3.5	164	53	175	0.4	-4.3
Mar 15 03:21	138917	RD	2.9	163	47	241	3.2	3.2
Mar 15 03:21	X54027	RD	3.5	163	47	241	3.2	3.2
Mar 15 04:58	138933	RD	6.1	163	31	271	1.4	1.2
Mar 17 03:14	139794	RD	7.1	142	63	302	2.1	-1.3
Mar 18 00:22	158915	RD	5.6	131	41	257	1.7	-0.7
Mar 18 00:41	158935	RD	6.4	131	44	0	-0.7	-5.7
Mar 19 23:04	159971	RD	6.9	109	10	278	**	-1.3
Mar 22 04:59	161564	DB	5.2	84	60	124	1.7	-2.4
Mar 24 03:07	163437	RD	7.4	59	16	283	0.2	-1.5
Mar 25 04:25	164303	RD	6.7	46	19	287	0.3	-1.7
Mar 25 05:46	164364	DB	5.5	45	35	62	1.1	**
Apr 03 19:31	95852	DD	6.9	84	32	70	2.3	1.3
Apr 03 21:00	95902	DD	7.8	85	22	114	1.2	0.2
Apr 04 21:17	96995	DD	7.8	97	27	118	1.4	**
Apr 07 20:39	98931	DD	7.0	131	43	74	3.0	0.4
Apr 11 00:42	119399	DD	7.7	165	51	164	0.9	-3.1
Apr 16 05:12	159929	RD	7.1	137	57	301	2.0	-0.7
Apr 17 02:30	160418	RD	7.4	127	65	213	3.9	5.3
Apr 17 05:08	160462	RD	6.0	126	66	286	2.3	-0.3
Apr 18 01:31	X43398	RD	7.4	115	45	212	2.9	3.4
Apr 21 04:33	164027	RD	5.9	77	48	257	1.6	-0.4
Apr 23 04:18	146347	RD	7.3	51	20	239	0.6	-0.1
Apr 24 04:33	146915	RD	5.6	37	9	225	0.2	0.4
Apr 30 19:48	95402	DD	7.7	53	13	116	0.7	0.3
Apr 30 20:38	95432	DD	5.2	54	4	159	-0.6	-2.0
May 02 19:13	97545	DD	7.7	78	33	130	1.6	-0.7
May 03 18:45	98250	DD	5.6	89	39	107	2.3	-0.4
May 06 19:12	118804	RB	4.1	123	44	321	1.6	-2.3
May 07 20:27	119245	DD	6.1	134	51	75	3.2	0.3
May 09 00:27	139072	DD	6.8	147	45	176	0.4	-4.5
May 10 02:08	139548	DD	6.9	158	37	107	1.4	0.4
May 10 02:48	139559	DD	6.6	158	30	119	1.0	**
May 11 22:43	159146	DD	7.1	175	60	192	9.9	9.9
May 11 23:02	159146	RD	7.1	175	63	216	6.9	8.8
May 14 01:30	160226	RD	7.7	156	72	309	2.1	-2.1
May 14 03:58	160257	RD	7.2	155	57	299	2.1	-0.6
May 14 21:28	160819	RD	7.5	146	21	294	0.2	-1.7
May 16 01:39	161848	RD	6.5	133	60	252	2.1	0.1
May 16 01:39	161850	RD	7.0	133	60	245	2.2	0.5
May 16 04:06	161929	RD	7.0	132	72	337	3.4	-8.4
May 16 04:33	161935	RD	6.9	132	69	234	2.0	2.2
May 21 04:59	146736	RD	6.4	68	40	205	0.9	1.9
May 21 08:33	Jupiter	DB	-2.2	67	58	115	3.2	-1.2
May 21 09:21	Jupiter	RD	-2.2	67	53	188	0.4	3.7
May 29 20:16	97221	DD	5.0	47	4	72	0.8	1.8
May 30 20:22	98033	DD	7.8	59	14	87	1.0	1.2
Jun 02 18:21	118648	RB	4.7	93	48	276	2.6	-0.4
Jun 04 19:43	138889	DD	7.2	116	56	187	-0.7	-6.1
Jun 05 18:49	139322	DD	7.1	126	49	91	2.2	-0.9
Jun 06 21:13	139794	DD	7.1	138	63	113	2.2	-1.2
Jun 07 00:10	139834	DD	6.6	139	46	122	1.6	-0.4
Jun 07 00:46	139847	DD	6.7	139	39	143	1.3	-1.4
Jun 07 18:22	158915	DD	5.6	148	34	132	0.6	-2.3
Jun 09 02:13	159587	DD	6.2	162	43	44	1.3	4.3
Jun 11 23:22	161540	RD	5.8	162	58	271	1.9	-0.8
Jun 11 23:57	161557	RD	7.0	162	64	232	2.5	1.5
Jun 12 00:35	161582	RD	7.7	162	70	215	2.7	3.8
Jun 12 02:49	X44258	RD	7.6	161	66	316	2.7	-2.4
Jun 12 20:37	162512	DB	3.9	152	15	12	2.9	7.5
Jun 12 20:46	162512	RB	3.9	152	17	353	9.9	9.9
Jun 12 21:07	162521	RD	6.0	151	21	221	1.0	0.8
Jun 13 00:15	162637	RD	7.3	150	58	211	2.3	3.1
Jun 13 00:27	162643	RD	6.9	150	60	206	2.4	4.1
Jun 13 23:15	X48192	RD	7.5	138	35	181	9.9	9.9
Jun 15 00:57	164310	RD	7.0	125	43	218	1.4	1.4
Jun 17 02:22	146543	RD	7.0	99	35	297	1.5	-2.6
Jun 17 03:28	146585	DB	4.4	98	46	124	2.4	-3.5
Jun 17 04:10	146585	RD	4.4	98	53	187	0.6	4.0
Jun 26 18:25	97680	DD	7.8	27	11	113	0.5	0.4
Jun 28 17:52	98876	RB	5.2	51	34	288	1.7	0.2
Jul 01 20:20	X54025	DD	6.0	86	42	88	2.1	1.1
Jul 02 22:27	139229	DD	7.5	98	30	100	1.2	0.8
Jul 05 00:46	158817	DD	7.5	120	24	78	0.7	1.7
Jul 07 00:57	159929	DD	7.1	143	43	71	1.3	2.0
Jul 07 02:59	159963	DD	4.4	144	19	166	1.8	-4.5
Jul 07 03:18	159963	RB	4.4	144	15	201	-1.2	6.4
Jul 07 21:57	160418	DD	7.4	154	71	105	2.3	-1.0
Jul 08 00:25	160462	DD	6.0	154	60	40	1.8	4.1
Jul 08 20:05	X43398	DD	7.4	165	44	81	1.4	-0.7
Jul 09 00:45	161227	DD	6.1	166	66	75	2.1	1.3
Jul 09 00:56	X43594	DD	7.9	166	64	139	2.6	-2.6
Jul 09 02:16	161278	DD	6.6	167	49	114	1.8	**
Jul 09 02:44	161304	DD	6.4	167	44	77	1.2	1.5
Jul 09 22:00	162204	DD	6.4	176	56	146	1.2	-4.3
Jul 13 22:51	146362	DB	3.7	130	18	25	0.6	1.6
Jul 13 23:34	146362	RD	3.7	129	27	301	0.9	-2.8
Jul 14 04:56	146447	RD	6.4	127	58	206	1.0	2.8
Jul 14 06:07	146465	RD	6.5	127	48	274	1.9	0.7
Jul 18 03:57	93034	RD	6.8	74	25	183	-0.4	3.5
Jul 20 05:17	94019	RD	7.1	47	16	222	0.4	0.5
Jul 27 19:32	118804	DD	4.1	44	17	148	0.3	-1.1
Jul 28 20:57	119245	DD	6.1	56	12	152	0.2	-1.3
Aug 04 01:08	160226	DD	7.7	124	26	107	0.8	0.6
Aug 06 00:18	161848	DD	6.5	148	57	87	1.8	0.9
Aug 06 00:20	161850	DD	7.0	148	56	94	1.9	0.6
Aug 06 02:49	161929	DD	7.0	149	27	43	0.1	2.5
Aug 06 02:54	161935	DD	6.9	149	26	138	1.4	-1.0
Aug 07 22:38	163783	DD	5.9	173	65	133	2.5	-3.6
Aug 08 01:41	163848	DD	6.9	174	60	133	3.3	-2.5
Aug 10 04:54	146271	RD	6.8	158	39	231	0.9	2.0
Aug 11 01:20	146774	RD	7.0	145	55	263	2.1	-0.2
Aug 11 23:49	128760	RD	6.4	132	29	249	1.0	-0.3
Aug 13 00:20	109835	RD	7.0	118	22	247	0.8	-0.3
Aug 13 03:22	109905	RD	7.3	117	48	248	1.9	0.4
Aug 14 03:51	110516	RD	7.6	104	42	220	1.3	1.2
Aug 15 03:13	93387	RD	7.7	90	27	220	0.7	0.8
Aug 16 02:48	93838	RD	6.8	78	12	178	-1.6	5.5
Aug 16 04:46	93870	RD	6.9	77	30	201	0.5	1.9
Aug 16 06:10	93900	DB	5.7	76	37	129	3.2	-2.4
Aug 17 04:22	94431	RD	7.5	64	17	213	0.3	1.0
Aug 26 20:05	139322	DD	7.1	48	18	118	0.6	0.2
Aug 28 20:29	158915	DD	5.6	70	34	140	1.2	-1.1
Aug 28 21:18	158935	DD	6.4	70	25	55	0.6	3.2
Aug 28 21:50	158946	DD	6.0	71	18	34	-0.1	5.7
Sep 01 19:00	161267	DD	6.4	115	70	44	2.7	2.8
Sep 01 19:10	161278	DD	6.6	115	71	124	2.2	-2.1
Sep 01 19:39	161304	DD	6.4	115	73	80	2.5	0.4
Sep 01 20:00	X43728	DD	7.9	115	73	52	2.5	2.3
Sep 01 21:47	161376	DD	5.2	116	60	143	2.7	-3.0
Sep 01 22:32	161376	RB	5.2	116	52	208	0.7	4.7
Sep 02 02:47	161564	DD	5.2	118	2	91	-0.3	0.9
Sep 03 00:44	162521	DD	6.0	129	36	143	2.3	-2.1
Sep 03 00:48	162512	DD	3.9	129	35	21	-0.2	4.0
Sep 03 01:23	162512	RB	3.9	129	28	316	1.5	-0.9
Sep 04 21:41	164204	DD	6.4	154	66	93	2.3	-0.5
Sep 04 22:03	164211	DD	7.7	154	69	121	2.8	-2.3
Sep 04 22:24	164218	DD	7.9	154	69	93	2.4	-0.2
Sep 05 02:57	164315	DD	7.0	156	29	49	0.3	2.1
Sep 05 22:27	164907	DD	7.0	168	62	72	2.0	0.3
Sep 07 02:41	146585	DB	4.4	177	48	134	3.7	-2.7
Sep 07 03:05	146585	RD	4.4	177	44	173	-0.9	5.6
Sep 10 00:46	110286	RD	7.2	135	36	205	0.7	1.6
Sep 10 02:00	110316	RD	7.6	135	44	196	0.7	2.4
Sep 10 05:16	110359	RD	7.8	134	37	249	1.6	1.3
Sep 11 05:20	93276	RD	5.8	120	39	306	2.7	-1.1
Sep 14 05:02	95119	RD	7.6	80	30	233	1.6	0.5
Sep 14 05:15	95166	DB	5.2	80	31	68	1.8	**
Sep 15 04:31	96312	RD	7.3	68	20	308	1.9	-2.4
Sep 27 20:27	160305	DD	6.1	73	41	95	1.3	0.9
Sep 28 21:10	X43208	DD	7.6	85	43	77	1.2	1.6
Sep 29 20:08	161935	DD	6.9	96	64	78	2.0	1.2
Sep 29 22:11	162001	DD	6.6	97	40	122	1.7	-0.3
Sep 29 23:52	162050	DD	6.3	98	20	119	0.7	0.2
Oct 01 21:00	163848	DD	6.9	121	69	98	2.5	-0.1
Oct 03 23:53	146271	DD	6.8	149	54	68	1.6	1.4
Oct 04 17:07	Jupiter	DD	-2.9	160	6	88	0.1	-1.0
Oct 04 18:01	Jupiter	RB	-2.9	160	17	236	0.5	**
Oct 04 19:47	146774	DD	7.0	161	37	38	1.0	1.1
Oct 05 02:26	146877	DD	7.2	164	34	66	1.0	1.6
Oct 05 04:12	146915	DD	5.6	164	13	56	0.3	1.7
Oct 09 23:57	94019	RD	7.1	126	16	198	-0.1	1.8
Oct 11 02:40	94739	RD	7.8	112	29	339	5.5	-9.5
Oct 12 03:19	95968	RD	7.4	99	27	221	1.2	0.9
Oct 13 03:30	97087	RD	6.8	86	22	221	0.9	0.9
Oct 14 03:21	97878	RD	7.7	74	13	256	0.9	-0.7
Oct 16 04:29	99025	RD	7.3	51	12	271	0.8	-1.2
Oct 29 21:14	164310	DD	7.0	102	54	62	1.4	1.8
Oct 31 23:54	146585	DD	4.4	129	39	101	1.6	0.7
Nov 01 00:48	146585	RB	4.4	129	28	209	0.4	2.5
Nov 05 00:51	93276	RD	5.8	173	42	265	2.1	0.3
Nov 06 00:31	93776	RD	7.5	159	37	245	1.8	0.4
Nov 06 02:13	93805	RD	7.0	159	37	222	1.7	1.7
Nov 06 22:54	94332	RD	5.0	146	18	239	0.7	-0.1
Nov 08 00:11	95359	RD	5.7	132	19	224	0.7	0.5
Nov 09 02:19	96697	RD	7.2	118	28	282	1.9	-1.1
Nov 22 19:57	161376	RB	5.2	36	18	305	0.7	**
Nov 23 21:15	162442	DD	7.4	47	12	112	0.3	0.5
Nov 23 21:25	X45827	DD	7.7	48	10	126	0.4	**
Dec 08 03:00	98133	RD	7.5	125	36	302	2.1	-1.3
Dec 23 21:20	164627	DD	6.7	53	14	54	**	1.8
Dec 26 23:27	128760	DD	6.4	91	11	66	0.3	1.6
Dec 28 22:18	110408	DD	4.5	117	36	116	2.1	-0.1
Dec 28 23:08	110408	RB	4.5	118	28	201	1.0	3.0
Dec 29 21:46	93301	DD	7.1	131	41	149	5.8	-7.8
Dec 30 21:00	93776	DD	7.5	144	37	79	2.0	**
Dec 30 22:56	93805	DD	7.0	145	36	105	2.2	**
Dec 31 20:06	94332	DD	5.0	157	25	138	2.8	-3.6

BRISBANE (27° 30' S, 153° 01'E)

AEST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 05 21:19	109507	DD	6.5	88	29	73	1.1	1.4
Jan 09 22:43	94015	DD	7.8	140	39	34	2.3	2.9
Jan 10 22:51	94634	DD	7.7	153	42	53	2.6	1.7
Jan 11 01:08	94678	DD	7.4	154	26	142	0.8	-1.5
Jan 14 21:58	98381	RD	7.5	159	25	268	1.5	-0.9
Jan 25 04:21	160462	RD	6.0	44	27	238	1.2	0.3
Feb 02 20:28	109926	DD	5.1	70	23	134	1.3	-1.5
Feb 02 20:58	109926	RB	5.1	70	17	188	0.6	4.2
Feb 03 20:07	92932	DD	5.5	83	34	47	1.5	2.1
Feb 03 20:29	92942	DD	7.6	83	31	83	1.5	1.1
Feb 03 20:50	92948	DD	7.5	83	26	64	1.3	1.6
Feb 03 21:06	92952	DD	6.6	83	24	87	1.2	1.0
Feb 06 00:07	93900	DD	5.7	110	5	109	0.3	0.3
Feb 06 22:41	94431	DD	7.5	122	30	107	1.6	0.2
Feb 07 23:12	95390	DD	7.5	134	32	134	1.4	-1.1
Feb 07 23:30	95402	DD	7.7	134	29	53	2.4	2.4
Feb 08 00:03	95432	DD	5.2	134	24	90	1.5	0.9
Feb 08 22:00	96493	DD	7.9	146	43	41	3.3	3.0
Feb 11 01:22	98247	DD	5.2	170	38	66	3.0	2.1
Feb 12 20:35	99136	RD	6.0	168	19	275	1.0	-1.2
Feb 12 22:59	118355	DB	3.8	167	44	126	2.0	-2.0
Feb 13 00:33	118355	RD	3.8	167	53	284	2.7	-0.7
Feb 16 23:40	139428	RD	5.8	123	30	295	0.9	-1.7
Feb 21 03:06	160171	RD	6.5	77	39	315	0.6	-2.5
Feb 22 01:41	160819	RD	7.5	66	11	214	1.1	2.0
Feb 22 04:28	160879	RD	7.7	65	46	279	1.4	-1.2
Feb 23 03:55	161834	RD	7.8	52	28	245	1.0	**
Feb 24 04:32	162980	RD	6.7	39	23	265	0.6	-0.7
Mar 03 21:17	93276	DD	5.8	65	5	59	0.6	1.7
Mar 06 20:07	X 7838	DD	7.9	103	40	131	2.2	-1.3
Mar 06 22:55	95070	DD	7.1	104	15	132	0.4	-0.6
Mar 07 19:48	96153	DD	7.6	115	43	72	2.9	0.8
Mar 09 22:51	98007	DD	7.8	139	41	71	3.1	1.6
Mar 10 23:33	98617	DD	7.6	151	44	69	3.3	1.8
Mar 12 00:26	99061	DD	7.9	162	46	166	0.6	-3.2
Mar 15 01:40	138889	RD	7.2	164	62	341	1.2	-3.3
Mar 15 03:06	138917	DB	2.9	164	50	124	1.8	-0.9
Mar 15 03:06	X54027	DB	3.5	164	50	124	1.8	-0.9
Mar 15 04:29	138917	RD	2.9	163	34	289	1.3	0.1
Mar 15 04:29	X54027	RD	3.5	163	34	289	1.3	0.1
Mar 16 02:23	139325	RD	7.6	153	65	278	2.9	-0.1
Mar 17 03:49	139794	RD	7.1	142	62	353	0.9	-5.4
Mar 18 01:09	158915	RD	5.6	131	59	299	1.8	-1.9
Mar 18 22:38	159438	RD	6.8	121	18	253	0.6	-0.4
Mar 19 23:22	159971	RD	6.9	110	18	311	**	-2.0
Mar 22 02:40	161449	RD	7.9	85	40	205	3.5	5.6
Mar 23 02:24	162512	DB	3.9	73	24	117	0.3	-1.8
Mar 23 03:26	162512	RD	3.9	72	38	247	1.4	**
Mar 24 02:10	163399	RD	7.2	60	10	231	0.4	0.4
Mar 24 03:20	163437	RD	7.4	60	24	332	-0.3	-5.0
Mar 25 03:18	Venus	GD	-4.4	46	11			
Mar 25 03:54	164279	RD	6.2	46	19	290	0.3	-1.6
Apr 02 19:31	94678	DD	7.4	72	28	123	1.3	-0.4
Apr 02 19:56	94694	DD	7.8	72	24	81	1.5	1.1
Apr 03 21:11	95873	DD	7.7	85	20	124	0.8	-0.3
Apr 04 22:12	96995	DD	7.8	97	19	79	1.4	1.4
Apr 11 01:22	119399	DD	7.7	165	46	117	1.8	-0.5
Apr 17 03:58	160418	RD	7.4	126	78	262	2.9	0.7
Apr 18 02:42	X43398	RD	7.4	115	67	263	2.5	-0.2
Apr 21 05:26	164027	RD	5.9	77	66	281	2.5	-1.1
Apr 23 04:58	146347	RD	7.3	51	35	264	1.2	-0.6
Apr 24 05:11	146915	RD	5.6	37	24	250	0.8	-0.2
Apr 29 18:14	94332	RB	5.0	39	18	295	0.8	0.1
May 02 20:07	97545	DD	7.7	78	28	91	1.7	0.8
May 03 19:49	98247	DD	5.2	89	40	130	1.6	-1.0
May 03 19:58	98250	DD	5.6	89	38	64	3.2	2.3
May 03 21:08	98247	RB	5.2	90	28	274	1.5	0.7
May 09 00:58	139072	DD	6.8	146	37	127	1.3	-0.7
May 10 03:02	139548	DD	6.9	158	22	75	0.8	1.7
May 10 03:33	139559	DD	6.6	158	15	91	0.5	0.9
May 10 23:11	139953	DD	6.7	167	72	159	1.4	-3.7
May 14 04:49	160257	RD	7.2	155	43	323	2.1	-2.2
May 14 21:39	160819	RD	7.5	146	28	340	-0.5	-4.1
May 15 03:43	160909	RD	6.4	144	68	230	2.2	3.0
May 16 02:41	161848	RD	6.5	133	80	283	2.8	-0.9
May 16 02:45	161850	RD	7.0	133	80	276	2.8	-0.5
May 21 09:42	Jupiter	DB	-2.2	67	51	119	3.0	-1.0
May 21 10:24	Jupiter	RD	-2.2	67	42	187	0.1	4.0
May 31 20:30	98617	DD	7.6	71	22	163	-0.1	-2.4
Jun 02 17:45	118648	DD	4.7	93	55	102	2.8	-0.7
Jun 02 19:16	118648	RB	4.7	93	52	318	1.7	-1.7
Jun 04 20:07	138889	DD	7.2	115	62	130	2.1	-1.7
Jun 05 00:13	138933	DD	6.1	117	20	159	0.5	-2.3
Jun 05 20:55	139325	DD	7.6	127	66	171	0.7	-4.5
Jun 06 22:28	139794	DD	7.1	138	62	64	3.6	2.8
Jun 07 01:03	139834	DD	6.6	139	31	91	1.1	1.0
Jun 07 01:28	139847	DD	6.7	139	26	112	0.9	0.1
Jun 07 18:55	158915	DD	5.6	148	48	95	1.8	-1.1
Jun 11 18:46	161376	GD	5.2	164	8	188	9.9	9.9
Jun 12 00:12	161540	RD	5.8	163	76	307	2.5	-2.5
Jun 12 01:07	161571	RD	6.3	162	81	204	2.6	6.7
Jun 12 01:10	161557	RD	7.0	162	81	265	2.7	0.3
Jun 12 01:21	161576	RD	7.3	162	80	203	2.4	6.7
Jun 12 01:58	161582	RD	7.7	162	74	248	2.4	1.5
Jun 12 21:51	162521	RD	6.0	151	35	264	1.1	-0.7
Jun 13 01:32	162637	RD	7.3	150	80	246	2.6	1.1
Jun 13 01:49	162643	RD	6.9	150	81	242	2.5	1.5
Jun 14 00:32	X48192	RD	7.5	138	58	238	2.1	0.9
Jun 15 02:00	164310	RD	7.0	125	64	245	2.2	0.7
Jun 15 23:38	164907	RD	7.0	113	21	251	0.7	-0.3
Jun 17 04:20	146585	DB	4.4	98	64	109	3.2	-1.7
Jun 17 05:19	146585	RD	4.4	98	69	194	0.9	3.6
Jun 26 18:31	97646	RB	5.1	27	7	285	0.4	0.4
Jun 28 18:33	98876	RB	5.2	51	29	333	0.4	-1.7
Jul 02 23:21	139229	DD	7.5	98	14	64	0.5	2.4
Jul 07 01:56	159929	DD	7.1	143	25	51	0.3	2.7
Jul 07 03:28	159963	DD	4.4	144	6	143	0.5	-1.2
Jul 07 23:05	160418	DD	7.4	154	73	72	2.7	1.4
Jul 08 20:17	161077	DD	7.8	165	54	164	0.1	-6.2
Jul 09 01:50	X43594	DD	7.9	166	49	119	2.1	-0.6
Jul 09 01:53	161227	DD	6.1	166	49	59	1.3	2.2
Jul 09 02:56	161255	DD	7.5	167	35	148	2.4	-3.0
Jul 09 03:09	161278	DD	6.6	167	33	104	1.1	0.4
Jul 09 03:37	161304	DD	6.4	167	26	69	0.4	1.6
Jul 09 05:10	161376	DD	5.2	168	7	162	2.4	-5.9
Jul 18 04:50	93034	RD	6.8	74	43	189	0.2	3.3
Jul 21 05:20	94634	RD	7.7	34	14	306	1.6	-2.5
Jul 27 20:04	118804	DD	4.1	44	7	110	0.3	0.2
Jul 30 18:04	139428	DD	5.8	77	62	149	1.6	-2.6
Jul 30 19:22	139428	RB	5.8	77	48	265	2.3	1.2
Aug 06 01:18	161848	DD	6.5	148	39	78	1.1	1.3
Aug 06 01:19	161850	DD	7.0	148	39	85	1.1	1.1
Aug 06 19:44	162816	DD	5.9	159	52	120	1.5	-2.2
Aug 07 23:32	163783	DD	5.9	173	78	109	3.0	-1.1
Aug 08 02:40	163848	DD	6.9	174	44	129	2.5	-1.4
Aug 09 21:07	146111	RD	7.6	161	31	253	1.0	-0.3
Aug 11 02:25	146774	RD	7.0	145	66	265	2.6	0.3
Aug 12 00:37	128760	RD	6.4	132	47	260	1.9	-0.3
Aug 13 01:04	109835	RD	7.0	119	39	257	1.6	-0.3
Aug 13 04:27	109905	RD	7.3	117	56	246	2.2	1.1
Aug 14 04:55	110516	RD	7.6	104	53	218	1.7	2.0
Aug 15 04:06	93387	RD	7.7	90	44	221	1.4	1.4
Aug 16 03:35	93838	RD	6.8	77	29	189	-0.3	3.5
Aug 17 05:11	94431	RD	7.5	64	34	217	1.1	1.4
Aug 18 04:49	95402	RD	7.7	51	21	234	0.8	0.4
Aug 28 21:10	158915	DD	5.6	70	20	114	0.7	0.1
Aug 29 18:53	159438	DD	6.8	80	60	80	2.5	1.3
Aug 30 19:28	159963	DD	4.4	92	64	146	2.4	-3.0
Aug 30 20:31	159963	RB	4.4	92	50	231	1.7	3.4
Sep 01 18:29	161227	DD	6.1	115	75	68	2.8	0.9
Sep 01 18:34	X43594	DD	7.9	115	76	129	2.4	-2.6
Sep 01 19:46	161255	DD	7.5	115	80	137	2.8	-3.1
Sep 01 20:09	161278	DD	6.6	115	76	94	2.7	0.1
Sep 01 20:56	161304	DD	6.4	115	67	54	2.1	2.5
Sep 01 21:31	X43728	DD	7.9	115	60	17	0.6	7.7
Sep 01 22:40	161376	DD	5.2	116	45	124	2.0	-0.8
Sep 01 23:36	161376	RB	5.2	116	33	222	0.3	2.8
Sep 03 01:28	162521	DD	6.0	129	20	135	1.2	-1.1
Sep 03 01:40	162512	DD	3.9	129	17	11	-1.2	4.7
Sep 03 02:02	162512	RB	3.9	129	12	326	1.3	-2.2
Sep 04 22:46	164204	DD	6.4	154	74	82	2.4	0.6
Sep 04 23:05	164211	DD	7.7	154	71	109	3.0	-0.7
Sep 05 23:33	164907	DD	7.0	168	72	66	2.1	1.2
Sep 07 03:38	146585	DB	4.4	177	34	132	2.4	-1.9
Sep 10 01:44	110286	RD	7.2	135	53	205	1.1	2.3
Sep 10 03:03	110316	RD	7.6	135	54	194	0.9	3.3
Sep 27 19:05	160257	DD	7.2	73	53	58	1.7	2.6
Sep 27 21:19	160305	DD	6.1	73	24	82	0.5	1.2
Sep 28 18:44	160909	DD	6.4	84	68	116	2.7	-0.9
Sep 28 22:03	X43208	DD	7.6	85	25	67	0.4	1.7
Sep 29 18:47	161848	DD	6.5	95	77	11	9.9	9.9
Sep 29 21:14	161935	DD	6.9	96	47	67	1.3	1.8
Sep 29 23:00	162001	DD	6.6	97	24	115	0.9	**
Oct 01 18:50	163783	DD	5.9	120	72	84	2.5	-0.1
Oct 01 22:06	163848	DD	6.9	121	57	93	2.1	0.6
Oct 03 19:04	146161	DD	6.8	146	50	123	2.3	-3.2
Oct 04 00:54	146271	DD	6.8	149	41	69	1.2	1.5
Oct 04 17:38	Jupiter	DD	-2.9	160	19	60	0.5	0.1
Oct 04 17:46	Ganymede	DD	4.4	160	20	58	0.6	0.2
Oct 04 18:40	Jupiter	RB	-2.9	160	32	260	1.1	-0.5
Oct 04 18:49	Ganymede	RB	4.4	160	34	261	1.2	-0.5
Oct 04 20:46	146774	DD	7.0	161	56	22	1.1	2.6
Oct 05 03:19	146877	DD	7.2	164	19	60	0.5	1.6
Oct 06 20:37	109905	RD	7.3	170	28	301	1.8	-2.8
Oct 10 00:44	94019	RD	7.1	126	33	203	0.5	2.1
Oct 12 00:52	95852	RD	6.9	100	13	199	-0.5	2.8
Oct 12 04:22	95968	RD	7.4	99	42	234	2.4	1.2
Oct 14 04:04	97878	RD	7.7	74	30	267	1.8	-0.7
Oct 27 19:54	162637	DD	7.3	77	47	60	1.2	2.0
Oct 27 20:08	162643	DD	6.9	77	45	67	1.2	1.7
Oct 28 20:18	X48192	DD	7.5	89	53	55	1.3	2.1
Oct 29 22:14	164310	DD	7.0	102	38	62	0.8	1.7
Oct 30 20:10	164907	DD	7.0	114	70	358	-0.4	6.4
Oct 30 20:37	164922	DD	7.4	114	67	101	2.9	-0.2
Nov 01 00:47	146585	DD	4.4	129	24	98	0.9	0.7
Nov 05 01:55	93276	RD	5.8	173	41	270	2.0	0.6
Nov 06 01:35	93776	RD	7.5	159	45	249	2.2	0.9
Nov 06 03:22	93805	RD	7.0	159	34	236	1.8	1.7
Nov 06 23:40	94332	RD	5.0	146	34	242	1.5	0.3
Nov 08 01:02	95359	RD	5.7	132	36	230	1.6	0.9
Nov 09 03:14	96697	RD	7.2	118	42	296	2.5	-1.1
Nov 11 02:05	98361	RD	7.3	94	23	228	1.1	1.0
Nov 12 09:04	98967	DB	1.3	80	36	131	1.2	-0.8
Nov 12 10:19	98967	RD	1.3	79	22	281	1.1	0.5
Nov 22 19:55	161376	DD	5.2	35	10	33	-0.7	2.8
Nov 25 21:16	164082	DD	7.8	71	24	150	4.0	-6.7
Dec 04 21:41	94684	RD	7.6	167	28	267	1.5	-0.6
Dec 05 00:01	94739	RD	7.8	166	42	253	2.3	0.4
Dec 08 03:45	98133	RD	7.5	126	45	335	1.5	-2.7
Dec 09 00:42	98683	RD	6.6	114	23	203	0.6	7.4
Dec 24 20:06	146161	DD	6.8	64	32	56	0.7	1.8
Dec 25 21:20	146724	DD	7.1	77	25	99	1.0	0.7
Dec 28 22:35	110390	DD	5.7	117	33	149	3.4	-8.0
Dec 28 23:14	110408	DD	4.5	117	25	103	1.2	0.5
Dec 29 00:11	110408	RB	4.5	118	14	220	0.7	2.2
Dec 29 22:41	93301	DD	7.1	130	38	130	2.4	-1.5
Dec 29 23:59	93327	DD	6.4	131	25	124	1.2	-0.5
Dec 30 22:04	93776	DD	7.5	144	45	76	2.3	0.7
Dec 30 23:57	93805	DD	7.0	145	32	90	1.7	0.7
Dec 31 20:56	94332	DD	5.0	157	40	133	3.3	-3.0

CANBERRA (35° 15' S, 149° 08'E)

AEST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 05 21:04	109507	DD	6.5	88	31	89	1.4	1.1
Jan 08 22:30	93524	DD	6.5	128	32	21	1.6	3.3
Jan 09 22:19	94015	DD	7.8	140	35	55	2.1	1.4
Jan 10 22:33	94634	DD	7.7	153	36	72	2.3	0.6
Jan 12 02:04	95852	DD	6.9	166	22	64	1.9	1.9
Jan 16 02:00	98931	RD	7.0	146	43	347	1.0	-3.4
Feb 03 19:47	92932	DD	5.5	83	34	63	1.6	1.5
Feb 03 20:16	92942	DD	7.6	83	31	100	1.7	0.7
Feb 03 20:34	92948	DD	7.5	83	28	81	1.4	1.2
Feb 03 20:55	92952	DD	6.6	83	24	106	1.3	0.6
Feb 06 00:06	93900	DD	5.7	110	5	140	**	-0.7
Feb 06 22:36	94431	DD	7.5	122	27	132	1.4	-0.6
Feb 07 23:09	95402	DD	7.7	134	28	80	2.0	1.1
Feb 07 23:53	95432	DD	5.2	135	23	114	1.3	0.2
Feb 08 21:38	96493	DD	7.9	146	36	67	2.5	0.6
Feb 10 01:11	97545	DD	7.7	159	28	55	2.7	2.7
Feb 11 01:04	98247	DD	5.2	170	36	96	2.2	0.4
Feb 12 20:39	99136	RD	6.0	168	14	256	0.8	-0.8
Feb 12 23:10	118355	DB	3.8	167	38	149	1.5	-2.7
Feb 13 00:24	118355	RD	3.8	167	44	258	2.9	0.2
Feb 16 23:48	139428	RD	5.8	123	26	273	1.0	-1.4
Feb 18 23:46	159049	RD	7.4	101	12	307	**	-1.9
Feb 19 23:41	159607	RD	4.7	90	4	339	-0.6	-2.8
Feb 21 03:18	160171	RD	6.5	77	38	287	0.9	-1.6
Feb 22 04:28	160879	RD	7.7	65	42	250	1.5	-0.3
Feb 23 03:41	161834	RD	7.8	53	22	197	2.8	5.8
Feb 24 04:32	162980	RD	6.7	39	21	235	0.7	**
Mar 01 20:13	Saturn	DD	0.7	37	2	44	0.2	2.0
Mar 03 21:04	93276	DD	5.8	65	8	81	0.6	1.3
Mar 06 20:23	X 7838	DD	7.9	103	33	173	9.9	9.9
Mar 07 19:36	96153	DD	7.6	115	36	91	2.4	-0.2
Mar 09 22:35	98007	DD	7.8	139	37	98	2.3	0.2
Mar 10 23:17	98617	DD	7.6	151	40	99	2.3	0.1
Mar 15 01:51	138889	RD	7.2	164	55	309	1.9	-1.4
Mar 15 03:11	138917	DB	2.9	164	47	156	1.1	-2.3
Mar 15 03:11	X54027	DB	3.5	164	47	156	1.1	-2.3
Mar 15 04:16	138917	RD	2.9	163	36	256	1.8	2.0
Mar 15 04:16	X54027	RD	3.5	163	36	256	1.8	2.0
Mar 16 02:03	139325	RD	7.6	153	60	239	4.1	2.7
Mar 17 04:05	139794	RD	7.1	142	57	314	1.8	-1.4
Mar 18 01:12	158915	RD	5.6	131	53	272	2.0	-1.0
Mar 18 22:33	159438	RD	6.8	121	15	216	1.4	2.1
Mar 19 23:35	159971	RD	6.9	109	19	287	0.2	-1.5
Mar 23 02:46	162512	DB	3.9	73	26	157	-0.5	-5.0
Mar 23 03:13	162512	RD	3.9	72	32	206	1.9	2.9
Mar 24 02:55	163418	RD	7.4	60	17	304	**	-2.2
Mar 24 03:40	163437	RD	7.4	59	26	291	0.4	-1.8
Mar 25 03:29	164265	RD	6.5	46	11	287	**	-1.6
Mar 25 04:02	164279	RD	6.2	46	18	261	0.4	-0.8
Mar 25 05:00	164303	RD	6.7	46	29	292	0.7	-2.0
Apr 02 19:36	94678	DD	7.4	72	24	158	0.5	-2.8
Apr 02 19:44	94694	DD	7.8	72	23	104	1.4	0.5
Apr 03 20:23	95852	DD	6.9	84	25	60	2.1	2.0
Apr 03 21:17	95873	DD	7.7	85	17	160	-0.1	-2.4
Apr 03 21:41	95902	DD	7.8	85	13	104	0.9	0.7
Apr 04 22:00	96995	DD	7.8	97	19	107	1.1	0.5
Apr 07 21:45	98931	DD	7.0	131	42	54	4.1	2.9
Apr 11 01:24	119399	DD	7.7	165	44	148	1.2	-1.7
Apr 17 03:34	160418	RD	7.4	127	73	227	3.0	3.2
Apr 18 02:28	X43398	RD	7.4	115	58	228	2.6	1.7
Apr 21 05:21	164027	RD	5.9	77	59	254	1.9	**
Apr 23 04:56	146347	RD	7.3	51	30	237	0.9	0.1
Apr 24 05:07	146915	RD	5.6	37	18	222	0.5	0.6
Apr 29 18:05	94332	RB	5.0	39	18	271	1.2	1.0
May 02 19:58	97545	DD	7.7	78	26	118	1.3	**
May 03 19:39	98250	DD	5.6	89	36	95	2.2	0.4
May 03 19:56	98247	DD	5.2	89	34	162	0.6	-2.4
May 03 20:49	98247	RB	5.2	90	28	240	2.5	2.6
May 06 18:47	118804	DD	4.1	123	42	79	2.6	-0.3
May 06 19:58	118804	RB	4.1	123	48	336	1.3	-2.7
May 07 21:40	119245	DD	6.1	135	52	46	6.5	6.8
May 09 01:05	139072	DD	6.8	146	36	162	0.8	-2.6
May 09 17:47	139428	DD	5.8	155	19	125	0.4	-2.0
May 10 02:50	139548	DD	6.9	158	26	105	0.9	0.6
May 10 03:26	139559	DD	6.6	158	19	119	0.6	0.2
May 11 23:14	159146	DD	7.1	175	65	162	0.9	-4.1
May 14 02:24	160226	RD	7.7	156	69	313	2.2	-2.1
May 14 04:48	160257	RD	7.2	155	45	293	1.6	0.1
May 14 22:01	160819	RD	7.5	146	30	305	0.4	-2.2
May 16 02:33	161848	RD	6.5	133	70	255	2.4	0.4
May 16 02:33	161850	RD	7.0	133	71	248	2.4	0.8
May 16 05:11	161929	RD	7.0	132	60	320	2.9	-2.8
May 16 05:20	161935	RD	6.9	132	59	224	1.4	3.0
May 21 05:37	146736	RD	6.4	68	48	191	0.7	3.3
May 21 09:48	Jupiter	GD	-2.2	67	49			
Jun 02 17:45	118648	DD	4.7	93	46	126	2.0	-1.6
Jun 02 19:16	118648	RB	4.7	93	46	291	2.2	-0.4
Jun 04 20:18	138889	DD	7.2	115	55	161	1.0	-3.0
Jun 05 19:48	139322	DD	7.1	126	57	73	3.3	0.6
Jun 06 22:08	139794	DD	7.1	138	61	100	2.4	-0.1
Jun 07 00:55	139834	DD	6.6	139	35	119	1.2	**
Jun 07 01:28	139847	DD	6.7	139	28	142	0.9	-1.0
Jun 07 19:02	158915	DD	5.6	148	44	120	1.2	-2.0
Jun 09 02:52	159587	DD	6.2	162	33	51	0.7	3.2
Jun 12 00:14	161540	RD	5.8	162	69	276	2.2	-0.7
Jun 12 00:53	161557	RD	7.0	162	73	235	2.4	1.8
Jun 12 01:30	161582	RD	7.7	162	73	215	2.2	4.0
Jun 12 03:46	X44258	RD	7.6	161	54	304	2.2	-0.8
Jun 12 21:49	162521	RD	6.0	151	32	233	1.2	0.3
Jun 13 01:08	162637	RD	7.3	150	69	213	2.2	3.3
Jun 13 01:20	162643	RD	6.9	150	70	207	2.2	4.3
Jun 14 00:09	X48192	RD	7.5	138	48	197	2.0	4.6
Jun 14 05:53	163641	RD	7.0	136	48	332	5.7	-8.3
Jun 15 01:43	164310	RD	7.0	125	54	216	1.7	1.9
Jun 15 23:35	164907	RD	7.0	113	18	220	0.6	0.7
Jun 17 03:11	146543	RD	7.0	99	46	286	2.0	-1.8
Jun 26 18:15	97669	DD	6.4	27	10	101	0.7	0.8
Jun 26 18:20	97646	RB	5.1	27	9	255	0.9	1.7
Jun 28 18:36	98876	RB	5.2	51	26	301	1.0	-0.1
Jul 01 21:10	X54025	DD	6.0	86	31	76	1.7	2.0
Jul 02 23:07	139229	DD	7.5	98	20	97	0.7	1.0
Jul 07 01:37	159929	DD	7.1	143	33	78	0.8	1.6
Jul 07 17:36	160305	DD	6.1	152	27	140	**	-2.5
Jul 07 22:52	160418	DD	7.4	154	71	101	2.4	-0.3
Jul 08 01:09	160462	DD	6.0	154	49	48	1.2	3.2
Jul 08 20:53	X43398	DD	7.4	165	56	71	2.0	**
Jul 09 01:23	X43584	DD	7.7	166	57	54	1.5	2.5
Jul 09 01:34	161227	DD	6.1	166	55	82	1.7	1.2
Jul 09 01:56	X43594	DD	7.9	166	50	156	3.2	-5.3
Jul 09 02:54	161267	DD	6.4	167	39	44	0.5	2.9
Jul 09 03:03	161278	DD	6.6	167	37	127	1.5	-0.4
Jul 09 03:24	161304	DD	6.4	167	33	88	0.8	1.2
Jul 09 22:48	162204	DD	6.4	176	67	140	1.9	-3.8
Jul 13 23:28	146362	DB	3.7	130	28	26	0.8	1.6
Jul 14 00:17	146362	RD	3.7	129	38	296	1.5	-2.5
Jul 14 05:31	146447	RD	6.4	127	52	182	-0.1	4.5
Jul 20 05:50	94019	RD	7.1	47	23	205	0.3	1.5
Jul 27 20:04	118804	DD	4.1	44	9	141	0.2	-0.6
Jul 28 21:29	119245	DD	6.1	56	3	150	**	-1.0
Aug 06 01:05	161848	DD	6.5	148	45	98	1.4	0.7
Aug 06 01:08	161850	DD	7.0	148	45	105	1.5	0.4
Aug 06 03:18	161929	DD	7.0	149	19	57	**	1.9
Aug 07 23:42	163783	DD	5.9	173	71	150	4.6	-9.1
Aug 09 21:02	146111	RD	7.6	161	26	224	0.8	0.6
Aug 10 05:30	146271	RD	6.8	158	30	219	0.4	2.3
Aug 11 02:12	146774	RD	7.0	145	59	248	2.0	0.8
Aug 12 00:31	128760	RD	6.4	132	39	239	1.3	0.3
Aug 13 00:59	109835	RD	7.0	119	31	236	1.0	0.2
Aug 13 04:10	109905	RD	7.3	117	50	232	1.7	1.3
Aug 14 04:33	110516	RD	7.6	104	45	201	1.0	2.3
Aug 15 03:50	93387	RD	7.7	91	34	201	0.6	1.9
Aug 17 04:53	94431	RD	7.5	64	23	190	-0.3	3.2
Aug 18 04:43	95402	RD	7.7	51	13	213	0.1	1.0
Aug 28 21:10	158915	DD	5.6	70	24	143	0.9	-1.1
Aug 28 21:51	158935	DD	6.4	70	15	61	0.2	2.5
Aug 28 22:18	158946	DD	6.0	70	10	46	-0.2	3.4
Aug 29 18:41	159438	DD	6.8	80	61	110	2.2	-0.3
Sep 01 18:20	161227	DD	6.1	115	66	98	2.2	-0.9
Sep 01 19:57	161267	DD	6.4	115	73	42	2.4	3.3
Sep 01 20:05	161278	DD	6.6	115	73	123	2.4	-1.6
Sep 01 20:34	161304	DD	6.4	115	69	82	2.3	0.8
Sep 01 20:53	X43728	DD	7.9	115	67	56	2.0	2.3
Sep 03 01:16	162512	DD	3.9	129	27	39	**	2.6
Sep 03 02:03	162512	RB	3.9	130	17	298	0.6	0.3
Sep 04 22:36	164204	DD	6.4	154	69	104	2.5	-0.6
Sep 04 23:11	164211	DD	7.7	154	66	147	5.5	-8.2
Sep 04 23:19	164218	DD	7.9	154	65	107	2.5	-0.5
Sep 05 03:29	164315	DD	7.0	156	20	60	0.2	1.7
Sep 05 23:19	164907	DD	7.0	168	66	85	2.2	0.2
Sep 10 01:20	110286	RD	7.2	135	42	181	-0.2	3.9
Sep 27 21:08	160305	DD	6.1	73	30	104	0.9	0.7
Sep 28 21:49	X43208	DD	7.6	85	32	87	0.8	1.3
Sep 29 20:57	161935	DD	6.9	96	52	88	1.7	1.0
Sep 29 22:59	162001	DD	6.6	97	28	142	1.7	-1.5
Sep 30 00:29	162050	DD	6.3	98	11	135	0.6	-0.5
Oct 01 18:47	163783	DD	5.9	120	64	112	2.3	-1.8
Oct 01 21:56	163848	DD	6.9	121	59	114	2.5	-0.5
Oct 04 00:39	146271	DD	6.8	149	44	83	1.5	1.1
Oct 04 17:39	Jupiter	DD	-2.9	160	15	88	0.4	-1.0
Oct 04 17:47	Ganymede	DD	4.4	160	16	86	0.5	-0.9
Oct 04 18:38	Jupiter	RB	-2.9	160	27	234	0.8	0.2
Oct 04 18:47	Ganymede	RB	4.4	160	29	235	0.8	0.2
Oct 04 20:29	146774	DD	7.0	161	46	48	1.3	0.8
Oct 05 03:05	146877	DD	7.2	164	24	75	0.7	1.4
Oct 06 20:46	109905	RD	7.3	170	23	271	1.0	-1.1
Oct 07 21:08	110537	RD	6.5	156	14	299	1.2	-2.6
Oct 10 00:40	94015	RD	7.8	126	24	323	3.4	-5.0
Oct 11 03:46	94739	RD	7.8	112	34	315	2.7	-2.2
Oct 12 04:02	95968	RD	7.4	99	32	209	1.5	2.2
Oct 13 04:12	97087	RD	6.8	86	28	209	1.3	2.3
Oct 14 04:02	97878	RD	7.7	74	22	249	1.3	-0.4
Oct 27 19:36	162637	DD	7.3	77	53	79	1.6	1.3
Oct 27 19:51	162643	DD	6.9	77	50	86	1.6	1.1
Oct 28 19:58	X48192	DD	7.5	89	58	73	1.7	1.4
Oct 29 21:57	164310	DD	7.0	102	43	76	1.2	1.4
Oct 30 19:35	164907	DD	7.0	114	66	28	1.3	2.8
Oct 30 20:33	164922	DD	7.4	114	63	127	3.7	-2.5
Oct 31 23:09	146543	DD	7.0	128	44	357	-0.5	4.9
Nov 01 00:39	146585	DD	4.4	129	28	117	1.3	0.2
Nov 01 01:19	146585	RB	4.4	129	20	197	**	2.9
Nov 05 01:42	93276	RD	5.8	173	37	255	1.9	0.9
Nov 06 01:20	93776	RD	7.5	159	38	234	1.8	1.0
Nov 06 03:00	93805	RD	7.0	159	33	216	1.7	2.2
Nov 06 23:32	94332	RD	5.0	146	25	224	0.9	0.5
Nov 08 00:48	95359	RD	5.7	132	26	208	0.7	1.6
Nov 09 03:11	96697	RD	7.2	118	33	278	2.2	-0.6
Nov 12 09:12	98967	DB	1.3	80	32	165	0.3	-2.3
Nov 12 10:02	98967	RD	1.3	79	24	246	2.0	2.5
Nov 22 19:38	161376	DD	5.2	35	19	56	-0.1	2.1
Nov 27 23:28	146362	DD	3.7	96	17	5	-0.4	3.7
Nov 27 23:54	146362	RB	3.7	97	12	311	0.7	-0.5
Dec 04 23:49	94739	RD	7.8	166	33	237	1.7	0.5
Dec 25 21:12	146724	DD	7.1	77	28	118	1.4	0.1
Dec 28 20:37	110359	DD	7.8	116	44	13	0.8	3.0
Dec 28 23:08	110408	DD	4.5	117	26	126	1.5	-0.3
Dec 28 23:47	110408	RB	4.5	117	19	195	0.8	3.3
Dec 29 21:10	93276	DD	5.8	130	41	16	1.0	2.8
Dec 30 21:52	93776	DD	7.5	144	38	91	2.2	0.1
Dec 30 23:47	93805	DD	7.0	145	30	109	1.8	0.2
Dec 31 21:42	94351	DD	7.9	158	35	97	2.2	-0.6

MELBOURNE (37° 50' S, 145° 00'E)

AEST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 05 20:56	109507	DD	6.5	88	34	91	1.5	1.0
Jan 08 22:16	93524	DD	6.5	127	33	28	1.6	2.5
Jan 09 22:07	94015	DD	7.8	140	34	59	2.0	1.0
Jan 10 22:23	94634	DD	7.7	153	33	76	2.1	0.3
Jan 12 01:52	95852	DD	6.9	166	24	75	1.8	1.3
Jan 16 02:03	98931	RD	7.0	146	40	333	1.4	-2.4
Feb 03 20:48	92952	DD	6.6	83	27	112	1.5	0.4
Feb 06 00:12	93900	DD	5.7	110	6	162	-1.0	-4.3
Feb 06 22:33	94431	DD	7.5	122	27	143	1.4	-1.3
Feb 07 22:59	95402	DD	7.7	134	29	88	2.0	0.7
Feb 07 23:48	95432	DD	5.2	135	24	124	1.3	-0.1
Feb 08 21:27	96493	DD	7.9	146	32	73	2.2	0.1
Feb 10 00:56	97545	DD	7.7	159	29	70	2.3	1.5
Feb 11 00:55	98247	DD	5.2	170	35	107	2.0	-0.1
Feb 12 20:38	99136	RD	6.0	168	9	250	0.6	-0.8
Feb 12 23:12	118355	DB	3.8	167	34	161	1.2	-3.2
Feb 13 00:11	118355	RD	3.8	167	40	244	2.9	0.6
Feb 16 23:48	139428	RD	5.8	123	23	264	0.8	-1.2
Feb 19 23:50	159607	RD	4.7	90	3	327	-0.5	-2.3
Feb 21 03:18	160171	RD	6.5	77	35	276	0.9	-1.4
Feb 22 04:22	160879	RD	7.7	65	38	235	1.5	0.2
Feb 24 04:29	162980	RD	6.7	39	17	221	0.7	0.6
Mar 01 20:06	Saturn	DD	0.7	37	6	51	0.3	1.9
Mar 01 20:09	Titan	DD	8.3	37	6	53	0.3	1.9
Mar 03 20:58	93276	DD	5.8	65	11	89	0.7	1.2
Mar 06 21:22	95031	DD	7.9	103	26	83	1.9	1.0
Mar 08 23:32	97268	DD	7.6	128	24	34	3.8	5.7
Mar 09 22:26	98007	DD	7.8	139	36	109	2.1	-0.3
Mar 10 23:08	98617	DD	7.6	151	38	110	2.1	-0.4
Mar 15 01:46	138889	RD	7.2	164	53	296	2.1	-0.9
Mar 15 03:16	138917	DB	2.9	164	47	176	0.3	-4.2
Mar 15 03:16	X54027	DB	3.5	164	47	176	0.3	-4.2
Mar 15 04:00	138917	RD	2.9	163	40	237	2.7	3.8
Mar 15 04:00	X54027	RD	3.5	163	40	237	2.7	3.8
Mar 15 05:32	138933	RD	6.1	163	25	264	1.1	1.6
Mar 16 01:25	139316	RD	8.0	153	55	299	1.9	-1.5
Mar 17 04:00	139794	RD	7.1	142	57	301	2.0	-0.9
Mar 18 01:06	158915	RD	5.6	131	47	259	2.0	-0.6
Mar 18 01:24	158935	RD	6.4	131	50	3	-0.9	-6.4
Mar 19 23:38	159971	RD	6.9	109	16	277	0.2	-1.4
Mar 22 05:48	161564	DB	5.2	84	66	132	1.9	-2.8
Mar 24 03:00	163418	RD	7.4	60	15	292	**	-1.8
Mar 24 03:43	163437	RD	7.4	59	23	279	0.4	-1.4
Mar 24 05:27	163500	RD	7.9	59	43	269	1.3	-1.0
Mar 25 04:02	164279	RD	6.2	46	15	250	0.3	-0.6
Mar 25 05:02	164303	RD	6.7	46	26	280	0.6	-1.5
Apr 02 19:37	94694	DD	7.8	72	24	113	1.4	0.3
Apr 03 20:11	95852	DD	6.9	84	26	72	2.0	1.4
Apr 03 21:36	95902	DD	7.8	85	15	115	0.9	0.4
Apr 04 21:55	96995	DD	7.8	97	21	118	1.1	0.2
Apr 05 19:43	97753	DD	7.1	108	35	26	4.8	7.1
Apr 07 21:27	98931	DD	7.0	131	41	72	3.0	0.8
Apr 11 01:26	119399	DD	7.7	165	44	165	0.7	-2.8
Apr 17 05:51	160462	RD	6.0	126	58	275	2.0	0.6
Apr 18 02:08	X43398	RD	7.4	115	51	203	3.7	6.4
Apr 18 04:09	X24772	RD	8.0	115	69	231	2.5	2.0
Apr 21 05:14	164027	RD	5.9	77	53	246	1.7	0.2
Apr 23 04:52	146347	RD	7.3	51	25	228	0.7	0.3
Apr 24 05:03	146915	RD	5.6	37	14	212	0.3	0.9
May 02 19:53	97545	DD	7.7	78	27	129	1.2	-0.4
May 03 19:30	98250	DD	5.6	89	35	106	2.0	-0.1
May 03 20:08	98247	DD	5.2	90	32	191	9.9	9.9
May 03 20:23	98247	RB	5.2	90	31	210	9.9	9.9
May 05 22:53	118418	DD	7.9	113	29	130	1.0	-0.4
May 06 18:39	118804	DD	4.1	123	37	90	2.1	-1.0
May 06 19:59	118804	RB	4.1	123	45	323	1.6	-2.1
May 07 21:16	119245	DD	6.1	134	50	72	3.3	0.9
May 09 01:14	139072	DD	6.8	147	36	186	-0.2	-7.0
May 10 02:45	139548	DD	6.9	158	30	115	1.0	0.3
May 10 03:23	139559	DD	6.6	158	23	128	0.7	-0.1

AEST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
May 11 23:29	159146	DD	7.1	175	63	191	9.9	9.9
May 11 23:48	159146	RD	7.1	175	64	215	6.4	9.6
May 14 02:19	160226	RD	7.7	156	69	302	2.2	-1.4
May 14 04:41	160257	RD	7.2	155	49	286	1.7	0.4
May 14 22:04	160819	RD	7.5	146	28	293	0.4	-1.8
May 16 02:21	161850	RD	7.0	133	65	237	2.3	1.2
May 16 02:22	161848	RD	6.5	133	65	245	2.2	0.7
May 16 05:06	161935	RD	6.9	132	63	217	1.5	3.5
May 16 05:06	161929	RD	7.0	132	63	311	2.5	-1.8
May 21 05:25	146736	RD	6.4	68	42	181	0.3	4.6
May 21 09:37	Jupiter	GD	-2.2	67	51			
Jun 01 20:56	99081	DD	7.9	82	27	66	2.2	2.6
Jun 02 17:42	118648	DD	4.7	93	43	137	1.7	-1.9
Jun 02 19:08	118648	RB	4.7	93	45	278	2.4	-0.1
Jun 04 20:25	138889	DD	7.2	116	53	182	-0.2	-5.1
Jun 05 19:36	139322	DD	7.1	126	53	89	2.5	-0.6
Jun 06 22:00	139794	DD	7.1	138	60	113	2.1	-0.8
Jun 07 00:51	139834	DD	6.6	139	38	130	1.3	-0.5
Jun 07 01:27	139847	DD	6.7	139	31	154	1.0	-1.8
Jun 07 19:03	158915	DD	5.6	148	40	131	0.8	-2.3
Jun 09 00:23	159559	DD	8.0	161	61	75	2.3	1.4
Jun 09 02:41	159587	DD	6.2	161	38	61	1.0	2.6
Jun 12 00:07	161540	RD	5.8	162	64	265	2.1	-0.4
Jun 12 00:37	161557	RD	7.0	162	68	222	2.5	2.6
Jun 12 01:04	161582	RD	7.7	162	70	192	9.9	9.9
Jun 12 03:38	X44258	RD	7.6	161	57	297	2.1	-0.5
Jun 12 21:07	162512	DB	3.9	152	20	21	1.7	3.1
Jun 12 21:27	162512	RD	3.9	152	24	343	-0.9	-5.9
Jun 12 21:42	162521	RD	6.0	151	27	216	1.3	1.2
Jun 13 00:46	162637	RD	7.3	150	61	192	2.6	8.5
Jun 14 05:49	163641	RD	7.0	136	51	323	3.7	-3.8
Jun 15 01:31	164310	RD	7.0	125	48	204	1.5	2.7
Jun 15 23:30	164907	RD	7.0	113	13	206	0.6	1.4
Jun 17 03:08	146543	RD	7.0	99	41	279	1.6	-1.5
Jun 26 18:10	97646	RB	5.1	27	12	239	1.5	2.5
Jun 26 18:10	97645	RB	6.0	27	12	239	1.4	2.5
Jun 28 18:31	98876	RB	5.2	51	28	289	1.4	0.4
Jul 01 20:59	X54025	DD	6.0	86	35	91	1.6	1.1
Jul 02 23:01	139229	DD	7.5	98	24	108	0.8	0.6
Jul 05 01:16	158817	DD	7.5	120	19	90	0.5	1.3
Jul 07 01:29	159929	DD	7.1	143	37	84	1.1	1.4
Jul 07 22:44	160418	DD	7.4	154	70	112	2.2	-1.0
Jul 08 00:56	160462	DD	6.0	154	54	57	1.5	2.6
Jul 08 20:47	X43398	DD	7.4	165	51	83	1.6	-0.7
Jul 08 22:30	X24772	DD	8.0	165	67	65	2.3	0.8
Jul 08 22:38	X43466	DD	8.0	165	68	143	1.8	-3.5
Jul 09 01:10	X43584	DD	7.7	166	61	61	1.7	2.0
Jul 09 01:24	161227	DD	6.1	166	58	88	1.8	0.9
Jul 09 02:44	161267	DD	6.4	167	44	49	0.8	2.7
Jul 09 02:58	161278	DD	6.6	167	41	132	1.7	-0.8
Jul 09 03:17	161304	DD	6.4	167	38	92	1.0	1.1
Jul 09 03:29	X43728	DD	7.9	167	35	69	0.7	1.8
Jul 09 22:55	162204	DD	6.4	176	64	162	1.3	-9.0
Jul 10 23:13	163210	RD	8.0	168	57	242	1.9	0.5
Jul 13 06:20	164866	RD	7.0	140	38	319	3.1	-2.5
Jul 13 23:22	146362	DB	3.7	130	23	38	0.7	0.8
Jul 14 00:17	146362	RD	3.7	129	34	286	1.2	-1.9
Jul 14 05:20	146447	RD	6.4	127	54	181	-0.1	4.6
Jul 20 05:46	94019	RD	7.1	47	18	202	0.1	1.5
Jul 27 20:06	118804	DD	4.1	44	11	155	0.1	-1.3
Jul 28 21:33	119245	DD	6.1	56	5	164	**	-2.0
Aug 04 01:41	160226	DD	7.7	124	20	123	0.7	0.2
Aug 04 21:41	160819	DD	7.5	135	69	19	9.9	9.9
Aug 06 00:57	161848	DD	6.5	148	49	102	1.6	0.5
Aug 06 01:00	161850	DD	7.0	148	49	110	1.7	0.2
Aug 06 03:13	161929	DD	7.0	149	23	59	0.1	2.0
Aug 10 05:22	146271	RD	6.8	158	34	217	0.5	2.3
Aug 11 02:02	146774	RD	7.0	145	56	247	1.8	0.6
Aug 12 00:26	128760	RD	6.4	132	34	234	1.0	0.3
Aug 13 00:55	109835	RD	7.0	119	27	232	0.8	0.2

AEST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Aug 13 04:01	109905	RD	7.3	117	47	231	1.6	1.1
Aug 14 04:24	110516	RD	7.6	104	41	200	0.8	2.1
Aug 15 03:44	93387	RD	7.7	91	29	199	0.4	1.8
Aug 17 04:47	94431	RD	7.5	64	18	185	-1.0	4.1
Aug 26 20:38	139322	DD	7.1	48	12	128	0.4	-0.1
Aug 28 21:10	158915	DD	5.6	70	27	155	1.0	-1.9
Aug 28 21:44	158935	DD	6.4	70	20	70	0.4	2.1
Aug 28 22:10	158946	DD	6.0	70	15	57	0.1	2.8
Sep 01 19:40	161267	DD	6.4	115	70	55	2.4	1.9
Sep 01 20:01	161278	DD	6.6	115	71	134	2.3	-2.6
Sep 01 20:17	161294	DD	8.0	115	70	56	2.3	2.0
Sep 01 20:24	161304	DD	6.4	115	70	90	2.3	0.2
Sep 01 20:24	161306	DD	8.0	115	70	89	2.3	0.2
Sep 01 20:40	X43728	DD	7.9	115	69	65	2.2	1.6
Sep 02 00:16	161449	DD	7.9	117	32	95	0.8	1.0
Sep 03 01:09	162512	DD	3.9	129	32	42	0.2	2.6
Sep 03 02:00	162512	RB	3.9	130	21	295	0.7	0.5
Sep 03 23:08	163384	DD	8.0	141	62	103	2.2	**
Sep 04 22:28	164204	DD	6.4	154	67	109	2.5	-1.1
Sep 04 23:11	164218	DD	7.9	154	66	111	2.5	-0.9
Sep 05 03:23	164315	DD	7.0	156	24	62	0.3	1.7
Sep 05 23:10	164907	DD	7.0	168	63	88	2.2	-0.1
Sep 10 01:11	110286	RD	7.2	135	37	177	-0.6	4.4
Sep 15 05:19	96312	RD	7.3	68	23	294	1.9	-1.6
Sep 27 21:02	160305	DD	6.1	73	34	109	1.1	0.6
Sep 28 21:42	X43208	DD	7.6	85	37	91	1.0	1.2
Sep 29 20:48	161935	DD	6.9	96	56	92	1.8	0.8
Sep 29 22:55	162001	DD	6.6	97	32	148	2.2	-2.3
Sep 30 00:27	162050	DD	6.3	98	15	140	0.9	-0.7
Oct 01 21:47	163848	DD	6.9	121	61	118	2.6	-0.9
Oct 04 00:30	146271	DD	6.8	149	48	84	1.6	1.1
Oct 04 17:41	Jupiter	DD	-2.9	160	12	98	0.3	-1.4
Oct 04 18:34	Jupiter	RB	-2.9	160	22	225	0.6	0.4
Oct 04 18:43	Ganymede	RB	4.4	160	24	227	0.7	0.3
Oct 04 20:22	146774	DD	7.0	161	41	53	1.2	0.4
Oct 05 02:58	146877	DD	7.2	164	28	77	0.9	1.4
Oct 05 04:39	146915	DD	5.6	164	9	64	0.2	1.6
Oct 06 20:44	109905	RD	7.3	170	19	265	0.8	-1.0
Oct 07 21:10	110537	RD	6.5	156	10	292	0.8	-2.1
Oct 11 03:40	94739	RD	7.8	112	31	311	2.5	-2.0
Oct 12 03:51	95968	RD	7.4	99	27	202	0.9	2.5
Oct 13 04:01	97087	RD	6.8	86	23	199	0.5	3.7
Oct 14 03:59	97878	RD	7.7	74	17	244	1.1	-0.4
Oct 29 21:48	164310	DD	7.0	102	47	78	1.4	1.4
Oct 30 20:24	164922	DD	7.4	114	63	131	3.8	-3.4
Oct 31 22:59	146543	DD	7.0	128	47	359	-0.3	4.6
Nov 01 00:32	146585	DD	4.4	129	31	119	1.5	0.1
Nov 01 01:11	146585	RB	4.4	129	24	193	**	3.1
Nov 01 21:18	128571	DD	8.0	141	54	82	2.1	0.1
Nov 05 01:32	93276	RD	5.8	173	37	253	1.8	0.8
Nov 06 01:10	93776	RD	7.5	159	36	232	1.6	0.9
Nov 06 02:48	93805	RD	7.0	159	33	210	1.6	2.2
Nov 06 23:28	94332	RD	5.0	146	20	222	0.7	0.4
Nov 07 00:36	94351	RD	7.9	146	28	266	1.7	-0.6
Nov 08 00:42	95359	RD	5.7	132	21	204	0.4	1.6
Nov 09 03:04	96697	RD	7.2	118	29	273	2.0	-0.6
Nov 12 09:25	98967	DB	1.3	80	30	195	9.9	9.9
Nov 12 09:32	98967	GD	1.3	80	29			
Nov 12 09:40	98967	RD	1.3	80	28	215	9.9	9.9
Nov 27 23:20	146362	DD	3.7	96	22	10	-0.2	3.3
Nov 27 23:52	146362	RB	3.7	97	15	306	0.8	**
Dec 03 01:04	93524	DD	6.5	165	31	358	0.8	6.1
Dec 23 21:45	164627	DD	6.7	53	10	65	-0.1	1.6
Dec 25 21:05	146724	DD	7.1	77	32	121	1.7	**
Dec 28 23:02	110408	DD	4.5	117	28	133	1.9	-0.9
Dec 28 23:34	110408	RB	4.5	117	23	187	0.8	3.8
Dec 29 20:59	93276	DD	5.8	130	39	17	0.9	2.4
Dec 30 21:43	93776	DD	7.5	144	36	92	2.2	-0.1
Dec 30 23:39	93805	DD	7.0	145	30	114	1.9	**
Dec 31 21:35	94351	DD	7.9	158	31	99	2.0	-0.8

SYDNEY (33° 54' S, 151° 15'E)

AEST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 05 21:09	109507	DD	6.5	88	30	87	1.3	1.1
Jan 08 22:38	93524	DD	6.5	128	31	17	1.7	3.9
Jan 09 22:25	94015	DD	7.8	140	36	52	2.1	1.6
Jan 10 22:39	94634	DD	7.7	153	37	70	2.3	0.8
Jan 12 02:10	95852	DD	6.9	166	21	57	1.9	2.2
Jan 14 22:00	98381	RD	7.5	159	21	252	1.2	-0.5
Jan 16 01:57	98931	RD	7.0	146	44	358	0.3	-4.8
Feb 03 19:53	92932	DD	5.5	83	34	61	1.6	1.6
Feb 03 20:20	92942	DD	7.6	83	29	98	1.6	0.7
Feb 03 20:38	92948	DD	7.5	83	26	78	1.3	1.3
Feb 03 20:58	92952	DD	6.6	83	23	103	1.2	0.7
Feb 06 22:39	94431	DD	7.5	122	26	127	1.4	-0.4
Feb 07 23:15	95402	DD	7.7	134	28	75	2.0	1.3
Feb 07 23:23	95390	DD	7.5	134	27	165	0.1	-4.1
Feb 07 23:56	95432	DD	5.2	134	22	109	1.3	0.4
Feb 10 01:22	97545	DD	7.7	159	26	43	3.2	4.2
Feb 11 01:09	98247	DD	5.2	170	35	90	2.2	0.7
Feb 12 20:39	99136	RD	6.0	168	16	259	0.9	-0.9
Feb 12 23:10	118355	DB	3.8	167	40	144	1.6	-2.5
Feb 13 00:30	118355	RD	3.8	167	46	265	2.9	**
Feb 16 23:48	139428	RD	5.8	123	29	278	1.0	-1.4
Feb 18 23:43	159049	RD	7.4	101	13	312	**	-2.0
Feb 19 23:36	159607	RD	4.7	90	4	347	-0.8	-3.4
Feb 21 03:18	160171	RD	6.5	77	40	293	0.9	-1.8
Feb 22 04:31	160879	RD	7.7	65	45	257	1.6	-0.5
Feb 23 03:49	161834	RD	7.8	53	26	214	1.5	1.7
Feb 24 04:34	162980	RD	6.7	39	23	242	0.7	-0.2
Mar 03 21:07	93276	DD	5.8	65	7	77	0.6	1.4
Mar 07 19:41	96153	DD	7.6	115	37	88	2.5	**
Mar 09 22:40	98007	DD	7.8	139	37	92	2.4	0.4
Mar 10 23:22	98617	DD	7.6	151	40	93	2.4	0.4
Mar 15 01:53	138889	RD	7.2	164	55	317	1.7	-1.6
Mar 15 03:11	138917	DB	2.9	164	47	148	1.3	-1.8
Mar 15 03:11	X54027	DB	3.5	164	47	148	1.3	-1.8
Mar 15 04:22	138917	RD	2.9	163	34	264	1.6	1.5
Mar 15 04:22	X54027	RD	3.5	163	34	264	1.6	1.5
Mar 16 02:13	139325	RD	7.6	153	60	251	3.5	1.5
Mar 17 04:07	139794	RD	7.1	142	56	321	1.7	-1.8
Mar 18 01:15	158915	RD	5.6	131	55	279	2.0	-1.2
Mar 18 22:37	159438	RD	6.8	121	17	228	1.0	0.6
Mar 19 23:33	159971	RD	6.9	109	20	292	0.2	-1.7
Mar 23 02:40	162512	DB	3.9	73	27	145	-0.1	-3.5
Mar 23 03:03	162512	GD	3.9	72	32			
Mar 23 03:19	162512	RD	3.9	72	35	218	1.6	1.5
Mar 24 02:52	163418	RD	7.4	60	18	312	-0.1	-2.7
Mar 24 03:39	163437	RD	7.4	59	27	297	0.5	-2.1
Mar 25 03:26	164265	RD	6.5	46	12	293	**	-1.8
Mar 25 04:02	164279	RD	6.2	46	19	266	0.4	-0.9
Mar 25 04:59	164303	RD	6.7	46	31	298	0.7	-2.3
Apr 02 19:34	94678	DD	7.4	72	24	148	0.8	-1.6
Apr 02 19:48	94694	DD	7.8	72	22	100	1.4	0.7
Apr 03 20:31	95852	DD	6.9	84	23	53	2.1	2.4
Apr 03 21:15	95873	DD	7.7	85	17	150	0.2	-1.4
Apr 04 22:03	96995	DD	7.8	97	18	100	1.1	0.7
Apr 07 22:04	98931	DD	7.0	131	42	34	9.9	9.9
Apr 11 01:24	119399	DD	7.7	165	43	141	1.3	-1.3
Apr 17 03:43	160418	RD	7.4	127	74	235	2.8	2.4
Apr 18 02:35	X43398	RD	7.4	115	62	236	2.5	1.2
Apr 21 05:26	164027	RD	5.9	77	61	258	2.1	-0.1
Apr 23 04:58	146347	RD	7.3	51	32	242	1.0	**
Apr 24 05:09	146915	RD	5.6	37	21	227	0.6	0.4
Apr 29 18:09	94332	RB	5.0	39	17	275	1.1	0.9
May 02 20:01	97545	DD	7.7	78	26	111	1.3	0.2
May 03 19:45	98250	DD	5.6	89	36	88	2.3	0.7
May 03 19:55	98247	DD	5.2	89	35	153	0.9	-1.8
May 03 20:56	98247	RB	5.2	90	26	250	2.1	2.0
May 06 18:52	118804	DD	4.1	123	45	72	3.0	0.2
May 06 19:57	118804	RB	4.1	123	50	344	1.0	-3.2
May 09 01:04	139072	DD	6.8	146	35	154	0.9	-1.9
May 09 17:45	139428	DD	5.8	155	20	120	0.5	-1.9
May 10 02:53	139548	DD	6.9	158	24	100	0.8	0.8
May 10 03:28	139559	DD	6.6	158	17	114	0.6	0.3
May 14 02:26	160226	RD	7.7	156	69	320	2.3	-2.6
May 14 04:51	160257	RD	7.2	155	43	296	1.6	-0.1
May 14 21:58	160819	RD	7.5	146	31	311	0.3	-2.4
May 16 02:38	161848	RD	6.5	133	73	260	2.4	0.3
May 16 02:40	161850	RD	7.0	133	73	253	2.5	0.6
May 16 05:13	161929	RD	7.0	132	59	325	3.2	-3.7
May 16 05:27	161935	RD	6.9	132	57	227	1.3	2.8
May 21 05:43	146736	RD	6.4	68	51	194	0.8	3.0
May 21 09:53	Jupiter	GD	-2.2	67	47			
Jun 02 17:47	118648	DD	4.7	93	48	120	2.2	-1.3
Jun 02 19:20	118648	RB	4.7	93	46	298	2.0	-0.6
Jun 04 20:17	138889	DD	7.2	115	56	152	1.4	-2.5
Jun 05 19:57	139322	DD	7.1	126	60	62	4.1	2.0
Jun 06 22:14	139794	DD	7.1	138	61	93	2.6	0.4
Jun 07 00:58	139834	DD	6.6	139	33	114	1.1	0.2
Jun 07 01:28	139847	DD	6.7	139	27	136	0.9	-0.7
Jun 07 19:02	158915	DD	5.6	148	46	114	1.3	-1.8
Jun 09 02:58	159587	DD	6.2	162	30	45	0.5	3.6
Jun 12 00:18	161540	RD	5.8	163	71	281	2.3	-0.9
Jun 12 01:00	161557	RD	7.0	162	75	241	2.5	1.5
Jun 12 01:39	161582	RD	7.7	162	73	222	2.2	3.3
Jun 12 03:49	X44258	RD	7.6	161	52	307	2.2	-1.0
Jun 12 21:51	162521	RD	6.0	151	34	241	1.2	**
Jun 13 01:17	162637	RD	7.3	150	72	220	2.3	2.7
Jun 13 01:30	162643	RD	6.9	150	73	214	2.2	3.4
Jun 14 00:18	X48192	RD	7.5	138	52	208	2.0	2.9
Jun 15 01:49	164310	RD	7.0	125	57	221	1.8	1.7
Jun 15 23:37	164907	RD	7.0	113	20	227	0.6	0.4
Jun 17 03:13	146543	RD	7.0	99	49	290	2.2	-2.0
Jun 26 18:18	97669	DD	6.4	27	8	95	0.7	0.9
Jun 26 18:24	97646	RB	5.1	27	7	262	0.7	1.4
Jun 28 18:38	98876	RB	5.2	51	25	308	0.9	-0.3
Jul 01 21:16	X54025	DD	6.0	86	29	68	1.7	2.6
Jul 02 23:10	139229	DD	7.5	98	18	92	0.6	1.2
Jul 07 01:41	159929	DD	7.1	143	30	74	0.7	1.7
Jul 07 17:33	160305	DD	6.1	152	28	133	0.2	-2.3
Jul 07 22:56	160418	DD	7.4	154	71	96	2.4	**
Jul 08 01:16	160462	DD	6.0	154	46	44	1.0	3.5
Jul 08 20:58	X43398	DD	7.4	165	59	64	2.3	0.6
Jul 09 01:29	X43584	DD	7.7	166	54	50	1.3	2.7
Jul 09 01:39	161227	DD	6.1	166	52	79	1.6	1.3
Jul 09 02:59	161267	DD	6.4	167	36	42	0.4	3.0
Jul 09 03:06	161278	DD	6.6	167	35	124	1.4	-0.3
Jul 09 03:27	161304	DD	6.4	167	31	87	0.7	1.2
Jul 13 23:32	146362	DB	3.7	130	31	20	0.8	2.3
Jul 13 23:54	146362	GD	3.7	129	36			
Jul 14 00:17	146362	RD	3.7	129	40	301	1.7	-3.0
Jul 14 05:37	146447	RD	6.4	127	50	183	-0.1	4.4
Jul 20 05:53	94019	RD	7.1	47	25	206	0.4	1.5
Jul 21 05:30	94634	RD	7.7	34	12	284	1.1	-1.5
Jul 27 20:04	118804	DD	4.1	44	7	135	0.2	-0.4
Jul 28 21:28	119245	DD	6.1	56	1	143	**	-0.8
Jul 30 18:27	139428	DD	5.8	77	55	185	-0.3	-6.8
Jul 30 19:01	139428	RB	5.8	77	50	228	3.8	5.9
Aug 06 01:09	161848	DD	6.5	148	43	96	1.3	0.8
Aug 06 01:12	161850	DD	7.0	148	42	103	1.4	0.5
Aug 06 03:21	161929	DD	7.0	149	16	55	-0.1	1.9
Aug 06 20:05	162816	DD	5.9	159	54	156	0.9	-6.8
Aug 07 23:42	163783	DD	5.9	173	72	142	3.8	-5.3
Aug 09 21:05	146111	RD	7.6	161	29	230	0.9	0.4
Aug 10 05:34	146271	RD	6.8	158	28	220	0.4	2.2
Aug 11 02:17	146774	RD	7.0	145	61	249	2.0	0.8
Aug 12 00:34	128760	RD	6.4	132	42	241	1.4	0.3
Aug 13 01:02	109835	RD	7.0	119	34	239	1.1	0.2
Aug 13 04:16	109905	RD	7.3	117	51	232	1.7	1.3
Aug 14 04:38	110516	RD	7.6	104	46	202	1.1	2.4
Aug 15 03:54	93387	RD	7.7	91	36	202	0.7	1.9
Aug 16 05:18	93870	RD	6.9	77	36	170	9.9	9.9
Aug 17 04:57	94431	RD	7.5	64	26	193	-0.1	3.0
Aug 18 04:45	95402	RD	7.7	51	15	215	0.3	1.0
Aug 28 21:11	158915	DD	5.6	70	22	138	0.8	-0.8
Aug 28 21:54	158935	DD	6.4	70	13	56	**	2.7
Aug 28 22:22	158946	DD	6.0	70	7	40	-0.4	4.0
Aug 29 18:45	159438	DD	6.8	80	60	104	2.2	**
Sep 01 18:23	161227	DD	6.1	115	69	92	2.3	-0.6
Sep 01 20:07	161267	DD	6.4	115	72	35	2.3	4.4
Sep 01 20:08	161278	DD	6.6	115	73	118	2.5	-1.2
Sep 01 20:40	161304	DD	6.4	115	68	78	2.3	1.1
Sep 01 22:51	161376	DD	5.2	116	44	161	4.0	-7.8
Sep 01 23:07	161376	RB	5.2	116	40	187	9.9	9.9
Sep 03 01:19	162512	DD	3.9	129	24	37	-0.1	2.6
Sep 03 02:05	162512	RB	3.9	130	15	300	0.5	0.2
Sep 04 22:41	164204	DD	6.4	154	70	101	2.5	-0.4
Sep 04 23:12	164211	DD	7.7	154	66	141	4.5	-5.3
Sep 05 03:31	164315	DD	7.0	156	17	59	0.1	1.7
Sep 05 23:24	164907	DD	7.0	168	67	83	2.2	0.4
Sep 10 01:25	110286	RD	7.2	135	44	182	**	3.8
Sep 27 18:49	160257	DD	7.2	72	56	82	1.9	1.3
Sep 27 21:11	160305	DD	6.1	73	28	101	0.8	0.8
Sep 28 18:51	160909	DD	6.4	84	65	144	2.7	-3.3
Sep 28 21:53	X43208	DD	7.6	85	29	85	0.7	1.3
Sep 29 21:02	161935	DD	6.9	96	50	85	1.6	1.1
Sep 29 23:00	162001	DD	6.6	97	26	139	1.5	-1.2
Sep 30 00:29	162050	DD	6.3	98	9	133	0.5	-0.4
Oct 01 18:50	163783	DD	5.9	120	67	108	2.4	-1.4
Oct 01 22:01	163848	DD	6.9	121	57	112	2.4	-0.3
Oct 04 00:44	146271	DD	6.8	149	43	82	1.4	1.2
Oct 04 17:39	Jupiter	DD	-2.9	160	17	83	0.5	-0.8
Oct 04 18:39	Jupiter	RB	-2.9	160	29	238	0.9	0.1
Oct 04 18:49	Ganymede	RB	4.4	160	31	239	0.9	0.1
Oct 04 20:33	146774	DD	7.0	161	49	45	1.3	1.0
Oct 05 03:08	146877	DD	7.2	164	22	74	0.6	1.4
Oct 06 20:46	109905	RD	7.3	170	26	273	1.1	-1.2
Oct 07 21:07	110537	RD	6.5	156	16	303	1.4	-3.0
Oct 10 00:41	94015	RD	7.8	126	26	326	4.1	-6.1
Oct 11 03:48	94739	RD	7.8	112	36	318	2.8	-2.4
Oct 12 04:09	95968	RD	7.4	99	34	213	1.8	2.0
Oct 13 04:18	97087	RD	6.8	86	31	214	1.7	2.0
Oct 14 04:05	97878	RD	7.7	74	24	251	1.5	-0.4
Oct 27 19:41	162637	DD	7.3	77	51	78	1.5	1.4
Oct 27 19:56	162643	DD	6.9	77	48	84	1.5	1.2
Oct 28 20:03	X48192	DD	7.5	89	56	71	1.6	1.5
Oct 29 22:02	164310	DD	7.0	102	41	76	1.1	1.5
Oct 30 19:42	164907	DD	7.0	114	67	26	1.2	3.0
Oct 30 20:37	164922	DD	7.4	114	63	125	3.6	-2.1
Oct 31 23:15	146543	DD	7.0	128	42	356	-0.6	5.1
Nov 01 00:42	146585	DD	4.4	129	26	115	1.2	0.3
Nov 01 01:23	146585	RB	4.4	129	17	199	**	2.8
Nov 05 01:47	93276	RD	5.8	173	37	256	1.8	1.0
Nov 06 01:25	93776	RD	7.5	159	39	235	1.9	1.1
Nov 06 03:07	93805	RD	7.0	159	32	219	1.7	2.2
Nov 06 23:35	94332	RD	5.0	146	27	226	1.0	0.6
Nov 08 00:52	95359	RD	5.7	132	28	210	0.9	1.6
Nov 09 03:15	96697	RD	7.2	118	35	280	2.3	-0.6
Nov 12 09:10	98967	DB	1.3	80	32	155	0.6	-1.7
Nov 12 10:09	98967	RD	1.3	79	22	255	1.6	1.9
Nov 22 19:41	161376	DD	5.2	35	16	54	-0.2	2.1
Nov 27 23:32	146362	DD	3.7	96	15	2	-0.5	4.1
Nov 27 23:47	146362	GD	3.7	96	11			
Nov 27 23:55	146362	RB	3.7	97	10	315	0.7	-0.9
Dec 04 23:54	94739	RD	7.8	166	35	239	1.9	0.6
Dec 25 21:15	146724	DD	7.1	77	26	117	1.3	0.2
Dec 28 20:43	110359	DD	7.8	116	44	12	0.8	3.2
Dec 28 23:10	110408	DD	4.5	117	24	122	1.4	-0.1
Dec 28 23:53	110408	RB	4.5	117	17	200	0.8	3.1
Dec 29 21:16	93276	DD	5.8	130	42	14	1.0	3.0
Dec 30 21:57	93776	DD	7.5	144	39	89	2.3	0.2
Dec 30 23:51	93805	DD	7.0	145	29	106	1.7	0.4

LUNAR OCCULTATION TABLE

DARWIN (12° 23' S, 130° 44' E)

ACST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 05 23:09	Saturn	GD	0.7	89	22			
Jan 10 21:05	94628	DD	4.2	153	48	111	2.9	-1.4
Jan 10 22:22	94649	DD	5.5	153	58	150	4.6	-6.6
Jan 10 22:25	94628	RB	4.2	153	58	228	2.6	2.1
Jan 24 05:25	159963	DB	4.4	55	37	132	0.7	-2.0
Feb 02 20:41	109926	RB	5.1	70	38	249	1.5	1.2
Feb 05 23:23	93900	DD	5.7	110	34	79	1.7	0.8
Feb 07 22:56	95432	DD	5.2	135	55	62	3.2	1.7
Feb 08 00:15	95432	RB	5.2	135	43	308	1.7	-1.4
Feb 09 20:32	97472	DD	5.8	158	37	126	2.2	-2.1
Feb 11 00:02	98247	DD	5.2	170	62	42	5.6	5.6
Feb 12 21:30	118355	DB	3.8	167	22	93	1.0	-0.6
Feb 12 22:48	118355	RD	3.8	167	40	303	1.8	-1.8
Mar 03 21:04	93276	DD	5.8	65	26	9	1.7	6.2
Mar 15 01:21	138917	DB	2.9	164	75	115	2.9	-1.5
Mar 15 01:21	X54027	DB	3.5	164	75	115	2.9	-1.5
Mar 15 03:03	138917	RD	2.9	163	71	311	2.3	-2.0
Mar 15 03:03	X54027	RD	3.5	163	71	311	2.3	-2.0
Mar 15 04:23	138933	RD	6.1	163	53	349	0.8	-4.4
Mar 15 23:17	139308	RD	5.9	153	40	227	3.8	4.2
Mar 17 23:44	158915	RD	5.6	131	27	310	0.5	-1.8
Mar 22 04:33	161564	DB	5.2	84	49	46	2.9	2.4
Mar 22 04:54	161540	RD	5.8	84	54	240	2.7	1.4
Mar 22 05:31	161564	RD	5.2	83	63	326	1.8	-4.2
Mar 23 02:34	162512	RD	3.9	72	10	275	0.2	-0.6
Apr 16 05:56	159963	DB	4.4	137	58	58	2.5	2.5
Apr 18 06:24	161227	RD	6.1	114	73	304	3.4	-2.1
Apr 23 04:50	146362	RD	3.7	51	19	239	0.7	0.7
Apr 23 05:56	146382	RD	6.3	50	35	284	1.4	-1.1
Apr 30 20:28	95432	DD	5.2	53	23	87	1.2	0.5
May 03 19:11	98250	RB	5.6	90	62	2	-0.5	-8.7
May 03 19:49	98247	RB	5.2	90	60	286	2.9	-0.6
May 09 01:37	139096	DD	6.1	147	46	144	1.4	-2.3
May 15 02:19	160909	RD	6.4	144	75	286	3.0	-1.1
May 18 01:58	163783	RD	5.9	108	35	216	1.8	2.5
May 21 04:47	146736	RD	6.4	68	36	303	1.8	-2.7
May 21 08:36	Jupiter	DB	-2.2	67	81	27	1.5	3.0
May 21 09:51	Jupiter	RD	-2.2	66	68	270	3.0	0.2
Jun 04 21:27	138917	DD	2.9	116	73	157	1.5	-3.5
Jun 04 21:27	X54027	DD	3.5	116	73	157	1.5	-3.5
Jun 04 22:48	138917	RB	2.9	117	56	266	3.0	0.6
Jun 04 22:48	X54027	RB	3.5	117	56	266	3.0	0.6
Jun 04 22:54	138933	DD	6.1	117	55	121	2.1	-1.2
Jun 12 00:00	161571	RD	6.3	162	61	264	2.6	**
Jun 13 06:35	162816	RD	5.9	148	38	237	0.9	1.7
Jun 17 03:15	146585	DB	4.4	98	44	26	1.2	2.7
Jun 17 04:18	146585	RD	4.4	98	59	285	2.9	-1.3
Jul 07 02:51	159963	DD	4.4	144	24	64	0.6	1.6
Jul 08 03:16	160523	DD	6.3	155	30	115	1.4	-0.6
Jul 09 04:23	161376	DD	5.2	168	27	66	0.6	1.3
Jul 14 05:05	146447	RD	6.4	127	78	292	4.2	-1.6
Jul 15 02:45	146954	RD	6.1	115	53	258	2.1	0.2
Jul 18 06:00	93067	RD	6.3	73	55	217	1.4	2.0
Jul 26 20:00	118355	MB	3.8	33	13	203	9.9	9.9
Jul 27 19:25	118804	DD	4.1	44	33	73	2.0	1.5
Jul 27 20:18	118804	RB	4.1	45	20	339	0.1	-2.6
Jul 28 20:55	119245	DD	6.1	56	23	68	1.3	1.8
Aug 05 20:31	161754	DD	6.0	147	59	166	0.4	-8.6
Aug 06 00:59	161871	DD	6.4	148	56	132	3.3	-2.6
Aug 07 19:14	163712	DD	6.2	172	16	104	0.3	-0.9
Aug 07 22:14	163783	DD	5.9	173	58	39	2.3	2.6
Aug 16 05:45	93900	DB	5.7	76	50	45	1.6	1.7
Aug 28 20:33	158915	DD	5.6	70	42	47	2.0	4.4
Aug 28 21:17	158915	RB	5.6	70	32	344	1.5	-4.5
Aug 30 19:16	159963	RB	4.4	92	81	288	3.2	-1.0
Aug 31 19:09	160523	DD	6.3	104	81	129	2.8	-2.5
Sep 01 21:32	161376	DD	5.2	116	73	47	2.7	3.1
Sep 01 22:47	161376	RB	5.2	116	55	304	2.9	-1.7
Sep 03 00:46	162521	DD	6.0	129	41	49	0.8	2.1
Sep 07 02:37	146585	DB	4.4	177	65	43	1.6	2.1
Sep 07 03:51	146585	RD	4.4	176	47	259	1.7	0.8
Sep 10 03:39	110337	RD	6.2	134	69	252	2.7	0.8
Sep 30 00:15	162050	DD	6.3	98	17	37	-0.3	2.4
Oct 04 17:27	Jupiter	GD	-2.9	160	2			
Oct 30 19:16	164910	RB	5.4	114	74	234	2.4	1.6
Nov 01 00:18	146585	DD	4.4	129	46	28	0.8	2.7
Nov 01 01:16	146585	RB	4.4	129	32	278	1.3	0.1
Nov 01 03:17	Jupiter	GD	-2.7	130	3			
Nov 03 23:17	110337	DD	6.2	170	67	80	2.7	0.3
Nov 04 03:49	110408	DD	4.5	172	31	128	1.5	-1.8
Nov 07 23:48	95359	RD	5.7	132	22	310	1.9	-2.4
Nov 12 07:31	98967	DB	1.3	80	66	124	2.7	-1.7
Nov 12 09:09	98967	RD	1.3	79	56	294	2.3	-0.9
Nov 23 21:04	162413	DD	5.0	47	16	84	0.4	0.6
Dec 05 05:39	94942	RD	6.0	164	24	321	0.3	-1.8
Dec 09 03:39	98733	RD	5.6	113	53	278	2.8	-0.7
Dec 28 21:03	110390	DD	5.7	117	68	57	2.4	1.5
Dec 28 22:22	110408	DD	4.5	117	55	45	1.9	2.1
Dec 28 23:38	110408	RB	4.5	118	39	268	1.8	0.5
Dec 29 22:50	93327	DD	6.4	131	57	67	2.4	1.2

LUNAR OCCULTATION TABLE

HOBART (42° 48' S, 147° 13‘E)

AEST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 08 00:03	93083	DD	5.2	115	10	8	1.1	4.2
Jan 08 22:09	93524	DD	6.5	127	28	41	1.5	1.8
Jan 12 01:50	95852	DD	6.9	166	19	85	1.5	1.1
Feb 03 20:49	92952	DD	6.6	83	22	125	1.3	0.1
Feb 07 23:51	95432	DD	5.2	135	19	135	1.0	-0.2
Feb 11 01:00	98247	DD	5.2	170	30	116	1.6	-0.1
Feb 11 01:27	98250	DD	5.6	170	27	36	4.2	5.5
Feb 12 23:32	118355	DB	3.8	167	33	174	0.7	-3.8
Feb 13 00:13	118355	RD	3.8	167	36	231	3.2	1.5
Feb 14 00:10	118804	DB	4.1	156	35	51	2.9	1.1
Feb 14 00:47	118804	RD	4.1	156	39	359	0.2	-4.2
Feb 15 03:03	119245	RD	6.1	144	45	357	0.2	-3.9
Feb 16 23:55	139428	RD	5.8	123	25	255	1.0	-1.1
Feb 20 00:00	159607	RD	4.7	90	8	317	-0.3	-2.1
Feb 21 03:27	160171	RD	6.5	77	37	266	1.0	-1.2
Feb 24 04:24	162980	RD	6.7	39	19	195	1.6	3.5
Mar 01 19:58	Saturn	DD	0.7	37	5	60	0.3	1.8
Mar 01 20:01	Titan	DD	8.3	37	5	63	0.3	1.7
Mar 03 20:53	93276	DD	5.8	65	8	98	0.6	1.1
Mar 15 03:41	138917	GD	2.9	164	40			
Mar 18 01:12	158915	RD	5.6	131	47	247	2.2	-0.1
Mar 18 01:47	158935	RD	6.4	131	51	344	0.5	-3.8
Mar 19 23:45	159971	RD	6.9	109	20	268	0.3	-1.3
Mar 21 04:08	160629	RD	6.9	96	57	338	0.8	-4.7
Mar 25 03:38	164265	RD	6.5	46	12	261	0.2	-1.0
Mar 25 04:05	164279	RD	6.2	46	17	234	0.4	-0.2
Mar 25 05:10	164303	RD	6.7	46	29	264	0.7	-1.1
Apr 03 20:08	95852	DD	6.9	84	21	81	1.7	1.1
Apr 21 05:15	164027	RD	5.9	77	52	228	1.5	0.9
Apr 24 04:56	146915	RD	5.6	37	14	183	0.2	3.4
May 03 19:34	98250	DD	5.6	89	30	115	1.7	-0.1
May 06 18:48	118804	DD	4.1	123	36	97	1.9	-1.1
May 06 20:11	118804	RB	4.1	123	41	315	1.6	-1.5
May 07 21:19	119245	DD	6.1	134	45	83	2.5	0.3
May 10 02:47	139548	DD	6.9	158	27	132	0.8	-0.2
May 10 03:27	139559	DD	6.6	158	20	148	0.6	-0.9
May 16 02:17	161850	RD	7.0	133	62	214	2.2	3.1
May 16 02:20	161848	RD	6.5	133	62	225	2.1	1.9
Jun 02 17:55	118648	DD	4.7	93	39	145	1.4	-1.9
Jun 02 19:12	118648	RB	4.7	93	39	268	2.3	0.4
Jun 07 00:57	139834	DD	6.6	139	33	149	1.0	-1.3
Jun 07 19:17	158915	DD	5.6	148	42	139	0.8	-2.5
Jun 09 02:33	159587	DD	6.2	161	37	80	1.0	1.7
Jun 12 00:12	161540	RD	5.8	162	62	249	2.0	0.4
Jun 12 21:03	162512	DB	3.9	152	22	44	0.8	0.2
Jun 12 21:46	162512	RD	3.9	151	30	318	0.1	-3.1
Jun 26 17:57	97646	RB	5.1	27	10	217	2.2	4.7
Jun 28 18:30	98876	RB	5.2	51	23	277	1.3	0.9
Jul 01 20:57	X54025	DD	6.0	86	31	106	1.3	0.7
Jul 07 18:02	160305	DD	6.1	152	31	173	-0.9	-5.1
Jul 08 00:50	160462	DD	6.0	154	51	76	1.5	1.6
Jul 09 01:25	161227	DD	6.1	166	54	106	1.7	0.3
Jul 09 02:35	161267	DD	6.4	167	43	68	1.0	1.9
Jul 09 03:15	161304	DD	6.4	167	36	109	1.1	0.7
Jul 09 18:44	162050	DD	6.3	175	20	146	-0.4	-3.1
Jul 13 23:22	146362	DB	3.7	130	24	57	0.7	-0.2
Jul 14 00:27	146362	RD	3.7	129	35	266	1.2	-1.0
Jul 14 01:22	146382	RD	6.3	129	43	321	2.7	-6.8
Jul 15 05:07	Jupiter	GD	-2.6	114	46			
Jul 27 20:17	118804	DD	4.1	44	6	184	-0.6	-5.0
Aug 06 00:59	161848	DD	6.5	148	46	121	1.6	-0.1
Aug 10 05:10	146271	RD	6.8	158	33	202	0.3	2.7
Aug 10 23:41	146736	RD	6.4	146	37	298	1.7	-2.7
Aug 12 00:25	128760	RD	6.4	132	32	215	0.8	0.9
Aug 28 21:36	158935	DD	6.4	70	20	89	0.5	1.5
Aug 28 21:59	158946	DD	6.0	70	16	77	0.2	1.9
Aug 29 18:44	159438	DD	6.8	80	56	138	1.7	-1.6
Sep 01 19:39	161267	DD	6.4	115	66	74	2.1	0.7
Sep 01 20:29	161304	DD	6.4	115	64	107	2.0	-0.5
Sep 01 20:30	161278	DD	6.6	115	64	172	9.9	9.9
Sep 03 00:58	162512	DD	3.9	129	32	59	0.4	2.1
Sep 03 01:57	162512	RB	3.9	130	21	280	0.4	1.1
Sep 04 22:44	164204	DD	6.4	154	62	137	3.1	-3.8
Sep 27 21:03	160305	DD	6.1	73	32	128	1.1	**
Sep 29 20:49	161935	DD	6.9	96	52	110	1.8	0.2
Oct 04 00:29	146271	DD	6.8	149	43	99	1.6	0.7
Oct 04 17:51	Jupiter	DD	-2.9	160	15	119	0.4	-2.5
Oct 04 18:31	Jupiter	RB	-2.9	160	22	203	0.5	1.3
Oct 04 18:41	Ganymede	RB	4.4	160	24	206	0.6	1.2
Oct 05 04:31	146915	DD	5.6	164	8	74	0.2	1.5
Oct 07 21:20	110537	RD	6.5	156	12	271	0.7	-1.3
Nov 01 00:41	146585	DD	4.4	129	27	149	3.9	-5.6
Nov 01 00:50	146585	RB	4.4	129	25	164	-2.5	8.9
Nov 05 01:31	93276	RD	5.8	173	32	242	1.5	1.1
Nov 06 23:25	94332	RD	5.0	146	17	202	0.2	1.2
Nov 12 09:34	98967	GD	1.3	80	27			
Nov 27 23:06	146362	DD	3.7	96	22	26	0.1	2.6
Nov 27 23:51	146362	RB	3.7	97	14	290	0.4	0.9
Dec 03 00:49	93524	DD	6.5	165	27	21	1.2	2.4
Dec 23 21:37	164627	DD	6.7	53	11	75	**	1.5

MERCURY

RISE AND SET TIMES AEST (Adelaide & Darwin ACST)

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

MERCURY

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

VENUS

RISE AND SET TIMES AEST (Adelaide & Darwin ACST)

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

VENUS

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

MARS

RISE AND SET TIMES

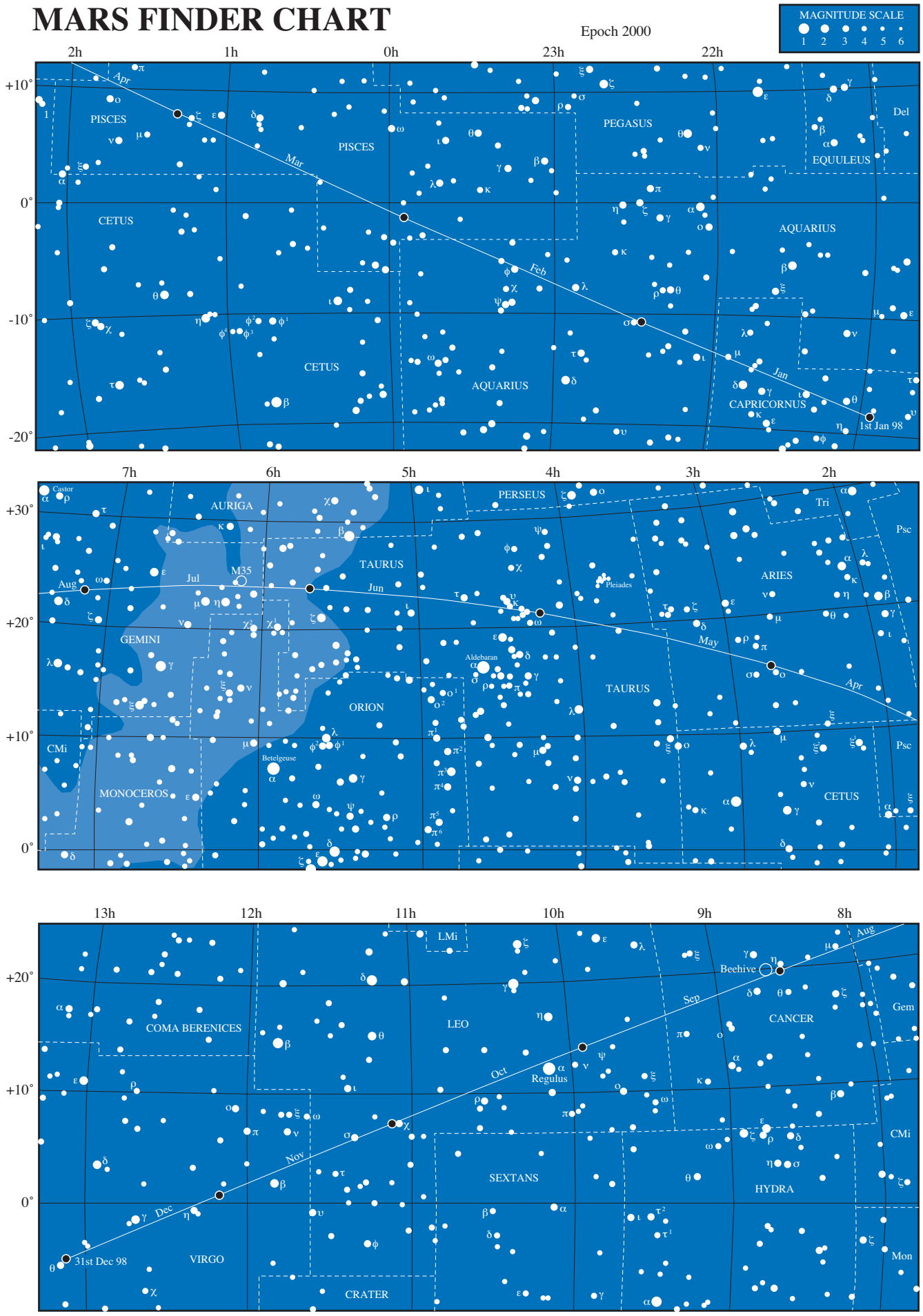
AEST (Adelaide & Darwin ACST)

POSITION

(0hrs UT Epoch 2000.0)

	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Sydney		Townsville		RA	DEC
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	h m s	° ' "
Jan 3	07:30	21:22	07:17	20:40	07:18	21:10	08:39	21:17	07:08	21:36	07:29	21:33	07:12	20:59	07:55	20:52	21 00 43	- 18 12 05
10	07:30	21:11	07:15	20:31	07:17	21:00	08:35	21:09	07:09	21:23	07:29	21:21	07:11	20:49	07:52	20:44	21 22 46	- 16 32 15
17	07:30	20:59	07:13	20:21	07:17	20:48	08:31	21:02	07:11	21:09	07:29	21:09	07:11	20:37	07:49	20:35	21 44 26	- 14 44 05
24	07:29	20:47	07:11	20:10	07:17	20:36	08:26	20:54	07:12	20:55	07:29	20:56	07:10	20:25	07:45	20:26	22 05 45	- 12 48 44
31	07:29	20:35	07:09	19:59	07:16	20:23	08:22	20:45	07:14	20:41	07:30	20:43	07:09	20:13	07:42	20:17	22 26 45	- 10 47 24
Feb 7	07:28	20:22	07:07	19:48	07:15	20:10	08:17	20:36	07:15	20:26	07:29	20:29	07:08	20:00	07:38	20:07	22 47 25	- 08 41 19
14	07:27	20:08	07:04	19:36	07:15	19:57	08:11	20:27	07:16	20:10	07:29	20:15	07:07	19:47	07:34	19:56	23 07 49	- 06 31 41
21	07:26	19:55	07:01	19:24	07:13	19:43	08:06	20:18	07:17	19:54	07:29	20:01	07:06	19:34	07:29	19:46	23 27 58	- 04 19 41
28	07:24	19:41	06:58	19:12	07:12	19:29	08:00	20:08	07:18	19:39	07:28	19:46	07:04	19:20	07:25	19:35	23 47 57	- 02 06 25
Mar 7	07:23	19:27	06:55	18:59	07:11	19:15	07:55	19:58	07:18	19:23	07:27	19:31	07:02	19:06	07:20	19:24	00 07 47	+ 00 06 58
14	07:21	19:13	06:52	18:47	07:09	19:01	07:49	19:49	07:18	19:07	07:26	19:17	07:00	18:53	07:15	19:13	00 27 30	+ 02 19 23
21	07:19	18:59	06:49	18:34	07:07	18:47	07:43	19:39	07:19	18:51	07:25	19:02	06:58	18:39	07:11	19:02	00 47 11	+ 04 29 50
28	07:17	18:45	06:45	18:22	07:05	18:33	07:37	19:29	07:19	18:35	07:24	18:47	06:56	18:25	07:06	18:51	01 06 52	+ 06 37 21
Apr 4	07:15	18:31	06:42	18:10	07:03	18:19	07:31	19:19	07:18	18:19	07:22	18:33	06:54	18:12	07:01	18:40	01 26 35	+ 08 40 58
11	07:13	18:18	06:38	17:58	07:01	18:05	07:24	19:10	07:18	18:04	07:21	18:19	06:52	17:58	06:56	18:30	01 46 22	+ 10 39 47
18	07:11	18:05	06:34	17:46	06:59	17:52	07:18	19:00	07:18	17:49	07:19	18:05	06:49	17:45	06:51	18:19	02 06 15	+ 12 32 56
25	07:09	17:52	06:31	17:34	06:57	17:39	07:13	18:51	07:17	17:34	07:18	17:52	06:47	17:33	06:46	18:09	02 26 16	+ 14 19 39
May 2	07:06	17:39	06:27	17:23	06:55	17:27	07:07	18:42	07:17	17:20	07:16	17:39	06:44	17:20	06:41	17:59	02 46 26	+ 15 59 10
9	07:04	17:27	06:23	17:13	06:52	17:15	07:01	18:33	07:16	17:06	07:14	17:26	06:41	17:09	06:36	17:50	03 06 45	+ 17 30 46
16	07:01	17:16	06:19	17:02	06:50	17:03	06:55	18:25	07:15	16:53	07:12	17:14	06:38	16:57	06:31	17:41	03 27 13	+ 18 53 49
23	06:58	17:05	06:15	16:52	06:47	16:52	06:49	18:17	07:13	16:41	07:09	17:03	06:35	16:47	06:26	17:32	03 47 50	+ 20 07 46
30	06:55	16:55	06:11	16:43	06:43	16:42	06:43	18:09	07:11	16:29	07:06	16:52	06:32	16:36	06:21	17:23	04 08 36	+ 21 12 09
Jun 6	06:51	16:45	06:07	16:34	06:40	16:32	06:38	18:01	07:08	16:18	07:03	16:42	06:28	16:27	06:15	17:15	04 29 27	+ 22 06 32
13	06:47	16:36	06:02	16:26	06:36	16:23	06:32	17:54	07:05	16:08	06:59	16:32	06:24	16:18	06:10	17:07	04 50 22	+ 22 50 38
20	06:42	16:27	05:56	16:18	06:31	16:14	06:26	17:47	07:01	15:59	06:55	16:24	06:19	16:09	06:04	17:00	05 11 18	+ 23 24 16
27	06:37	16:19	05:51	16:10	06:25	16:06	06:19	17:40	06:56	15:51	06:49	16:15	06:13	16:01	05:58	16:52	05 32 14	+ 23 47 22
Jul 4	06:31	16:12	05:45	16:03	06:20	15:59	06:13	17:33	06:51	15:43	06:43	16:08	06:07	15:54	05:52	16:45	05 53 05	+ 23 59 56
11	06:24	16:05	05:38	15:56	06:13	15:52	06:06	17:26	06:44	15:36	06:37	16:01	06:01	15:47	05:45	16:38	06 13 48	+ 24 02 06
18	06:16	15:58	05:30	15:49	06:05	15:45	05:59	17:19	06:36	15:30	06:29	15:54	05:53	15:40	05:38	16:31	06 34 20	+ 23 54 08
25	06:08	15:52	05:22	15:43	05:57	15:39	05:51	17:12	06:28	15:24	06:21	15:48	05:45	15:34	05:30	16:25	06 54 40	+ 23 36 21
Aug 1	05:59	15:46	05:14	15:36	05:48	15:33	05:43	17:05	06:18	15:18	06:12	15:43	05:36	15:28	05:22	16:18	07 14 43	+ 23 09 12
8	05:49	15:40	05:04	15:30	05:38	15:27	05:35	16:57	06:07	15:13	06:01	15:37	05:26	15:22	05:13	16:11	07 34 28	+ 22 33 10
15	05:39	15:35	04:55	15:23	05:27	15:22	05:26	16:50	05:56	15:08	05:50	15:32	05:16	15:16	05:04	16:04	07 53 53	+ 21 48 48
22	05:27	15:29	04:44	15:17	05:16	15:16	05:17	16:42	05:43	15:04	05:39	15:26	05:04	15:11	04:54	15:57	08 12 58	+ 20 56 43
29	05:15	15:23	04:33	15:10	05:04	15:10	05:07	16:34	05:30	14:59	05:26	15:21	04:52	15:05	04:43	15:50	08 31 40	+ 19 57 33
Sep 5	05:02	15:18	04:21	15:04	04:51	15:05	04:56	16:26	05:16	14:55	05:13	15:16	04:40	14:59	04:32	15:42	08 50 00	+ 18 51 59
12	04:49	15:12	04:09	14:57	04:38	14:59	04:46	16:18	05:02	14:50	04:59	15:10	04:27	14:53	04:21	15:34	09 07 57	+ 17 40 39
19	04:35	15:06	03:56	14:50	04:24	14:53	04:34	16:09	04:46	14:46	04:45	15:05	04:13	14:47	04:09	15:26	09 25 32	+ 16 24 14
26	04:21	14:59	03:42	14:42	04:09	14:47	04:23	16:00	04:30	14:41	04:30	14:59	03:59	14:40	03:57	15:18	09 42 46	+ 15 03 25
Oct 3	04:06	14:53	03:28	14:35	03:54	14:40	04:11	15:50	04:14	14:36	04:15	14:53	03:44	14:34	03:44	15:09	09 59 39	+ 13 38 53
10	03:50	14:46	03:14	14:27	03:39	14:34	03:59	15:41	03:57	14:31	03:59	14:47	03:29	14:27	03:31	15:00	10 16 12	+ 12 11 16
17	03:35	14:39	03:00	14:19	03:23	14:27	03:46	15:31	03:40	14:25	03:43	14:40	03:13	14:20	03:17	14:51	10 32 26	+ 10 41 12
24	03:19	14:32	02:45	14:11	03:07	14:19	03:33	15:20	03:23	14:19	03:26	14:33	02:57	14:12	03:03	14:42	10 48 22	+ 09 09 19
31	03:02	14:24	02:30	14:02	02:51	14:12	03:20	15:10	03:05	14:13	03:09	14:26	02:41	14:05	02:49	14:32	11 04 01	+ 07 36 17
Nov 7	02:46	14:17	02:14	13:53	02:34	14:04	03:06	14:59	02:47	14:07	02:52	14:19	02:25	13:57	02:35	14:22	11 19 23	+ 06 02 40
14	02:29	14:08	01:58	13:44	02:17	13:56	02:52	14:48	02:28	14:00	02:35	14:12	02:08	13:48	02:20	14:11	11 34 29	+ 04 29 02
21	02:12	14:00	01:42	13:34	02:00	13:48	02:38	14:37	02:10	13:53	02:17	14:04	01:51	13:40	02:05	14:01	11 49 20	+ 02 56 00
28	01:55	13:51	01:26	13:24	01:43	13:39	02:24	14:25	01:51	13:46	01:59	13:55	01:34	13:31	01:50	13:50	12 03 56	+ 01 24 10
Dec 5	01:37	13:42	01:10	13:14	01:25	13:30	02:09	14:13	01:32	13:38	01:42	13:47	01:17	13:22	01:35	13:39	12 18 16	- 00 05 56
12	01:20	13:33	00:53	13:04	01:08	13:21	01:54	14:01	01:14	13:30	01:24	13:38	00:59	13:12	01:19	13:27	12 32 20	- 01 33 46
19	01:02	13:23	00:37	12:53	00:50	13:11	01:39	13:48	00:55	13:22	01:05	13:28	00:42	13:02	01:04	13:16	12 46 06	- 02 58 48
26	00:44	13:13	00:20	12:42	00:32	13:01	01:24	13:35	00:35	13:12	00:47	13:19	00:24	12:52	00:48	13:03	12 59 33	- 04 20 27

MARS FINDER CHART



JUPITER

RISE AND SET TIMES

AEST (Adelaide & Darwin ACST)

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

POSITION

(0hrs UT Epoch 2000.0)

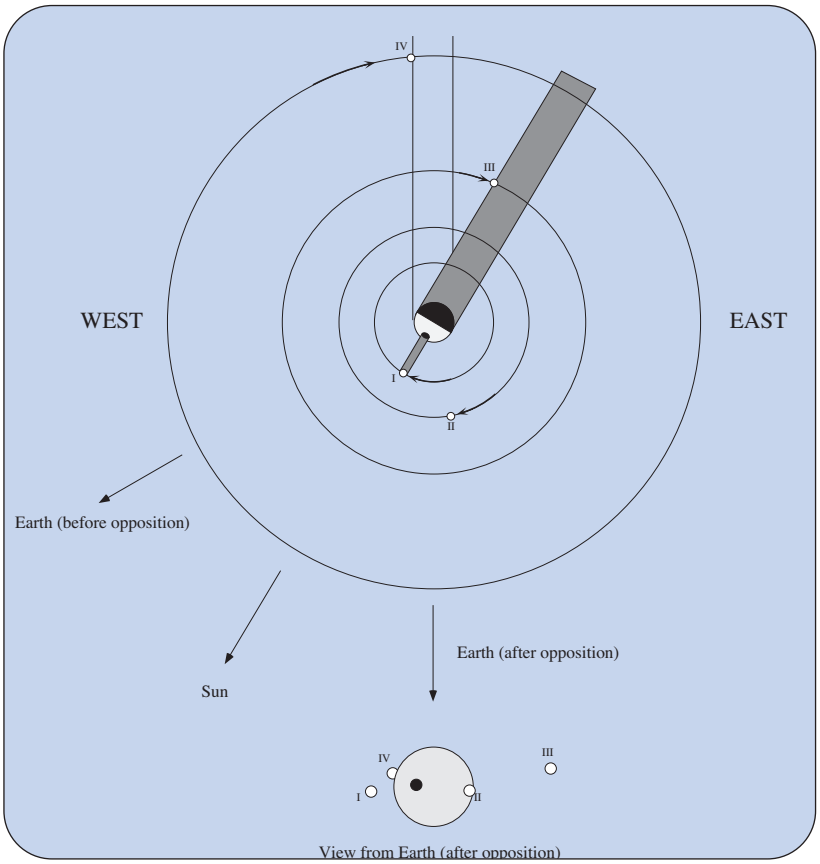
RA	DEC
h m s	° ' "
21 41 22	- 14 46 12
21 47 14	- 14 16 18
21 53 15	- 13 44 58
21 59 26	- 13 12 18
22 05 42	- 12 38 28
22 12 03	- 12 03 40
22 18 27	- 11 28 05
22 24 51	- 10 51 51
22 31 15	- 10 15 12
22 37 36	- 09 38 18
22 43 53	- 09 01 22
22 50 05	- 08 24 36
22 56 10	- 07 48 13
23 02 07	- 07 12 24
23 07 53	- 06 37 25
23 13 28	- 06 03 27
23 18 50	- 05 30 44
23 23 57	- 04 59 29
23 28 48	- 04 29 59
23 33 20	- 04 02 25
23 37 32	- 03 37 01
23 41 22	- 03 14 04
23 44 48	- 02 53 48
23 47 47	- 02 36 25
23 50 19	- 02 22 10
23 52 20	- 02 11 15
23 53 49	- 02 03 52
23 54 45	- 02 00 09
23 55 06	- 02 00 10
23 54 52	- 02 04 00
23 54 02	- 02 11 35
23 52 39	- 02 22 44
23 50 43	- 02 37 09
23 48 19	- 02 54 29
23 45 30	- 03 14 10
23 42 22	- 03 35 32
23 39 02	- 03 57 49
23 35 37	- 04 20 14
23 32 14	- 04 41 56
23 29 02	- 05 02 07
23 26 06	- 05 20 03
23 23 34	- 05 35 09
23 21 30	- 05 46 55
23 20 00	- 05 54 58
23 19 04	- 05 59 07
23 18 46	- 05 59 16
23 19 04	- 05 55 25
23 20 00	- 05 47 37
23 21 31	- 05 36 02
23 23 37	- 05 20 52
23 26 15	- 05 02 19
23 29 22	- 04 40 36

JUPITER'S MOONS 1998

Jupiter and its moons can be likened to a miniature solar system. Although there are currently 16 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 (or moderate sized binoculars). The dance of these moons, as they pass back and forth across Jupiter, is illustrated in the monthly 'Jupiter's Moons' on pages 102-104. 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 appears to pass 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 1998 is September 16th.
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, 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. In fact, Io is so close to Jupiter, it is impossible to see both the disappearance and reappearance for the same eclipse. Positions for the disappearance (d) and reappearance (r) for each moon, relative to Jupiter, for each month, are presented in the diagram below.

The diagram above 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's (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).

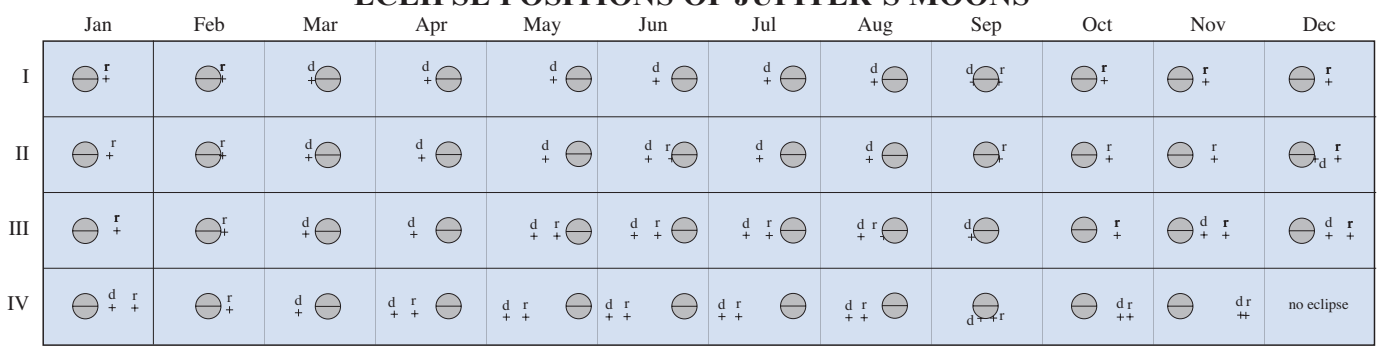
Satellite IV (Callisto) is about to move out of sight as it is occulted by Jupiter's disc.

Note: In the table on (pp 100-101), 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.

JUPITER'S MOONS Legend (pp. 100-101)

Column 1 Date & time (in AEST). Date only appears for the first event for each day.
Column 2 I = Io, II = Europa, III = Ganymede, IV = Callisto
Column 3 OC = Occultation, SH = Shadow Transit, TR = Satellite Transit, EC = Eclipse
Column 4 I = Ingress, E = Egress, D = Disappearance, R = Reappearance

ECLIPSE POSITIONS OF JUPITER'S MOONS



These diagrams represent the edge of Jupiter's shadow for each moon on the 15th of each month, showing where a moon would disappear or reappear for an eclipse on that date..

JUPITER'S MOONS (AEST)

December			
31	18:59	IV	SHI
	20:48	III	SHE
January			
1	20:40	I	TRI
	21:32	I	SHI
2	20:57	I	ECR
6	19:46	II	SHI
	21:00	II	TRE
7	21:13	III	SHI
9	19:49	I	OCD
10	19:29	I	TRE
	20:13	I	SHE
15	20:19	II	ECR
17	19:13	I	TRI
	19:51	I	SHI
18	18:41	III	ECR
	19:17	I	ECR
22	18:58	II	OCD
31	18:59	II	TRE
	19:47	II	SHE
February			
7	18:59	II	TRI
18	18:39	I	TRE
	18:45	I	SHE
25	18:22	I	SHI
	18:24	I	TRI
March			
6	05:22	III	SHI
	06:07	III	TRI
8	06:06	II	SHI
10	05:59	I	SHE
	06:14	I	TRE
17	05:37	I	SHI
	05:43	IV	ECD
	05:59	I	TRI
18	05:30	I	OCR
24	06:06	II	ECD
25	04:43	I	ECD
26	04:16	I	SHE
	04:35	II	TRE
	04:47	I	TRE
April			
2	03:54	I	SHI
	04:32	I	TRI
	04:38	II	TRI
	06:08	II	SHE
	06:10	I	SHE
3	04:02	IV	ECR
	04:04	I	OCR
	06:10	IV	OCD
9	05:48	I	SHI
	05:57	II	SHI
	06:32	I	TRI
10	06:05	I	OCR
11	04:37	III	TRI
	04:53	II	OCR
	04:57	III	SHE
17	04:55	I	ECD
18	03:07	II	ECD
	04:26	I	SHE
	05:18	I	TRE
	05:27	III	SHI
20	06:35	IV	OCR
24	06:50	I	ECD
25	04:04	I	SHI
	05:02	I	TRI
	05:42	II	ECD
	06:20	I	SHE
26	04:36	I	OCR
27	03:18	II	SHE
	05:21	II	TRE
28	02:56	IV	SHI
	06:49	IV	SHE
29	02:50	III	ECR
	03:34	III	OCD
May			
2	05:58	I	SHI
3	03:13	I	ECD
	06:36	I	OCR
4	02:42	I	SHE
	03:08	II	SHI
	03:46	I	TRE
	05:22	II	TRI
	05:56	II	SHE
6	02:32	II	OCR
	03:20	III	ECD
	06:50	III	ECR
7	02:33	IV	OCR
10	05:07	I	ECD
11	02:20	I	SHI
	03:29	I	TRI
	04:35	I	SHE
	05:44	I	TRE
	05:46	II	SHI
12	03:05	I	OCR
13	05:15	II	OCR
17	02:31	III	TRI
	05:51	III	TRE
	07:02	I	ECD
18	04:14	I	SHI
	05:27	I	TRI
	06:29	I	SHE
19	05:03	I	OCR
20	02:11	I	TRE
	02:42	II	ECD
22	03:01	II	TRE
23	06:37	IV	ECD
24	01:31	III	SHI
	04:57	III	SHE
	06:46	III	TRI
25	06:08	I	SHI
26	03:24	I	ECD
	07:00	I	OCR
27	01:54	I	TRI
	02:51	I	SHE
	04:07	I	TRE
	05:17	II	ECD
28	01:29	I	OCR
29	03:01	II	TRI
	03:05	II	SHE
	05:43	II	TRE
31	05:31	III	SHI
June			
1	04:52	IV	TRI
2	05:19	I	ECD
3	02:30	I	SHI
	03:50	I	TRI
	04:45	I	SHE
	06:03	I	TRE
4	00:57	III	OCD
	03:25	I	OCR
	04:15	III	OCR
5	02:56	II	SHI
	05:42	II	SHE
	05:42	II	TRI
7	02:36	II	OCR
9	00:51	IV	ECD
	04:26	IV	ECR
	07:13	I	ECD
10	04:24	I	SHI
	05:45	I	TRI
	06:38	I	SHE
11	01:41	I	ECD
	02:50	III	ECR
	05:05	III	OCD
	05:21	I	OCR
12	00:14	I	TRI
	01:07	I	SHE
	02:27	I	TRE
	05:33	II	SHI
14	02:29	II	ECR
	02:32	II	OCD
	05:13	II	OCR
16	00:20	II	TRE
17	06:18	I	SHI
18	01:47	IV	TRE
	03:24	III	ECD
	03:35	I	ECD
	06:50	III	ECR
	07:15	I	OCR
19	00:46	I	SHI
	02:08	I	TRI
	03:00	I	SHE
	04:21	I	TRE
20	01:44	I	OCR
21	02:19	II	ECD
	05:04	II	ECR
	05:07	II	OCD
22	02:23	III	TRE
23	00:12	II	SHE
	00:16	II	TRI
	02:56	II	TRE
25	05:29	I	ECD
	07:24	III	ECD
26	02:40	I	SHI
	04:01	I	TRI
	04:54	I	SHE
	06:15	I	TRE
	23:58	I	ECD
27	03:37	I	OCR
	23:23	I	SHE
28	00:43	I	TRE
	04:54	II	ECD
29	00:56	III	SHE
	03:11	III	TRI
	06:19	III	TRE
30	00:04	II	SHI
	02:48	II	SHE
	02:50	II	TRI
	05:29	II	TRE
July			
1	23:38	II	OCR
2	07:23	I	ECD
3	04:33	I	SHI
	05:54	I	TRI
	06:48	I	SHE
4	01:52	I	ECD
	04:06	IV	SHI
	05:29	I	OCR
	07:22	IV	SHE
	23:02	I	SHI
5	00:22	I	TRI
	01:16	I	SHE
	02:35	I	TRE
	07:29	II	ECD
	23:57	I	OCR
6	01:34	III	SHI
	04:55	III	SHE
	07:04	III	TRI
7	02:40	II	SHI
	05:22	II	TRI
	05:24	II	SHE
9	02:09	II	OCR
10	00:00	III	OCR
	06:27	I	SHI
11	03:46	I	ECD
	07:20	I	OCR
12	00:56	I	SHI
	02:13	I	TRI
	03:10	I	SHE
	04:26	I	TRE
13	01:47	I	OCR
	02:31	IV	OCD
	03:26	IV	OCR
	05:34	III	SHI
	22:53	I	TRE
14	05:17	II	SHI
15	23:23	II	ECD
16	04:37	II	OCR
	22:49	III	ECR
17	00:38	III	OCD
	03:44	III	OCR
	23:43	II	TRE
18	05:40	I	ECD
19	02:49	I	SHI
	04:03	I	TRI
	05:04	I	SHE
	06:16	I	TRE
20	00:08	I	ECD
	03:37	I	OCR
	22:24	IV	SHI
	22:30	I	TRI
	23:32	I	SHE
21	00:43	I	TRE
	01:29	IV	SHE
	22:04	I	OCR
23	01:58	II	ECD
	07:03	II	OCR
	23:27	III	ECD
24	02:50	III	ECR
	04:20	III	OCD
	07:24	III	OCR
	23:31	II	TRI
	23:54	II	SHE
25	02:08	II	TRE
26	04:43	I	SHI
	05:51	I	TRI
	06:58	I	SHE
27	02:03	I	ECD
	05:25	I	OCR
	23:12	I	SHI
28	00:18	I	TRI
	01:26	I	SHE
	02:32	I	TRE
	23:52	I	OCR
30	04:34	II	ECD
31	03:28	III	ECD
	06:50	III	ECR
	23:46	II	SHI
August			
1	01:54	II	TRI
	02:29	II	SHE
	04:31	II	TRE
2	06:37	I	SHI
	22:38	II	OCR
3	03:57	I	ECD
	07:13	I	OCR
	20:54	III	SHE
	21:47	III	TRI
4	00:48	III	TRE
	01:06	I	SHI
	02:06	I	TRI
	03:21	I	SHE
	04:19	I	TRE
	22:25	I	ECD
5	01:39	I	OCR
	21:49	I	SHE
	22:46	I	TRE
6	07:11	II	ECD
8	02:22	II	SHI
	04:15	II	TRI
	05:05	II	SHE
	06:52	II	TRE
9	20:29	II	ECD
10	00:59	II	OCR
	05:51	I	ECD
	21:36	III	SHI
11	00:55	III	SHE
	01:16	III	TRI
	03:00	I	SHI
	03:52	I	TRI
	04:17	III	TRE
	05:15	I	SHE
	06:06	I	TRE
12	00:19	I	ECD
	03:26	I	OCR
	21:28	I	SHI
	22:19	I	TRI
	23:43	I	SHE
13	00:32	I	TRE
	21:52	I	OCR
15	01:53	IV	ECD
	04:46	IV	ECR
	04:57	II	SHI
	06:34	II	TRI
16	23:05	II	ECD
17	03:18	II	OCR
18	01:37	III	SHI
	04:42	III	TRI
	04:54	I	SHI
	04:56	III	SHE
	05:38	I	TRI
	20:58	II	SHE
	22:19	II	TRE
19	02:14	I	ECD
	05:11	I	OCR
	23:22	I	SHI

JUPITER'S MOONS (AEST)

20	00:04	I	TRI
	01:38	I	SHE
	02:18	I	TRE
	20:42	I	ECD
	23:37	I	OCR
21	20:06	I	SHE
	20:44	I	TRE
	21:18	III	OCR
24	01:42	II	ECD
	05:36	II	OCR
25	05:38	III	SHI
	06:48	I	SHI
	20:51	II	SHI
	21:59	II	TRI
	23:33	II	SHE
26	00:35	II	TRE
	04:08	I	ECD
27	01:17	I	SHI
	01:49	I	TRI
	03:32	I	SHE
	04:03	I	TRE
	22:36	I	ECD
28	01:21	I	OCR
	19:31	III	ECD
	19:46	I	SHI
	20:15	I	TRI
	22:01	I	SHE
	22:29	I	TRE
29	00:38	III	OCR
	19:47	I	OCR
31	04:19	II	ECD
	20:11	IV	ECD
	22:51	IV	ECR

September

1	23:26	II	SHI
2	00:13	II	TRI
	02:08	II	SHE
	02:50	II	TRE
	06:02	I	ECD
3	03:11	I	SHI
	03:33	I	TRI
	05:27	I	SHE
	05:47	I	TRE
	21:00	II	OCR
4	00:31	I	ECD
	03:05	I	OCR
	21:40	I	SHI
	21:59	I	TRI
	23:33	III	ECD
	23:56	I	SHE
5	00:13	I	TRE
	03:55	III	OCR
	18:59	I	ECD
	21:31	I	OCR
6	18:24	I	SHE
	18:39	I	TRE
9	02:02	II	SHI
	02:27	II	TRI
	04:44	II	SHE
	05:04	II	TRE
	05:25	IV	SHI
10	05:06	I	SHI
	05:17	I	TRI
	20:15	II	ECD
	23:16	II	OCR
11	02:25	I	ECD
	04:48	I	OCR
	23:35	I	SHI
	23:43	I	TRI
12	01:50	I	SHE
	01:57	I	TRE
	03:35	III	ECD
	18:01	II	SHE
	18:11	II	TRE
	20:54	I	ECD
	23:14	I	OCR
13	18:04	I	SHI
	18:09	I	TRI
	20:19	I	SHE
	20:23	I	TRE
15	17:52	III	TRI
	20:55	III	TRE
	20:57	III	SHE
16	04:37	II	SHI
	04:40	II	TRI
17	22:51	II	OCD
18	01:37	II	ECR
	04:18	I	OCD
19	01:26	I	TRI
	01:30	I	SHI
	03:41	I	TRE
	03:45	I	SHE
	17:47	II	TRI
	17:55	II	SHI
	20:24	II	TRE
	20:36	II	SHE
	22:44	I	OCD
20	01:03	I	ECR
	19:52	I	TRI
	19:59	I	SHI
	22:07	I	TRE
	22:14	I	SHE
21	19:32	I	ECR
22	21:07	III	TRI
	21:44	III	SHI
23	00:12	III	TRE
	00:58	III	SHE
25	01:06	II	OCD
	04:15	II	ECR
	23:49	IV	SHI
26	01:58	IV	SHE
	03:10	I	TRI
	03:25	I	SHI
	05:25	I	TRE
	20:00	II	TRI
	20:31	II	SHI
	22:38	II	TRE
	23:12	II	SHE
27	00:28	I	OCD
	02:58	I	ECR
	21:36	I	TRI
	21:54	I	SHI
	23:51	I	TRE
28	00:09	I	SHE
	17:33	II	ECR
	18:54	I	OCD
	21:27	I	ECR
29	18:17	I	TRE
	18:38	I	SHE
30	00:23	III	TRI
	01:46	III	SHI
	03:29	III	TRE
	04:59	III	SHE

October

2	03:21	II	OCD
3	04:55	I	TRI
	18:52	III	ECR
	22:14	II	TRI
	23:06	II	SHI
4	00:52	II	TRE
	01:47	II	SHE
	02:12	I	OCD
	23:21	I	TRI
	23:49	I	SHI
5	01:35	I	TRE
	02:05	I	SHE
	20:12	II	ECR
	20:38	I	OCD
	23:21	I	ECR
6	17:47	I	TRI
	18:18	I	SHI
	20:02	I	TRE
	20:33	I	SHE
7	03:42	III	TRI
	17:50	I	ECR
10	22:53	III	ECR
11	00:30	II	TRI
	01:42	II	SHI
	03:08	II	TRE
	03:56	I	OCD
12	01:06	I	TRI
	01:45	I	SHI
	03:21	I	TRE
	04:00	I	SHE
	18:15	IV	SHI
	18:47	II	OCD
	20:04	IV	SHE
	22:23	I	OCD
	22:50	II	ECR
13	01:16	I	ECR
	19:33	I	TRI
	20:14	I	SHI
	21:47	I	TRE
	22:29	I	SHE
14	17:40	II	SHE
	19:45	I	ECR
17	20:36	III	OCD
18	02:47	II	TRI
	02:55	III	ECR
19	02:53	I	TRI
	03:41	I	SHI
	21:06	II	OCD
20	00:09	I	OCD
	01:28	II	ECR
	03:11	I	ECR
	19:31	IV	OCD
	21:18	IV	OCR
	21:20	I	TRI
	22:10	I	SHI
	23:34	I	TRE
21	00:24	I	SHE
	03:15	IV	ECD
	18:35	II	TRE
	18:35	I	OCD
	20:15	II	SHE
	21:40	I	ECR
22	18:01	I	TRE
	18:53	I	SHE
25	00:03	III	OCD
	03:15	III	OCR
26	23:28	II	OCD
27	01:56	I	OCD
	23:07	I	TRI
28	00:05	I	SHI
	01:22	I	TRE
	02:20	I	SHE
	17:55	III	SHI
	18:16	II	TRI
	20:12	II	SHI
	20:23	I	OCD
	20:55	II	TRE
	21:04	III	SHE
	22:51	II	SHE
	23:35	I	ECR
29	03:04	IV	TRI
	18:34	I	SHI
	19:49	I	TRE
	20:49	I	SHE
30	18:04	I	ECR

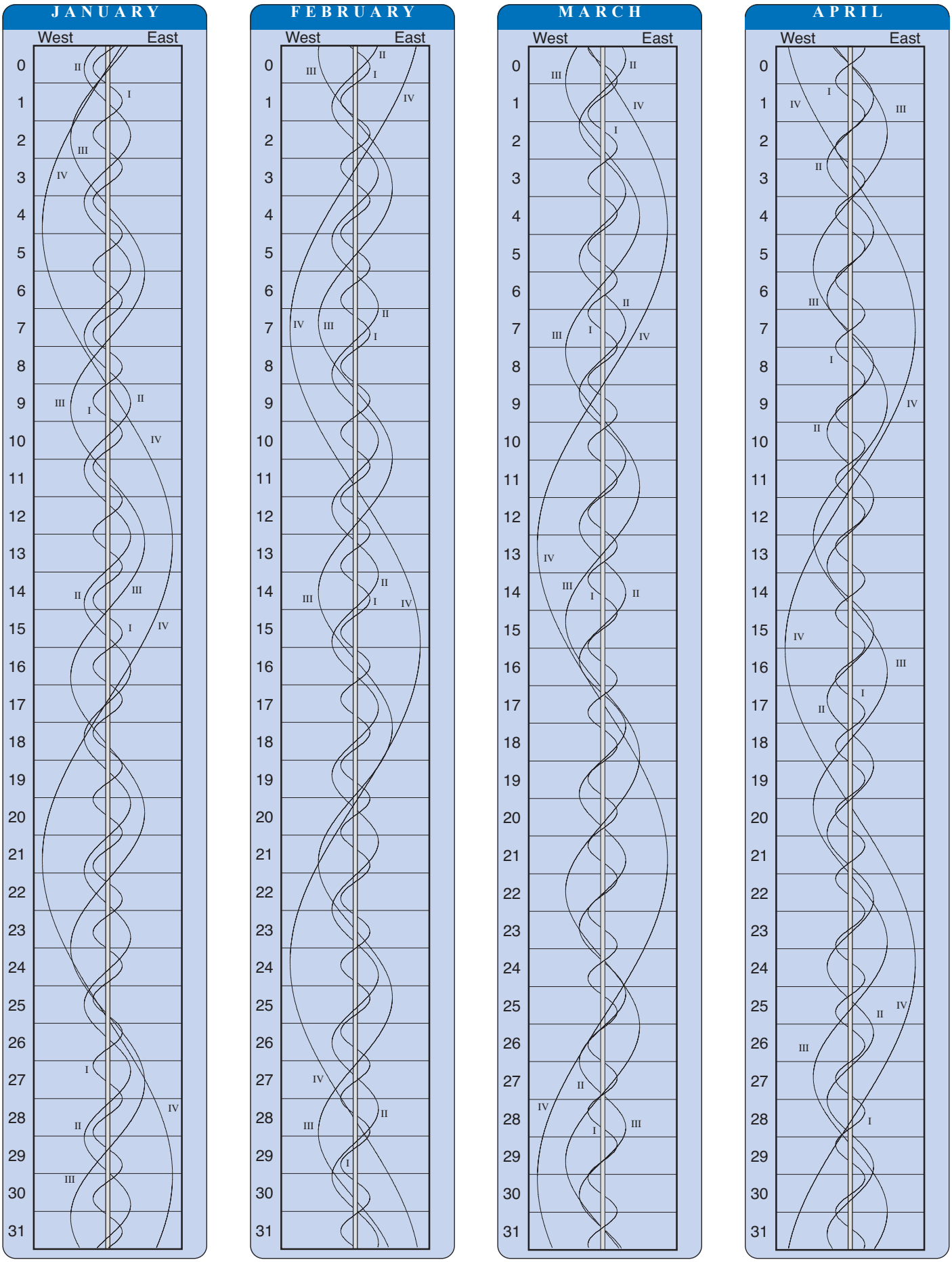
November

3	01:52	II	OCD
4	00:57	I	TRI
	02:01	I	SHI
	20:39	II	TRI
	20:44	III	TRE
	21:58	III	SHI
	22:11	I	OCD
	22:47	II	SHI
	23:18	II	TRE
5	01:06	III	SHE
	01:26	II	SHE
	01:30	I	ECR
	19:24	I	TRI
	20:30	I	SHI
	21:38	I	TRE
	22:44	I	SHE
6	19:59	I	ECR
	20:06	II	ECR
	21:41	IV	ECD
	23:09	IV	ECR
11	21:11	III	TRI
	23:04	II	TRI
12	00:01	I	OCD
	00:24	III	TRE
	01:23	II	SHI
	01:43	II	TRE
	02:01	III	SHI
	21:15	I	TRI
	22:26	I	SHI
	23:29	I	TRE
13	00:40	I	SHE
	18:28	I	OCD
	21:54	I	ECR
	22:44	II	ECR
14	18:57	IV	TRI
	19:09	I	SHE
	21:11	IV	TRE
15	19:00	III	ECR
19	00:55	III	TRI
	01:31	II	TRI
	23:06	I	TRI
20	00:22	I	SHI
	01:21	I	TRE
	20:05	II	OCD
	20:20	I	OCD
	23:49	I	ECR
21	01:23	II	ECR
	18:51	I	SHI
	19:49	I	TRE
	21:05	I	SHE
22	18:18	I	ECR
	19:54	III	ECD
	19:55	II	SHE
	23:01	III	ECR
27	01:00	I	TRI
	22:12	I	OCD
	22:38	II	OCD
28	19:28	I	TRI
	20:47	I	SHI
	21:43	I	TRE
	23:01	I	SHE
29	18:30	III	OCD
	19:54	II	SHI
	19:57	II	TRE
	20:13	I	ECR
	21:47	III	OCR
	22:31	II	SHE
	23:56	III	ECD

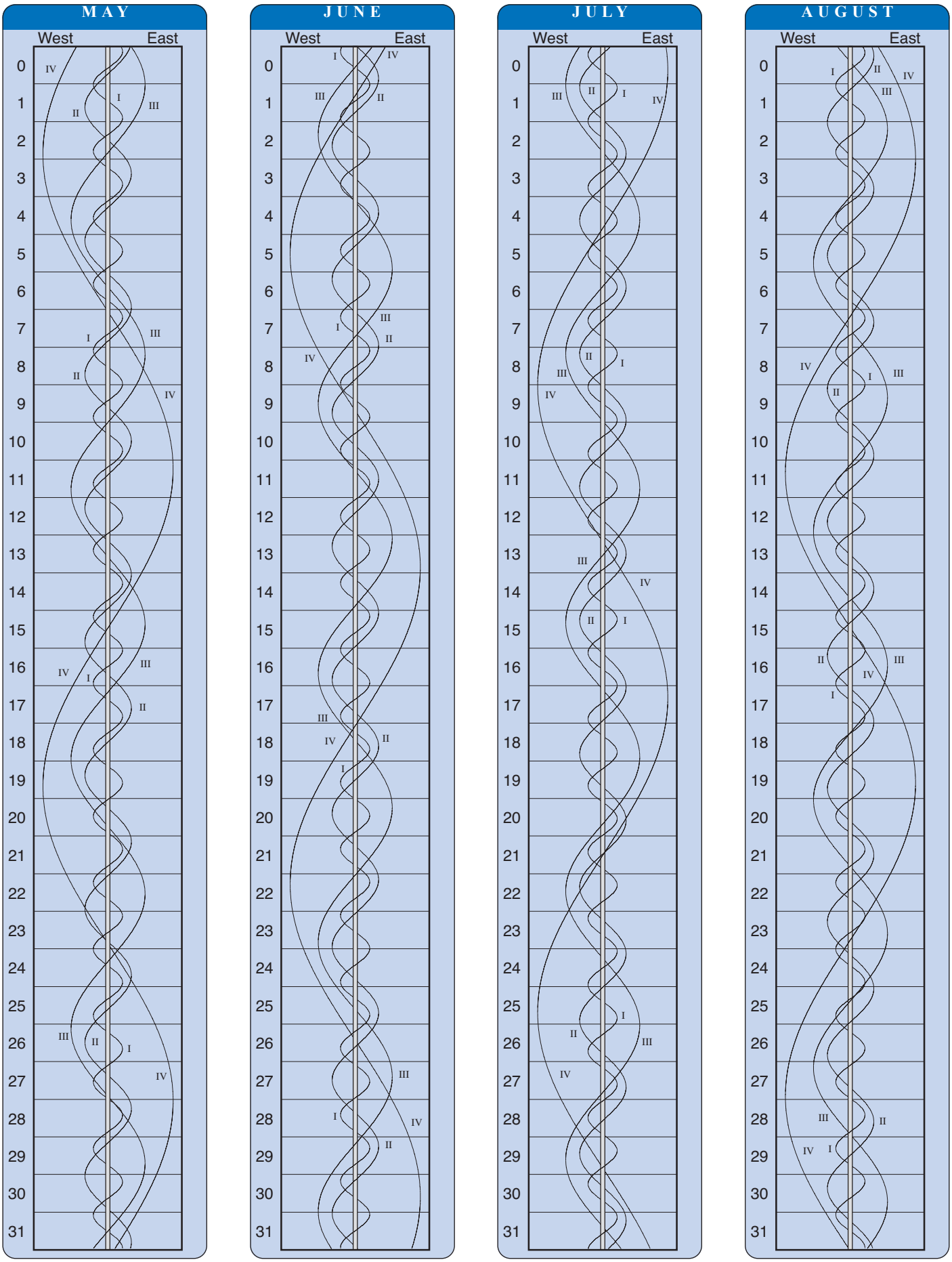
December

5	00:06	I	OCD
	21:23	I	TRI
	22:43	I	SHI
	23:37	I	TRE
6	18:35	I	OCD
	19:50	II	TRI
	22:09	I	ECR
	22:26	III	OCD
	22:30	II	SHI
	22:30	II	TRE
7	19:26	I	SHE
8	20:00	II	ECR
9	21:00	IV	OCD
	23:38	IV	OCR
10	21:15	III	SHE
12	23:19	I	TRI
13	20:30	I	OCD
	22:26	II	TRI
14	00:04	I	ECR
	19:09	I	SHI
	20:02	I	TRE
	21:22	I	SHE
15	18:33	I	ECR
	19:56	II	OCR
	19:58	II	ECD
	22:39	II	ECR
17	19:58	III	TRE
	22:16	III	SHI
20	22:26	I	OCD
21	19:45	I	TRI
	21:05	I	SHI
	21:59	I	TRE
	23:18	I	SHE
22	19:52	II	OCD
	20:28	I	ECR
	22:37	II	OCR
	22:37	II	ECD
24	19:37	II	SHE
	20:51	III	TRI
28	19:09	III	ECR
	21:42	I	TRI
	23:01	I	SHI
29	18:53	I	OCD
	22:24	I	ECR
	22:35	II	OCD
30	19:43	I	SHE
31	19:37	II	SHI
	19:44	II	TRE
	22:14	II	SHE

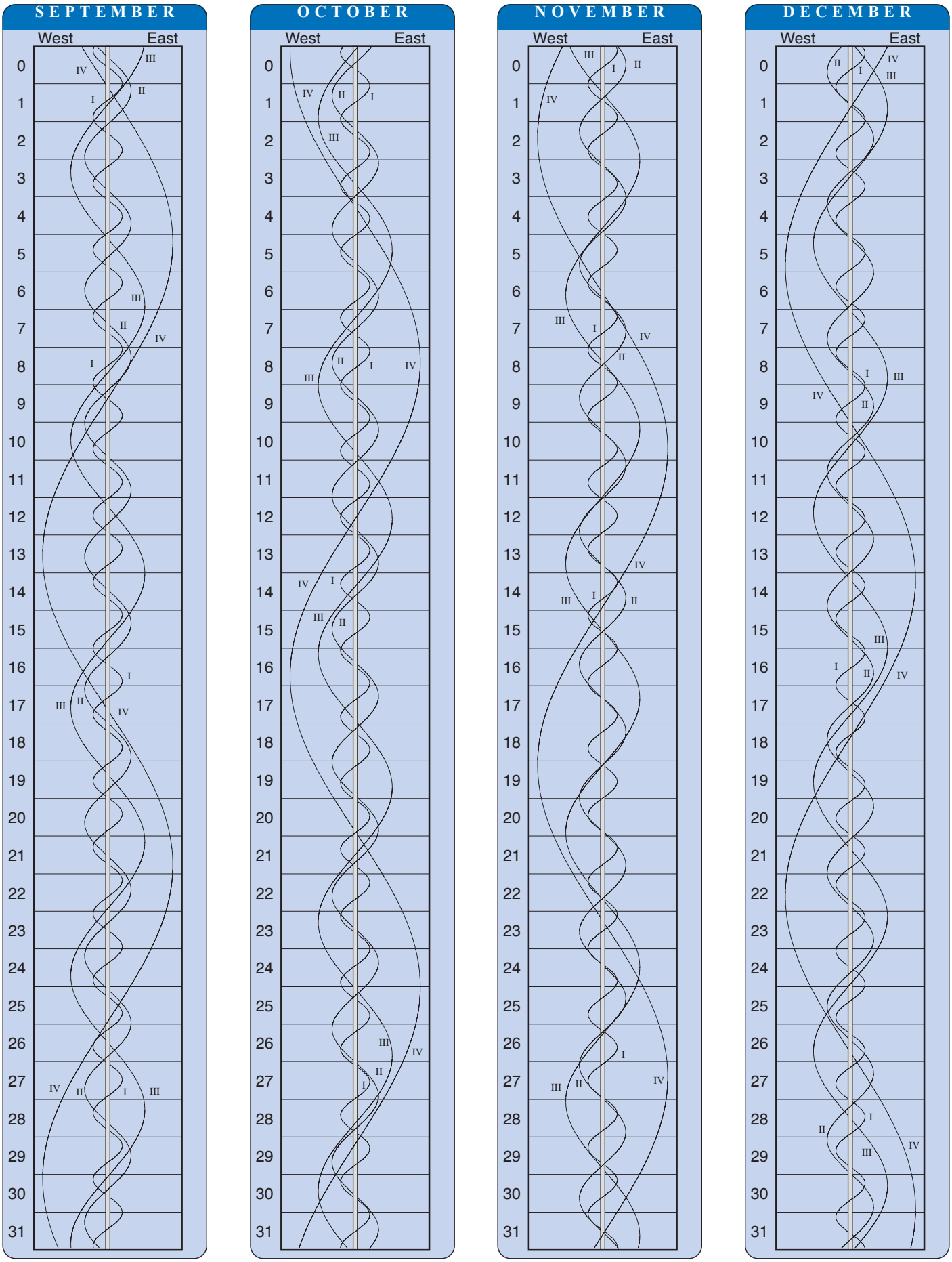
JUPITER'S MOONS (AEST)



JUPITER'S MOONS (AEST)



JUPITER'S MOONS (AEST)



JUPITER — LONGITUDE OF CENTRAL MERIDIAN

SYSTEM I (0hr UT)

DATE	JAN °	FEB °	MAR °	APR °	MAY °	JUN °	JUL °	AUG °	SEP °	OCT °	NOV °	DEC °	DATE
1	108.8	315.6	049.9	258.1	310.3	162.2	218.7	075.6	294.5	355.4	211.6	266.2	1
2	266.5	113.2	207.5	055.9	108.1	320.1	016.6	233.6	092.6	153.4	009.5	064.0	2
3	064.1	270.9	005.2	213.6	265.8	117.9	174.5	031.6	250.6	311.4	167.4	221.7	3
4	221.7	068.5	162.9	011.3	063.6	275.7	332.4	189.6	048.6	109.4	325.3	019.5	4
5	019.4	226.2	320.5	169.0	221.4	073.6	130.4	347.6	206.7	267.4	123.1	177.2	5
6	177.0	023.8	118.2	326.7	019.2	231.4	288.3	145.6	004.7	065.3	281.0	335.0	6
7	334.7	181.5	275.9	124.4	176.9	029.3	086.2	303.6	162.8	223.3	078.8	132.7	7
8	132.3	339.1	073.5	282.2	334.7	187.2	244.2	101.7	320.8	021.3	236.7	290.5	8
9	289.9	136.8	231.2	079.9	132.5	345.0	042.1	259.7	118.9	179.3	034.5	088.2	9
10	087.6	294.4	028.9	237.6	290.3	142.9	200.1	057.7	276.9	337.2	192.4	245.9	10
11	245.2	092.0	186.6	035.3	088.1	300.8	358.0	215.7	074.9	135.2	350.2	043.7	11
12	042.8	249.7	344.3	193.1	245.9	098.6	156.0	013.8	233.0	293.2	148.1	201.4	12
13	200.5	047.3	141.9	350.8	043.7	256.5	313.9	171.8	031.0	091.1	305.9	359.1	13
14	358.1	205.0	299.6	148.5	201.5	054.4	111.9	329.8	189.1	249.1	103.7	156.8	14
15	155.7	002.6	097.3	306.3	359.3	212.2	269.9	127.8	347.1	047.0	261.6	314.6	15
16	313.4	160.3	255.0	104.0	157.1	010.1	067.8	285.9	145.1	205.0	059.4	112.3	16
17	111.0	317.9	052.7	261.7	314.9	168.0	225.8	083.9	303.2	002.9	217.2	270.0	17
18	268.7	115.6	210.4	059.5	112.7	325.9	023.7	241.9	101.2	160.9	015.0	067.7	18
19	066.3	273.3	008.0	217.2	270.5	123.8	181.7	040.0	259.2	318.8	172.8	225.4	19
20	223.9	070.9	165.7	015.0	068.3	281.7	339.7	198.0	057.2	116.8	330.6	023.1	20
21	021.6	228.6	323.4	172.7	226.1	079.6	137.7	356.0	215.3	274.7	128.4	180.8	21
22	179.2	026.2	121.1	330.5	023.9	237.5	295.6	154.1	013.3	072.6	286.2	338.5	22
23	336.8	183.9	278.8	128.2	181.7	035.4	093.6	312.1	171.3	230.5	084.0	136.2	23
24	134.5	341.5	076.5	286.0	339.6	193.3	251.6	110.2	329.3	028.4	241.8	293.9	24
25	292.1	139.2	234.2	083.7	137.4	351.2	049.6	268.2	127.3	186.4	039.6	091.6	25
26	089.8	296.9	031.9	241.5	295.2	149.1	207.6	066.3	285.4	344.3	197.4	249.3	26
27	247.4	094.5	189.6	039.2	093.0	307.0	005.6	224.3	083.4	142.2	355.1	047.0	27
28	045.0	252.2	347.3	197.0	250.9	104.9	163.6	022.3	241.4	300.1	152.9	204.7	28
29	202.7		145.0	354.8	048.7	262.8	321.6	180.4	039.4	098.0	310.7	002.4	29
30	000.3		302.7	152.5	206.5	060.7	119.6	338.4	197.4	255.9	108.5	160.0	30
31	158.0		100.4		004.4		277.6	136.5		053.7		317.7	31

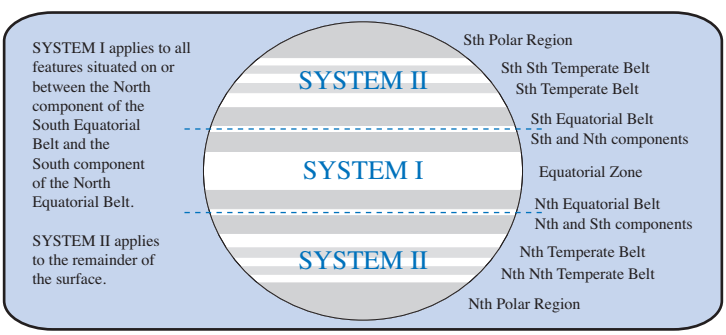
SYSTEM II (0hr UT)

DATE	JAN °	FEB °	MAR °	APR °	MAY °	JUN °	JUL °	AUG °	SEP °	OCT °	NOV °	DEC °	DATE
1	259.0	229.2	109.9	081.6	264.8	240.2	067.7	048.1	030.5	222.5	202.2	027.9	1
2	049.0	019.3	259.9	231.7	055.0	030.4	218.0	198.5	180.9	012.8	352.5	178.0	2
3	199.0	169.3	049.9	021.8	205.1	180.6	008.3	348.9	331.3	163.2	142.7	328.2	3
4	349.0	319.3	200.0	171.9	355.3	330.9	158.6	139.2	121.8	313.6	292.9	118.3	4
5	139.0	109.3	350.0	321.9	145.4	121.1	308.9	289.6	272.2	103.9	083.2	268.4	5
6	289.0	259.3	140.1	112.0	295.6	271.3	099.2	080.0	062.6	254.3	233.4	058.5	6
7	079.0	049.3	290.1	262.1	085.7	061.5	249.5	230.4	213.0	044.6	023.6	208.6	7
8	229.0	199.3	080.1	052.2	235.9	211.8	039.9	020.8	003.4	195.0	173.9	358.8	8
9	019.1	349.4	230.2	202.3	026.0	002.0	190.2	171.2	153.8	345.3	324.1	148.9	9
10	169.1	139.4	020.2	352.4	176.2	152.2	340.5	321.6	304.2	135.7	114.3	299.0	10
11	319.1	289.4	170.3	142.5	326.3	302.5	130.8	112.0	094.6	286.0	264.5	089.1	11
12	109.1	079.4	320.3	292.6	116.5	092.7	281.1	262.4	245.0	076.3	054.7	239.2	12
13	259.1	229.4	110.4	082.7	266.7	242.9	071.4	052.8	035.4	226.7	204.9	029.3	13
14	049.1	019.4	260.4	232.8	056.8	033.2	221.8	203.1	185.9	017.0	355.1	179.4	14
15	199.1	169.5	050.5	022.9	207.0	183.4	012.1	353.5	336.3	167.3	145.3	329.5	15
16	349.1	319.5	200.5	173.0	357.2	333.7	162.4	144.0	126.7	317.6	295.5	119.5	16
17	139.1	109.5	350.6	323.1	147.3	123.9	312.8	294.4	277.1	108.0	085.7	269.6	17
18	289.1	259.5	140.7	113.2	297.5	274.2	103.1	084.8	067.5	258.3	235.9	059.7	18
19	079.1	049.6	290.7	263.3	087.7	064.4	253.5	235.2	217.9	048.6	026.1	209.8	19
20	229.1	199.6	080.8	053.5	237.9	214.7	043.8	025.6	008.3	198.9	176.2	359.9	20
21	019.1	349.6	230.8	203.6	028.1	005.0	194.1	176.0	158.7	349.2	326.4	149.9	21
22	169.1	139.6	020.9	353.7	178.2	155.2	344.5	326.4	309.0	139.5	116.6	300.0	22
23	319.2	289.7	171.0	143.8	328.4	305.5	134.8	116.8	099.4	289.8	266.7	090.1	23
24	109.2	079.7	321.0	293.9	118.6	095.8	285.2	267.2	249.8	080.1	056.9	240.1	24
25	259.2	229.7	111.1	084.1	268.8	246.0	075.6	057.6	040.2	230.3	207.1	030.2	25
26	049.2	019.8	261.2	234.2	059.0	036.3	225.9	208.0	190.6	020.6	357.2	180.3	26
27	199.2	169.8	051.2	024.3	209.2	186.6	016.3	358.4	341.0	170.9	147.4	330.3	27
28	349.2	319.8	201.3	174.4	359.4	336.9	166.6	148.9	131.4	321.2	297.5	120.4	28
29	139.2		351.4	324.6	149.6	127.2	317.0	299.3	281.7	111.4	087.6	270.4	29
30	289.2		141.5	114.7	299.8	277.5	107.4	089.7	072.1	261.7	237.8	060.5	30
31	079.2		291.5		090.0		257.7	240.1		052.0		210.5	31

SYSTEM I
Rotation: 9h 50m 30.003s

hr	deg°	hr	deg°	min	deg°
01	036.6	13	115.5	05	03.0
02	073.2	14	152.1	10	06.1
03	109.7	15	188.7	15	09.1
04	146.3	16	225.3	20	12.2
05	182.9	17	261.8	25	15.2
06	219.5	18	298.4	30	18.3
07	256.1	19	335.0	35	21.3
08	292.6	20	011.6	40	24.4
09	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

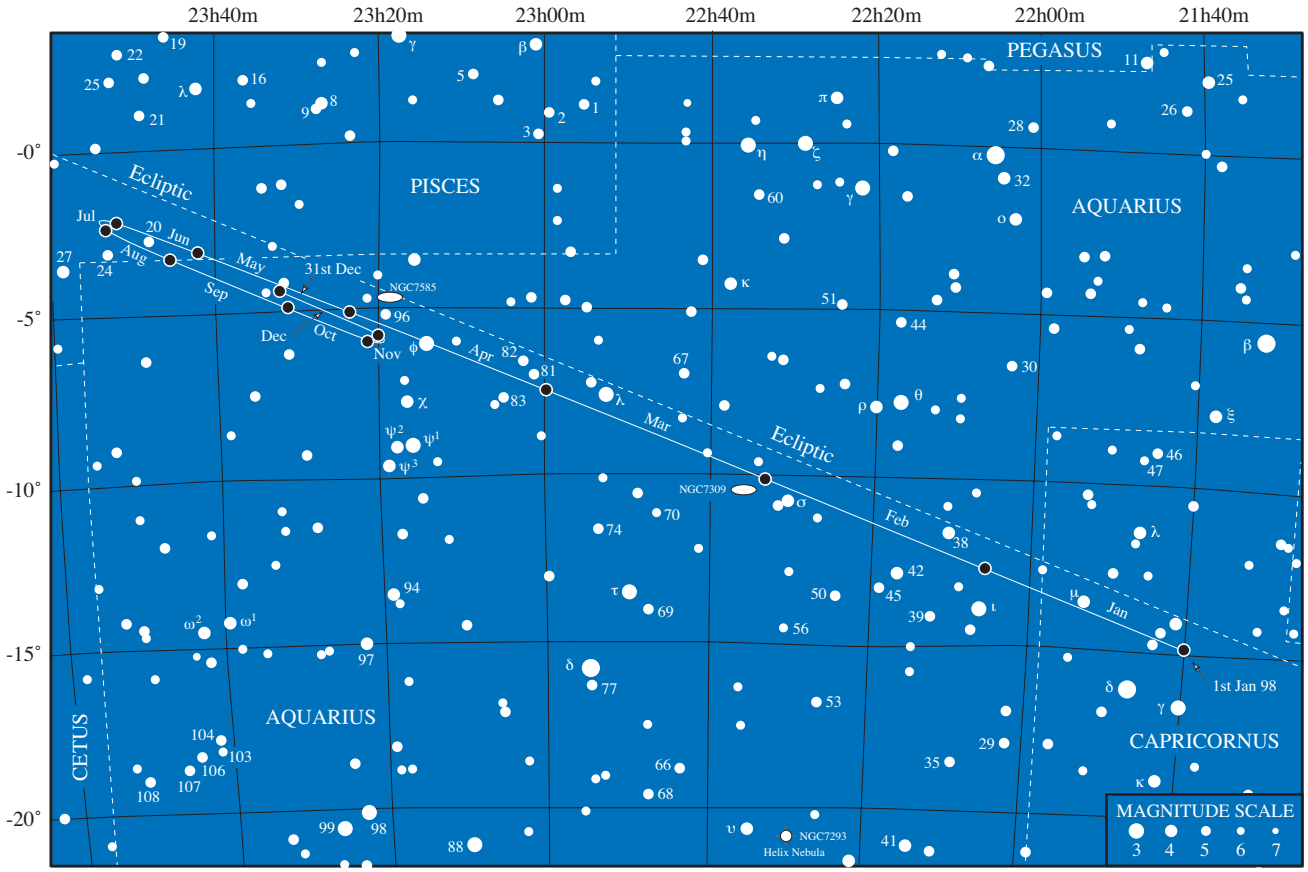
hr	deg°	hr	deg°	min	deg°
01	036.3	13	111.4	05	03.0
02	072.5	14	147.7	10	06.0
03	108.8	15	183.9	15	09.1
04	145.0	16	220.2	20	12.1
05	181.3	17	256.5	25	15.1
06	217.6	18	292.7	30	18.1
07	253.8	19	329.0	35	21.2
08	290.1	20	005.2	40	24.2
09	326.4	21	041.5	45	27.2
10	002.6	22	077.8	50	30.2
11	038.9	23	114.0	55	33.2
12	075.1	24	150.3	60	36.3

Increase in longitude

For further explanation see page 67

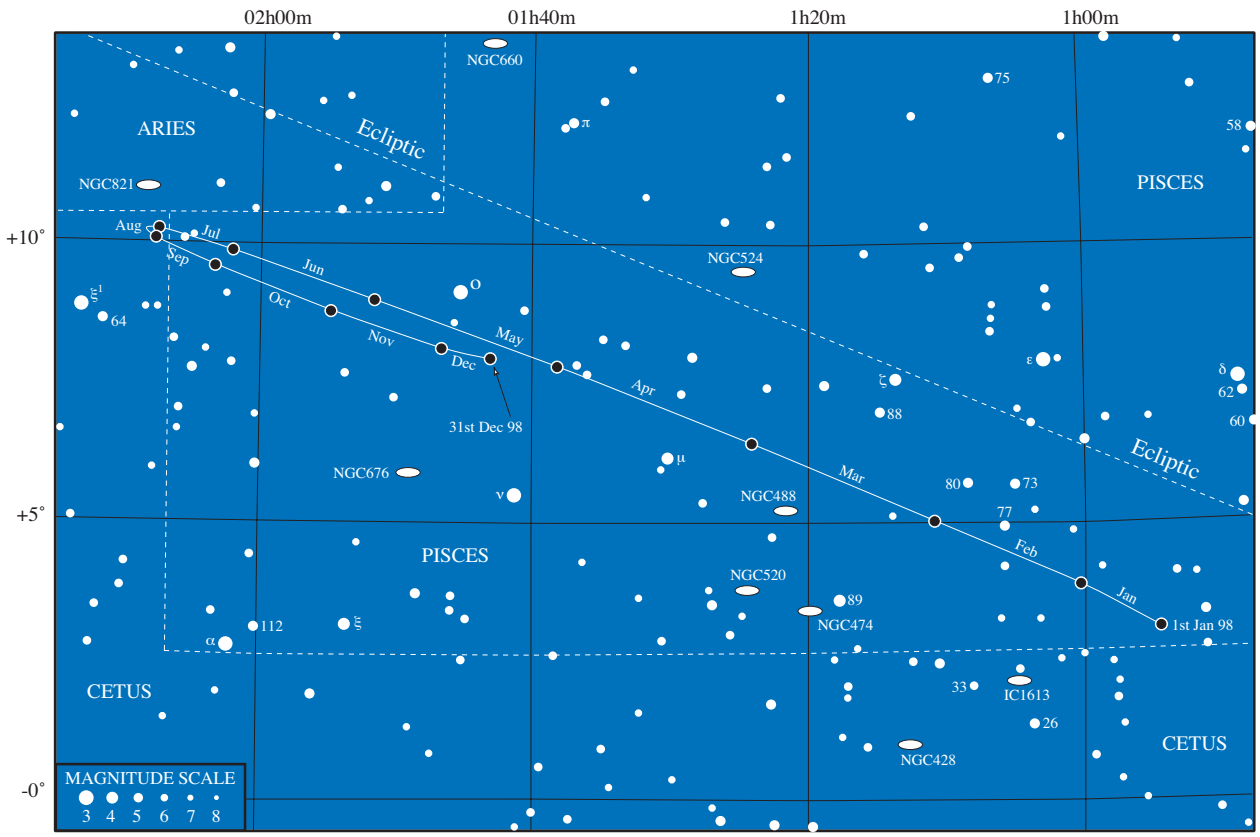
JUPITER FINDER CHART

Epoch 2000



SATURN FINDER CHART

Epoch 2000



SATURN

RISE AND SET TIMES

AEST (Adelaide & Darwin ACST)

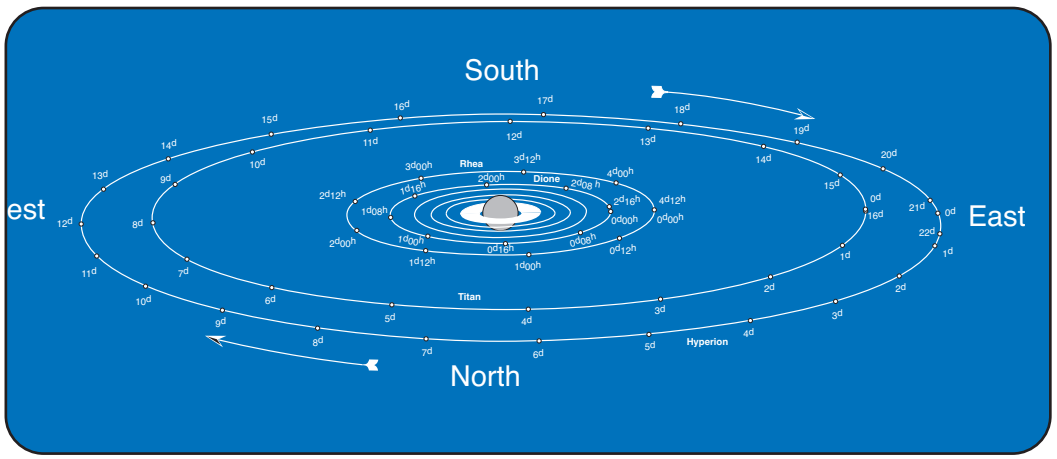
	Adelaide		Brisbane		Canberra		Darwin		Hobart		Melbourne		Sydney		Townsville	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
Jan 3	12:26	00:16	11:57	23:47	12:14	00:04	12:52	00:53	12:24	00:09	12:32	00:20	12:05	23:52	12:20	00:17
10	12:00	23:45	11:30	23:20	11:48	23:33	12:26	00:26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

POSITION

(0hrs UT Epoch 2000.0)

RA	DEC
h m s	° ' "
00 54 51	+ 03 09 25
00 55 47	+ 03 17 19
00 57 02	+ 03 27 04
00 58 35	+ 03 38 32
01 00 24	+ 03 51 36
01 02 28	+ 04 06 05
01 04 46	+ 04 21 50
01 07 17	+ 04 38 40
01 09 59	+ 04 56 25
01 12 50	+ 05 14 55
01 15 50	+ 05 33 59
01 18 56	+ 05 53 27
01 22 08	+ 06 13 11
01 25 24	+ 06 33 00
01 28 42	+ 06 52 44
01 32 01	+ 07 12 16
01 35 20	+ 07 31 28
01 38 37	+ 07 50 10
01 41 51	+ 08 08 15
01 45 01	+ 08 25 35
01 48 04	+ 08 42 04
01 51 01	+ 08 57 35
01 53 49	+ 09 12 01
01 56 27	+ 09 25 16
01 58 53	+ 09 37 15
02 01 07	+ 09 47 52
02 03 07	+ 09 57 02
02 04 52	+ 10 04 40
02 06 20	+ 10 10 44
02 07 31	+ 10 15 09
02 08 24	+ 10 17 52
02 08 58	+ 10 18 53
02 09 12	+ 10 18 11
02 09 07	+ 10 15 48
02 08 42	+ 10 11 45
02 07 58	+ 10 06 07
02 06 56	+ 09 59 01
02 05 37	+ 09 50 35
02 04 03	+ 09 41 01
02 02 17	+ 09 30 31
02 00 20	+ 09 19 21
01 58 17	+ 09 07 48
01 56 10	+ 08 56 10
01 54 03	+ 08 44 46
01 51 59	+ 08 33 57
01 50 02	+ 08 23 59
01 48 15	+ 08 15 10
01 46 41	+ 08 07 45
01 45 21	+ 08 01 58
01 44 19	+ 07 57 57
01 43 35	+ 07 55 49
01 43 12	+ 07 55 41

SATELLITES OF SATURN



Apparent Orbits Diagram (at date of opposition, October 24).

Only the inner satellites are shown. The orbits of Iapetus and Phoebe would be too large to show on the above diagram.

Satellite	Mean Synodic Period d hh.h
I Mimas	0 22.6
II Enceladus	1 08.9
III Tethys	1 21.3
IV Dione	2 17.7
V Rhea	4 12.5
VI Titan	15 23.3
VII Hyperion	21 07.6
VIII Iapetus	79 22.1
IX Phoebe	523 15.6

TITAN (AEST) Mean Synodic Period 15d 23.3h

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
		Jan 5 00.5	Jan 8 19.5
Jan 12 18.9	Jan 16 23.7	Jan 20 23.9	Jan 24 19.1
Jan 28 18.5	Feb 1 23.5	Feb 5 23.7	Feb 9 18.9
Feb 13 18.6	Feb 17 23.6	Feb 21 23.8	Feb 25 19.1
Mar 1 18.9	Mar 6 00.0	Mar 10 00.2	Mar 13 19.5
Mar 17 19.5	Mar 22 00.7	Mar 26 00.7	Mar 29 20.0
Apr 2 20.2	Apr 7 01.4	Apr 11 01.3	Apr 14 20.6
Apr 18 21.0	Apr 23 02.2	Apr 27 01.9	Apr 30 21.3
May 4 21.8	May 9 03.0	May 13 02.5	May 16 21.9
May 20 22.5	May 25 03.6	May 29 03.0	Jun 1 22.3
Jun 5 23.1	Jun 10 04.1	Jun 14 03.2	Jun 17 22.5
Jun 21 23.4	Jun 26 04.3	Jun 30 03.2	Jul 3 22.5
Jul 7 23.3	Jul 12 04.1	Jul 16 02.9	Jul 19 22.1
Jul 23 22.9	Jul 28 03.6	Aug 1 02.2	Aug 4 21.3
Aug 8 22.1	Aug 13 02.6	Aug 17 01.1	Aug 20 20.1
Aug 24 20.7	Aug 29 01.1	Sep 1 23.6	Sep 5 18.4
Sep 9 18.9	Sep 13 23.2	Sep 17 21.6	Sep 21 16.4
Sep 25 16.7	Sep 29 20.9	Oct 3 19.3	Oct 7 14.0
Oct 11 14.2	Oct 15 18.4	Oct 19 16.8	Oct 23 11.4
Oct 27 11.5	Oct 31 15.7	Nov 4 14.3	Nov 8 08.9
Nov 12 08.9	Nov 16 13.2	Nov 20 11.9	Nov 24 06.5
Nov 28 06.5	Dec 2 10.9	Dec 6 09.8	Dec 10 04.5
Dec 14 04.5	Dec 18 09.0	Dec 22 08.0	Dec 26 02.8
Dec 30 03.0			

IAPETUS (AEST) Mean Synodic Period 79d 22.1h

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
	Jan 12 17.0	Feb 2 12.0	Feb 21 22.4
Mar 13 15.0	Apr 3 21.4	Apr 24 20.7	May 14 08.2
Jun 3 04.7	Jun 24 10.1	Jul 14 23.1	Aug 3 00.7
Aug 22 12.1	Sep 12 03.6	Oct 2 02.3	Oct 20 17.1
Nov 8 18.4	Nov 29 04.7	Dec 19 07.8	

HYPERION (AEST) Mean Synodic Period 21d 7.6h

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
			Jan 5 13.9
Jan 9 23.8	Jan 15 18.9	Jan 22 02.0	Jan 26 20.1
Jan 31 06.4	Feb 6 03.2	Feb 12 10.4	Feb 17 03.6
Feb 21 14.5	Feb 27 13.0	Mar 5 19.7	Mar 10 12.3
Mar 14 23.8	Mar 21 00.1	Mar 27 06.3	Mar 31 21.7
Apr 5 09.9	Apr 11 12.1	Apr 17 17.5	Apr 22 07.8
Apr 26 21.0	May 3 00.9	May 9 05.2	May 13 18.4
May 18 08.3	May 24 13.9	May 30 17.0	Jun 4 05.2
Jun 8 20.0	Jun 15 02.8	Jun 21 04.6	Jun 25 15.9
Jun 30 07.4	Jul 6 15.1	Jul 12 15.8	Jul 17 02.3
Jul 21 18.3	Jul 28 02.6	Aug 3 02.1	Aug 7 12.1
Aug 12 04.3	Aug 18 12.8	Aug 24 11.7	Aug 28 21.1
Sep 2 13.2	Sep 8 21.6	Sep 14 19.9	Sep 19 05.1
Sep 23 21.2	Sep 30 05.1	Oct 6 03.2	Oct 10 12.4
Oct 15 04.0	Oct 21 11.5	Oct 27 10.0	Oct 31 19.1
Nov 5 10.3	Nov 11 17.5	Nov 17 16.2	Nov 22 01.6
Nov 26 16.8	Dec 2 23.7	Dec 8 22.6	Dec 13 08.2
Dec 17 23.5	Dec 24 06.6	Dec 30 05.4	

SATURN'S RINGS

Major and Minor axes (in arc seconds) are for the outer edge of the outer ring. To work out the dimensions 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' equal the Geocentric longitude and the tilt of the rings respectively.

For more information. see page 69.

Date	Major "	Minor "	U °	B °
Jan 01	43.63	14.27	268.058	-19.094
Jan 09	43.04	14.08	267.936	-19.097
Jan 17	42.42	13.91	267.934	-19.138
Jan 25	41.81	13.76	268.052	-19.217
Feb 02	41.20	13.64	268.288	-19.332
Feb 10	40.62	13.55	268.639	-19.481
Feb 18	40.06	13.48	269.099	-19.660
Feb 26	39.54	13.44	269.660	-19.866
Mar 05	39.06	13.42	270.315	-20.094
Mar 13	38.63	13.43	271.055	-20.341
Mar 21	38.25	13.46	271.871	-20.603
Mar 29	37.92	13.51	272.752	-20.874
Apr 06	37.64	13.58	273.690	-21.152
Apr 14	37.42	13.67	274.676	-21.433
Apr 22	37.26	13.78	275.698	-21.712
Apr 30	37.15	13.91	276.748	-21.987
May 08	37.11	14.05	277.816	-22.255
May 16	37.11	14.21	278.893	-22.514
May 24	37.18	14.38	279.968	-22.760
Jun 01	37.30	14.57	281.033	-22.992
Jun 09	37.47	14.77	282.077	-23.208
Jun 17	37.70	14.98	283.090	-23.408
Jun 25	37.98	15.20	284.063	-23.589

Date	Major "	Minor "	U °	B °
Jul 03	38.32	15.43	284.986	-23.751
Jul 11	38.71	15.68	285.848	-23.893
Jul 19	39.14	15.93	286.640	-24.015
Jul 27	39.62	16.19	287.352	-24.117
Aug 04	40.14	16.45	287.974	-24.199
Aug 12	40.69	16.72	288.497	-24.260
Aug 20	41.28	16.99	288.913	-24.302
Aug 28	41.88	17.25	289.215	-24.324
Sep 05	42.50	17.51	289.397	-24.326
Sep 13	43.12	17.75	289.454	-24.310
Sep 21	43.73	17.98	289.388	-24.276
Sep 29	44.31	18.18	289.197	-24.224
Oct 07	44.84	18.35	288.889	-24.157
Oct 15	45.32	18.49	288.471	-24.074
Oct 23	45.73	18.58	287.957	-23.979
Oct 31	46.04	18.63	287.363	-23.872
Nov 08	46.26	18.64	286.711	-23.759
Nov 16	46.36	18.59	286.022	-23.641
Nov 24	46.36	18.50	285.322	-23.524
Dec 02	46.23	18.37	284.636	-23.412
Dec 10	46.00	18.20	283.990	-23.309
Dec 18	45.67	18.01	283.406	-23.221
Dec 26	45.25	17.79	282.904	-23.151

TIMES OF GREATEST EASTERN ELONGATION (AEST)

RHEA Mean Synodic Period 4d 12.5h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
3 15.7	4 07.2	3 10.5	4 02.5	1 06.0	1 22.0	3 13.7	4 05.0	4 19.8	1 21.9	2 12.1	4 02.5
8 04.2	8 19.7	7 23.1	8 15.1	5 18.6	6 10.5	8 02.2	8 17.4	9 08.2	6 10.2	7 00.4	8 14.9
12 16.7	13 08.3	12 11.6	13 03.7	10 07.2	10 23.1	12 14.7	13 05.8	13 20.5	10 22.5	11 12.7	13 03.2
17 05.2	17 20.8	17 00.2	17 16.3	14 19.7	15 11.6	17 03.2	17 18.3	18 08.9	15 10.8	16 01.1	17 15.6
21 17.7	22 09.4	21 12.8	22 04.8	19 08.3	20 00.1	21 15.6	22 06.7	22 21.2	19 23.2	20 13.4	22 04.0
26 06.2	26 21.9	26 01.4	26 17.4	23 20.9	24 12.7	26 04.1	26 19.1	27 09.5	24 11.5	25 01.8	26 16.4
30 18.7		30 14.0		28 09.4	29 01.2	30 16.6	31 07.4		28 23.8	29 14.1	31 04.9

DIONE Mean Synodic Period 2d 17.7h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
2 09.5	1 12.4	3 15.5	2 18.7	2 21.9	2 01.0	2 03.9	1 06.7	3 02.8	3 05.1	2 07.2	2 09.4
5 03.2	4 06.1	6 09.2	5 12.4	5 15.6	4 18.7	4 21.7	4 00.4	5 20.5	5 22.7	5 00.9	5 03.1
7 20.9	6 23.9	9 03.0	8 06.1	8 09.3	7 12.4	7 15.4	6 18.1	8 14.2	8 16.4	7 18.5	7 20.8
10 14.6	9 17.6	11 20.7	10 23.9	11 03.1	10 06.2	10 09.1	9 11.8	11 07.8	11 10.0	10 12.1	10 14.4
13 08.4	12 11.3	14 14.5	13 17.6	13 20.8	12 23.9	13 02.8	12 05.4	14 01.5	14 03.7	13 05.8	13 08.1
16 02.1	15 05.1	17 08.2	16 11.4	16 14.6	15 17.6	15 20.5	14 23.1	16 19.2	16 21.3	15 23.5	16 01.8
18 19.8	17 22.8	20 01.9	19 05.1	19 08.3	18 11.4	18 14.2	17 16.8	19 12.8	19 15.0	18 17.1	18 19.5
21 13.5	20 16.5	22 19.7	21 22.9	22 02.0	21 05.1	21 07.9	20 10.5	22 06.5	22 08.6	21 10.8	21 13.2
24 07.2	23 10.3	25 13.4	24 16.6	24 19.8	23 22.8	24 01.6	23 04.2	25 00.1	25 02.3	24 04.4	24 06.8
27 01.0	26 04.0	28 07.2	27 10.4	27 13.5	26 16.5	26 19.3	25 21.8	27 17.8	27 19.9	26 22.1	27 00.5
29 18.7	28 21.7	31 00.9	30 04.1	30 07.2	29 10.2	29 13.0	28 15.5	30 11.4	30 13.5	29 15.8	29 18.2
							31 09.2				

TETHYS Mean Synodic Period 1d 21.3h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
2 03.7	1 08.9	1 16.9	2 19.5	1 03.6	2 06.2	2 11.4	1 16.4	2 18.6	1 02.0	2 03.9	2 08.6
4 01.0	3 06.2	3 14.2	4 16.9	3 00.9	4 03.5	4 08.7	3 13.7	4 15.9	2 23.3	4 01.2	4 05.9
5 22.4	5 03.5	5 11.5	6 14.2	4 22.2	6 00.9	6 06.0	5 11.0	6 13.2	4 20.6	5 22.5	6 03.2
7 19.7	7 00.9	7 08.9	8 11.6	6 19.6	7 22.2	8 03.4	7 08.4	8 10.5	6 17.8	7 19.8	8 00.5
9 17.0	8 22.2	9 06.2	10 08.9	8 16.9	9 19.5	10 00.7	9 05.7	10 07.8	8 15.1	9 17.0	9 21.8
11 14.3	10 19.5	11 03.5	12 06.2	10 14.2	11 16.8	11 22.0	11 03.0	12 05.1	10 12.4	11 14.3	11 19.1
13 11.6	12 16.9	13 00.9	14 03.6	12 11.6	13 14.2	13 19.3	13 00.3	14 02.4	12 09.7	13 11.6	13 16.4
15 09.0	14 14.2	14 22.2	16 00.9	14 08.9	15 11.5	15 16.6	14 21.6	15 23.6	14 07.0	15 08.9	15 13.7
17 06.3	16 11.5	16 19.5	17 22.2	16 06.2	17 08.8	17 13.9	16 18.9	17 20.9	16 04.3	17 06.2	17 11.0
19 03.6	18 08.9	18 16.9	19 19.6	18 03.6	19 06.1	19 11.3	18 16.2	19 18.2	18 01.6	19 03.5	19 08.3
21 00.9	20 06.2	20 14.2	21 16.9	20 00.9	21 03.5	21 08.6	20 13.5	21 15.5	19 22.9	21 00.8	21 05.6
22 22.3	22 03.5	22 11.5	23 14.2	21 22.2	23 00.8	23 05.9	22 10.8	23 12.8	21 20.1	22 22.1	23 02.9
24 19.6	24 00.8	24 08.9	25 11.6	23 19.6	24 22.1	25 03.2	24 08.1	25 10.1	23 17.4	24 19.4	25 00.2
26 16.9	25 22.2	26 06.2	27 08.9	25 16.9	26 19.4	27 00.5	26 05.4	27 07.4	25 14.7	26 16.7	26 21.5
28 14.2	27 19.5	28 03.5	29 06.2	27 14.2	28 16.8	28 21.8	28 02.7	29 04.7	27 12.0	28 14.0	28 18.9
30 11.6		30 00.9		29 11.6	30 14.1	30 19.1	30 00.0		29 09.3	30 11.3	30 16.2
		31 22.2		31 08.9			31 21.3		31 06.6		

ENCELADUS Mean Synodic Period 1d 8.9h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
2 05.2	1 08.8	2 03.7	1 07.5	1 11.3	2 00.0	2 03.6	1 07.2	1 19.5	1 22.8	1 02.0	1 05.4
3 14.1	2 17.7	3 12.6	2 16.4	2 20.2	3 08.9	3 12.5	2 16.1	3 04.3	3 07.6	2 10.9	2 14.2
4 22.9	4 02.6	4 21.5	4 01.3	4 05.1	4 17.8	4 21.4	4 00.9	4 13.2	4 16.5	3 19.8	3 23.1
6 07.8	5 11.5	6 06.4	5 10.2	5 14.0	6 02.7	6 06.3	5 09.8	5 22.1	6 01.4	5 04.7	5 08.0
7 16.7	6 20.4	7 15.3	6 19.1	6 22.9	7 11.6	7 15.2	6 18.7	7 07.0	7 10.3	6 13.5	6 16.9
9 01.6	8 05.3	9 00.2	8 04.0	8 07.8	8 20.4	9 00.1	8 03.6	8 15.9	8 19.1	7 22.4	8 01.8
10 10.5	9 14.2	10 09.1	9 12.9	9 16.7	10 05.3	10 09.0	9 12.5	10 00.7	10 04.0	9 07.3	9 10.6
11 19.4	10 23.1	11 18.0	10 21.8	11 01.6	11 14.2	11 17.9	10 21.4	11 09.6	11 12.9	10 16.2	10 19.5
13 04.3	12 08.0	13 02.9	12 06.7	12 10.5	12 23.1	13 02.7	12 06.2	12 18.5	12 21.8	12 01.0	12 04.4
14 13.2	13 16.9	14 11.8	13 15.6	13 19.4	14 08.0	14 11.6	13 15.1	14 03.4	14 06.6	13 09.9	13 13.3
15 22.1	15 01.8	15 20.7	15 00.5	15 04.3	15 16.9	15 20.5	15 00.0	15 12.2	15 15.5	14 18.8	14 22.2
17 07.0	16 10.7	17 05.6	16 09.4	16 13.2	17 01.8	17 05.4	16 08.9	16 21.1	17 00.4	16 03.7	16 07.1
18 15.9	17 19.6	18 14.5	17 18.3	17 22.1	18 10.7	18 14.3	17 17.8	18 06.0	18 09.3	17 12.6	17 15.9
20 00.8	19 04.5	19 23.4	19 03.2	19 07.0	19 19.6	19 23.2	19 02.7	19 14.9	19 18.1	18 21.4	19 00.8
21 09.7	20 13.4	21 08.3	20 12.1	20 15.9	21 04.5	21 08.1	20 11.5	20 23.8	21 03.0	20 06.3	20 09.7
22 18.6	21 22.3	22 17.2	21 21.0	22 00.8	22 13.4	22 17.0	21 20.4	22 08.6	22 11.9	21 15.2	21 18.6
24 03.5	23 07.2	24 02.1	23 05.9	23 09.7	23 22.3	24 01.9	23 05.3	23 17.5	23 20.8	23 00.1	23 03.5
25 12.4	24 16.1	25 11.0	24 14.8	24 18.6	25 07.2	25 10.7	24 14.2	25 02.4	25 05.6	24 09.0	24 12.4
26 21.3	26 01.0	26 19.9	25 23.7	26 03.5	26 16.1	26 19.6	25 23.1	26 11.3	26 14.5	25 17.8	25 21.3
28 06.1	27 09.9	28 04.8	27 08.6	27 12.4	28 01.0	28 04.5	27 07.9	27 20.1	27 23.4	27 02.7	27 06.2
29 15.0	28 18.8	29 13.7	28 17.5	28 21.3	29 09.8	29 13.4	28 16.8	29 05.0	29 08.3	28 11.6	28 15.0
30 23.9		30 22.6	30 02.4	30 06.2	30 18.7	30 14.3	30 01.7	30 13.9	30 17.1	29 20.5	29 23.9
				31 15.1			31 10.6				31 08.8

URANUS

RISE AND SET TIMES

AEST (Adelaide & Darwin ACST)

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

POSITION

(0hrs UT Epoch 2000.0)

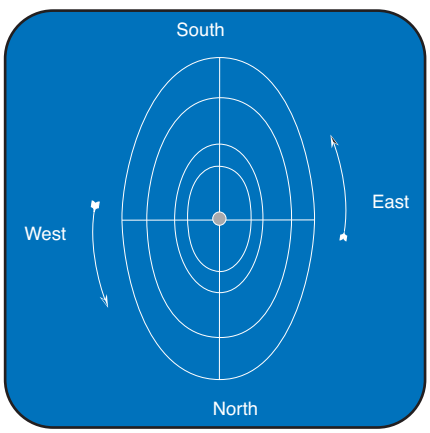
RA	DEC
h m s	° ' "
20 39 18	- 19 02 18
20 40 53	- 18 56 18
20 42 31	- 18 50 06
20 44 11	- 18 43 46
20 45 51	- 18 37 21
20 47 30	- 18 30 56
20 49 08	- 18 24 34
20 50 44	- 18 18 20
20 52 16	- 18 12 18
20 53 44	- 18 06 32
20 55 07	- 18 01 07
20 56 23	- 17 56 04
20 57 33	- 17 51 30
20 58 35	- 17 47 26
20 59 29	- 17 43 55
21 00 15	- 17 41 01
21 00 51	- 17 38 45
21 01 17	- 17 37 09
21 01 34	- 17 36 14
21 01 41	- 17 36 00
21 01 39	- 17 36 28
21 01 27	- 17 37 35
21 01 05	- 17 39 20
21 00 35	- 17 41 42
20 59 57	- 17 44 36
20 59 11	- 17 48 00
20 58 19	- 17 51 49
20 57 21	- 17 55 57
20 56 19	- 18 00 21
20 55 13	- 18 04 55
20 54 06	- 18 09 33
20 52 58	- 18 14 10
20 51 51	- 18 18 39
20 50 46	- 18 22 57
20 49 45	- 18 26 56
20 48 48	- 18 30 34
20 47 58	- 18 33 46
20 47 14	- 18 36 28
20 46 38	- 18 38 37
20 46 12	- 18 40 11
20 45 54	- 18 41 07
20 45 46	- 18 41 25
20 45 48	- 18 41 04
20 46 01	- 18 40 02
20 46 24	- 18 38 22
20 46 56	- 18 36 03
20 47 38	- 18 33 06
20 48 30	- 18 29 33
20 49 30	- 18 25 26
20 50 38	- 18 20 47
20 51 52	- 18 15 39
20 53 14	- 18 10 05

SATELLITES OF URANUS — GREATEST NORTHERN ELONGATION (AEST)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
					ARIEL						
2 22.6	2 04.4	1 21.7	1 03.5	1 09.2	3 03.5	3 09.3	2 15.2	1 21.2	2 03.2	1 09.0	1 15.0
5 11.1	4 16.9	4 10.1	3 15.9	3 21.7	5 16.0	5 21.9	5 03.8	4 09.7	4 15.6	3 21.6	4 03.5
7 23.6	7 05.4	6 22.7	6 04.4	6 10.2	8 04.5	8 10.3	7 16.2	6 22.2	7 04.2	6 10.0	6 16.0
10 12.0	9 17.8	9 11.1	8 16.9	8 22.7	10 17.0	10 22.8	10 04.8	9 10.7	9 16.7	8 22.5	9 04.5
13 00.5	12 06.3	11 23.6	11 05.4	11 11.2	13 05.5	13 11.3	12 17.2	11 23.2	12 05.2	11 11.0	11 17.0
15 13.0	14 18.8	14 12.1	13 17.9	13 23.6	15 18.0	15 23.8	15 05.8	14 11.7	14 17.6	13 23.5	14 05.4
18 01.5	17 07.3	17 00.5	16 06.4	16 12.1	18 06.5	18 12.3	17 18.2	17 00.2	17 06.1	16 12.0	16 17.9
20 14.0	19 19.8	19 13.1	18 18.8	19 00.6	20 19.0	21 00.8	20 06.7	19 12.6	19 18.6	19 00.5	19 06.4
23 02.4	22 08.3	22 01.5	21 07.3	21 13.1	23 07.4	23 13.3	22 19.2	22 01.2	22 07.1	21 13.0	21 18.9
25 14.9	24 20.8	24 14.0	23 19.8	24 01.6	25 19.9	26 01.8	25 07.7	24 13.6	24 19.6	24 01.5	24 07.4
28 03.4	27 09.2	27 02.5	26 08.3	26 14.1	28 08.4	28 14.3	27 20.2	27 02.2	27 08.1	26 14.0	26 19.9
30 15.9		29 15.0	28 20.8	29 02.6	30 20.9	31 02.8	30 08.7	29 14.6	29 20.6	29 02.5	29 08.4
				31 15.0							31 20.8
					UMBRIEL						
5 02.2	3 02.4	4 02.4	2 02.4	1 02.6	3 06.4	2 06.5	4 10.1	2 10.6	1 10.9	3 14.7	2 14.8
9 05.7	7 05.8	8 05.8	6 05.9	5 06.1	7 09.8	6 09.9	8 13.6	6 13.9	5 14.3	7 18.1	6 18.2
13 09.2	11 09.2	12 09.2	10 09.3	9 09.6	11 13.3	10 13.5	12 17.0	10 17.4	9 17.8	11 21.5	10 21.7
17 12.6	15 12.6	16 12.6	18 16.2	13 12.9	15 16.7	14 16.9	16 20.5	14 20.9	13 21.3	16 01.0	15 01.1
21 16.0	19 16.2	20 16.2	22 19.6	17 16.4	19 20.2	18 20.3	21 00.0	19 00.5	18 00.8	20 04.4	19 04.6
25 19.5	23 19.6	24 19.6	26 23.1	21 19.9	23 23.6	22 23.7	25 03.5	23 04.0	22 04.2	24 07.8	23 08.1
29 22.9	27 23.0	28 23.0		25 23.4	28 03.0	27 03.2	29 07.0	27 07.5	26 07.7	28 11.2	27 11.6
				30 02.9		31 06.6			30 11.1		31 14.9
					TITANIA						
5 02.9	8 22.2	7 00.7	2 03.4	6 23.1	2 01.9	6 21.7	2 00.5	5 20.5	1 23.5	5 19.3	1 22.1
13 19.7	17 15.1	15 17.6	10 20.3	15 16.1	10 18.9	15 14.6	10 17.6	14 13.5	10 16.5	14 12.3	10 15.0
22 12.5	26 07.8	24 10.5	19 13.3	24 08.9	19 11.8	24 07.6	19 10.5	23 06.5	19 09.4	23 05.2	19 07.9
31 05.3			28 06.1		28 04.7		28 03.5		28 02.4		28 00.8
					OBERON						
9 02.8	5 00.9	3 23.0	13 07.8	10 05.7	6 03.9	3 02.3	12 12.0	8 10.5	5 08.8	1 07.1	11 16.4
22 13.9	18 11.9	17 09.9	26 18.8	23 16.8	19 15.1	16 13.6	25 23.3	21 21.7	18 20.0	14 18.2	25 03.4
		30 20.9				30 00.8				28 05.3	

SATELLITES OF URANUS

Apparent orbit of Satellites I-IV at date of opposition, August 3.

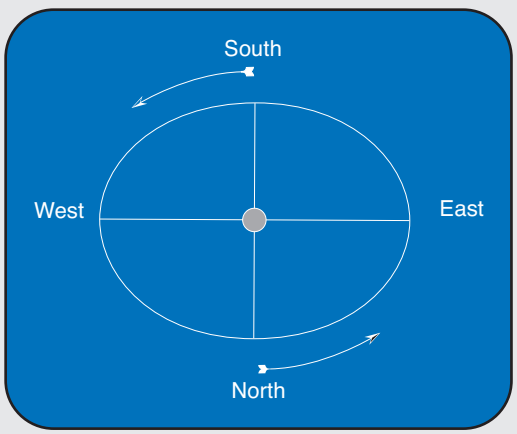


Name		Sidereal Period d	h
I	Ariel	2	12.489
II	Umbriel	4	03.460
III	Titania	8	16.941
IV	Oberon	13	11.118

See introduction to Part II (p. 70) for more information.

SATELLITE OF NEPTUNE

Apparent orbit of Triton at date of opposition, July 24.



Name		Sidereal Period d	h
I	Triton	5	21.044

See introduction to Part II (p. 70) for more information.

SATELLITE OF NEPTUNE — GREATEST EASTERN ELONGATION (AEST)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
					TRITON						
5 06.2	3 14.8	4 23.4	3 08.1	2 17.1	1 02.4	6 09.1	4 18.8	3 04.4	2 14.0	6 20.2	6 05.1
11 03.2	9 11.7	10 20.3	9 05.1	8 14.2	6 23.5	12 06.2	10 15.9	9 01.6	8 11.0	12 17.2	12 02.1
17 00.1	15 08.6	16 17.3	15 02.1	14 11.2	12 20.6	18 03.3	16 13.1	14 22.7	14 08.1	18 14.2	17 23.0
22 21.0	21 05.6	22 14.2	20 23.1	20 08.3	18 17.7	24 00.5	22 10.2	20 19.8	20 05.1	24 11.2	23 20.0
28 17.9	27 02.5	28 11.2	26 20.1	26 05.3	24 14.8	29 21.6	28 07.3	26 16.9	26 02.2	30 08.2	29 16.9
					30 11.9				31 23.2		

NEPTUNE

RISE AND SET TIMES

AEST (Adelaide & Darwin ACST)

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

POSITION

(0hrs UT Epoch 2000.0)

RA	DEC
h m s	° ' "
20 04 27	- 19 59 38
20 05 32	- 19 56 30
20 06 38	- 19 53 17
20 07 44	- 19 50 01
20 08 50	- 19 46 44
20 09 55	- 19 43 29
20 10 57	- 19 40 18
20 11 57	- 19 37 13
20 12 54	- 19 34 17
20 13 46	- 19 31 31
20 14 34	- 19 28 59
20 15 17	- 19 26 42
20 15 55	- 19 24 42
20 16 26	- 19 23 00
20 16 51	- 19 21 38
20 17 10	- 19 20 36
20 17 22	- 19 19 56
20 17 28	- 19 19 38
20 17 27	- 19 19 41
20 17 19	- 19 20 06
20 17 05	- 19 20 52
20 16 45	- 19 21 58
20 16 19	- 19 23 21
20 15 48	- 19 25 02
20 15 13	- 19 26 57
20 14 34	- 19 29 05
20 13 51	- 19 31 23
20 13 07	- 19 33 48
20 12 20	- 19 36 18
20 11 33	- 19 38 50
20 10 46	- 19 41 22
20 10 00	- 19 43 50
20 09 16	- 19 46 13
20 08 35	- 19 48 27
20 07 57	- 19 50 30
20 07 23	- 19 52 20
20 06 54	- 19 53 56
20 06 31	- 19 55 16
20 06 13	- 19 56 18
20 06 02	- 19 57 01
20 05 57	- 19 57 24
20 05 59	- 19 57 27
20 06 08	- 19 57 10
20 06 24	- 19 56 32
20 06 47	- 19 55 33
20 07 16	- 19 54 14
20 07 51	- 19 52 36
20 08 32	- 19 50 39
20 09 18	- 19 48 25
20 10 09	- 19 45 55
20 11 05	- 19 43 11
20 12 04	- 19 40 13

PLUTO

RISE AND SET TIMES

AEST (Adelaide & Darwin ACST)

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

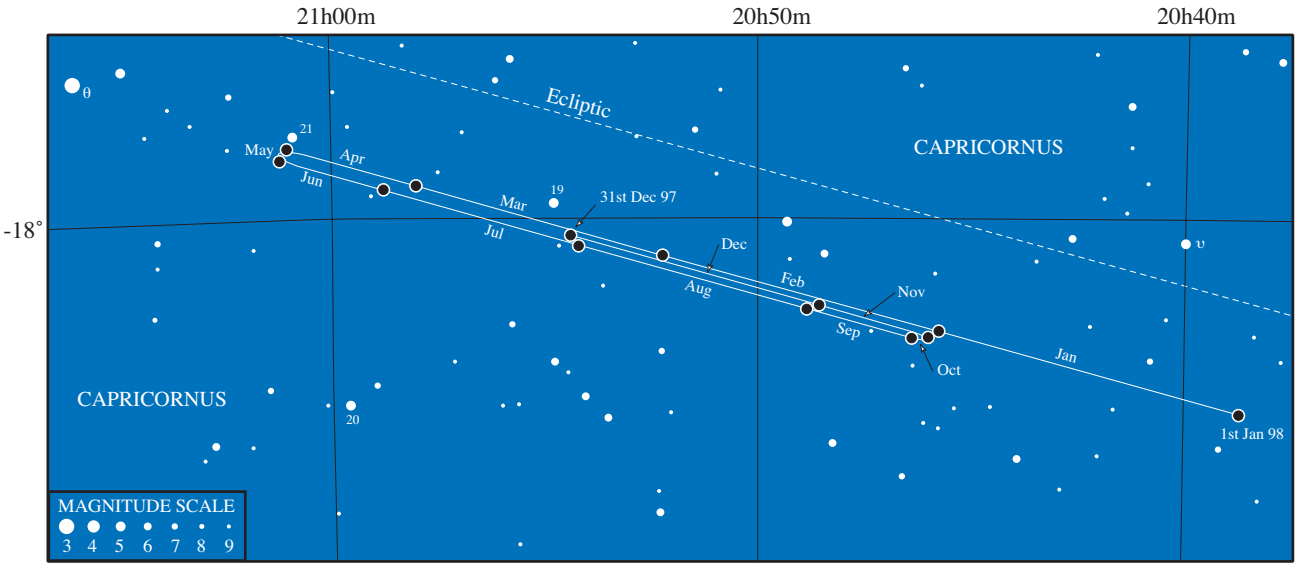
POSITION

(0hrs UT Epoch 2000.0)

RA	DEC
h m s	° ' "
16 28 10	- 09 42 54
16 29 04	- 09 43 49
16 29 54	- 09 44 18
16 30 40	- 09 44 22
16 31 20	- 09 44 00
16 31 54	- 09 43 15
16 32 22	- 09 42 08
16 32 44	- 09 40 41
16 32 59	- 09 38 55
16 33 08	- 09 36 54
16 33 10	- 09 34 39
16 33 05	- 09 32 15
16 32 54	- 09 29 43
16 32 37	- 09 27 07
16 32 14	- 09 24 30
16 31 45	- 09 21 55
16 31 13	- 09 19 26
16 30 36	- 09 17 06
16 29 56	- 09 14 57
16 29 13	- 09 13 03
16 28 29	- 09 11 26
16 27 43	- 09 10 08
16 26 58	- 09 09 12
16 26 14	- 09 08 39
16 25 31	- 09 08 30
16 24 51	- 09 08 46
16 24 14	- 09 09 28
16 23 40	- 09 10 36
16 23 12	- 09 12 10
16 22 48	- 09 14 09
16 22 29	- 09 16 31
16 22 17	- 09 19 16
16 22 10	- 09 22 23
16 22 10	- 09 25 48
16 22 16	- 09 29 30
16 22 29	- 09 33 27
16 22 48	- 09 37 36
16 23 13	- 09 41 54
16 23 44	- 09 46 18
16 24 21	- 09 50 46
16 25 03	- 09 55 14
16 25 50	- 09 59 41
16 26 42	- 10 04 02
16 27 37	- 10 08 15
16 28 35	- 10 12 17
16 29 36	- 10 16 06
16 30 39	- 10 19 40
16 31 43	- 10 22 57
16 32 48	- 10 25 53
16 33 52	- 10 28 29
16 34 55	- 10 30 42
16 35 56	- 10 32 32

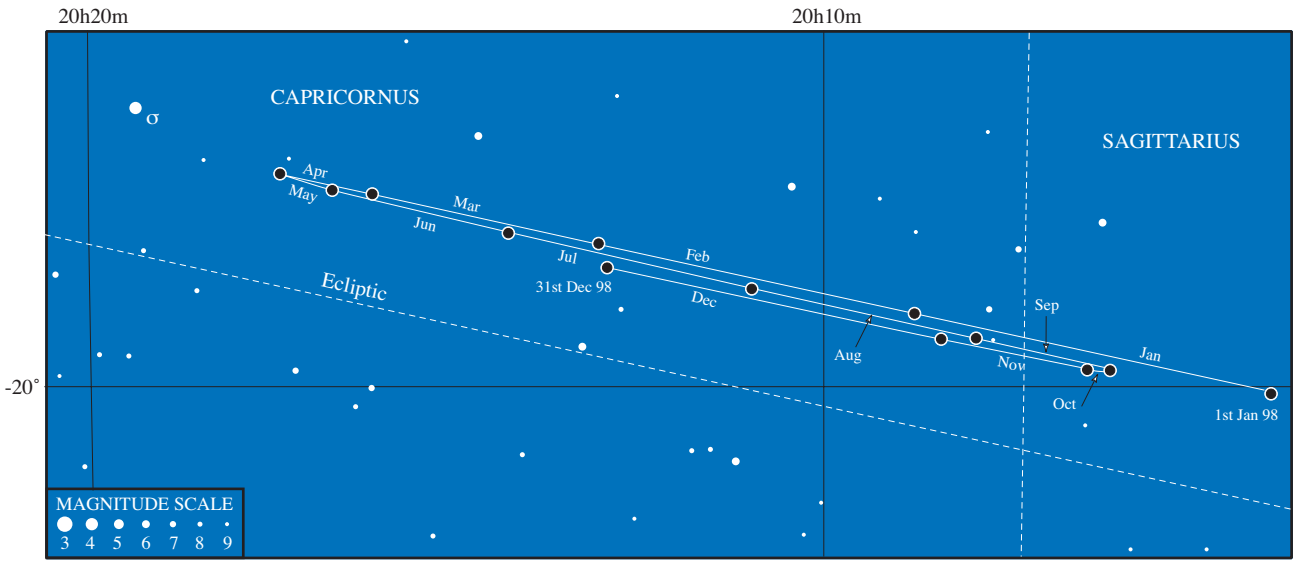
URANUS FINDER CHART

Epoch 2000



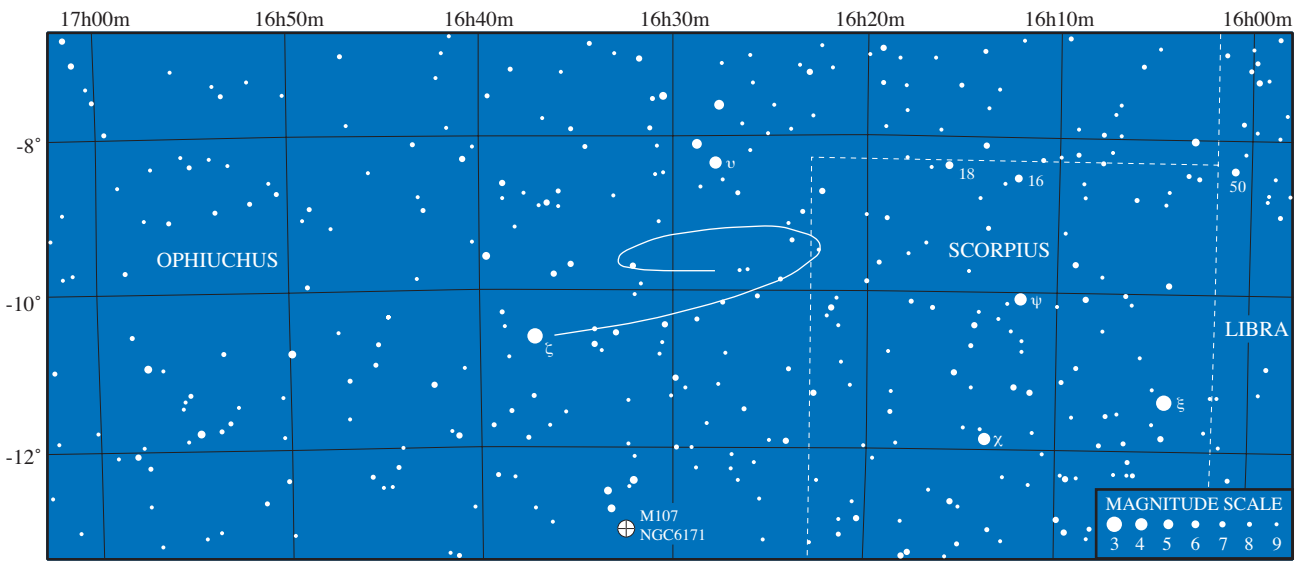
NEPTUNE FINDER CHART

Epoch 2000



PLUTO POINTER CHART

Epoch 2000

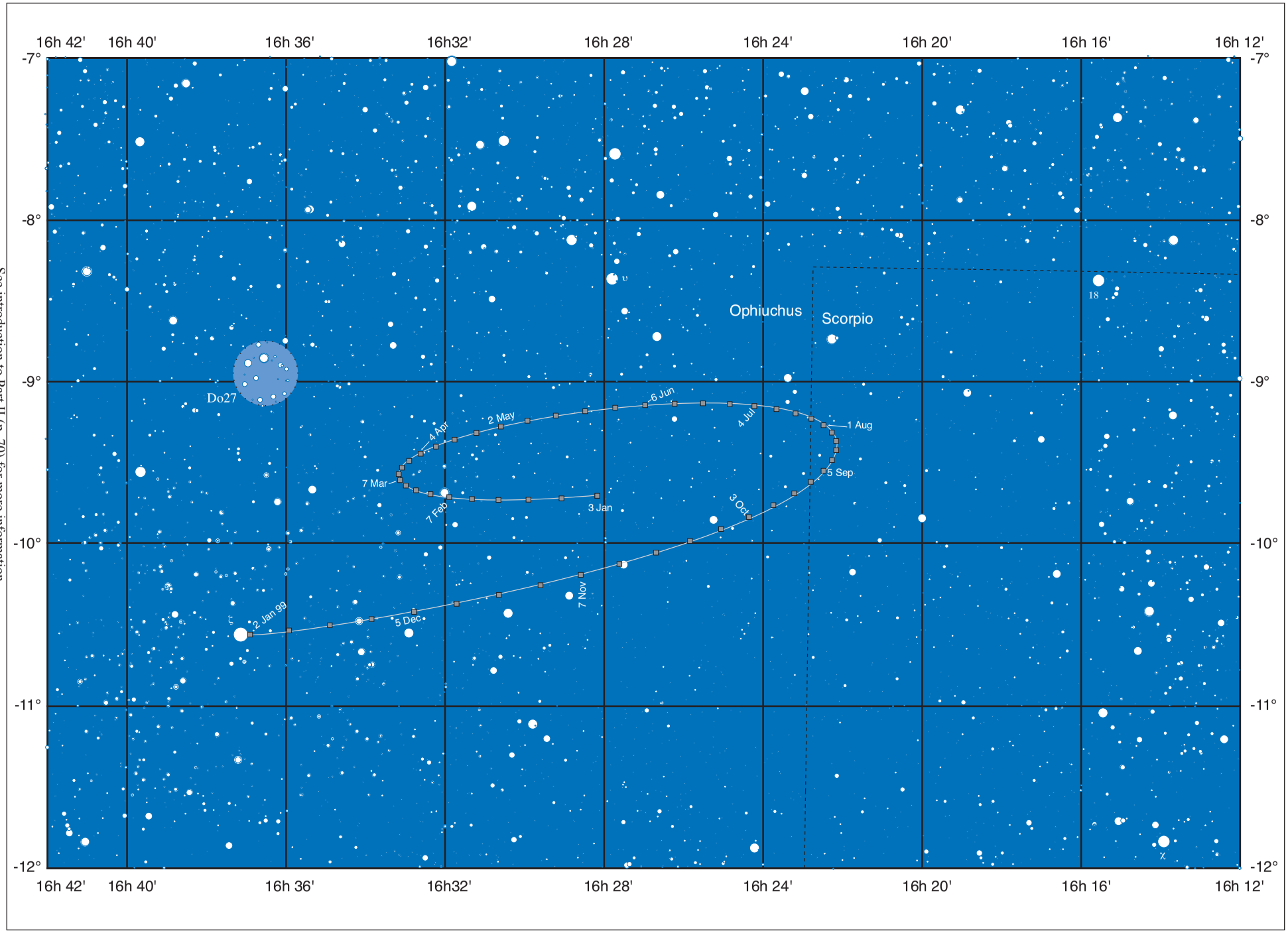


See introduction to Part II (p. 68) for more information.

Stars range in magnitude from 5.5 to 14.5

PLUTO FINDER CHART 1998

Epoch 2000.0



See introduction to Part II (p. 70) for more information.

COMETS FOR 1998

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 the 'periodic', or regularly reappearing, comets are quite elongated or 'egg shaped' compared to those of the planets. They also differ from the planets by being far less massive and mainly composed 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 comet with the shortest period, Encke, takes just over 3 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 around 5 to 10 new comets that have not been recorded before. The majority of these have either open ended orbits (i.e., they are believed to be making their only visit to the Solar System and are not expected to ever return) or Have extremely long orbital periods in the thousands of years.

As a comet draws closer to the Sun, the nucleus or snowball heats up and the ice sublimes forming a cloud called a 'Coma' around the core. The coma can be tens of thousands of kilometres in diameter. The solar radiation or wind, on its outward journey from the Sun, sweeps the coma cloud away forming the 'tail' of the comet. 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 are normally named after their discoverers (up to the first two to report the find). There are also other designations given to comets (you will see examples on the following pages). The prefix 'P' refers to the fact the comet is periodic. The number before the 'P' indicates the number of the periodic comet. For example Comet 43P/Wolf-Harrington indicates Wolf-Harrington was the 43rd comet confirmed to be periodic. The prefix is not assigned until the comet is found on a later return. Interestingly, Halley's Comet's prefix is 1P/ because it was the first comet shown to be periodic. In fact Halley did not find the comet. It was named after him after he successfully predicted its return. You will also see references to a new preliminary naming system. It is best to explain this with an example. You will notice Comet Hale-Bopp is referred to as 'C/1995 01'. 1995 refers to the year, O refers to the 14th half month period ('O' is the 15th letter but 'T' is not used) during the year and 1 shows it was the first discovery in this half month. Therefore Hale-Bopp was the first discovery in the last half of July 1995.

It is true that there is no such thing as a 'typical comet'. Like people, they are all slightly different. The orbits, the overall brightness, the size of the coma and the tail can vary dramatically from comet to comet. 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 'periodic' comets that are expected to be observable during 1998. The table (opposite) lists these objects as well as their orbital elements. This is the data required to calculate their locations in the sky. This is followed by 'ephemerides' (a list of expected positions in the sky and magnitude estimates for different dates) for some of the brighter comets. These tables of positions and magnitudes are only approximate, for only a few of these comets have been found so far on this return (as of early September 1997). Hence the orbital elements and magnitude parameters, used to generate the ephemerides, have been based on their behaviour on previous returns. There are also non gravitational effects, associated with comets, which can render predicted ephemerides inaccurate.

Many of the comets expected in 1998 are extremely faint and would require professional size telescopes or long exposure astrophotographs to detect them. But who knows what new discoveries lie in the future!

NOTES ON SELECTED COMETS FOR 1998

by Greg Bryant

General notes can be found under the Part I "Monthly section", which discuss when and where to look for the comets, on a month by month basis.

C/1995.01 (Hale-Bopp): The Great Comet of 1997 may have passed perihelion and begun to head out to the outer Solar System, but for Southern Hemisphere observers, Hale-Bopp will remain visible through binoculars for much of 1998, and a telescopic target well into 1999, if not beyond.

In reviewing the performance (thus far) of Hale-Bopp, it is apparent that the peak brightness of Hale-Bopp was about magnitude -0.8, about one magnitude down on the original predictions. Northern Hemisphere observers were very fortunate to witness a surge in the rate of brightening during the two months leading up to perihelion, while Southern Hemisphere observers have benefited from a slow rate of fading post-perihelion.

Comparing Hale-Bopp to past comets reveals some interesting results. While there have been perhaps 50 comets in recorded history that were brighter than Hale-Bopp at their peak, Hale-Bopp holds the record for displaying a brightness greater than magnitude 0 for the longest period i.e., 7 weeks. Furthermore, Hale-Bopp has been visible to the unaided eye since May 1996, and is expected to remain so until late Spring 1997 (doubling the record previously held by the Great Comet of 1811).

C/1997 J2 (Meunier-Dupouy): The discovery of this comet is a stark reminder that it pays to observe comets. On 3rd May 1997, Jean Mueller discovered a 13th magnitude comet on plates taken with the 1.2m Oschin Schmidt. French amateurs Michel Meunier and Philippe Dupouy, each independently imaging the above comet using 20cm telescopes and CCD cameras on the night of 7th May, reported a new comet located only 6 are minutes from comet C/1997 J1 (Mueller). Comet Meunier-Dupouy reaches perihelion on 9th March at a distance of over 3 AU from the Sun. The fact that it is visible to amateurs is testimony to its intrinsic brightness. The comet has spent all of 1997 visible only in the Northern Hemisphere, but it will become visible to Australian observers in autumn.

21P/Giacobini-Zinner: This comet was visually discovered at magnitude 10.5 by M. Giacobini on 20th December 1900. The comet was recognised as being periodic, returning every 6.8 years. The comet's return in 1907 was missed due to poor observing geometry, and a similar situation was expected for 1914. However, in October 1913, a German astronomer by the name of Zinner accidentally came across the comet whilst observing variable stars. Observations soon showed it was Giacobini's comet, only that the period was 6.46 years rather than 6.8 - the comet's return to perihelion was some six months earlier than had been anticipated.

Since 1926, Comet Giacobini-Zinner has been seen at every return except the unfavourable 1953 apparition. In 1946, the comet passed within 0.26 AU of Earth. It was 7th magnitude at the time, but a fortuitous outburst in brightness saw the comet rise to 6th magnitude.

Comet Giacobini-Zinner is perhaps best known as being the first comet to be approached by a spacecraft. The International Sun-Earth Explorer 3 (ISEE-3) spacecraft, was redirected towards the comet in 1985 as a precursor to the armada that encountered Halley in 1986.

43P/Wolf-Harrington: On 22nd December 1924, Dr. Max Wolf from Germany discovered this comet on photographic plates. At the time, the comet was 16th magnitude and fading. Orbital calculations were imprecise, but they revealed that the comet was periodic and would have a close approach to Jupiter in 1936. On 4th October 1951, Robert Harrington from Palomar Observatory discovered a 16th magnitude comet on photographic plates. It brightened to 12th magnitude by the beginning of 1952 and then began to fade. An orbit calculation revealed a similarity to the comet discovered by Wolf in 1924, and by 1957 it was generally accepted that the comets were in fact the same object.

Comet Wolf-Harrington is making its 9th observed apparition, having already reached perihelion on 29th September 1997 at a distance of 1.58 AU. Looking ahead to the future of Comet Wolf-Harrington, it will pass within 0.44 AU of Jupiter in October 2007, which will reduce the comet's perihelion distance from 1.58 AU in 2004 to 1.36 AU in 2010 and 2016. However, an even closer Jupiter approach of 0.07 AU in March 2019 will throw Wolf-Harrington's perihelion distance out to 2.44 AU in 2025.

55P/Tempel-Tuttle: On 19th December 1865, Ernst Tempel, observing from Marseilles, France, discovered a 6th magnitude comet near the star Beta Ursae Majoris. An independent discovery was made on 6th January 1866, by Horace Tuttle, observing from Harvard College Observatory,

Massachusetts, U.S. Perihelion occurred on January 12 1866, around which time it reached its peak brightness of 5th magnitude.

While enough observations were made during the discovery apparition to calculate an elliptical orbit of period 33 years, the comet was not seen during its expected returns in 1899 and 1932. In 1933, the comet's past was examined, and it was concluded that the comet of 1366 was most likely Tempel-Tuttle. In 1965, Joachim Schubert confirmed the comet observed in late October 1699 was also Tempel-Tuttle. Using a newly refined orbit, the comet was recovered in 1965.

The comet apparitions in 1366 and 1699 are significant. On 26th October 1366, the comet passed only 0.0229 AU from Earth - the third closest approach of a comet in recorded history. Tempel-Tuttle is likely to have reached 3rd magnitude at that time. In 1699, the comet passed only 0.0644 AU from Earth - the 18th closest approach of a comet, and is believed to have reached 4th magnitude.

The 1998 return of Tempel-Tuttle favours Northern Hemisphere observers, passing only seven degrees from the North Celestial Pole, during which time it should brighten to better than 10th magnitude as it approaches Earth to within 0.4 AU.

Comet Tempel-Tuttle is best known as the parent comet of the Leonid meteor shower, and meteor storms are expected in 1998 and 1999 (p. 61).

103P/Hartley 2: This relatively new periodic comet was discovered by Malcolm Hartley, on a plate taken on Siding Spring's Schmidt telescope in March 1986. It was determined to be a short-period comet, which had reached perihelion in June 1985. As no visual observations were made in 1986, Hartley 2's return in 1991 was the first opportunity to follow it visually. It surpassed expectations, reaching 8th magnitude in August and September of that year. Hartley 2 is similarly expected to reach 8th magnitude by the end of 1997 (perihelion is on 21st December), and slowly fade during 1998.

Greg Bryant is a well known member of the amateur community with extensive interests in comets. He is editor of the newsletter "Comet Tales" (p. 131).

EXPLANATION OF COMET ELEMENTS TABLE

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 one would indicate an open orbit which means either it is a once only visit to the Solar System or it has a very long period (thousands of years) or the comet is newly discovered and astronomers have not clearly defined its orbit.

Period The comet's period in years. The time it takes to complete 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. If the value is greater than 90°, the comets direction of orbit is retrograde i.e., moving 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)

The mathematics used to calculate the ephemerides from these elements is complex (but not impossible, considering the power of home computers) but is beyond the scope of this publication.

EXPLANATION OF COMET EPHEMERIDES

Date is for 0 hr UT or 10am AEST (9:30am ACST) 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:

$$\text{Mag.} = H1 + 5 \log(\Delta) + K1 \log R.$$

See the table of elements for the values of H1 and K1. For many comets the K1 value is equal to 10. For newly discovered comets the value of 'K1' is nearly always 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. 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.

COMETS FOR 1998 — ORBITAL ELEMENTS (EQUINOX 2000.0)

Comet Name	Perihelion Date		q	e	Period	ω	Ω	i	H1	K1
	yy mm	d.dd	A.U.		years	deg	deg	deg		
C/1995 O1 (Hale-Bopp)	97 Apr	01.13025	0.913689	0.995005		130.56760	282.45140	089.42423	-1.0	8.5
43P/Wolf-Harrington	97 Sep	29.24189	1.581825	0.543983	6.46	187.13329	254.75666	018.51043	6.5	21.0
103P/Hartley 2	97 Dec	21.94036	1.031758	0.700360	6.39	180.72297	219.95430	013.61974	8.0	15.0
130P/McNaught-Hughes	98 Feb	23.76489	2.116241	0.404124	6.69	224.36645	089.97241	007.30327	10.0	15.0
55P/Tempel-Tuttle	98 Feb	28.10450	0.976628	0.905500	33.2	172.49600	235.25810	162.48590	10.0	25.0
104P/Kowal 2	98 Mar	02.18041	1.396513	0.585394	6.18	191.91086	246.14923	015.48922	12.5	10.0
129P/Shoemaker-Levy 3	98 Mar	04.79934	2.817275	0.247917	7.25	181.37079	303.71115	005.00836	11.0	10.0
C/1997 J2 (Meunier-Dupouy)	98 Mar	09.29591	3.045805	1		122.61423	148.82885	091.22586	3.5	10.0
C/1997 G2 (Montani)	98 Apr	16.32620	3.084920	0.994552		239.85149	055.80298	069.84605	8.0	10.0
62P/Tsuchinshan 1	98 Apr	19.10164	1.495867	0.576615	6.64	022.77647	096.81099	010.49519	8.0	25.0
68P/Klemola	98 May	01.66509	1.754513	0.641319	10.8	154.54327	175.54325	011.08872	10.0	10.0
49P/Arend-Rigaux	98 Jul	12.59853	1.368585	0.611543	6.61	330.56167	121.72924	018.29060	11.3	11.0
80P/Peters-Hartley	98 Aug	11.73560	1.623964	0.598019	8.12	338.40886	260.00641	029.85549	9.0	20.0
P/1991 V2 (Shoemaker-Levy 7)	98 Aug	25.27439	1.697407	0.531149	6.89	095.57051	309.50068	010.09053	14.0	15.0
83P/Russell 1	98 Aug	26.10561	2.182452	0.437500	7.64	333.88532	226.43874	017.74595	14.0	15.0
88P/Howell 1	98 Sep	27.25327	1.406136	0.552688	5.57	234.91193	057.66882	004.39834	8.0	15.0
93P/Lovas 1	98 Oct	14.15874	1.691780	0.613125	9.14	074.49161	340.02032	012.23656	9.5	15.0
98P/Takamizawa	98 Nov	07.97439	1.585210	0.575130	7.21	147.80622	124.84587	009.48974	9.0	20.0
P/1983 J3 (Kowal-Vavrova)	98 Nov	15.18071	2.577261	0.586658	15.6	018.92638	202.27794	004.34469	10.5	10.0
21P/Giacobini-Zinner	98 Nov	21.31685	1.033713	0.706483	6.61	172.54330	195.39847	031.85873	9.0	15.0

Comet C/1997 J2 (Meunier-Dupouy)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Dec 6	18 17.98	+46 29.4	3.348	3.181	71.8	10.6
1997 Dec 13	18 36.35	+44 50.8	3.358	3.162	70.1	10.6
1997 Dec 20	18 53.99	+43 15.4	3.374	3.144	68.2	10.6
1997 Dec 27	19 10.88	+41 44.6	3.396	3.128	66.0	10.6
1998 Jan 3	19 27.03	+40 19.4	3.422	3.113	63.6	10.6
1998 Jan 10	19 42.45	+39 00.4	3.452	3.099	61.2	10.6
1998 Jan 17	19 57.15	+37 48.0	3.483	3.087	58.6	10.6
1998 Jan 24	20 11.15	+36 42.6	3.516	3.077	56.1	10.6
1998 Jan 31	20 24.47	+35 44.2	3.547	3.068	53.7	10.6
1998 Feb 7	20 37.13	+34 52.7	3.577	3.060	51.4	10.6
1998 Feb 14	20 49.14	+34 07.7	3.603	3.054	49.4	10.6
1998 Feb 21	21 00.52	+33 29.0	3.626	3.050	47.8	10.6
1998 Feb 28	21 11.27	+32 56.0	3.643	3.047	46.5	10.6
1998 Mar 7	21 21.41	+32 28.3	3.654	3.046	45.8	10.7
1998 Mar 14	21 30.94	+32 05.3	3.658	3.046	45.6	10.7
1998 Mar 21	21 39.85	+31 46.3	3.655	3.048	46.0	10.7
1998 Mar 28	21 48.15	+31 30.7	3.644	3.051	46.9	10.7
1998 Apr 4	21 55.81	+31 18.1	3.625	3.056	48.5	10.6
1998 Apr 11	22 02.82	+31 07.5	3.598	3.063	50.7	10.6
1998 Apr 18	22 09.15	+30 58.3	3.562	3.071	53.4	10.6
1998 Apr 25	22 14.78	+30 49.8	3.518	3.080	56.6	10.6
1998 May 2	22 19.66	+30 41.1	3.466	3.091	60.2	10.6
1998 May 9	22 23.74	+30 31.4	3.406	3.104	64.2	10.6
1998 May 16	22 26.99	+30 19.7	3.340	3.118	68.7	10.6
1998 May 23	22 29.35	+30 04.9	3.267	3.133	73.5	10.5
1998 May 30	22 30.76	+29 45.8	3.189	3.150	78.6	10.5
1998 Jun 6	22 31.15	+29 20.9	3.108	3.168	84.1	10.5
1998 Jun 13	22 30.48	+28 48.7	3.023	3.187	89.9	10.4
1998 Jun 20	22 28.71	+28 07.5	2.938	3.208	96.0	10.4
1998 Jun 27	22 25.81	+27 15.4	2.853	3.230	102.5	10.4
1998 Jul 4	22 21.79	+26 10.4	2.772	3.253	109.3	10.3
1998 Jul 11	22 16.68	+24 50.7	2.696	3.278	116.4	10.3
1998 Jul 18	22 10.60	+23 14.9	2.629	3.303	123.8	10.3
1998 Jul 25	22 03.67	+21 21.8	2.571	3.330	131.3	10.3
1998 Aug 1	21 56.11	+19 11.6	2.528	3.358	138.7	10.3
1998 Aug 8	21 48.16	+16 45.2	2.500	3.387	145.7	10.3
1998 Aug 15	21 40.11	+14 05.4	2.491	3.417	151.7	10.3
1998 Aug 22	21 32.23	+11 15.6	2.501	3.448	155.6	10.4
1998 Aug 29	21 24.81	+08 20.5	2.532	3.479	156.0	10.4
1998 Sep 5	21 18.07	+05 25.0	2.584	3.512	152.9	10.5
1998 Sep 12	21 12.19	+02 33.8	2.656	3.546	147.4	10.6
1998 Sep 19	21 07.29	-00 09.3	2.746	3.580	140.6	10.7
1998 Sep 26	21 03.45	-02 41.6	2.854	3.615	133.2	10.9
1998 Oct 3	21 00.69	-05 01.3	2.976	3.651	125.7	11.0
1998 Oct 10	20 58.99	-07 07.6	3.110	3.688	118.2	11.1
1998 Oct 17	20 58.28	-09 00.5	3.253	3.725	110.8	11.3
1998 Oct 24	20 58.53	-10 40.6	3.404	3.763	103.5	11.4
1998 Oct 31	20 59.65	-12 08.5	3.560	3.802	96.4	11.6
1998 Nov 7	21 01.56	-13 25.3	3.719	3.841	89.5	11.7
1998 Nov 14	21 04.17	-14 32.1	3.879	3.881	82.8	11.8
1998 Nov 21	21 07.42	-15 29.9	4.037	3.921	76.2	12.0
1998 Nov 28	21 11.22	-16 19.8	4.194	3.962	69.8	12.1
1998 Dec 5	21 15.50	-17 02.6	4.346	4.003	63.4	12.2
1998 Dec 12	21 20.20	-17 39.3	4.492	4.045	57.2	12.3
1998 Dec 19	21 25.25	-18 10.7	4.633	4.087	51.1	12.4
1998 Dec 26	21 30.61	-18 37.5	4.765	4.130	45.1	12.5
1999 Jan 2	21 36.21	-19 00.5	4.888	4.173	39.2	12.7

Comet 43P/Wolf-Harrington

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Dec 6	10 02.45	-07 18.5	1.277	1.720	98.1	12.1
1997 Dec 13	10 08.29	-09 54.3	1.247	1.747	102.4	12.1
1997 Dec 20	10 12.45	-12 22.0	1.220	1.777	107.0	12.2
1997 Dec 27	10 14.82	-14 39.2	1.195	1.808	111.8	12.2
1998 Jan 3	10 15.33	-16 43.1	1.174	1.841	116.9	12.3
1998 Jan 10	10 13.98	-18 30.5	1.157	1.875	122.1	12.4
1998 Jan 17	10 10.89	-19 58.4	1.146	1.910	127.4	12.5
1998 Jan 24	10 06.24	-21 04.1	1.141	1.947	132.6	12.6
1998 Jan 31	10 00.38	-21 45.2	1.143	1.984	137.5	12.8
1998 Feb 7	09 53.78	-22 00.7	1.154	2.023	141.8	12.9
1998 Feb 14	09 46.99	-21 51.7	1.174	2.062	145.0	13.1
1998 Feb 21	09 40.53	-21 20.4	1.203	2.101	146.8	13.2
1998 Feb 28	09 34.88	-20 30.7	1.243	2.142	146.8	13.4
1998 Mar 7	09 30.43	-19 27.5	1.293	2.182	145.2	13.6
1998 Mar 14	09 27.38	-18 16.0	1.353	2.223	142.2	13.9
1998 Mar 21	09 25.84	-17 00.9	1.422	2.265	138.3	14.1
1998 Mar 28	09 25.78	-15 46.2	1.501	2.306	133.8	14.3
1998 Apr 4	09 27.15	-14 35.0	1.587	2.348	128.9	14.6
1998 Apr 11	09 29.81	-13 29.7	1.681	2.390	124.0	14.8
1998 Apr 18	09 33.62	-12 31.7	1.781	2.432	119.0	15.0

Comet 21P/Giacobini-Zinner

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1998 Jun 13	17 07.67	+25 54.9	1.426	2.226	130.7	15.0
1998 Jun 20	16 58.72	+27 07.7	1.388	2.164	127.7	14.7
1998 Jun 27	16 49.66	+27 57.7	1.357	2.102	124.0	14.5
1998 Jul 4	16 41.01	+28 23.6	1.334	2.040	119.8	14.3
1998 Jul 11	16 33.25	+28 25.6	1.315	1.977	115.3	14.0
1998 Jul 18	16 26.81	+28 05.3	1.300	1.913	110.8	13.8
1998 Jul 25	16 22.00	+27 24.5	1.288	1.849	106.2	13.6
1998 Aug 1	16 19.07	+26 25.9	1.276	1.785	101.8	13.3
1998 Aug 8	16 18.14	+25 12.2	1.264	1.721	97.6	13.0
1998 Aug 15	16 19.27	+23 45.5	1.250	1.657	93.6	12.8
1998 Aug 22	16 22.47	+22 07.6	1.235	1.594	89.8	12.5
1998 Aug 29	16 27.76	+20 19.9	1.216	1.531	86.4	12.2
1998 Sep 5	16 35.12	+18 23.2	1.194	1.469	83.2	11.9
1998 Sep 12	16 44.54	+16 17.8	1.168	1.408	80.3	11.6
1998 Sep 19	16 56.05	+14 03.5	1.139	1.349	77.8	11.2
1998 Sep 26	17 09.73	+11 39.6	1.106	1.293	75.5	10.9
1998 Oct 3	17 25.63	+09 05.4	1.070	1.240	73.5	10.5
1998 Oct 10	17 43.86	+06 19.8	1.032	1.191	71.8	10.2
1998 Oct 17	18 04.57	+03 21.6	0.994	1.146	70.3	9.9
1998 Oct 24	18 27.91	+00 10.5	0.956	1.108	69.2	9.6
1998 Oct 31	18 54.03	-03 12.6	0.921	1.077	68.3	9.3
1998 Nov 7	19 23.00	-06 45.1	0.891	1.053	67.8	9.1
1998 Nov 14	19 54.82	-10 21.1	0.868	1.039	67.7	8.9
1998 Nov 21	20 29.34	-13 51.5	0.854	1.034	67.8	8.9
1998 Nov 28	21 06.11	-17 04.9	0.850	1.038	68.4	8.9
1998 Dec 5	21 44.42	-19 49.3	0.858	1.052	69.2	9.0
1998 Dec 12	22 23.34	-21 55.1	0.877	1.074	70.2	9.2
1998 Dec 19	23 01.87	-23 17.2	0.908	1.105	71.3	9.4
1998 Dec 26	23 39.08	-23 55.7	0.949	1.143	72.5	9.8
1999 Jan 2	00 14.32	-23 54.8	0.998	1.186	73.5	10.1

COMET EPHEMERIDES

Comet 93P/Lovas 1

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1998 Jul 18	02 18.82	+20 05.8	1.883	1.915	76.2	15.1
1998 Jul 25	02 34.21	+22 09.5	1.795	1.883	78.8	14.9
1998 Aug 1	02 50.02	+24 13.0	1.711	1.854	81.4	14.7
1998 Aug 8	03 06.24	+26 15.6	1.630	1.826	83.9	14.5
1998 Aug 15	03 22.89	+28 16.6	1.553	1.801	86.5	14.3
1998 Aug 22	03 39.92	+30 15.2	1.479	1.778	89.0	14.1
1998 Aug 29	03 57.26	+32 10.6	1.410	1.757	91.6	13.9
1998 Sep 5	04 14.83	+34 01.8	1.344	1.739	94.3	13.7
1998 Sep 12	04 32.53	+35 48.1	1.283	1.724	97.0	13.6
1998 Sep 19	04 50.18	+37 28.8	1.225	1.712	99.8	13.4
1998 Sep 26	05 07.54	+39 03.3	1.172	1.702	102.8	13.3
1998 Oct 3	05 24.37	+40 31.2	1.122	1.696	105.9	13.2
1998 Oct 10	05 40.37	+41 52.4	1.076	1.692	109.3	13.1
1998 Oct 17	05 55.18	+43 06.9	1.034	1.692	112.9	13.0
1998 Oct 24	06 08.40	+44 14.8	0.996	1.695	116.8	12.9
1998 Oct 31	06 19.66	+45 15.9	0.962	1.701	120.9	12.9
1998 Nov 7	06 28.62	+46 10.1	0.932	1.710	125.5	12.8
1998 Nov 14	06 34.94	+46 56.4	0.907	1.722	130.3	12.8
1998 Nov 21	06 38.41	+47 33.1	0.888	1.736	135.4	12.8
1998 Nov 28	06 39.01	+47 57.8	0.875	1.754	140.6	12.9
1998 Dec 5	06 37.00	+48 07.5	0.870	1.774	145.9	12.9
1998 Dec 12	06 32.88	+47 59.9	0.872	1.796	150.7	13.0
1998 Dec 19	06 27.38	+47 33.0	0.883	1.821	154.5	13.1
1998 Dec 26	06 21.44	+46 46.8	0.904	1.848	156.6	13.3
1999 Jan 2	06 15.96	+45 43.5	0.935	1.878	156.3	13.5

Comet 88P/Howell

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1998 Feb 28	13 56.69	-07 02.0	1.695	2.447	129.5	15.0
1998 Mar 7	13 56.99	-06 58.0	1.585	2.403	136.4	14.7
1998 Mar 14	13 55.94	-06 47.6	1.483	2.358	143.6	14.4
1998 Mar 21	13 53.44	-06 31.0	1.391	2.314	151.2	14.2
1998 Mar 28	13 49.49	-06 08.6	1.309	2.269	159.0	13.9
1998 Apr 4	13 44.17	-05 41.3	1.238	2.224	167.0	13.7
1998 Apr 11	13 37.72	-05 10.9	1.180	2.179	174.1	13.4
1998 Apr 18	13 30.45	-04 39.4	1.133	2.134	173.2	13.2
1998 Apr 25	13 22.79	-04 09.5	1.100	2.089	165.4	13.0
1998 May 2	13 15.29	-03 44.2	1.078	2.044	157.0	12.8
1998 May 9	13 08.47	-03 26.1	1.067	1.999	148.7	12.7
1998 May 16	13 02.79	-03 17.5	1.065	1.955	140.7	12.5
1998 May 23	12 58.61	-03 19.7	1.072	1.911	133.0	12.4
1998 May 30	12 56.19	-03 33.8	1.084	1.868	125.8	12.2
1998 Jun 6	12 55.67	-03 59.9	1.101	1.826	119.2	12.1
1998 Jun 13	12 57.07	-04 37.7	1.122	1.784	113.1	12.0
1998 Jun 20	13 00.36	-05 26.4	1.144	1.743	107.5	11.9
1998 Jun 27	13 05.48	-06 25.4	1.167	1.704	102.4	11.8
1998 Jul 4	13 12.37	-07 33.9	1.191	1.666	97.7	11.7
1998 Jul 11	13 20.93	-08 50.7	1.213	1.629	93.5	11.6
1998 Jul 18	13 31.08	-10 14.7	1.236	1.595	89.6	11.5
1998 Jul 25	13 42.77	-11 45.0	1.257	1.562	86.2	11.4
1998 Aug 1	13 55.97	-13 20.1	1.277	1.532	83.1	11.3
1998 Aug 8	14 10.63	-14 58.8	1.297	1.505	80.3	11.2
1998 Aug 15	14 26.73	-16 39.3	1.316	1.480	77.8	11.2
1998 Aug 22	14 44.27	-18 19.8	1.334	1.459	75.5	11.1
1998 Aug 29	15 03.23	-19 58.3	1.353	1.441	73.5	11.0
1998 Sep 5	15 23.58	-21 32.6	1.372	1.426	71.8	11.0
1998 Sep 12	15 45.26	-23 00.2	1.393	1.416	70.2	11.0
1998 Sep 19	16 08.21	-24 18.6	1.415	1.409	68.8	11.0
1998 Sep 26	16 32.32	-25 25.3	1.440	1.406	67.6	11.0
1998 Oct 3	16 57.41	-26 18.0	1.468	1.407	66.4	11.1
1998 Oct 10	17 23.26	-26 54.7	1.499	1.413	65.3	11.1
1998 Oct 17	17 49.62	-27 13.9	1.535	1.422	64.3	11.2
1998 Oct 24	18 16.22	-27 14.9	1.574	1.435	63.3	11.3
1998 Oct 31	18 42.77	-26 57.6	1.619	1.452	62.2	11.5
1998 Nov 7	19 08.99	-26 22.8	1.668	1.472	61.1	11.6
1998 Nov 14	19 34.65	-25 31.6	1.722	1.496	59.9	11.8
1998 Nov 21	19 59.57	-24 25.7	1.781	1.522	58.6	12.0
1998 Nov 28	20 23.63	-23 07.2	1.845	1.551	57.2	12.2
1998 Dec 5	20 46.74	-21 38.2	1.913	1.583	55.7	12.4
1998 Dec 12	21 08.87	-20 00.9	1.985	1.617	54.0	12.6
1998 Dec 19	21 30.03	-18 17.2	2.062	1.653	52.2	12.8
1998 Dec 26	21 50.27	-16 28.8	2.141	1.690	50.2	13.1
1999 Jan 2	22 09.63	-14 37.5	2.223	1.729	48.1	13.3

FOR 1998

Comet 103P/Hartley 2

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Dec 6	21 30.18	-09 27.5	0.899	1.056	68.0	8.7
1997 Dec 13	21 59.59	-09 14.4	0.873	1.040	67.7	8.5
1997 Dec 20	22 31.18	-08 47.7	0.850	1.032	68.0	8.4
1997 Dec 27	23 04.73	-08 06.0	0.832	1.034	68.9	7.8
1998 Jan 3	23 39.88	-07 08.7	0.821	1.046	70.2	7.9
1998 Jan 10	00 16.09	-05 56.4	0.819	1.066	71.9	8.0
1998 Jan 17	00 52.71	-04 31.1	0.826	1.095	73.9	8.2
1998 Jan 24	01 29.04	-02 56.2	0.845	1.131	75.9	8.4
1998 Jan 31	02 04.45	-01 16.0	0.876	1.173	77.9	8.8
1998 Feb 7	02 38.43	+00 24.7	0.918	1.221	79.6	9.1
1998 Feb 14	03 10.62	+02 01.5	0.972	1.272	81.0	9.5
1998 Feb 21	03 40.88	+03 31.2	1.036	1.327	81.9	9.9
1998 Feb 28	04 09.18	+04 51.9	1.110	1.385	82.3	10.3
1998 Mar 7	04 35.63	+06 02.1	1.193	1.445	82.2	10.8
1998 Mar 14	05 00.33	+07 01.6	1.284	1.506	81.7	11.2
1998 Mar 21	05 23.45	+07 50.4	1.382	1.569	80.8	11.6
1998 Mar 28	05 45.16	+08 29.0	1.487	1.632	79.4	12.1
1998 Apr 4	06 05.62	+08 57.9	1.597	1.695	77.8	12.5
1998 Apr 11	06 24.96	+09 17.8	1.711	1.759	75.9	12.8
1998 Apr 18	06 43.29	+09 29.4	1.829	1.822	73.7	13.2
1998 Apr 25	07 00.74	+09 33.4	1.951	1.886	71.3	13.6
1998 May 2	07 17.41	+09 30.5	2.074	1.949	68.7	13.9
1998 May 9	07 33.35	+09 21.3	2.200	2.012	66.0	14.3
1998 May 16	07 48.64	+09 06.4	2.326	2.074	63.1	14.6
1998 May 23	08 03.35	+08 46.4	2.453	2.136	60.1	14.9
1998 May 30	08 17.52	+08 21.7	2.579	2.197	57.0	15.2

Comet C/1995 O1 (Hale-Bopp)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Dec 6	07 19.25	-61 26.9	3.493	3.644	90.9	6.5
1997 Dec 13	07 03.26	-62 46.7	3.559	3.721	91.7	6.6
1997 Dec 20	06 45.81	-63 43.4	3.629	3.797	92.2	6.7
1997 Dec 27	06 27.69	-64 16.5	3.705	3.872	92.4	6.8
1998 Jan 3	06 09.81	-64 26.7	3.784	3.947	92.3	7.0
1998 Jan 10	05 53.05	-64 16.0	3.867	4.022	91.9	7.1
1998 Jan 17	05 38.09	-63 47.5	3.953	4.095	91.3	7.2
1998 Jan 24	05 25.33	-63 04.7	4.043	4.169	90.5	7.3
1998 Jan 31	05 14.95	-62 11.1	4.134	4.242	89.5	7.4
1998 Feb 7	05 06.93	-61 10.1	4.227	4.314	88.4	7.5
1998 Feb 14	05 01.10	-60 04.5	4.321	4.386	87.2	7.6
1998 Feb 21	04 57.25	-58 56.9	4.416	4.458	86.0	7.7
1998 Feb 28	04 55.14	-57 49.0	4.512	4.529	84.7	7.8
1998 Mar 7	04 54.56	-56 42.6	4.606	4.600	83.4	8.0
1998 Mar 14	04 55.28	-55 39.0	4.701	4.670	82.2	8.1
1998 Mar 21	04 57.12	-54 38.9	4.794	4.740	80.9	8.1
1998 Mar 28	04 59.91	-53 43.2	4.885	4.810	79.8	8.2
1998 Apr 4	05 03.50	-52 52.5	4.975	4.879	78.7	8.3
1998 Apr 11	05 07.79	-52 07.2	5.064	4.947	77.7	8.4
1998 Apr 18	05 12.65	-51 27.5	5.150	5.016	76.8	8.5
1998 Apr 25	05 18.00	-50 53.8	5.233	5.084	76.0	8.6
1998 May 2	05 23.76	-50 26.2	5.315	5.152	75.3	8.7
1998 May 9	05 29.85	-50 04.9	5.394	5.219	74.7	8.8
1998 May 16	05 36.22	-49 49.8	5.470	5.286	74.2	8.8
1998 May 23	05 42.81	-49 40.9	5.544	5.352	73.9	8.9
1998 May 30	05 49.57	-49 38.3	5.615	5.419	73.7	9.0
1998 Jun 6	05 56.46	-49 42.0	5.685	5.485	73.6	9.1
1998 Jun 13	06 03.41	-49 51.8	5.752	5.550	73.6	9.1
1998 Jun 20	06 10.41	-50 07.6	5.816	5.616	73.7	9.2
1998 Jun 27	06 17.41	-50 29.4	5.879	5.681	73.8	9.3
1998 Jul 4	06 24.35	-50 56.9	5.940	5.745	74.1	9.3
1998 Jul 11	06 31.22	-51 29.9	5.999	5.810	74.4	9.4
1998 Jul 18	06 37.96	-52 08.3	6.057	5.874	74.8	9.4
1998 Jul 25	06 44.54	-52 51.9	6.114	5.938	75.3	9.5
1998 Aug 1	06 50.91	-53 40.3	6.169	6.001	75.8	9.6
1998 Aug 8	06 57.02	-54 33.3	6.223	6.064	76.3	9.6
1998 Aug 15	07 02.82	-55 30.5	6.277	6.127	76.9	9.7
1998 Aug 22	07 08.27	-56 31.6	6.331	6.190	77.5	9.7
1998 Aug 29	07 13.28	-57 36.3	6.384	6.253	78.0	9.8
1998 Sep 5	07 17.80	-58 44.0	6.436	6.315	78.6	9.8
1998 Sep 12	07 21.74	-59 54.2	6.489	6.377	79.1	9.9
1998 Sep 19	07 25.03	-61 06.5	6.542	6.438	79.7	10.0
1998 Sep 26	07 27.55	-62 20.3	6.596	6.500	80.2	10.0
1998 Oct 3	07 29.19	-63 34.9	6.649	6.561	80.6	10.1
1998 Oct 10	07 29.83	-64 49.5	6.703	6.622	81.0	10.1
1998 Oct 17	07 29.34	-66 03.5	6.758	6.683	81.4	10.2
1998 Oct 24	07 27.54	-67 15.8	6.813	6.743	81.8	10.2
1998 Oct 31	07 24.31	-68 25.5	6.869	6.803	82.0	10.3
1998 Nov 7	07 19.49	-69 31.4	6.926	6.863	82.3	10.3
1998 Nov 14	07 13.0	-70 32.4	6.983	6.923	82.5	10.4
1998 Nov 21	07 04.7	-71 27.3	7.041	6.982	82.6	10.4
1998 Nov 28	06 54.7	-72 14.7	7.099	7.042	82.7	10.5
1998 Dec 5	06 43.0	-72 53.5	7.158	7.101	82.8	10.5
1998 Dec 12	06 30.1	-73 22.6	7.217	7.160	82.8	10.6
1998 Dec 19	06 16.2	-73 41.4	7.276	7.218	82.8	10.6
1998 Dec 26	06 02.0	-73 49.5	7.335	7.277	82.8	10.7
1999 Jan 2	05 48.1	-73 47.2	7.394	7.335	82.7	10.7

Comet 55P/Tempel-Tuttle

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Dec 6	12 32.78	+15 53.9	1.605	1.632	73.8	16.3
1997 Dec 13	12 35.55	+17 53.4	1.368	1.553	80.9	15.5
1997 Dec 20	12 37.51	+20 59.2	1.126	1.476	88.5	14.5
1997 Dec 27	12 38.01	+26 04.2	0.885	1.400	96.9	13.4
1998 Jan 3	12 35.14	+35 11.6	0.653	1.327	106.6	12.1
1998 Jan 10	12 19.76	+53 26.9	0.454	1.257	117.1	10.8
1998 Jan 17	07 06.1	+82 59.0	0.357	1.192	117.7	9.7
1998 Jan 24	01 39.16	+52 03.5	0.434	1.132	98.4	9.5
1998 Jan 31	01 22.42	+32 02.2	0.619	1.080	81.2	9.8
1998 Feb 7	01 17.62	+21 54.1	0.837	1.037	68.8	10.0
1998 Feb 14	01 15.52	+16 02.3	1.058	1.004	58.7	10.2
1998 Feb 21	01 14.32	+12 11.8	1.271	0.984	49.7	10.3
1998 Feb 28	01 13.46	+09 25.7	1.469	0.977	41.3	10.6
1998 Mar 7	01 12.77	+07 17.4	1.648	0.983	33.3	10.9
1998 Mar 14	01 12.17	+05 32.6	1.803	1.003	25.6	11.3
1998 Mar 21	01 11.68	+04 03.4	1.934	1.035	18.2	11.8
1998 Mar 28	01 11.32	+02 44.6	2.040	1.078	11.3	12.4
1998 Apr 4	01 11.04	+01 32.8	2.119	1.130	6.3	13.0
1998 Apr 11	01 10.81	+00 24.8	2.174	1.190	7.9	13.6
1998 Apr 18	01 10.57	-00 41.8	2.206	1.255	14.0	14.2
1998 Apr 25	01 10.24	-01 49.3	2.215	1.325	20.9	14.8

MINOR PLANET POSITIONS (0hr UT, Epoch 2000.0)

	1 CERES			2 PALLAS			3 JUNO			4 VESTA			5 ASTRAEA		
	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.
Jan 3	23 13.3	- 15 09	9.2	20 37.5	- 01 10	10.5	12 16.0	- 03 34	10.2	01 24.1	+ 01 06	7.8	22 34.9	- 11 26	12.7
10	23 21.2	- 14 02	9.2	20 46.5	- 01 07	10.5	12 19.7	- 03 37	10.1	01 29.0	+ 02 01	7.9	22 43.4	- 10 37	12.7
17	23 29.4	- 12 51	9.3	20 55.6	- 01 00	10.5	12 22.4	- 03 31	10.0	01 34.7	+ 03 00	8.0	22 52.3	- 09 46	12.7
24	21 38.0	- 11 43	9.3	21 04.8	- 00 49	10.4	12 23.9	- 03 16	9.9	01 41.2	+ 04 00	8.1	21 01.4	- 08 52	12.7
31	23 46.8	- 10 32	9.3	21 14.0	- 00 35	10.4	12 24.3	- 02 52	9.8	01 48.4	+ 05 03	8.2	23 10.7	- 07 57	12.7
Feb 7	23 55.8	- 09 21	9.2	21 23.2	- 00 17	10.4	12 23.4	- 02 18	9.7	01 56.3	+ 06 06	8.2	23 20.2	- 06 59	12.7
14	00 05.0	- 08 09	9.2	21 32.3	+ 00 04	10.3	12 21.4	- 01 35	9.6	02 04.7	+ 07 11	8.3	23 29.9	- 06 00	12.6
21	00 14.4	- 06 56	9.2	21 41.4	+ 00 27	10.3	12 18.2	- 00 41	9.5	02 13.6	+ 08 15	8.3	23 39.7	- 05 00	12.6
28	00 23.9	- 05 44	9.2	21 50.5	+ 00 53	10.4	12 14.1	+ 00 16	9.4	02 22.9	+ 09 19	8.4	23 49.7	- 01 58	12.5
Mar 7	00 33.6	- 04 32	9.1	21 59.4	+ 01 21	10.4	12 09.1	+ 01 19	9.3	02 32.7	+ 10 22	8.4	23 59.7	- 02 56	12.5
14	00 41.4	- 03 20	9.1	22 08.2	+ 01 50	10.4	12 03.7	+ 02 26	9.2	02 42.9	+ 11 24	8.4	00 09.9	- 01 53	12.4
21	00 53.3	- 02 09	9.0	22 16.9	+ 02 21	10.4	11 58.1	+ 01 32	9.1	02 53.4	+ 12 25	8.4	00 20.1	- 00 50	12.3
28	01 03.1	- 00 58	9.0	22 25.5	+ 02 52	10.5	11 52.6	+ 04 35	9.3	03 04.2	+ 13 24	8.5	00 30.5	+ 00 12	12.2
Apr 4	01 13.3	+ 00 11	8.9	22 33.8	+ 03 24	10.5	11 47.6	+ 05 32	9.5	03 15.3	+ 14 21	8.5	00 40.8	+ 01 15	12.2
11	01 23.4	+ 01 19	8.9	22 42.0	+ 03 56	10.5	11 43.1	+ 06 22	9.6	03 26.7	+ 15 15	8.5	00 51.3	+ 02 17	12.3
18	01 33.5	+ 02 25	8.9	22 49.9	+ 04 27	10.5	11 39.6	+ 07 04	9.8	03 38.3	+ 16 07	8.5	01 01.8	+ 03 18	12.4
25	01 43.7	+ 03 30	9.0	22 57.7	+ 04 58	10.5	11 37.0	+ 07 36	10.0	03 50.2	+ 16 55	8.4	01 12.3	+ 04 18	12.4
May 2	01 54.0	+ 04 33	9.0	23 05.1	+ 05 28	10.5	11 35.5	+ 08 00	10.1	04 02.3	+ 17 41	8.4	01 22.9	+ 05 17	12.5
9	02 04.2	+ 05 34	9.1	23 12.2	+ 05 56	10.4	11 35.0	+ 08 14	10.2	04 14.5	+ 18 23	8.4	01 33.5	+ 06 14	12.5
16	02 14.4	+ 06 33	9.1	23 19.0	+ 06 23	10.4	11 35.5	+ 08 19	10.4	04 26.9	+ 19 01	8.3	01 44.1	+ 07 10	12.5
23	02 24.6	+ 07 29	9.1	23 25.5	+ 06 46	10.4	11 37.0	+ 08 17	10.5	04 39.5	+ 19 36	8.3	01 54.7	+ 08 03	12.5
30	02 34.8	+ 08 23	9.2	23 31.5	+ 07 06	10.3	11 39.4	+ 08 08	10.6	04 52.2	+ 20 07	8.2	02 05.3	+ 08 54	12.5
Jun 6	02 45.0	+ 09 14	9.2	23 37.0	+ 07 23	10.3	11 42.6	+ 07 52	10.7	05 05.0	+ 20 34	8.2	02 15.8	+ 09 43	12.5
13	02 55.0	+ 10 02	9.2	23 42.1	+ 07 35	10.2	11 46.6	+ 07 31	10.8	05 17.9	+ 20 57	8.2	02 26.4	+ 10 29	12.5
20	03 05.0	+ 10 48	9.2	23 46.6	+ 07 43	10.1	11 51.2	+ 07 06	10.9	05 30.8	+ 21 16	8.2	02 36.8	+ 11 12	12.5
27	03 14.8	+ 11 30	9.2	23 50.4	+ 07 44	10.0	11 56.5	+ 06 35	11.0	05 43.8	+ 21 31	8.3	02 47.2	+ 11 52	12.4
Jul 4	03 24.5	+ 12 10	9.2	23 53.5	+ 07 39	9.9	12 02.2	+ 06 01	11.1	05 56.7	+ 21 41	8.3	02 57.4	+ 12 28	12.4
11	03 33.9	+ 12 46	9.2	23 55.9	+ 07 26	9.8	12 08.4	+ 05 24	11.1	06 09.7	+ 21 48	8.4	03 07.4	+ 13 01	12.3
18	03 41.2	+ 13 20	9.1	23 57.5	+ 07 04	9.7	12 15.0	+ 04 44	11.2	06 22.5	+ 21 51	8.4	03 17.3	+ 13 31	12.3
25	03 52.1	+ 13 50	9.1	23 58.2	+ 06 14	9.6	12 22.0	+ 04 02	11.2	06 35.4	+ 21 49	8.4	03 26.9	+ 11 56	12.2
Aug 1	04 00.8	+ 14 17	9.1	23 57.9	+ 05 53	9.5	12 29.4	+ 03 18	11.3	06 48.1	+ 21 44	8.4	03 36.2	+ 14 18	12.2
8	04 09.0	+ 14 41	9.0	23 56.7	+ 05 02	9.3	12 37.0	+ 02 33	11.3	07 00.6	+ 21 36	8.5	03 45.1	+ 14 35	12.1
15	04 16.7	+ 15 03	8.9	23 54.5	+ 04 00	9.2	12 44.8	+ 01 46	11.3	07 13.1	+ 21 24	8.5	03 53.6	+ 14 49	12.0
22	04 23.9	+ 15 22	8.9	23 51.4	+ 02 48	9.0	12 52.9	+ 00 58	11.4	07 25.3	+ 21 09	8.5	04 01.6	+ 14 58	11.9
29	04 30.5	+ 15 38	8.8	23 47.5	+ 01 26	8.8	13 01.2	+ 00 10	11.4	07 37.3	+ 20 51	8.4	04 08.9	+ 15 04	11.8
Sep 5	04 36.4	+ 15 52	8.7	23 42.9	- 00 04	8.6	13 09.7	- 00 38	11.4	07 49.1	+ 20 31	8.4	04 15.5	+ 15 05	11.7
12	04 41.5	+ 16 03	8.6	23 37.9	- 01 40	8.4	13 18.3	- 01 27	11.4	08 00.6	+ 20 10	8.4	04 21.2	+ 15 02	11.6
19	04 45.6	+ 16 14	8.5	23 32.6	- 03 19	8.3	13 27.1	- 02 15	11.4	08 11.7	+ 19 46	8.4	04 26.1	+ 14 55	11.4
26	04 48.7	+ 16 22	8.4	23 27.4	- 04 58	8.5	13 36.1	- 03 02	11.4	08 22.6	+ 19 21	8.3	04 29.8	+ 14 44	11.3
Oct 3	04 50.7	+ 16 30	8.3	23 22.4	- 06 33	8.7	13 45.1	- 03 49	11.1	08 13.0	+ 18 56	8.3	04 32.3	+ 14 30	11.1
10	04 51.5	+ 16 37	8.1	23 18.1	- 08 02	8.8	13 54.2	- 04 34	11.3	08 43.0	+ 18 31	8.2	04 33.5	+ 14 13	11.0
17	04 51.0	+ 16 41	8.0	23 14.5	- 09 22	9.0	14 03.5	- 05 18	11.1	08 52.5	+ 18 07	8.2	04 33.2	+ 11 53	10.8
24	04 49.1	+ 16 49	7.8	23 11.8	- 10 32	9.1	14 12.7	- 06 00	11.2	09 01.4	+ 17 44	8.1	04 11.5	+ 11 30	10.6
31	04 45.8	+ 16 55	7.7	23 10.2	- 11 32	9.2	14 22.0	- 06 40	11.2	09 09.7	+ 17 23	8.0	04 28.4	+ 13 06	10.4
Nov 7	04 41.3	+ 17 02	7.5	23 09.6	- 12 20	9.3	14 31.4	- 07 18	11.3	09 17.4	+ 17 05	7.9	04 23.8	+ 12 42	10.2
14	04 35.8	+ 17 08	7.3	23 10.2	- 12 57	9.4	14 40.7	- 07 54	11.3	09 24.3	+ 16 51	7.8	04 18.2	+ 12 19	10.0
21	04 29.3	+ 17 16	7.1	23 11.8	- 13 24	9.5	14 50.0	- 08 27	11.4	09 30.3	+ 16 41	7.7	04 11.6	+ 11 57	9.9
28	04 22.4	+ 17 23	7.0	23 14.5	- 13 42	9.6	14 59.3	- 08 58	11.4	09 35.4	+ 16 38	7.6	04 04.7	+ 11 39	9.8
Dec 5	04 15.3	+ 17 32	7.1	23 18.1	- 13 51	9.7	15 08.5	- 09 25	11.5	09 39.4	+ 16 41	7.5	03 57.8	+ 11 25	9.9
12	04 08.5	+ 17 43	7.2	23 22.6	- 13 52	9.7	15 17.6	- 09 49	11.5	09 42.2	+ 16 51	7.4	03 51.4	+ 11 18	10.1
19	04 02.4	+ 17 55	7.4	23 27.8	- 11 46	9.8	15 26.5	- 10 09	11.5	09 41.6	+ 17 09	7.2	01 45.9	+ 11 18	10.2
26	03 57.2	+ 18 09	7.6	23 33.9	- 13 34	9.8	15 35.3	- 10 27	11.5	09 43.7	+ 17 36	7.1	03 41.7	+ 11 25	10.4

	6 HEBE			7 IRIS			14 IRENE			15 EUNOMIA			16 PSYCHE		
Jan 3	15 50.3	- 07 40	11.4	17 09.1	- 23 38	11.2	20 54.0	- 23 14	12.0	20 15.1	- 17 19	10.4	14 46.1	- 13 35	12.1
10	16 00.4	- 07 55	11.4	17 20.8	- 23 46	11.2	21 05.5	- 22 30	12.0	20 28.0	- 16 21	10.3	14 53.4	- 14 02	12.1
17	16 10.1	- 08 05	11.3	17 32.5	- 23 50	11.2	21 16.9	- 21 43	12.0	20 40.9	- 15 19	10.3	15 00.4	- 14 26	12.0
24	16 19.6	- 08 10	11.3	17 44.0	- 23 50	11.3	21 28.2	- 20 55	11.9	20 53.9	- 14 12	10.2	15 06.8	- 14 47	12.0
31	16 28.8	- 08 11	11.3	17 55.3	- 23 47	11.2	21 39.5	- 20 05	11.9	21 06.8	- 13 02	10.1	15 12.7	- 15 04	11.9
Feb 7	16 37.6	- 08 07	11.2	18 06.4	- 23 41	11.2	21 50.7	- 19 13	11.8	21 19.7	- 11 48	10.0	15 18.0	- 15 18	11.9
14	16 45.9	- 07 58	11.1	18 17.3	- 23 32	11.2	22 01.8	- 18 21	11.8	21 32.6	- 10 31	10.0	15 22.6	- 15 28	11.8
21	16 53.7	- 07 45	11.1	18 27.8	- 23 20	11.2	22 12.7	- 17 27	11.8	21 45.4	- 09 10	10.1	15 26.4	- 15 34	11.7
28	17 00.9	- 07 27	11.0	18 38.0	- 23 05	11.1	22 23.5	- 16 33	11.9	21 58.2	- 07 46	10.1	15 29.3	- 15 36	11.6
Mar 7	17 07.4	- 07 05	10.9	18 47.8	- 22 48	11.1	22 34.2	- 15 38	12.0	22 10.9	- 06 19	10.2	15 31.3	- 15 35	11.5
14	17 13.1	- 06 39	10.8	18 57.1	- 22 29	11.0	22 44.7	- 14 43	12.0	22 23.5	- 04 49	10.2	15 32.3	- 15 30	11.4
21	17 18.0	- 06 09	10.7	19 05.9	- 22 07	11.0	22 55.0	- 13 48	12.1	22 36.1	- 03 17	10.2	15 32.3	- 15 21	11.3
28	17 21.9	- 05 36	10.6	19 14.1	- 21 45	10.9	23 05.2	- 12 54	12.1	22 48.6	- 01 42	10.2	15 31.2	- 15 08	11.2
Apr 4	17 24.7	- 05 01	10.5	19 21.7	- 21 21	10.8	23 15.1	- 12 01	12.2	23 01.0	- 00 06	10.2	15 29.0	- 14 52	11.1
11	17 26.5	- 04 24	10.4	19 28.5	- 20 56	10.7	23 24.9	- 11 09	12.2	23 13.4	+ 01 32	10.2	15 25.9	- 14 32	10.9
18	17 27.0	- 03 47	10.2	19 34.5	- 20 32	10.6	23 34.4	- 10 19	12.2	23 25.7	+ 03 11	10.2	15 21.8	- 14 10	10.8
25	17 26.2	- 03 09	10.1	19 39.6	- 20 07	10.5	23 43.7	- 09 30	12.2	23 38.0	+ 04 51	10.2	15 17.1	- 13 46	10.7
May 2	17 24.1	- 02 34	10.0	19 43.8	- 19 44	10.4	23 52.7	- 08 43	12.2	23 50.2	+ 06 32	10.2	15 11.7	- 13 21	10.5
9	17 20.8	- 02 01	9.8	19 46.8	- 19 21	10.2	00 01.5	- 07 59	12.2	00 02.3	+ 08 14	10.2	15 06.1	- 12 55	10.4
16	17 16.3	- 01 34	9.7	19 48.7	- 19 01	10.1	00 09.9	- 07 18	12.2	00 14.4	+ 09 55	10.1	15 00.5	- 12 31	10.5
23	17 10.8	- 01 13	9.6	19 49.3	- 18 42	9.9	00 18.1	- 06 40	12.2	00 26.4	+ 11 37	10.1	14 55.1	- 12 09	10.6
30	17 04.5	- 01 00	9.5	19 48.5	- 18 26	9.8	00 25.8	- 06 06	12.2	00 38.3	+ 13 18	10.1	14 50.1	- 11 50	10.8
Jun 6	16 57.7	- 00 56	9.4	19 46.3	- 18 13	9.6	00 33.2	- 05 35	12.2	00 50.2	+ 14 58	10.0	14 45.9	- 11 35	10.9
13	16 50.8	- 01 03	9.4	19 42.8	- 18 03	9.4	00 40.1	- 05 09	12.1	01 01.9	+ 16 37	10.0	14 42.5	- 11 24	11.0
20	16 44.2	- 01 20	9.5	19 37.9	- 17 55	9.2	00 46.5	- 04 47	12.1	01 13.5	+ 18 15	10.0	14 40.0	- 11 19	11.1
27	16 38.2	- 01 46	9.6	19 31.9	- 17 50	9.0	00 52.4	- 04 30	12.0	01 25.0	+ 19 52	9.9	14 38.5	- 11 19	11.2
Jul 4	16 33.0	- 02 22	9.6	19 25.1	- 17 47	8.8	00 57.6	- 04 19	11.9	01 36.3	+ 21 26	9.8	14 38.0	- 11 24	11.3
11	16 29.0	- 03 06	9.7	19 17.6	- 17 45	8.6	01 02.2	- 04 13	11.9	01 47.4	+ 22 59	9.8	14 38.5	- 11 34	11.4
18	16 26.2	- 03 56	9.8	19 10.1	- 17 45	8.7	01 06.0	- 04 13	11.8	01 58.1	+ 24 29	9.7	14 40.0	- 11 49	11.5
25	16 24.7	- 04 51	9.9	19 02.8	- 17 46	8.9	01 08.9	- 04 20	11.7	02 08.5	+ 25 57	9.6	14 42.4	- 12 08	11.6
Aug 1	16 24.5	- 05 50	10.0	18 56.2	- 17 47	9.0	01 10.9	- 04 33	11.6	02 18.4	+ 27 21	9.5	14 45.7	- 12 30	11.7
8	16 25.8	- 06 51	10.1	18 50.8	- 17 49	9.2	01 12.0	- 04 52	11.5	02 27.8	+ 28 43	9.5	14 49.8	- 12 56	11.7
15	16 28.2	- 07 53	10.2	18 46.6	- 17 50	9.3	01 12.0	- 05 18	11.4	02 36.5	+ 30 01	9.4	14 54.6	- 13 24	11.8
22	16 31.9	- 08 56	10.3	18 43.9	- 17 52	9.4	01 10.8	- 05 49	11.2	02 44.4	+ 31 16	9.3	15 00.2	- 13 54	11.8
29	16 36.8	- 09 59	10.4	18 42.8	- 17 54	9.5	01 08.6	- 06 25	11.1	02 51.2	+ 32 27	9.1	15 06.4	- 14 26	11.9
Sep 5	16 42.7	- 11 00	10.4	18 43.3	- 17 56	9.6	01 05.3	- 07 05	11.0	02 57.0	+ 33 32	9.0	15 13.2	- 14 59	11.9
12	16 49.7	- 12 00	10.5	18 45.2	- 17 56	9.7	01 01.1	- 07 47	10.9	03 01.3	+ 34 33	8.9	15 20.5	- 15 32	11.9
19	16 57.5	- 12 57	10.5	18 48.7	- 17 56	9.8	00 56.0	- 08 28	10.7	03 04.2	+ 35 26	8.8	15 28.4	- 16 06	11.9
26	17 06.2	- 13 52	10.6	18 53.5	- 17 54	9.9	00 50.3	- 09 08	10.6	03 05.4	+ 36 12	8.6	15 36.7	- 16 40	11.9
Oct 3	17 15.7	- 14 43	10.6	18 59.5	- 17 49	10.0	00 44.3	- 09 44	10.6	03 04.7	+ 36 48	8.5	15 45.4	- 17 13	12.0
10	17 25.9	- 15 30	10.6	19 06.6	- 17 42	10.1	00 38.2	- 10 13	10.7	03 02.3	+ 37 12	8.4	15 54.6	- 17 46	11.9
17	17 36.8	- 16 13	10.6	19 14.8	- 17 32	10.1	00 32.4	- 10 35	10.8	02 58.2	+ 37 22	8.2	16 04.1	- 18 17	11.9
24	17 48.4	- 16 52	10.6	19 23.9	- 17 19	10.2	00 27.1	- 10 49	11.0	02 52.7	+ 37 16	8.1	16 14.0	- 18 46	11.9
31	18 00.5	- 17 26	10.6	19 33.8	- 17 01	10.2	00 22.6	- 10 53	11.1	02 46.2	+ 36 53	8.0	16 24.2	- 19 14	11.9
Nov 7	18 13.1	- 17 55	10.6	19 44.4	- 16 39	10.2	00 19.0	- 10 48	11.2	02 39.4	+ 36 14	7.9	16 34.7	- 19 40	11.9
14	18 26.2	- 18 18	10.6	19 55.6	- 16 13	10.2	00 16.5	- 10 35	11.3	02 32.7	+ 35 20	7.9	16 45.4	- 20 03	11.8
21	18 39.8	- 18 36	10.6	20 07.4	- 15 41	10.3	00 15.1	- 10 13	11.5	02 26.9	+ 34 15	8.0	16 56.4	- 20 23	11.8
28	18 53.7	- 18 47	10.6	20 19.8	- 15 05	10.3	00 14.7	- 09 44	11.6	02 22.3	+ 33 04	8.1	17 07.5	- 20 41	11.7
Dec 5	19 08.0	- 18 53	10.5	20 32.5	- 14 23	10.3	00 15.5	- 09 09	11.7	02 19.4	+ 31 51	8.3	17 18.9	- 20 56	11.6
12	19 22.6	- 18 53	10.5	20 45.6	- 13 36	10.3	00 17.3	- 08 28	11.8	02 18.2	+ 30 40	8.4	17 30.3	- 21 07	11.5
19	19 37.4	- 18 47	10.5	20 59.1	- 12 44	10.2	00 20.0	- 07 42	11.8	02 18.7	+ 29 34	8.6	17 41.9	- 21 15	11.5
26	19 52.4	- 18 34	10.4	21 12.8	- 11 46	10.2	00 23.6	- 06 52	11.9	02 20.9	+ 28 36	8.8	17 53.5	- 21 20	11.5

MINOR PLANET POSITIONS (0hr UT, Epoch 2000.0)

	18 MELPOMENE			20 MASSALIA			25 PHOCAEA			29 AMPHITRITE			30 URANIA		
	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.
Jan 3	15 59.9	- 12 29	12.0	20 45.1	- 17 32	11.9	13 34.7	- 20 19	13.0	17 48.2	- 27 57	11.3	09 57.6	+ 12 19	11.3
10	16 10.7	- 12 48	12.0	20 56.8	- 16 46	11.9	13 43.5	- 20 57	13.0	18 01.6	- 28 01	11.3	09 54.5	+ 12 29	11.1
17	16 21.4	- 13 02	12.0	21 08.6	- 15 56	11.8	13 51.8	- 21 29	12.9	18 14.8	- 28 01	11.3	09 49.9	+ 12 45	11.0
24	16 31.9	- 13 12	11.9	21 20.4	- 15 03	11.8	13 59.7	- 21 57	12.8	18 28.0	- 27 58	11.4	09 44.1	+ 13 07	10.8
31	16 42.1	- 13 17	11.9	21 32.2	- 14 07	11.7	14 06.9	- 22 18	12.6	18 41.0	- 27 51	11.4	09 37.4	+ 13 34	10.6
Feb 7	16 52.0	- 13 19	11.8	21 44.0	- 13 09	11.6	14 13.3	- 22 32	12.5	18 53.8	- 27 41	11.4	09 30.1	+ 14 02	10.4
14	17 01.5	- 13 15	11.8	21 55.8	- 12 08	11.5	14 18.9	- 22 38	12.4	19 06.3	- 27 28	11.4	09 22.8	+ 14 30	10.6
21	17 10.6	- 13 08	11.7	22 07.5	- 11 05	11.5	14 23.5	- 22 36	12.2	19 18.6	- 27 13	11.4	09 15.9	+ 14 56	10.8
28	17 19.1	- 12 56	11.6	22 19.2	- 10 00	11.6	14 26.9	- 22 24	12.0	19 30.6	- 26 55	11.4	09 09.8	+ 15 18	11.0
Mar 7	17 27.1	- 12 41	11.5	22 30.8	- 08 53	11.6	14 29.2	- 22 00	11.9	19 42.2	- 26 35	11.4	09 04.9	+ 15 36	11.2
14	17 34.3	- 12 22	11.4	22 42.4	- 07 45	11.7	14 30.0	- 21 24	11.7	19 53.4	- 26 14	11.3	09 01.4	+ 15 47	11.4
21	17 40.8	- 11 59	11.3	22 53.8	- 06 36	11.7	14 29.5	- 20 34	11.5	20 04.2	- 25 51	11.3	08 59.3	+ 15 53	11.6
28	17 46.5	- 11 33	11.2	23 05.2	- 05 26	11.8	14 27.5	- 19 29	11.2	20 14.5	- 25 28	11.3	08 58.7	+ 15 53	11.7
Apr 4	17 51.1	- 11 05	11.1	23 16.5	- 04 15	11.8	14 24.1	- 18 09	11.0	20 24.3	- 25 05	11.2	08 59.6	+ 15 48	11.9
11	17 54.7	- 10 35	11.0	23 27.7	- 03 04	11.8	14 19.5	- 16 35	10.8	20 33.5	- 24 42	11.2	09 01.8	+ 15 38	12.0
18	17 57.1	- 10 04	10.8	23 38.8	- 01 52	11.8	14 14.0	- 14 48	10.5	20 42.1	- 24 20	11.1	09 05.2	+ 15 22	12.2
25	17 58.3	- 09 32	10.7	23 49.9	- 00 41	11.8	14 08.0	- 12 52	10.1	20 50.1	- 24 00	11.0	09 09.7	+ 15 02	12.3
May 2	17 58.1	- 09 01	10.5	00 00.8	+ 00 29	11.8	14 01.9	- 10 51	10.4	20 57.2	- 23 43	10.9	09 15.1	+ 14 37	12.4
9	17 56.4	- 08 31	10.4	00 11.5	+ 01 39	11.8	13 56.1	- 08 52	10.6	21 03.5	- 23 28	10.8	09 21.3	+ 14 08	12.5
16	17 53.4	- 08 03	10.2	00 22.2	+ 02 47	11.7	13 51.1	- 06 58	10.7	21 09.0	- 23 16	10.7	09 28.3	+ 13 34	12.6
23	17 49.0	- 07 40	10.0	00 32.7	+ 03 55	11.7	13 47.1	- 05 15	10.9	21 13.4	- 23 09	10.6	09 35.9	+ 12 57	12.7
30	17 43.5	- 07 22	9.9	00 43.1	+ 05 00	11.7	13 44.6	- 03 45	11.0	21 16.7	- 23 06	10.5	09 43.9	+ 12 16	12.8
Jun 6	17 37.0	- 07 11	9.7	00 53.2	+ 06 04	11.6	13 43.4	- 02 31	11.1	21 18.9	- 23 08	10.4	09 52.5	+ 11 32	12.8
13	17 29.9	- 07 07	9.7	01 03.2	+ 07 05	11.6	13 43.8	- 01 33	11.3	21 19.8	- 23 15	10.2	10 01.4	+ 10 44	12.9
20	17 22.5	- 07 11	9.6	01 12.9	+ 08 04	11.5	13 45.7	- 00 50	11.4	21 19.3	- 23 26	10.1	10 10.6	+ 09 53	12.9
27	17 15.4	- 07 23	9.7	01 22.3	+ 09 00	11.4	13 48.9	- 00 22	11.5	21 17.5	- 23 43	10.0	10 20.1	+ 08 59	13.0
Jul 4	17 08.8	- 07 44	9.8	01 31.4	+ 09 53	11.4	13 53.5	- 00 06	11.6	21 14.3	- 24 02	9.8	10 29.8	+ 08 03	13.0
11	17 03.3	- 08 13	9.9	01 40.2	+ 10 43	11.3	13 59.4	- 00 02	11.7	21 09.8	- 24 24	9.6	10 39.7	+ 07 04	13.0
18	16 59.0	- 08 48	10.0	01 48.4	+ 11 29	11.2	14 06.3	- 00 08	11.8	21 04.2	- 24 47	9.5	10 49.8	+ 06 02	13.0
25	16 56.1	- 09 28	10.1	01 56.1	+ 12 10	11.1	14 14.3	- 00 22	11.8	20 57.7	- 25 08	9.3	11 00.0	+ 04 59	13.1
Aug 1	16 54.7	- 10 12	10.2	02 03.2	+ 12 48	11.0	14 23.3	- 00 43	11.9	20 50.7	- 25 26	9.2	11 10.3	+ 03 54	13.1
8	16 54.9	- 11 00	10.3	02 09.6	+ 13 20	10.9	14 33.1	- 01 10	11.9	20 43.6	- 25 39	9.3	11 20.8	+ 02 47	13.0
15	16 56.6	- 11 49	10.4	02 15.1	+ 13 48	10.7	14 43.7	- 01 41	12.0	20 36.7	- 25 46	9.5	11 31.3	+ 01 39	13.0
22	16 59.8	- 12 40	10.5	02 19.7	+ 14 09	10.6	14 55.1	- 02 16	12.0	20 30.6	- 25 47	9.6	11 41.9	+ 00 30	13.0
29	17 04.3	- 13 30	10.6	02 23.1	+ 14 25	10.4	15 07.2	- 02 53	12.0	20 25.5	- 25 42	9.7	11 52.6	- 00 40	13.0
Sep 5	17 10.2	- 14 19	10.7	02 25.3	+ 14 34	10.3	15 20.0	- 03 31	12.1	20 21.7	- 25 30	9.9	12 03.4	- 01 51	13.0
12	17 17.2	- 15 07	10.7	02 26.1	+ 14 37	10.1	15 33.4	- 04 10	12.1	20 19.2	- 25 13	10.0	12 14.3	- 03 02	12.9
19	17 25.4	- 15 52	10.8	02 25.5	+ 14 31	9.9	15 47.5	- 04 48	12.1	20 18.3	- 24 52	10.1	12 25.2	- 04 13	12.9
26	17 34.6	- 16 35	10.9	02 23.4	+ 14 19	9.8	16 02.1	- 05 25	12.1	20 18.8	- 24 26	10.3	12 36.1	- 05 24	12.8
Oct 3	17 44.8	- 17 13	10.9	02 19.9	+ 13 59	9.6	16 17.2	- 06 00	12.1	20 20.6	- 23 57	10.4	12 47.2	- 06 35	12.7
10	17 55.8	- 17 48	10.9	02 15.0	+ 13 31	9.4	16 32.9	- 06 32	12.1	20 23.8	- 23 24	10.5	12 58.2	- 07 45	12.6
17	18 07.6	- 18 18	11.0	02 09.1	+ 12 58	9.2	16 49.0	- 07 01	12.1	20 28.2	- 22 48	10.6	13 09.4	- 08 55	12.7
24	18 20.1	- 18 42	11.0	02 02.6	+ 12 21	8.9	17 05.6	- 07 24	12.1	20 33.6	- 22 09	10.7	13 20.5	- 10 03	12.8
31	18 33.3	- 19 01	11.0	01 55.9	+ 11 41	9.0	17 22.6	- 07 43	12.1	20 40.0	- 21 28	10.8	13 31.7	- 11 10	12.9
Nov 7	18 47.1	- 19 14	11.0	01 49.4	+ 11 03	9.2	17 40.0	- 07 56	12.1	20 47.2	- 20 43	10.8	13 42.9	- 12 15	12.9
14	19 01.4	- 19 20	11.0	01 43.8	+ 10 29	9.3	17 57.7	- 08 03	12.1	20 55.1	- 19 55	10.9	13 54.1	- 13 19	13.0
21	19 16.2	- 19 20	11.0	01 39.2	+ 10 00	9.5	18 15.7	- 08 04	12.1	21 03.7	- 19 04	10.9	14 05.4	- 14 21	13.0
28	19 31.4	- 19 13	11.0	01 36.1	+ 09 40	9.6	18 33.9	- 07 57	12.0	21 12.8	- 18 10	11.0	14 16.6	- 15 20	13.1
Dec 5	19 46.9	- 19 00	11.0	01 34.4	+ 09 29	9.8	18 52.3	- 07 44	12.0	21 22.3	- 17 13	11.0	14 27.7	- 16 17	13.1
12	20 02.8	- 18 39	10.9	01 34.4	+ 09 27	9.9	19 10.7	- 07 23	12.0	21 32.3	- 16 13	11.1	14 38.8	- 17 12	13.1
19	20 18.9	- 18 11	10.9	01 36.0	+ 09 35	10.1	19 29.3	- 06 55	12.0	21 42.6	- 15 09	11.1	14 49.8	- 18 03	13.1
26	20 35.2	- 17 36	10.9	01 39.0	+ 09 52	10.2	19 47.8	- 06 20	12.0	21 53.2	- 14 03	11.1	15 00.6	- 18 52	13.1

	32 POMONA			43 ARIADNE			44 NYSA			52 EUROPA			230 ATHAMANTIS		
	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.	R.A. hr min	Dec. ° '	Mag.
Jan 3	13 48.1	- 14 18	12.5	15 38.9	- 21 33	12.5	20 42.3	- 18 30	12.4	23 45.0	- 08 24	12.3	09 02.0	+ 03 06	10.9
10	13 57.9	- 15 08	12.4	15 55.3	- 22 21	12.5	20 53.9	- 17 49	12.4	23 51.7	- 07 34	12.3	08 56.9	+ 02 52	10.8
17	14 07.3	- 15 54	12.4	16 11.7	- 23 04	12.5	21 05.4	- 17 04	12.3	23 58.8	- 06 42	12.3	08 50.7	+ 02 48	10.6
24	14 16.1	- 16 34	12.3	16 28.3	- 23 39	12.4	21 17.0	- 16 17	12.3	00 06.3	- 05 47	12.3	08 43.8	+ 02 54	10.5
31	14 24.2	- 17 10	12.2	16 44.9	- 24 09	12.4	21 28.6	- 15 27	12.2	00 14.3	- 04 50	12.3	08 36.7	+ 03 09	10.5
Feb 7	14 31.5	- 17 40	12.1	17 01.5	- 24 31	12.3	21 40.2	- 14 34	12.2	00 22.5	- 03 52	12.3	08 29.7	+ 03 33	10.6
14	14 37.9	- 18 03	12.0	17 18.1	- 24 46	12.3	21 51.7	- 13 40	12.1	00 31.1	- 02 53	12.3	08 23.4	+ 04 01	10.7
21	14 43.3	- 18 21	11.9	17 34.4	- 24 54	12.2	22 03.2	- 12 43	12.2	00 39.9	- 01 52	12.3	08 18.1	+ 04 34	10.8
28	14 47.5	- 18 32	11.8	17 50.6	- 24 56	12.2	22 14.6	- 11 44	12.2	00 49.0	- 00 52	12.3	08 14.0	+ 05 09	11.0
Mar 7	14 50.5	- 18 35	11.6	18 06.5	- 24 50	12.1	22 25.9	- 10 44	12.2	00 58.3	+ 00 09	12.3	08 11.3	+ 05 43	11.1
14	14 52.0	- 18 32	11.5	18 22.0	- 24 39	12.0	22 37.1	- 09 43	12.3	01 07.7	+ 01 10	12.2	08 10.1	+ 06 15	11.3
21	14 52.2	- 18 20	11.3	18 37.0	- 24 21	11.9	22 48.2	- 08 41	12.3	01 17.4	+ 02 11	12.2	08 10.4	+ 06 44	11.4
28	14 50.8	- 18 00	11.2	18 51.5	- 23 57	11.8	22 59.3	- 07 39	12.3	01 27.2	+ 03 11	12.1	08 12.1	+ 07 09	11.5
Apr 4	14 48.1	- 17 32	11.0	19 05.4	- 23 29	11.7	23 10.2	- 06 36	12.3	01 37.1	+ 04 10	12.1	08 15.1	+ 07 30	11.7
11	14 44.1	- 16 57	10.8	19 18.5	- 22 56	11.6	23 21.0	- 05 33	12.3	01 47.1	+ 05 08	12.0	08 19.3	+ 07 45	11.8
18	14 39.1	- 16 15	10.6	19 30.7	- 22 20	11.5	23 31.6	- 04 30	12.3	01 57.3	+ 06 05	12.0	08 24.6	+ 07 55	11.9
25	14 33.5	- 15 29	10.4	19 42.0	- 21 41	11.4	23 42.2	- 03 28	12.3	02 07.6	+ 07 00	12.0	08 30.8	+ 08 00	12.0
May 2	14 27.5	- 14 40	10.3	19 52.3	- 21 01	11.3	23 52.5	- 02 27	12.3	02 17.9	+ 07 53	12.0	08 37.8	+ 07 59	12.1
9	14 21.8	- 13 51	10.5	20 01.3	- 20 19	11.1	00 02.7	- 01 27	12.2	02 28.3	+ 08 44	12.0	08 45.5	+ 07 53	12.2
16	14 16.6	- 13 05	10.7	20 09.0	- 19 38	11.0	00 12.8	- 00 29	12.2	02 38.7	+ 09 33	12.1	08 53.8	+ 07 42	12.2
23	14 12.2	- 12 24	10.9	20 15.2	- 18 59	10.8	00 22.6	+ 00 28	12.1	02 49.2	+ 10 20	12.1	09 02.7	+ 07 25	12.3
30	14 09.0	- 11 49	11.1	20 19.7	- 18 22	10.6	00 32.2	+ 01 22	12.1	02 59.7	+ 11 04	12.2	09 12.0	+ 07 03	12.4
Jun 6	14 07.0	- 11 23	11.3	20 22.5	- 17 49	10.4	00 41.6	+ 02 14	12.0	03 10.2	+ 11 45	12.2	09 21.7	+ 06 36	12.4
13	14 06.4	- 11 06	11.4	20 23.5	- 17 20	10.2	00 50.7	+ 03 02	12.0	03 20.7	+ 12 23	12.2	09 31.8	+ 06 05	12.5
20	14 07.0	- 10 57	11.6	20 22.5	- 16 56	10.1	00 59.4	+ 03 48	11.9	03 31.1	+ 12 57	12.2	09 42.1	+ 05 30	12.5
27	14 09.0	- 10 56	11.7	20 19.7	- 16 38	9.8	01 07.8	+ 04 30	11.8	03 41.5	+ 13 29	12.2	09 52.6	+ 04 50	12.5
Jul 4	14 12.1	- 11 03	11.9	20 15.2	- 16 26	9.6	01 15.8	+ 05 08	11.8	03 51.7	+ 13 58	12.2	10 03.3	+ 04 06	12.6
11	14 16.4	- 11 16	12.0	20 09.5	- 16 19	9.4	01 23.2	+ 05 41	11.7	04 01.8	+ 14 22	12.2	10 14.2	+ 03 19	12.6
18	14 21.6	- 11 36	12.1	20 02.9	- 16 16	9.2	01 30.1	+ 06 09	11.6	04 11.7	+ 14 44	12.2	10 25.3	+ 02 29	12.6
25	14 27.8	- 12 00	12.2	19 56.2	- 16 16	9.2	01 36.3	+ 06 33	11.5	04 21.4	+ 15 02	12.1	10 36.5	+ 01 35	12.6
Aug 1	14 34.8	- 12 29	12.3	19 49.8	- 16 19	9.5	01 41.8	+ 06 50	11.4	04 30.8	+ 15 17	12.1	10 47.7	+ 00 39	12.6
8	14 42.6	- 13 00	12.4	19 44.5	- 16 22	9.7	01 46.4	+ 07 01	11.2	04 39.9	+ 15 28	12.1	10 59.1	- 00 20	12.6
15	14 51.0	- 13 34	12.5	19 40.6	- 16 26	10.0	01 50.1	+ 07 06	11.1	04 48.7	+ 15 36	12.0	11 10.5	- 01 20	12.6
22	15 00.1	- 14 10	12.6	19 38.5	- 16 29	10.2	01 52.6	+ 07 03	11.0	04 56.9	+ 15 41	12.0	11 22.0	- 02 23	12.6
29	15 09.7	- 14 47	12.6	19 38.2	- 16 31	10.4	01 53.9	+ 06 53	10.8	05 04.7	+ 15 43	11.9	11 33.6	- 03 27	12.5
Sep 5	15 19.9	- 15 23	12.7	19 39.7	- 16 30	10.6	01 54.0	+ 06 36	10.7	05 11.9	+ 15 42	11.8	11 45.3	- 04 33	12.5
12	15 30.6	- 16 00	12.7	19 43.0	- 16 27	10.8	01 52.7	+ 06 11	10.5	05 18.4	+ 15 38	11.8	11 57.0	- 05 40	12.4
19	15 41.6	- 16 36	12.8	19 47.8	- 16 21	11.0	01 50.0	+ 05 39	10.3	05 24.2	+ 15 32	11.7	12 08.8	- 06 47	12.4
26	15 53.1	- 17 10	12.8	19 54.2	- 16 11	11.2	01 46.1	+ 05 01	10.2	05 29.1	+ 15 24	11.6	12 20.6	- 07 54	12.3
Oct 3	16 05.0	- 17 42	12.8	20 01.7	- 15 57	11.3	01 41.0	+ 04 19	10.0	05 33.1	+ 15 15	11.5	12 32.5	- 09 02	12.3
10	16 17.1	- 18 12	12.9	20 10.4	- 15 38	11.5	01 35.1	+ 03 34	9.9	05 36.0	+ 15 05	11.4	12 44.4	- 10 09	12.3
17	16 29.6	- 18 39	12.9	20 20.0	- 15 15	11.6	01 28.7	+ 02 50	9.8	05 37.9	+ 14 54	11.2	12 56.4	- 11 16	12.4
24	16 42.3	- 19 03	12.9	20 30.3	- 14 47	11.8	01 22.3	+ 02 09	9.9	05 38.5	+ 14 43	11.1	13 08.5	- 12 22	12.4
31	16 55.3	- 19 23	12.9	20 41.3	- 14 13	11.9	01 16.2	+ 01 33	10.0	05 37.8	+ 14 32	11.0	13 20.6	- 13 26	12.5
Nov 7	17 08.5	- 19 39	12.9	20 52.9	- 13 35	12.0	01 10.8	+ 01 06	10.1	05 35.9	+ 14 22	10.8	13 32.7	- 14 29	12.5
14	17 21.8	- 19 52	12.9	21 04.8	- 12 52	12.1	01 06.5	+ 00 48	10.2	05 32.8	+ 14 14	10.7	13 44.8	- 15 30	12.5
21	17 35.3	- 20 00	12.8	21 17.1	- 12 04	12.2	01 03.5	+ 00 40	10.3	05 28.6	+ 14 08	10.6	13 57.0	- 16 29	12.6
28	17 48.9	- 20 03	12.8	21 29.7	- 11 11	12.3	01 02.0	+ 00 43	10.5	05 23.5	+ 14 05	10.4	14 09.1	- 17 26	12.6
Dec 5	18 02.6	- 20 02	12.8	21 42.5	- 10 13	12.4	01 01.8	+ 00 56	10.6	05 17.7	+ 14 04	10.3	14 21.3	- 18 20	12.6
12	18 16.2	- 19 57	12.7	21 55.5	- 09 12	12.5	01 03.2	+ 01 18	10.7	05 11.6	+ 14 07	10.2	14 33.4	- 19 10	12.6
19	18 29.9	- 19 46	12.7	22 08.5	- 08 07	12.5	01 05.8	+ 01 49	10.8	05 05.5	+ 14 13	10.3	14 45.4	- 19 58	12.6
26	18 43.5	- 19 31	12.6	22 21.7	- 06 59	12.6	01 09.8	+ 02 27	10.9	04 59.8	+ 14 23	10.4	14 57.3	- 20 42	12.6

METEOR SHOWERS

The table of Meteor Showers has been complied from the '1998 Meteor Shower Calendar' produced by the International Meteor Organization (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 sky, and preferably without the Moon. The best showers for this year, taking into consideration the lunar phase, are summarised in the monthly section.

One of the most significant astronomical events of 1998 will definitely be the Leonids meteor shower. The Leonids are one of the best known showers, with storms occurring about every 33 years, when its associated comet, P/Tempel-Tuttle, returns to perihelion. While no guarantees on the showers performance can be made, all observers should attempt to monitor this shower, a chance to see meteors virtually "rain" from the sky is not a sight to be missed.

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.

SHOWER NAME	MOON PHASE	ACTIVITY DURATION	MAX ACT	RADIANT		DIA	VEL	ZHR
				R.A.	Dec		km/s	
Quadrantids	FQ	Jan 01-Jan 05	Jan 03	230˚	+49˚	5˚	41	120
delta-Cancrids	LQ	Jan 01-Jan 24	Jan 17	130˚	+20˚	10˚-5˚	28	4
alpha-Centaurids	FM	Jan 28-Feb 21	Feb 07	210˚	-59˚	4˚	56	6
delta-Leonids	NM	Feb 15-Mar 10	Feb 24	168˚	+16˚	5˚	23	2
gamma-Normids	FM	Feb 25-Mar 22	Mar 13	249˚	-51˚	5˚	56	8
Virginids	LQ	Jan 25-Apr 15	Mar 24	195˚	-04˚	15˚-10˚	30	5
Lyrids	LQ	Apr 16-Apr 25	Apr 22	271˚	+34˚	5˚	49	15
pi-Puppids*	LQ	Apr 15 - Apr 28	Apr 23	110˚	-45˚	5˚	18	*
eta-Aquarids	FQ	Apr 19-May 28	May 05	338˚	-01˚	4˚	66	60
Sagittarids	LQ	Apr 15-Jul 15	May 20	247˚	-22˚	15˚-10˚	30	5
Pegasids	FM	Jul 07-Jul 13	Jul 10	340˚	+15˚	5˚	70	3
Phoenicids (July)*	FM	Jul 10 - Jul 16	Jul 13	032˚	-48˚	7˚	47	*
Pisces Austrinids	FQ	Jul 15-Aug 10	Jul 28	341˚	-30˚	15˚-10˚	35	5
Southern delta-Aquarids	FQ	Jul 12-Aug 19	Jul 28	339˚	-16˚	5˚	41	20
alpha-Capricornids	FQ	Jul 03-Aug 15	Jul 30	307˚	-10˚	8˚	23	4
Southern iota-Aquarids	FM	Jul 25-Aug 15	Aug 04	334˚	-15˚	5˚	34	2
Northern delta-Aquarids	FM	Jul 15-Aug 25	Aug 08	335˚	-05˚	5˚	42	4
Perseids	LQ	Jul 17-Aug 24	Aug 12	046˚	+58˚	5˚	59	90
kappa-Cygnids	LQ	Aug 03-Aug 25	Aug 18	286˚	+59˚	6˚	25	3
Northern iota-Aquarids	NM	Aug 11-Aug 31	Aug 20	327˚	-06˚	5˚	31	3
alpha-Aurigids	FQ	Aug 25-Sep 05	Sep 01	084˚	+42˚	5˚	66	10
delta-Aurigids	FM	Sep 05-Oct 10	Sep 08	060˚	+47˚	5˚	64	6
Piscids	NM	Sep 01-Sep 30	Sep 20	005˚	-01˚	5˚	26	3
Draconids*	FM	Oct 06 - Oct 10	Oct 08	262˚	+54˚	2˚	20	*
Epsilon Geminids	NM	Oct 14-Oct 27	Oct 18	102˚	+27˚	5˚	70	2
Orionids	NM	Oct 02-Nov 07	Oct 21	095˚	+16˚	10˚	66	20
SouthernTaurids	FM	Oct 01-Nov 25	Nov 05	052˚	+13˚	10˚-5˚	27	5
Northern Taurids	LQ	Oct 01-Nov 25	Nov 12	058˚	+22˚	10˚-5˚	29	5
Leonids	NM	Nov 14-Nov 21	Nov 17	153˚	+22˚	5˚	71	40+
alpha-Monocerotids	NM	Nov 15-Nov 25	Nov 21	117˚	+01˚	5˚	65	Var
chi-Orionids	FM	Nov 26-Dec 15	Dec 02	082˚	+23˚	8˚	28	3
Phoenicids	FM	Nov 28-Dec 09	Dec 06	018˚	-53˚	5˚	18	Var
Puppid-Velids	LQ	Dec 01-Dec 15	Dec 07	123˚	-45˚	10˚	40	10
Monocerotids (Dec)	LQ	Nov 27-Dec 17	Dec 09	100˚	+08˚	5˚	42	3
sigma-Hydrids	LQ	Dec 03-Dec 15	Dec 12	127˚	+02˚	5˚	58	2
Geminids	NM	Dec 07-Dec 17	Dec 14	112˚	+33˚	5˚	35	120
Coma Berenicids	NM	Dec 12-Jan 23	Dec 20	175˚	+25˚	5˚	65	5
Ursids	FQ	Dec 17-Dec 26	Dec 22	217˚	+76˚	5˚	33	10

Meteor showers occur when the Earth encounters large numbers of meteoroids moving together in the same orbit, in many cases these orbits can be identified with the orbits of comets. A group of meteoroids moving in such an orbit is known as a meteor stream and the visible manifestation in the Earth's atmosphere is known as a meteor shower. Due to perspective the meteors associated with showers appear to radiate from a focal point in the sky known as the radiant. The radiants are named after the constellation in which they appear and or after a bright star near the radiant.

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 periodic or 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.

ZHR

Zenith Hourly Rate, a theoretical rate assuming the radiant to be at the zenith with a sky limiting magnitude of 6.5 (perfect conditions).

MAX ACT

The date when maximum activity can be expected.

RADIANT, R.A. & Dec:

The position of the shower radiant in right ascension and declination (R.A. is expressed in degrees). These co-ordinates 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 km/s

The apparent velocity through the atmosphere in kilometres per second. The range can be from about 11 km/s (very slow) to 71 km/s (very fast), medium speed is about 40 km/s.

PART III - APPENDICES

BRIGHTEST AND NEARER STARS (p. 124)

The column descriptions are:

Designation The name of the star in the system created by Bayer. He numbered the stars in the constellations using Greek letters (p. 143). They were ordered by their brightness, alpha being the most brilliant.

Name Common names for the stars.

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.

ly is light year and **pc** is parsec (see glossary).

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**, **M, R, N** and **S** remembered by the mnemonic **O**h **B**e **A** **F**ine **G**irl(Guy) **K**iss **M**e **R**ight **N**ow, **S**mack!! These are then broken down into ten subclasses (1 to 10) and then even further subdivided into I, II, III, IV, etc. A discussion of these subclasses is beyond this publication.

- The **O** class stars are the hottest blue stars.
- **B** and **A** are white (e.g., Sirius, Rigel)
- **G** and early **K** (subclass <5) are yellow (e.g., Capella, the Sun and Arcturus)
- Late **K** (subclass > 5) and **M** stars are the cooler red stars (e.g., Aldebaran, Betelgeuse).

It is interesting trying to see the colour in 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 simply photographed. Mount your normal 35mm camera on a tripod and take a time exposure (some minutes) using a fast film. The resulting star trails often show the colours very well. An equatorially tracked time exposure (e.g., piggybacked on a telescope) with the camera slightly out of focus results in nicely coloured discs of the brightest stars. If the camera is in focus the colour of the brightest stars can be lost as their images burn out on the negative. All such photography should be conducted in country areas, away from city lights.

NON-STELLAR OBJECTS (p. 125)

The term 'Non-Stellar Object' refers to either clusters of stars, galaxies or nebulae (which include dark, bright and planetary nebulae).

Clusters of Stars can be anything from a collection of a few stars, close together (open star clusters), up to the massive collection of millions of stars (globular star clusters). Some globulars are so dense that the central regions, as seen through moderately sized telescopes, remain as cloudy blobs which are unable to be resolved into individual stars. 47 Tucanae is a good example.

Galaxies are the largest scale structures in the Universe, consisting of a collection of hundreds of billions of stars. The Milky Way and the two Clouds of Magellan (SMC and LMC) are the brightest examples of galaxies. They are all visible to the unaided eye providing you are under dark skies.

Nebulae are enormous clouds of gas that quite often mark the remains of a dead star (e.g., the Crab Nebula) or the birthplace of future stars (e.g., the Orion Nebula). Clouds of gas that do not glow are sometimes visible as shadows against the Milky Way. A good example of these dark nebulae is the Coal Sack which is clearly visible next to the Southern Cross.

The column descriptions are:-

CAT and **NUM**. Is the catalogue and the number of the object. NGC stands for New General Catalogue and IC, Index Catalogue.

RA and **DEC**. This is the position of the object in the sky in Right Ascension and Declination (Epoch 2000.0)

SIZE. The object's size expressed in arc minutes.

CON. Is the standard three letter abbreviation for the constellation the object is in (see table below).

TYPE. Is the broad classification as discussed above.

MAG. This is the brightness of the object expressed in magnitude. As these deep sky dwellers are large, compared to the pinpoint stars, the magnitude is expressed as if all the light from the object was compressed into a small 1 arc second square. This raises an interesting point. If the object is bright, it could still be quite faint and hard to locate if it is large. The light is spread out over a larger area and its surface brightness could be low. This is particularly important for galaxies. Therefore, when looking for a new galaxy, check its size before going to the telescope.

DESCRIPTION. This includes Messier numbers, common names and a general description.

CONSTELLATIONS - Abbreviations and Culmination at 9pm.

Name	Genitive	Abr.	Cul.	Name	Genitive	Abr.	Cul.	Name	Genitive	Abr.	Cul.
Andromeda	Andromedae	And	Nov 23	Crux	Crucis	Cru	May 12	Orion	Orionis	Ori	Jan 27
Antlia	Antliae	Ant	Apr 10	Cygnus	Cygni	Cyg	Sep 13	Pavo	Pavonis	Pav	Aug 29
Apus	Apodis	Aps	Jul 05	Delphinus	Delphini	Del	Sep 14	Pegasus	Pegasi	Peg	Oct 16
Aquarius	Aquarii	Aqr	Oct 09	Dorado	Doradus	Dor	Jan 31	Perseus	Persei	Per	Dec 22
Aquila	Aquilae	Aql	Aug 30	Draco	Draconis	Dra	Jul 08	Phoenix	Phoenicis	Phe	Nov 18
Ara	Arae	Ara	Jul 25	Equuleus	Equulei	Equ	Sep 22	Pictor	Pictoris	Pic	Jan 30
Aries	Arietis	Ari	Dec 14	Eridanus	Eridani	Eri	Dec 25	Pisces	Piscium	Psc	Nov 11
Auriga	Aurigae	Aur	Feb 04	Fornax	Fornacis	For	Dec 17	Piscis Austrinus	Piscis Austrini	PsA	Oct 09
Bootes	Bootis	Boo	Jun 16	Gemini	Geminorum	Gem	Feb 19	Puppis	Puppis	Pup	Feb 22
Caelum	Caeli	Cae	Jan 15	Grus	Gruis	Gru	Oct 12	Pyxis	Pyxidis	Pyx	Mar 21
Camelopardus	Camelopardi	Cam	Feb 06	Hercules	Herculis	Her	Jul 28	Reticulum	Reticuli	Ret	Jan 03
Cancer	Cancri	Cnc	Mar 16	Horologium	Horologii	Hor	Dec 25	Sagitta	Sagittae	Sge	Aug 30
Canes Venatici	Canum Venaticorum	CVn	May 22	Hydra	Hydrae	Hya	Apr 29	Sagittarius	Sagittarii	Sgr	Aug 21
				Hydrus	Hydri	Hyi	Dec 10	Scorpius	Scorpii	Sco	Jul 18
Canis Major	Canis Majoris	CMa	Feb 16	Indus	Indi	Ind	Sep 26	Sculptor	Sculptoris	Scl	Nov 10
Canis Minor	Canis Minoris	CMi	Feb 28	Lacerta	Lacertae	Lac	Oct 12	Scutum	Scuti	Sct	Aug 15
Capricornus	Capricorni	Cap	Sep 22	Leo	Leonis	Leo	Apr 15	Serpens	Serpentis	Ser	Jul 21
Carina	Carinae	Car	Mar 17	Leo Minor	Leonis Minoris	LMi	Apr 09	Sextans	Sextantis	Sex	Apr 08
Cassiopeia	Cassiopeiae	Cas	Nov 23	Lepus	Leporis	Lep	Jan 28	Taurus	Tauri	Tau	Jan 14
Centaurus	Centauri	Cen	May 14	Libra	Librae	Lib	Jun 23	Telescopium	Telescopii	Tel	Aug 24
Cepheus	Cephei	Cep	Nov 13	Lupus	Lupi	Lup	Jun 23	Triangulum	Trianguli	Tri	Dec 07
Cetus	Ceti	Cet	Nov 29	Lynx	Lyncis	Lyn	Mar 05	Triangulum Australe	Trianguli Australis	TrA	Jul 07
Chamaeleon	Chamaeleontis	Cha	Apr 15	Lyra	Lyrae	Lyr	Aug 18				
Circinus	Circini	Cir	Jun 14	Mensa	Mensae	Men	Jan 28	Tucana	Tucanae	Tuc	Nov 01
Columba	Columbae	Col	Feb 01	Microscopium	Microscopii	Mic	Sep 18	Ursa Major	Ursae Majoris	UMa	Apr 25
Coma Berenices	Comae Berenices	Com	May 17	Monoceros	Monocerotis	Mon	Feb 19	Ursa Minor	Ursae Minoris	UMi	Jun 27
Corona Australis	Coronae Australis	CrA	Aug 14	Musca	Muscae	Mus	May 14	Vela	Velorum	Vel	Mar 30
Corona Borealis	Coronae Borealis	CrB	Jul 03	Norma	Normae	Nor	Jul 03	Virgo	Virginis	Vir	May 26
Corvus	Corvi	Crv	May 12	Octans	Octantis	Oct	Circum	Volans	Volantis	Vol	Mar 04
Crater	Crateris	Crt	Apr 26	Ophiuchus	Ophiuchi	Oph	Jul 26	Vulpecula	Vulpeculae	Vul	Sep 08

THE BRIGHTEST STARS

See introduction to Part III (p. 125) for more information.

	Designation	Name	Constellation	R.A. (2000.0)	Dec (2000.0)	Magnitude App.	Magnitude Abs.	Spectral Type	Parallax	Distance ly	Distance pc
1		Sun				-26.70	4.8	G2 V			
2	α CMa	Sirius	Canis Major	06 45.2	-16 43	-1.46	1.4	A1 V	0.375	8.7	2.67
3	α Car	Canopus	Carina	06 23.9	-52 42	-0.72	-8.5	F0 Ia	0.018	180	55.21
4	α Cen	Rigil Kent	Centaurus	14 39.6	-60 50	-0.10	4.4	G2 V	0.751	4.3	1.32
5	α Boo	Arcturus	Bootes	14 15.7	+19 11	-0.04	-0.2	K2 IIIp	0.090	36	11.04
6	α Lyr	Vega	Lyra	18 36.9	+38 47	0.03	0.5	A0 V	0.123	26	7.98
7	α Aur	Capella	Auriga	05 16.7	+46 00	0.08	0.4	G8 III	0.073	45	13.80
8	β Ori	Rigel	Orion	05 14.5	-08 12	0.12	-7.1	B8 Ia	0.004	815	250.00
9	α CMi	Procyon	Canis Minor	07 39.3	+05 14	0.38	2.6	F5 IV	0.288	11	3.37
10	α Eri	Achernar	Eridanus	01 37.7	-57 14	0.46	-1.6	B5 IV	0.023	142	43.56
11	α Ori	Betelgeuse	Orion	05 55.2	+07 24	v0.50	-5.6	M2 Iab	0.005	650	199.39
12	β Cen	Hadar	Centaurus	14 03.8	-60 22	0.61	-5.1	B1 II	0.008	400	122.70
13	α Aql	Altair	Aquila	19 50.8	+08 52	0.77	2.2	A7 IV-V	0.198	16	4.91
14	α Tau	Aldebaran	Taurus	04 35.9	+16 31	0.85	-0.3	K5 III	0.048	68	20.86
15	α Cru	Acrux	Crux	12 26.6	-63 06	0.87	-3.9	B1 IV	0.012	270	82.82
16	α Sco	Antares	Scorpius	16 29.4	-26 26	0.96	-4.7	M1 Ib	0.008	400	122.70
17	α Vir	Spica	Virgo	13 25.2	-11 10	0.98	-3.5	B1 V	0.012	270	82.82
18	β Gem	Pollux	Gemini	07 45.3	+28 02	1.14	0.2	K0 III	0.093	35	10.74
19	α PsA	Fomalhaut	Piscis Austrinus	22 57.7	-29 37	1.16	2.0	A3 V	0.144	23	7.06
20	α Cyg	Deneb	Cygnus	20 41.4	+45 17	1.25	-7.5	A2 Ia	0.002	1600	490.80
21	β Cru	Becrux	Crux	12 47.7	-59 41	1.25	-5.0	B0 III	0.007	460	141.10
22	α Leo	Regulus	Leo	10 08.4	+11 58	1.35	-0.6	B7 V	0.039	85	26.07
23	ε CMa	Adhara	Canis Major	06 58.6	-28 58	1.50	-4.4	B2 II	0.005	650	199.39
24	α Gem	Castor	Gemini	07 34.6	+31 53	1.58	1.2	AI V	0.072	46	14.11
25	λ Sco	Shaula	Scorpius	17 33.6	-37 06	1.63	-3.0	B2 1V	0.010	300	92.02
26	γ Cru	Gacrux	Crux	12 31.2	-57 07	1.63	-0.5	M3 III	0.015	88	26.99
27	γ Ori	Bellatrix	Orion	05 25.1	+06 21	1.64	-3.6	B2 III	0.011	300	92.02
28	β Tau	Alnath	Taurus	05 26.3	+28 36	1.65	-1.6	B7 III	0.018	180	55.21
29	β Car	Miaplacidus	Carina	09 13.2	-69 43	1.68	-0.6	A0 III	0.031	85	26.07
30	ε Ori	Alnilam	Orion	05 36.2	-01 12	1.70	-6.2	BO Ia	0.003	1206	369.94

THE NEARER STARS

No	Star Name		Constellation	R.A. 2000 hh mm.m	Dec ° '	Magnitude Apparent	Magnitude Absolute	Spect Type	Parallax ' "	Proper Motion	Distance ly	Distance pc
1	Sun					-26.70	4.80	G2				
2	Proxima Centauri		Centaurus	14 29.7	-62 41	11.09	15.50	M5	0.772	3"82	4.23	1.30
3	Alpha Centauri	A	Centaurus	14 39.6	-60 50	0.01	4.40	G2	0.750	3"70	4.35	1.33
		B				1.34	5.70	K0				
4	Barnard's Star		Ophiuchus	17 57.8	+04 42	9.55	13.20	M4	0.545	10"37	5.98	1.83
5	Wolf 359		Leo	10 56.5	+07 01	13.45	16.60	M6	0.418	4"69	7.80	2.39
6	Lalande 21185		Ursa Major	11 03.4	+35 58	7.47	10.50	M2	0.395	4"82	8.23	2.52
7	UV Ceti (L726-8)	A	Cetus	01 39.0	-17 57	12.41	15.30	M6	0.381	3"37	8.57	2.63
		B				13.20	16.10	M6				
8	Sirius	A	Canis Major	06 45.2	-16 43	-1.43	1.50	A1	0.380	1"33	8.57	2.63
		B				8.40	11.30	DA2				
9	Ross 154		Sagittarius	18 49.8	-23 50	10.47	13.10	M4	0.341	0"72	9.56	2.93
10	Ross 248		Andromeda	23 41.9	+44 11	12.29	14.80	M6	0.316	1"63	10.33	3.17
11	Epsilon Eridani		Eridanus	03 32.9	-09 28	3.73	6.20	K2	0.306	0"98	10.67	3.27
12	Ross 128		Virgo	11 47.8	+00 48	11.12	13.50	M4	0.301	1"35	10.83	3.32
13	L 789-6	ABC	Aquarius	22 38.5	-15 18	12.33	14.70	M5	0.294	3"26	11.08	3.40
14	BD +43°44	A	Andromeda	00 18.4	+44 01	8.08	10.40	M1	0.290	2"91	11.27	3.46
	(Groombridge 34)	B				11.07	13.40	M4				
15	Epsilon Indi		Indus	22 03.4	-56 47	4.68	7.00	K5	0.289	4"71	11.29	3.46
16	61 Cygni	A	Cygnus	21 06.9	+38 45	5.22	7.50	K5	0.289	5"23	11.30	3.47
		B				6.03	8.30	K7				
17	BD +59°1915	A	Draco	18 42.9	+59 38	8.90	11.20	M3	0.286	2"27	11.40	3.50
		B				9.68	12.00	M4				
18	Tau Ceti		Cetus	01 44.1	-15 56	3.50	5.80	G8	0.286	1"92	11.40	3.50
19	Procyon	A	Canis Minor	07 39.3	+05 14	0.38	2.70	F5	0.286	1"24	11.41	3.50
		B				10.70	13.00	F5				
20	Lacaille 9352		Piscis Austrinus	23 05.9	-35 51	7.34	9.60	M2	0.284	6"90	11.47	3.52
21	GJ 1111		Cancer	08 29.8	+26 47	14.79	17.00	M7	0.276	1"29	11.83	3.63
22	GJ 1061		Horologium	03 36.0	-44 31	13.03	15.20	M6	0.270	0"84	12.06	3.70
23	YZ Ceti (L725-32)		Cetus	01 12.5	-17 00	12.05	14.20	M5	0.267	1"35	12.20	3.74
24	Luyten (BD + 5°1668)		Canis Minor	07 27.4	+05 14	9.86	12.00	M4	0.264	3"76	12.34	3.79
25	Lacaille 8760		Microscopium	21 17.3	-38 52	6.67	8.70	M0	0.259	3"45	12.61	3.87
26	Kapteyn's Star		Pictor	05 11.6	-45 01	8.84	10.90	M0	0.258	8"65	12.63	3.87

NON STELLAR OBJECTS (Epoch 2000.0)

See introduction to Part III (p. 130) for more information.

CAT	NUM	R.A.	DEC	SIZE	CON	TYPE	MAG	DESCRIPTION
NGC	55	00 14.9	-39° 11'	30'x6.3'	Scl	Spiral galaxy.	8.1	Brightest galaxy in Sculptor Group
NGC	104	00 24.1	-72° 05'	30.9'	Tuc	Globular cluster	3.8	47 Tucanae, one of the finest globulars
NGC	224	00 42.7	+41° 16'	185'x75'	And	Spiral galaxy	3.4	M31, The 'Andromeda Galaxy'
NGC	253	00 47.6	-25° 17'	30'x6.9'	Scl	Spiral galaxy	7.6	'Silver Coin' galaxy. Large, bright edge-on spiral
	SMC	00 52.7	-72° 30'	5°x4°	Tuc	Galaxy	2.3	Small Magellanic Cloud. Visible to unaided eye from dark sky
	Pleiades	03 47.0	+24° 07'	2°	Tau	Open cluster	1.2	M45 or 'Seven Sisters'. Naked eye cluster, the brighter stars mag. 2
	Hyades	04 27.0	+16° 00'	6°	Tau	Open cluster	0.5	A naked eye, 'V' shaped cluster. 28 stars, the brighter mag. 3 and 4
	LMC	05 23.6	-69° 45'	9°x10°	Dor	Galaxy	0.1	Large Magellanic Cloud. Visible to unaided eye from dark sky
NGC	1976	05 35.4	-05° 27'	65'x60'	Ori	Gaseous nebula	4.0	M42, 'Orion Nebula', emission and reflection nebula
NGC	2070	05 38.6	-69° 05'	30'x20'	Dor	Emission nebula	8.3	30 Doradus, 'Tarantula Nebula', bright complex looped structure
NGC	2169	06 08.4	+13° 57'	6'	Ori	Open cluster	5.9	Rich loose cluster, 30 stars magnitude 7 and fainter
NGC	2168	06 08.9	+24° 20'	28'	Gem	Open cluster	5.3	M35, 200 stars, magnitude range 9 to 16, no central concentration
NGC	2244	06 32.4	-04° 52'	23'	Mon	Open cluster	4.8	Rich cluster of 100 stars, with nebulosity (Rosette Nebula)
NGC	2264	06 41.1	+09° 53'	20'	Mon	Open cluster	3.9	40 stars, large brightness range, involved in nebulosity (Cone Nebula)
NGC	2287	06 47.0	-20° 44'	38'	CMa	Open cluster	4.5	M41, 80 stars 7th magnitude and fainter with 6.9 mag. red star near centre
NGC	2301	06 51.8	+00° 28'	12'	Mon	Open cluster	6.0	Rich cluster, 80 stars, large magnitude range, central concentration
NGC	2362	07 18.8	-24° 57'	8'	CMa	Open cluster	4.1	60 stars, large brightness range (4th mag. down), concentrated centre
NGC	2422	07 36.6	-14° 30'	29'	Pup	Open cluster	4.4	M47, Large coarse cluster with 30 bright and faint stars
NGC	2437	07 41.8	-14° 49'	27'	Pup	Open cluster	6.1	M46, rich open cluster, 100 stars, planetary nebula NGC2438 in same field
NGC	2447	07 44.6	-23° 52'	22'	Pup	Open cluster	6.2	M93, 80 stars magnitude 8 to 13 with strong central concentration
NGC	2451	07 45.4	-37° 58'	45'	Pup	Open cluster	2.8	Rich in stars with slight central concentration
NGC	2477	07 52.3	-38° 33'	27'	Pup	Open cluster	5.8	160 stars around 10 -12th magnitude, strong central concentration
NGC	2516	07 58.3	-60° 52'	29'	Car	Open cluster	3.8	80 stars 6th magnitude and fainter, strong central concentration
NGC	2547	08 10.7	-49° 16'	74'	Vel	Open cluster	4.7	Rich in stars with strong central concentration. Brightest stars mag. 6
NGC	2548	08 13.8	-05° 48'	54'	Hya	Open cluster	5.8	M48, Large cluster of 80 stars 8 to 13th magnitude, central concentration
NGC	2632	08 40.1	+19° 59'	95'	Cnc	Open cluster	3.1	M44, 'Praesepe' or 'Beehive Cluster', very large cluster, 50 stars
IC	2391	08 40.2	-53° 04'	50'	Vel	Open cluster	2.5	Moderately rich in bright (about mag. 3) and faint stars
IC	2395	08 41.1	-48° 12'	7'	Vel	Open cluster	4.6	40 stars 6th magnitude and fainter
NGC	2808	09 12.0	-64° 52'	13.8'	Car	Globular cluster	6.1	Large and rich, compressed centre, stars 13 to 15th magnitude
NGC	3114	10 02.7	-60° 07'	35'	Car	Open cluster	4.2	Rich cluster, stars 9 to 14th magnitude, slight central concentration
NGC	3132	10 07.1	-40° 26'	30"	Vel	Planetary nebula	9.7	The 'Eight Burst Nebula', ring and disk, 10th magnitude central star
IC	2602	10 43.2	-64° 24'	50'	Car	Open cluster	1.9	Rich in stars, strong central concentration, brightest stars mag. 3
NGC	3372	10 43.8	-59° 52'		Car	Emission nebula		The 'Eta Carinae Nebula', very bright, prominent dark lanes
NGC	3532	11 06.4	-58° 40'	55'	Car	Open cluster	3.0	Rich and large, slight central concentration, 150 stars 7 to 12th magnitude
NGC	3766	11 36.1	-61° 37'	12'	Cen	Open cluster	5.3	Rich cluster, 100 stars magnitude range 7 to 12th
NGC	4755	12 53.6	-60° 20'	10'	Cru	Open cluster	4.2	The 'Jewel Box', rich in stars, large brightness range
NGC	4945	13 05.4	-49° 28'	23'x5.9'	Cen	Spiral galaxy	9.0	Large edge on spiral, good field, another small galaxy in same field
NGC	5128	13 25.5	-43° 01'	31'x23'	Cen	Galaxy	6.7	'Centaurus A', bright sphere crossed by dark lane, radio source
NGC	5139	13 26.8	-47° 29'	36'	Cen	Globular cluster	3.5	Omega Centauri, perhaps the finest example of a globular cluster
NGC	5272	13 42.2	+28° 23'	16.2'	CVn	Globular cluster	5.9	M3, large bright globular, brightens suddenly towards the middle
NGC	5281	13 46.6	-62° 54'	5'	Cen	Open cluster	5.9	40 stars, moderately rich in bright and faint stars, magnitudes 6 to 12
NGC	5617	14 29.8	-60° 43'	10'	Cen	Open cluster	6.3	80 stars, large brightness range, strong central concentration
NGC	5904	15 18.6	+02° 05'	17.4'	Ser	Globular cluster	5.7	M5, bright, large very compressed in middle, slightly oval in shape
NGC	6025	16 03.7	-60° 30'	12'	TrA	Open cluster	5.1	60 stars, large brightness range, slight central concentration
NGC	6067	16 13.2	-54° 13'	12'	Nor	Open cluster	5.6	100 stars, large brightness range, strong central concentration
NGC	6087	16 18.9	-57° 54'	12.5'	Nor	Open cluster	5.4	40 stars, moderate brightness range, slight central concentration
NGC	6121	16 23.6	-26° 32'	26.3'	Sco	Globular cluster	5.8	M4, conspicuous globular near Antares
NGC	6124	16 25.6	-40° 40'	29'	Sco	Open cluster	5.8	100 stars, large brightness range, strong central concentration
NGC	6193	16 41.3	-48° 46'	14'	Ara	Open cluster	5.2	Few stars, large brightness range, slight central concentration
NGC	6205	16 41.7	+36° 28'	16.6'	Her	Globular cluster	5.7	M13, the 'Great Hercules Cluster', showpiece of northern skies
NGC	6231	16 54.0	-41° 48'	14'	Sco	Open cluster	2.6	A few stars with strong central concentration. Brightest stars mag.5
NGC	6405	17 40.1	-32° 13'	33'	Sco	Open cluster	4.2	M6, the 'Butterfly Cluster', 80 stars, large brightness range
NGC	6397	17 40.7	-53° 40'	25.7'	Ara	Globular cluster	5.8	Loose, scattered structure, possibly the nearest of the globulars
NGC	6475	17 53.9	-34° 49'	80'	Sco	Open cluster	3.2	M7, 80 stars brighter than 10th magnitude, large brightness range
NGC	6494	17 56.8	-19° 01'	27'	Sgr	Open cluster	5.5	M23, 150 stars, moderate brightness range, lies in good star field
NGC	6514	18 02.3	-23° 02'	20'	Sgr	Gaseous nebula	5.0	M20, 'Trifid Nebula', emission and reflection nebulosity cut by dark lanes
NGC	6523	18 03.8	-24° 23'	45'x30'	Sgr	Emission nebula	5.0	M8, 'Lagoon', densest section known as the 'Hourglass', dark lane
NGC	6611	18 18.8	-13° 47'	21'	Ser	Open cluster	6.0	M16, 100 bright and faint stars, involved in the 'Eagle Nebula'
IC	4725	18 31.6	-19° 15'	32'	Sgr	Open cluster	4.6	M25, 30 stars loosely scattered
NGC	6656	18 36.4	-23° 54'	24'	Sgr	Globular cluster	5.1	M22. Fine globular, only Omega Centauri and 47 Tucanae are brighter.
NGC	6705	18 51.1	-06° 16'	13'	Sct	Open cluster	5.8	M11, the 'Wild Duck Cluster', rich and compact open cluster
NGC	7009	21 04.2	-11° 22'	25"	Aqr	Planetary nebula	8.5	The 'Saturn Nebula', ring structure in a larger and fainter halo
NGC	7078	21 30.0	+12° 10'	12.3'	Peg	Globular cluster	6.0	M15, bright, irregularly round, well resolved into faint stars
NGC	7293	22 29.6	-20° 48'	12'	Aqr	Planetary nebula	7.3	The 'Helix Nebula', ring structure involved in larger and fainter disk

RISE/SET TIME CORRECTIONS FOR OTHER LOCATIONS

As mentioned previously in this book, the rise/set tables for the Sun, Moon and planets, in Part II, are calculated for Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Sydney and Townsville.

This page is designed to help people, who live outside of these cities, to make corrections to determine the rise/set times for their specific location. There are two corrections needed, they are:-

1. An adjustment 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**. Examples of corrections for various towns/cities are given in table 1.
2. An adjustment for the difference in latitude also requires the declination for the object of interest. Table 2 presents these corrections (south latitudes are negative). NB. **for rise times you add these values, for set you subtract**. For your specific latitude it is normally sufficient to interpolate these figures. If you wish a more accurate result, the following equation is used:-

   cosA = -tanB*tanC

   where A = the semi-diurnal arc, B = declination of object and C = observer's latitude.

You need to calculate the value of A for Sydney (C=-33.9) and subtract the value of A for your location/ object's declination. Express the answer in degrees (some computers/calculators give output in radians); then multiply by 4 to convert to minutes.

It is IMPORTANT that Rise/Set times for SYDNEY are used, IRRESPECTIVE of which town in Australia the calculations are for, when using these tables.

In all these calculations it is easier to first convert all latitudes and longitudes to decimal degrees.

Example of rise/set time corrections.

Calculate the rise/set times for the Sun on Jan 24 for Albury (36° 05'S, 146° 55'E)

	Rise	Set
From p.77 the rise/set values for Sydney are:-	5:08	19:06
Adjust for longitude (151.25-146.92)*4 (table 1)	+ :17	+ :17
(value is positive due to Albury being west of Syd.)		
Adjust for latitude & Declination of Sun from table 2 (Dec. = -19°53' p.78)	- :05	+ :05
Rise/Set times for Albury are :-	5:20	19:28

NB. If your local time is Australian Central Standard time, **subtract** 30 minutes.

If daylight saving is in force, **add** 60 minutes.

TABLE 1

LONGITUDE ADJUSTS FOR SOME TOWNS/CITIES

Relative to **SYDNEY**

Location	Latitude (° ' S)	Longitude ° ' E)	Change in Longitude (decimal °)	correction (mins.)
NSW				
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
Eden	37 01	149 56	1.3	5
Gosford	33 26	151 21	-0.1	0
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	8
Tennant Creek	19 34	134 08	17.1	68
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
TASMANIA				
Launceston	41 20	147 08	4.1	16
Stanley	40 40	145 08	6.1	24
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
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

TABLE 2 - RISE/SET CORRECTIONS FOR LATITUDE/DECLINATION (from Sydney)

Declination

South Latitude (negative)	30°	25°	20°	15°	10°	5°	0°	-5°	-10°	-15°	-20°	-25°	-30°
-12°	-63	-50	-39	-28	-19	-9	0	9	19	28	39	50	63
-14°	-58	-46	-36	-26	-17	-8	0	8	17	26	36	46	58
-16°	-53	-42	-33	-24	-16	-8	0	8	16	24	33	42	53
-18°	-48	-38	-29	-22	-14	-7	0	7	14	22	29	38	48
-20°	-43	-34	-26	-19	-13	-6	0	6	13	19	26	34	43
-22°	-37	-30	-23	-17	-11	-5	0	5	11	17	23	30	37
-24°	-32	-25	-19	-14	-9	-5	0	5	9	14	19	25	32
-26°	-26	-20	-16	-11	-7	-4	0	4	7	11	16	20	26
-28°	-20	-16	-12	-9	-6	-3	0	3	6	9	12	16	20
-30°	-13	-11	-8	-6	-4	-2	0	2	4	6	8	11	13
-32°	-7	-5	-4	-3	-2	-1	0	1	2	3	4	5	7
-34°	0	0	0	0	0	0	0	0	0	0	0	0	0
-36°	8	6	5	3	2	1	0	-1	-2	-3	-5	-6	-8
-38°	16	12	9	7	4	2	0	-2	-4	-7	-9	-12	-16
-40°	25	19	15	10	7	3	0	-3	-7	-10	-15	-19	-25
-42°	34	26	20	14	9	5	0	-5	-9	-14	-20	-26	-34
-44°	44	34	26	18	12	6	0	-6	-12	-18	-26	-34	-44

JULIAN DATE — 1998

To calculate Julian Date (JD), first convert local time to Universal Time (UT); subtract 10 hrs from AEST, 9.5 hrs from ACST 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 0hrs 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 wish to know the Julian date at 23:00 AEST on July 17th. Subtract 10 hours to get UT.

23 - 10 = 13:00 hrs UT

From the table the JD for July is 2450994.5
Add the day of month, 17 gives us 2451011.5

Now add the hours as a fraction of a day from the 2nd table. 13hr is 0.542. Thus JD at 23:00hr 17 Jul 1998 AEST is 2451012.042

JULIAN DATE at 0hrs UT		
Month		Julian Date
Jan	0	2450813.5
Feb	0	2450844.5
Mar	0	2450872.5
Apr	0	2450903.5
May	0	2450933.5
Jun	0	2450964.5
Jul	0	2450994.5
Aug	0	2451025.5
Sep	0	2451056.5
Oct	0	2451086.5
Nov	0	2451117.5
Dec	0	2451147.5

Hours as decimal of a day.			
01	0.042	13	0.542
02	0.083	14	0.583
03	0.125	15	0.625
04	0.167	16	0.667
05	0.208	17	0.708
06	0.250	18	0.750
07	0.292	19	0.792
08	0.333	20	0.833
09	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 — 1998

Greenwich mean sidereal time at 0hrs UT

Jan	0	6.6306	Jul	0	18.5241
Feb	0	8.6676	Aug	0	20.5611
Mar	0	10.5075	Sep	0	22.5981
Apr	0	12.5445	Oct	0	0.5694
May	0	14.5158	Nov	0	2.6064
Jun	0	16.5528	Dec	0	4.5777

You can use the following method to calculate Local Mean Sidereal Time. First convert your local time and date to U.T. Now calculate the Greenwich mean sidereal time (GMST) for that date.

GMST on day *d* of month at hour *t* U.T.
= GMST at 0h UT (from table above) + 0.06571 *d* + 1.00274 *t*

To convert this to Local mean sidereal time (LMST) we use

LMST = GMST + east longitude (or - west longitude)

where longitude is expressed in HOURS (not degrees!)

To convert longitude from degrees to hours, just divide by 15.

Example:

Find LMST at 23:00 hours Sydney time (AEST) on 17th July 1998.

23:00 AEST = 13:00 UT

GMST for July 0 is 18.5241 hours.

GMST = 18.5241 + (0.06571 x 17) + (1.00274 x 13) = 32.6768

Sydney's longitude is 151.25° which is 10.0833 hrs so

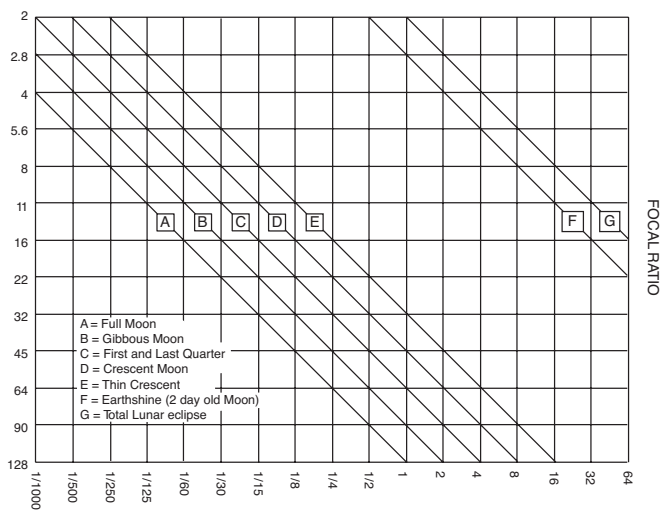
LMST = 32.6768 + 10.0833 = 42.7601

Subtract from or add to this multiples of 24 until it is in the range of 0 to 24

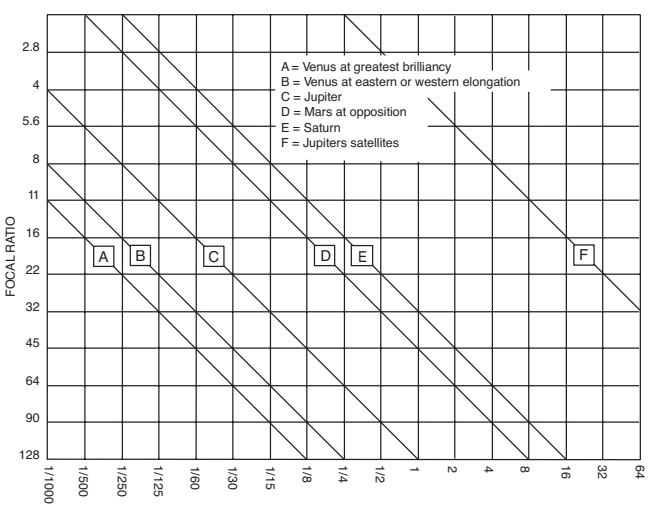
42.7601 - 24 = 18.7601 hrs or 18h 45m 36s

PHOTOGRAPHIC EXPOSURE GUIDES

PHOTOGRAPHIC EXPOSURE GUIDE for the MOON



PHOTOGRAPHIC EXPOSURE GUIDE for the PLANETS



These charts provide recommended photographic exposures for the Moon (left) and selected planets (right) using 100 ISO film. The charts should only be treated as a guide as many factors will influence the exposure time.

Follow a horizontal line nearest to your systems focal ratio to the oblique line that represents the Moon aspect or planet required, then follow the intersecting vertical line down to find the correct exposure.

For the best result always take one photo at the recommended speed and follow up with one at half and one at twice the exposure (bracketing). This will help smooth out variables and should provide at least one image at the required density.

Film Speed	Multiply By	Film Speed	Divide By
32 ISO	4	200 ISO	2
64 ISO	2	400 ISO	4

For ISO values other than 100 the above factors should be applied to the exposure time.

PLACES OF ASTRONOMICAL INTEREST

Following is a list of places of astronomical interest. Locations below cater to the public in regards to tours and/or displays. Costs are subject to change.

NEW SOUTH WALES & ACT

THE AUSTRALIA TELESCOPE - NARRABRI ARRAY

The Australia Telescope operates in the radio region of the spectrum. It essentially uses high technology to combine the signals from a number of dishes, or elements, to obtain the performance of a single theoretical dish a number of kilometres in diameter. The 'compact array', located at the CSIRO's Paul Wild Observatory near Narrabri, is the heart of the telescope. It consists of six 22m dishes which are spaced along a 3km track. A 7th dish for the array is located a few kilometres west of Coonabarabran (on the way up to Siding Spring Observatory). The Tidbinbilla Tracking Station and Parkes Radio Telescope are also equipped to form part of the array.

The visitor's centre at Narrabri is well located. Being adjacent to the array's track, good views of the dishes are available. There is an excellent display and video tape presentation which explains the concepts behind the telescope and radio astronomy in general..

Hours: 8am to 4pm daily (not staffed weekends, except school holidays).
Cost: No charge to visit the centre. Bookings are appreciated for groups.
Contact: Tim Kennedy (02) 6790-4070.

BOWEN MOUNTAIN OBSERVATORY

This observatory is operated by the Astronomical Society of NSW. It is located on Bowen Mountain near North Richmond (north west of Sydney). It houses a 40cm Dobsonian telescope. The observatory is open on Friday and Saturday nights (not every week). Visitors are most welcome.

Contact: Adrian Saw (02) 4572-1568

KATOOMBA FALLS SOLAR OBSERVATORY & CAFE

This historic cafe is beautifully situated between the 3 Sisters and the Scenic Railway and is the gateway to one of the best walks in the Blue Mountains. There is public viewing of the Sun in hydrogen-alpha and white light. Also a large collection of meteorites. The cafe is open 7 days and viewing is Thursday to Sunday..

Address: Katoomba Falls Rd., Katoomba
Contact: Bruce Jessup (02) 4782 6687

GREEN POINT OBSERVATORY

The observatory is operated by the Sutherland Astronomical Society (SAS). The two observatory buildings house a 41cm reflector and a 15cm refractor. Visitors are most welcome; the observatory is open on all Thursday nights. The society also runs regular open nights which are very popular with the general public. In 1998, open nights are scheduled for July 31st and August 1st. Contact the SAS (under society appendix) for details.

GILGANDRA OBSERVATORY

Located in the centre of town, this public observatory is open every night (except Sundays). Phone (02) 6847-2646

CANBERRA DEEP SPACE COMMUNICATION COMPLEX (TIDBINBILLA)

complex is located 40km southwest of Canberra, further along the same road you would take to visit Mt. Stromlo (Tourist Route 5). In fact, Stromlo and Tidbinbilla would make a fascinating day trip if you were visiting or living in the ACT. The Tidbinbilla complex is a major link in NASA's Deep Space Network. It has played a large role in nearly all of NASA's lunar and planetary probes. The complex periodically teams up with the Parkes Radio Telescope to jointly monitor faint signals from distant spacecraft as they make their historic flybys of the planets. As one would expect, the Space Centre concentrates on both NASA's manned and robotic probes. The centre incorporates audio and visual displays, interactives, models and images from the Mars Pathfinder and Global Surveyor spacecraft. The Space Centre offers an excellent view of the main antenna (dish). There is also the 'Moon Rock Cafe'' which is a well equipped souvenir and sandwich/ hot food shop.

Hours: 9am to 5pm, 7 days per week (8pm daylight saving time).
Cost: There is no charge for the Space Centre.
Contact: (02) 6201-7880
email: cdscc-pro@jpl.nasa.gov

DARBY FALLS OBSERVATORY

The observatory is located on Observatory Road (off the road to Mt. McDonald) Darby Falls, Cowra. The observatory offers one of the largest telescopes accessible to the public, a 500mm Newtonian. Also available are 400mm, 300mm and 200mm instruments..

Times: Winter: 7-10pm, Summer: 8.30-11pm, or by appointment. Coaches and schools welcome.
Contact: Mark Monk (02) 6345-1900 or Fax (02) 6345-1920

GROVE CREEK OBSERVATORY

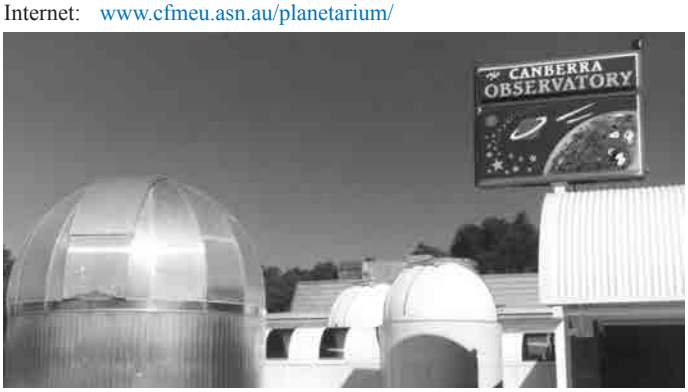
This observatory is a non-profit organisation located 60km south of Bathurst. The facility caters for amateur astronomers and groups who are looking to use large aperture telescopes under very dark skies. The facility boasts a Celestron C-14, 12.5" Newtonian and Meade 10" LX-200 which includes full astrophotography and CCD equipment. The instruments are located in two observatory buildings at the site. Grove Creek Observatory has modern on-site accommodation, sleeping up to 10 people with full facilities available. The cost for full use of the facility, including free on-site accommodation is $90 per person, per night. Discounts are available for groups over 4. Conditions apply, contact below for more information.

Phone: (02)9428-4334 (Jim Lynch)\.
Email: bookings@gco.apana.org.au
Internet: www.gco.org.au

THE CANBERRA SPACE DOME & OBSERVATORY

This professional quality astronomy complex is located at the Downer Club in Canberra. The address is Hawdon Place, Dickson (off Antill Street). The telescopes of the observatory are world class and include a 41cm Newtonian-cassegrain IK6 with 17.8 cm Astro-Physics Starfire refractor (in a 5.2 metre dome), an Astro Physics 6" *f*12 planetary refractor (in a 3 metre dome) and a Celestron 14 (in a 4.2 metre dome). The astronomers, staffing the observatory, are members of the Canberra Astronomical Society. The observatory will be opening a "world class" planetarium, in October 1997. Being located at a club there is a bistro (12 - 2:30pm, 6 - 9pm).

Bookings: Groups of 10 or over must book. ph (06) 249-7817, Fax (06) 248-7238 or email planetarium@cfmeu.asn.au
Cost: $2.00 entrance fee
Internet: www.cfmeu.asn.au/planetarium/



KINGS TABLELAND OBSERVATORY (BLUE MOUNTAINS)

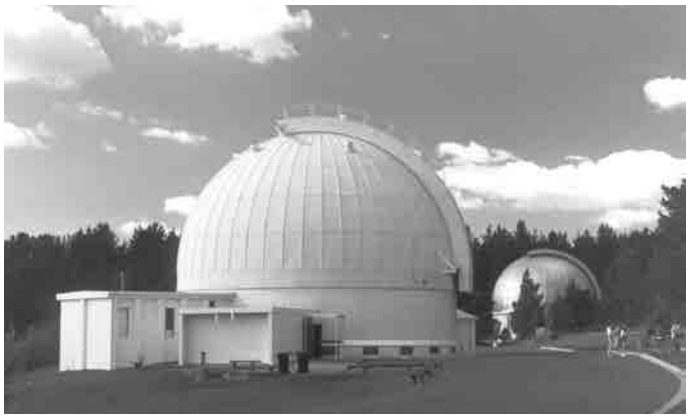
The observatory is located at Wentworth Falls. It is at an altitude of 930 metres which makes it a high and dark site, but still close to Sydney. The facility is open to any interested people or groups. Three modern telescopes are available for use; 10cm, 20cm and 25cm instruments, all housed in a 4.5 metre dome. The observatory also conducts classes for the Nepean Community College which includes: workshops on the night sky, use of star charts, astrophotography and instructions on the use of telescopes..

Hours: Flexible to meet demand.
Contact: Roger North, Sybil Barber (02) 4757-2954

MT. STROMLO OBSERVATORY

For many years, Mt Stromlo was largely responsible for the excellent worldwide reputation of Australian optical astronomical research. Since the establishment of Siding Spring Mountain Observatory many of the Astronomical breakthroughs are now being made in the dark, clear skies over the Warrumbungles. Ever increasing light pollution over Canberra is also restricting the type of research that can be conducted at Mt. Stromlo.

Mt. Stromlo is home to a multitude of telescopes. When first visiting the observatory, the number of domes, of all sizes, can be quite fascinating. While none of the domes are open to the public for inspection, the visitor's gallery, which is built onto the side of the 1.9m telescope building, gives a view of this instrument through a window. This was the largest (most light gathering power) optical telescope in Australia before the AAT and the ATT.



The Stromlo Exploratory is an exciting new interactive astronomy education and tourist centre, which was opened in July 1997. There is a Heliostat built into the Exploratory so visitors can see what the Sun really looks like! A Celestron telescope has also been set up to show the Moon and planets during the daytime. The centre has certainly been designed for adults and children with numerous exhibits, telescopes, a souvenir shop and an excellent restaurant. There is also a large sundial and outdoor barbecue area.

Cost: $5 adults, $3 Children/Concession. Groups welcome, discounts on application.
Address: 15 minutes from Canberra City, Mt Stromlo Observatory, off Cotter Road, Weston Creek, ACT
Hours: The Exploratory is open daily (except Christmas) 9:30am-4:30pm (night visits are available by appointment).
Contact: (02) 6249 0232
Internet: msowww.anu.edu.au/exploratory/index.html

PORT MACQUARIE OBSERVATORY

Open Wednesday & Sunday evenings at 7:30pm (8:15pm, daylight savings)..

Address: PO Box 1453, Port Macquarie NSW 2444
Contact: Jim Daniel (02) 6583-1933

KOOLANG OBSERVATORY AND SPACE SCIENCE CENTRE

Located on the border of the Central Coast, Lower Hunter and Wyong, the centre is just an hour from Hornsby, Gosford, Cessnock and Wyong and no more than 2 hours from most Sydney and Newcastle suburbs. At an altitude of 300 metres and surrounded by national park, Koolang's 0.5 metre and other telescopes are in operation 7 days and nights a week.

Over 5,000 students have visited the observatory during the last 3 years and they have developed curriculum based presentations to cover all school years from junior primary to year 12. Support material is available. Koolang has received "designated observatory" status from the ASA and the site benefits from a lighting policy implemented by the local council (Cessnock) to protect the dark sky environment.

Hours: 7 days: noon to 5pm for solar viewing and display centre tours. They are open about an hour after sunset for a two hour night show. Starting times vary and booking is essential..
Contact: (02) 4998 8216; fax (02) 4998 8162
Email: koolang@ hunterlink.net.au;
Internet: http://users.hunterlink.net.au/koolang

MAGELLAN OBSERVATORY

This facility is situated on 120 acres at Lake Bathurst which is in the NSW Southern Highlands, 35km south of Goulburn. It is 2.5 hours south of Sydney or 1 hr north of Canberra. Catering mainly for small groups, this well equipped observatory has something for every observer. The emphasis is "hands-on" with includes: a computerised 46cm New Generation Telescope (NGT), a 30cm f/6 Dobsonian, a 10cm Genesis refractor, a 10cm Questar Maksutov and various spotting scopes. Incredibly dark skies greet you on arrival. Observing is comfortable inside a 4.5m dome or a roll off observatory. There is a lounge area with tea/coffee making, some soothing sounds and some well stocked library shelves. Camera and photographic equipment are available for hire. Bookings are essential. Sky tours, which last about 2 hours, are conducted all year round.

Hours: 7pm-10pm
Hosts Zane and Fiona Hammond
Address: 4km along Covan Creek Rd off Braidwood Rd
Phone: (02) 4849 4489

SYDNEY OBSERVATORY

The observatory is located in a park just a short walk from the historic 'Rocks' district of Sydney. It is very close to the southern end of the Harbour Bridge. Since the Powerhouse Museum took over running the observatory, it has had a renewed interest in public education. The centre is set up for a more 'hands-on' approach for visitors, with a number of displays and films on Astronomy. On weekends, visitors are invited to observe the Sun - the safe way (weather permitting). Night time tours include observations of the Moon and Planets through the observatory's historic telescopes. A new exhibit will be opening in November 97 called "By the light of the Southern Stars".

Hours: 10am to 5pm, closed only on Christmas Day. Night sessions are every Wednesday. Bookings are required for evening tours. Call the observatory for times of Planetarium shows. There are also open nights, bookings not required..
Cost: Evening sessions - $6 ($5 day) Adults, $3 ($2 day) Students or concession and $15 ($12 day) for Families, Planetarium is $2..
Contact: (02) 9217-0485.
Internet: www.phm.gov.au/observe/

SKYWATCH NIGHT'N'DAY OBSERVATORY

This public observatory is the latest attraction in Coonabarabran (home of the Siding Spring Mountain Observatory). It is located on the Timor Road, 2km west of the Clock Tower. For the convenience of visitors all the displays, including the main dome/telescope and planetarium, are open during the day as well as the night. Light refreshments are also available.

Hours: 2pm to 5pm (closed for daytime hours during February) Evening session times vary with time of the year. Group booking can be made for any time/day of the year. Closed only Christmas day..
Contact: (02) 6842-2506 or fax (02) 6842-2978

PARKES RADIO TELESCOPE

The observatory is located on the western plains of NSW, twenty kilometres north of Parkes (just off the Newell Highway). The Parkes Telescope was indeed a pioneer in Radio Astronomy. After some recent upgrades it is, arguably, once again the best single dish radio telescope in the world. It also functions as part of the CSIRO Australia Telescope array. At the observatory, public education has a high priority, hence their impressive visitor's complex. As well as a great view of the telescope, the centre has displays, interactives and an informed and friendly staff. The latest addition is an impressive public picnic area, consisting of a large shelter and gas barbecue facility. Souvenirs and educational material are available.

Hours: 8:30am to 4:30pm - daily except Christmas and Boxing Day.
Cost: Admission to visitor's centre is free. A modest charge is made for the Audio/Visual presentation.
Contact: (02) 6861-1777
Email: rtwardy@atnf.csiro.au
Internet: www.parkes.atnf.csiro.au/visitors_centre/VCHomePage.html

SCIENCE CENTRE AND PLANETARIUM

Located at the University of Wollongong. This centre includes a planetarium, exhibit area and gift shop. The planetarium is one of the most popular attractions at the Science Centre. Although it only seats a small number, almost 30,000 people have passed through the doors for a twenty minute exposure to the stars since its opening in April 1994.

Open: Friday nights 7:00pm - 9:00pm (with a bonus of telescope viewing on clear nights) Saturday and Sunday 1:00pm - 5:00pm. also other times for group bookings and functions by arrangement.

Address: Science Centre, Cowper St., Fairy Meadow, NSW, 2519

Internet: http://www.uow.edu.au/science_centre/

SIDING SPRING OBSERVATORY

The Warrumbungle National Park indeed makes a magnificent setting for this world class observatory, one of the few located under the beautiful southern hemisphere skies. The Observatory is located 25 kilometres west of Coonabarabran. The most prominent feature, and the first sight to greet visitors, is the tall white dome of the Anglo-Australian Telescope (AAT). This 3.9 metre telescope is still the 'flag-ship' for optical astronomy in this country. Siding Spring Mountain also is the home for a number of other telescopes such as the Australian National University's (ANU) 0.4m, 0.6m, 1.0m and the 2.2m Advanced Technology Telescope (ATT). The 1.2m Schmidt Camera is also located on the mountain. For the public, the only telescope that is made available to visitors (except for open days) is the AAT itself. A viewing gallery offers visitors an excellent view of this telescope that has contributed so much to man's knowledge of the Universe. The Visitor's Centre or "Siding Spring Exploratory" consists of the 'Exploring the Universe' exhibition. This provides an introduction to the science and technology of modern astronomical research.

Hours: 9:30am to 4:00pm daily except Christmas Day.

Cost: $5:00 Adults, $3:00 Children/concession and $12:00 Family

Special tours can be arranged for buses or school groups.

Contact (02) 6842-6211.

QUEENSLAND

THE SIR THOMAS BRISBANE PLANETARIUM

The planetarium is located in the beautiful surrounds of the Mt. Cootha Botanic Gardens in Brisbane. Regular programmes are presented, lasting about 45 minutes, based on specific astronomical themes. The 'Cosmic Skydome' has an artificial sky projected onto the interior surface of a 12.5m dome. This is certainly a world class planetarium and well worth the visit! The foyer and gallery areas contain an interesting collection of displays and artefacts related to astronomy. The planetarium also has an observatory with a 15cm refractor and a 41cm reflector. If sky conditions are suitable on nights of operation, viewing sessions can be organised for limited numbers. Shows are 3:30pm & 7:30pm, Wednesday to Friday (also 1:30pm during Qld school holidays). Also 1:30pm, 3:30pm and 7:30pm on Saturday and 1:30pm and 3:30pm on Sunday. Visitors are requested to arrive at least 10 minutes before the starting time and bookings are advisable. Not recommended for children under 6.

Cost: $8 Adults, $4.50 Children (under 15 years) and concessions of $6.50 for Students / Pensioners.

Bookings: (07) 3403-2578 - Wednesday to Sunday ONLY (noon to 7pm).

Internet: http://www.powerup.com.au/~stbp/

ALLOWAY OBSERVATORY

Operated by the Bundaberg Astronomical Society, this observatory is open to the public by appointment. The 48cm Newtonian reflector telescope is housed in a geodesic dome and is one of the largest telescopes in Queensland open to the public.

Cost: Over 10 persons - $3 adults, $2 children
Under 10 persons - $5 adults, $3 children

Contact: Karlene Galway (07) 4159-9674

SOUTH AUSTRALIA

UNIVERSITY OF SOUTH AUSTRALIA PLANETARIUM

The planetarium was originally installed to teach surveying to students at the university. It is now available to the public.

TASMANIA

LAUNCESTON PLANETARIUM

The planetarium is in the Queen Victoria Museum, Wellington St.

Show Times: Tuesday to Friday 3:00pm, Saturday 2:00pm and 3:00pm. During government school holidays, shows run Monday to Saturday 2:00pm and 3:00pm. Group bookings by arrangement.

Cost: $2 Children (under 15), $3 Adults and $7 family (children under 5 years old are not admitted)

Contact: (03) 6323-3777

VICTORIA

BALLARAT MUNICIPAL OBSERVATORY

The observatory contains three historic telescopes; the Jelbart - a 5" refractor, The Oddie - an 8" Newtonian, and The Baker Great Equatorial Telescope - a 26" Newtonian, which was commissioned in 1888. This observatory is open most Friday nights (perhaps not during Xmas or Easter) by the Ballarat Astronomical Society. Daytime tours can also be arranged by appointment.

Contact: (03) 5332-7526

MELBOURNE OBSERVATORY

The historic Old Melbourne Observatory is located in the Botanic Gardens at South Yarra. Open days are on the last Sunday of each month (2-4pm), and open nights on the first Saturday (8-10pm). No bookings required.

Contact: Ms Linda Mockridge (Ast. Soc. of Vic.) (03) 9596-5884

ASTRONOMICAL COURSES, SOURCES OF INFORMATION

The following lists astronomy courses, events, magazines and radio programs known to the authors for 1998. 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. Enquires 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.

The internet should not be overlooked as a valuable source of information. See page 7 as well as the society homepage addresses, at the end of the appropriate organisations, in the next section.

ASSOCIATION AGAINST OBTRUSIVE LIGHTING

AAOL is a non-profit organisation which aims to protect the environment, the night sky, and the public from the detrimental effects of light pollution.

Contact: Qld - PO Box 8266, Wooloongabba QLD 4102, Ph (07) 3217 4080
Vic - PO Box 1023, Croydon VIC 3136, Ph (03) 9723-4356

SKY AND TELESCOPE-ASTRONOMY HOTLINE 'SKYLINE'.

Telephone 0011-1-617-497-4168. Internet: http://www.skypub.com/

QUESTACON STARLAB

Starlab is an inflatable planetarium which can accommodate up to 30 students. A specially designed projector enables trained operators to show the night sky onto the darkened interior surface of the Starlab. Starlab also enables the operator to clearly show the behaviour of the sun, moon, the planets, major constellations and other interesting features of the sky. Questacon have 5 starlabs available for hire to schools. They also conduct workshops to train teachers in the use of these planetariums.

Contact: Geoff Crane (Outreach Education)
Phone: 02 6270 2820 Fax:1800 641 171 e-mail gcrane@questacon.edu.au
The National Science and Technology Centre, Canberra ACT 2600

GENERAL PUBLICATIONS

ASTROCARDS

The Astronomical Society of NSW runs an information service called 'Astrocards'. This service alerts subscribers quickly to any new discoveries such as Novae, Comets or planetary events. The format is a simple letter.

Cost: $10 for 10 - Cheques (payable to ASNSW)
Contact: G. Bryant (as per "Comet Tales" below)

SKY & SPACE MAGAZINE

This astronomy and space exploration magazine is produced for enthusiasts in Australia and New Zealand. It has a wide range of astronomy related topics, catering to both the novice and the very experienced. The magazine is bi-monthly and available through newsagencies or by subscription. Sky & Space also publish two other magazines, "Southern Astronomy" (4 issues per year) and "Asia-Pacific Spaceflight" (6 issues per year)..

Contact: (02) 9369-3344, Fax (02) 9369-3366.
Address: Sky & Space Publishing, PO Box 1690, Bondi Junction NSW 1355

COMET TALES

This bi-monthly newsletter, edited by the former Southern Sky magazine comet columnist Greg Bryant, includes up-to-date information on comets, meteor showers, planetary and deep-sky observing, monthly sky highlights, astronomy news from around the world, space mission updates, Australian clubs, and amateur activities..

Cost $10 for 6 issues (payable to G. Bryant)
Address: 2/100-104 Kissing Point Rd, Dundas NSW 2117

PERIHELION

A bulletin for comet observers. This newsletter, published by David Seargent, is specifically designed for the Australian observer. Seargent is the head of the Australian Comet Section, author and contributor to Sky & Space magazine.

Cost: $12 (for 4 issues per year), $15 also includes special mail notices for new discoveries (Cheques payable to Karagi Publication).
Address: Australian Comet Section, PO Box 204, The Entrance NSW 2261

NEW SOUTH WALES

NATIONAL AUSTRALIAN CONVENTION OF AMATEUR ASTRONOMERS (NACAA).

The National Australian Convention of Amateur Astronomers is a convention of amateur astronomers held over Easter every even numbered year at a different location in Australia. The 1998 convention will be held April 10-13th in Sydney and is hosted by the Sutherland Astronomical Society. In addition to the formal presentation of papers, there is a public lecture and public astronomy expo. For further information, contact the Convenor on (02) 9832-4082, PO Box 31 Sutherland NSW 2232, or email sasi@ozemail.com.au.

The Convention is proudly sponsored by York Optical Company (Principal Sponsor), The Binocular & Telescope Shop, Macquarie University Foundation of Astronomy, Quasar Publishing and Sky & Space (Major Sponsors).

MACQUARIE UNIVERSITY ASTRONOMY OPEN NIGHTS

These nights are specifically designed with the general public in mind. Activities include: a special guest speaker, numerous telescopes operated by local amateurs and commercial stands where one can check out the latest astronomical merchandise. The local scout group will even sell you a steak sandwich! The 1998 dates are April 4 and October 31. The venue is Macquarie University (off Epping Rd., North Ryde, Sydney) and commences around 6pm. There is a small entrance fee which helps to fund equipment for the university observatory.

SOUTH PACIFIC STAR PARTY

A national gathering of amateurs for a week of observing under country skies. This is held at the Astronomical Society of NSW's (ASNSW) property at Ilford, NSW. This major event usually attracts over 200 amateurs from all over Australia and overseas. The 1998 SPSP will be held March 27th to 30th. Contact the ASNSW for details (p. 132)..

PRACTICAL ASTRONOMY (SASPAC)

A practical astronomy course for beginners and interested amateurs. This is an 8 week course conducted by Sutherland Astronomical Society (SAS) during spring. Each 1 hour lecture is followed by observations with the society's equipment. Cost: $80.

Venue: Green Point Observatory (Sutherland, Sydney).
Contact: Chris Toohey Ph (02) 9589-1014

ASTRONOMY (GOSFORD)

This course is conducted at Kariong, near Gosford, with urban observing included at each session. A field trip to Koolang Observatory (p. 129) is also offered (for a small additional charge) to benefit from a dark sky site and a large telescope. The course is designed for beginners, and covers basic topics including eclipses, phases of the Moon, the Solar System, and telescopes. Some theoretical topics are also discussed and include stellar evolution, the electromagnetic spectrum and exotic objects like black holes. The course runs for eight weeks each term (2 hour evening sessions). No prior experience is needed.

Tutor: Lesa Moore (Senior Guide, Koolang Observatory)
Booking: Central Coast Community College (02) 4348 4300.

UNIVERSITY OF NSW OPEN NIGHTS (SYDNEY)

The University of NSW has a new observatory and it is open to the public on Friday nights. During 1997 it was open from May to September. For bookings contact (02) 9385-5752.

W.E.A. - SYDNEY OBSERVATORY COURSE

Sydney Observatory and the WEA will run a number of beginner astronomy courses based at the observatory during 1998. Contact WEA (02) 9264-2781 for cost, timetable details.

NEPEAN COMMUNITY COLLEGE COURSES

Run at the Kings Tableland Observatory in Wentworth Falls (Blue Mountains). See also the entry under 'Places of Astronomical Interest'.

QUEENSLAND

ASTROFEST

The Queensland AstroFest has been held annually since 1993 at the Lions Camp Duckadang, about 2 hours drive northwest of Brisbane. It is held at a site with superb living conditions, a Celestron-14 telescope (the Stewart Observatory) and a very dark sky. The event is held over six nights, with main events held on Thursday, Friday and Saturday nights. Activities include; presentations from guest professional astronomers, awards in amateur astronomy, swap & sell, barbecue, smorgasboard, slide shows and light sports. For more information:

http://www.ozemail.com.au/~mhorn2/afest.html
or e-mail zac pujic: pujic@biosci.ug.oz.au

WEEKEND ASTRONOMY COURSES (BRISBANE)

Held at the Mt. Gravatt TAFE Campus, Mt Gravatt. Course is 17 hours (including 4 hours of practical at Manly Observatory).

Contact: J. Barclay (07) 3396-1391 (AH) or (07) 3893-2688 (Fax)
Manly observatory also offers professional day and night Astronomy courses for primary and secondary schools (contact J. Barclay, see above).

INTRODUCTION TO THE NIGHT SKY COURSE (Bundaberg)

Held by the Bundaberg Astronomical Society, these are conducted 3-4 times per year at the Alloway Observatory.

Contact: Karlene Galway (07) 4159 9674

SOUTHERN STAR EDUCATION

This Mobile Planetarium Service travels throughout South East Queensland offering on-site STARLAB planetarium/astronomy programmes to schools and resorts. Service established 1993.

Contact: Phone/Fax (07) 5533 3610
Address: 96 Doncaster Drive, Beechmont, 4211
Internet: www.ozemail.com.au/~ssemps
Email: ssemps@ozemail.com.au

SOUTH AUSTRALIA

W.E.A. COURSES (ADELAIDE)

Beginners course run each semester. Contact WEA (08) 8223-1272.

TASMANIA

The **'Adult Education Department' (Hobart)** occasionally run Astronomy courses conducted by members of the Astronomical Society of Tasmania.

In 1st and 3rd terms run a 2 week introductory course and an 8 week in depth course. In 2nd term run a 5 week astro-photography course.

Contact: Greg Burns (03) 6278 2184 (course contents)
Adult education on (03) 6233 7237 (schedules/costs).

VICTORIA

VASTROC

Victorian Amateur Astronomical Society's Conventions (VASTROC's) are held every second year (alternating between years with NACAA Conventions). Activities include speakers, keynote speakers, workshops, poster displays, forums, social gatherings at lunch/tea breaks and the Convention dinner. The next VASTROC will be held in 1999, further information will be published in ASTRONOMY 1999.

SKYLINE

A prerecorded information service, run by the Astronomical Society of Victoria, to cover the latest astronomical discoveries. Cost is only the phone call. Ph (03) 9888-7130. Updated weekly or more frequently as required.

THE SPACE SHOW

This Melbourne radio programme is run by Andrew Rennie & Mark Hillyer, Wednesday evening (1 hr) on 3SCB FM (88.3MHz).

C.A.E. COURSES

Beginners and advanced courses are run each semester. Contact the C.A.E. for costs and dates. Phone (03) 9652-0611.

AMATEUR ASTRONOMY SHORTWAVE STATION (VK3 EKH)

This service, run by members of the Astronomical Society of Victoria, broadcasts to Australia on Fridays from 10pm on 3.543MHz (LSB).

ASTRONOMICAL SOCIETIES

The following is a list of the amateur societies in Australia. A common philosophy within all these organisations is the emphasis they place on public education. Enquires from anyone with an interest in astronomy are most welcome. Where given, annual fees are subject to change. The authors of this publication are keen to keep the information in this section 'evergreen'. It would be appreciated if any significant change occurs (especially new organisations) that the society contact Quasar Publishing (p. 2). The deadline for ASTRONOMY 1999 will be 1 September 98.

Please note that a number of the societies now have internet addresses. These can be excellent sources of information such as latest astronomical discoveries, society events and connections to other astronomy sites on the Web.

NEW SOUTH WALES

ASTRONOMICAL SOCIETY OF COONABARABRAN

Meets on the third Thursday of each month at 7:30pm at the Coonabarabran High School. The club's 15cm Dobsonian reflector is available for members to hire.

Fees: $1.00 joining fee plus $15.00 annual subscription.
Address: c/- AAO Private Bag, Coonabarabran NSW 2357
Contact: Paul Cass 068 42 2994

ASTRONOMICAL SOCIETY OF THE HUNTER

Meetings are held at the Kurri TAFE College on the first Friday of each month at 7:30pm.

Fees: $20 adult, $25 family
Address: PO Box 69, Kurri Kurri NSW 2327
Contact: George Livanos (02) 4969-2313

ASTRONOMICAL SOCIETY OF NSW

The society holds meetings twice per month at the 'CSIRO, Division of Radio Physics', Pembroke St., Marsfield. At ordinary meetings, professional astronomers are invited to talk on various astronomical topics. The technical meetings are less formal, where members of the Society often present discussions on their amateur projects. Guests are most welcome. The Society also runs two observing sites. One at Bowen Mountain, near Richmond, west of Sydney, where the society has an observatory. The other, is their 'dark sky' property 'Wiruna', near Ilford. A monthly newsletter 'Universe' is published for members.

Fees $40 Full, $10 Juniors (under 18) and $30 Student (over 18). There is no joining fee.
Address: GPO Box 1123, Sydney, NSW, 2001.
Contact: Max Gardner (02) 9337 3371.
Internet: www.ozemail.com.au/~asnsw

BRITISH ASTRONOMICAL ASSOCIATION - NSW BRANCH

The BAA meets at Sydney Observatory on the third Wednesday of each month, commencing at 7:30pm. At these meetings, professional astronomers are often invited as guest speakers. Regular practical workshops are also held on weekends. The BAA also publish a regular newsletter called 'The Astronomer's Bulletin'.

Address: Sydney Observatory, Watson Rd., The Rocks, Sydney 2000
Fees: $35 Full, $17.50 Junior/concession and there are family concessions available. There is a 50% Joining Fee.
Contact: Elizabeth Cocking (02) 9398 9705

(ACT) CANBERRA ASTRONOMICAL SOCIETY

Hold meetings at the Duffield Building, Mt Stromlo, on the 3rd Thursday of each month (except Dec/Jan) at 8:00pm. Meetings frequently feature guest speakers from both the amateur and professional community (or related fields) who give a short lecture on astronomical topics. Members also give presentations on current items of interest or their own astronomical pursuits. The CAS also publish a monthly newsletter.

Fees: $25 adult, $12 student/ pensioner and $40 Family.
Address: PO Box 1338, Woden ACT 2606
Contact: John Howard (02) 6248 0552
Email: john.n.howard@atonat.ausgovtax.telememo.au
Web: http://msowww.anu.edu.au/cas/

HAWKESBURY ASTRONOMICAL ASSOCIATION

Meetings are held once a month on the 2nd Wednesday, commencing 7:45pm, in the 'Tebbutt rooms' at the Windsor Library (Dight St. Windsor). They also observe on the Third Quarter and New Moon weekends. The club organises several public field nights per year and presents a basic introduction to astronomy. The HAA prides itself on being family orientated and aims to cater for the newcomer at a basic level.

Fees: $20 adult, $30 family and $10 Junior.
Address: PO Box 670 Windsor NSW 2756
Contact: Adrian Saw (02) 4572 1568

ILLAWARRA ASTRONOMICAL SOCIETY

Meetings are held at the University of Wollongong Science Centre, Fairy Meadow, on the second Tuesday of each month at 7:30pm. There are monthly observing nights held at a 'deep sky' site west of Wollongong.

Address: PO Box 1814, Wollongong NSW 2500
Contact: Peter MacKinnon (02) 4276-3199

MACARTHUR ASTRONOMICAL SOCIETY

The society conducts monthly meetings at the University of Western Sydney (Macarthur) in Campbelltown. It has a newsletter and holds regular star nights.

Address C/- Secretary, PO Box 17, Minto NSW 2500.
Contact: Phillip Ainsworth, president (02) 9605-6174

THE NEWCASTLE ASTRONOMICAL SOCIETY

Meetings are held on the last Friday of each month (except December), at the University of Newcastle, Lecture Theatre EO1, Department of Physics at 7:30pm. Most meetings consist of a general summary of what is visible and late breaking news, followed by a variety of short talks on various aspects of astronomy. The club is aimed at the novice astronomer. Two or three times a year they have guest speakers who are normally professional astronomers. Observing nights are organised during the year.

Fees: Family $20, single $15, Student/Child $8, Guests $2
Address: c/- Dept. Physics, University of Newcastle Callahagn NSW 2308
Contact: Alan Meehan (02) 4929 6600 or George Barnes (02) 4967 1057
www.newcastle.edu.au/department/ph/plasma/NAS/nas_home.html

NORTHERN DISTRICTS SOCIETY OF AMATEUR ASTRONOMERS

Meetings are held at Riverview Observatory (St. Ignatius College), Lane Cove on the 3rd Tuesday of each month at 7:30pm. The society has a quarterly journal, "Reflections". Monthly observing nights are held at North Turramurra golf course.

Fees: $40 adult, $20 Student/Pensioner and $60 Family
Address: PO Box 214, West Ryde NSW 2114
Contact: Gordon Stott (02) 9871-7838

SHOALHAVEN ASTRONOMERS

Meet at the library, Falls Creek Public School on the third Friday of each month at 7:30pm. They also have a journal.

Address: PO Box 1053, Nowra NSW 2540
Contact: Jack Apfelbaum (president) (02) 4423 2255

SUTHERLAND ASTRONOMICAL SOCIETY

The society operates from Green Point Observatory near Sutherland. The observatory houses a 42cm reflecting telescope and has a well equipped library and meeting hall. Other telescopes include a high quality 15cm refractor. The SAS meets every Thursday at 8:00pm (visitors welcome). The Society also publishes a regular newsletter and star nights are available for interested groups. There is also a public open night held annually.

Fees: $30 Full, $20 Student/Associate, $15 Junior/Pensioners and $40 for families plus joining fee - Full/Family $20, others $10.
Address: PO Box 31, Sutherland NSW 1499.
Contact: The Secretary (02) 9589-1014
Internet: www.ozemail.com.au/~sasi
Email sasi@ozemail.com.au

TAREE ASTRONOMICAL SOCIETY

The society meets at the Community Centre, Nabiac on the second Thursday of each month at 7:30pm. There is also a bi-monthly newsletter and regular Friday night observing sessions.

Address: PO Box 111, Taree NSW 2430
Contact: Mr Jim Ross 02 6550-2213
Email: rosco@midcoast.com.au
Internet: http://www.midcoast.com.au/users/rosco/rosco.html

WESTERN SYDNEY AMATEUR ASTRONOMY GROUP INC

The society meets 3rd Wednesday of the month at the Nepean Astronomy Centre, University of Western Sydney, Werrington Campus. There are also regular observing nights at the Beames Observatory at Linden and a bi-monthly newsletter.

Fees: $20 Full, $15 Student/Concession, $30 family/school groups and $10 for newsletter only.
Address: PO Box 400, Kingswood NSW 2747
Contact: Peter Nakitch (02) 9835-1824 or
Richard Piotrowski (02) 4736-5493
Internet: http://physics.st.nepean.uws.edu.au/nac/wsaag.html

UNIVERSITY OF NEW ENGLAND AND NORTHERN TABLELANDS ASTRONOMICAL SOCIETY (UNENTAS)

This is a newly formed (January 1997) amateur society, meeting for mutual enjoyment and interest in astronomy. Meetings consist of a business section, followed by viewing if conditions allow, otherwise a short talk or other educational activity is conducted. Meetings are held once per month on Thursdays (date is event driven) at the Kirby Observatory (except December and January). Time is 7:30pm..

Fees: Family: $20, Individual: $15, Concession: $10
Address: c/-Physics Dept, University of New England, Armidale 2351
Contact: Vernie Everett 067 73 3118 (W)
Email: veveret1@metz.une.edu.au

QUEENSLAND

ASTRONOMICAL ASSOCIATION OF QUEENSLAND (AAQ)

Meetings are held on the Saturday nearest to full moon at 8pm at the association's clubhouse, Balmoral Park, Morningside. Club observing nights are held 2 weeks later. They also hold regular Astrocamps, public field nights and publish a monthly journal and Annual Proceedings..

Fees: $35 adult, $50 family, $23 student and pensioner.
Address: PO Box 101, St. Lucia Qld 4067
Contact: Maria and Stephen Hutcheon (07) 3206-4338

BRISBANE ASTRONOMICAL SOCIETY

Meet on the second Friday of each month at 7:30pm. Venue is Kelvin Grove State High School Library. There is a bi-monthly newsletter. The society holds occasional Members and Public Field Nights as well as Astrocamps. The BAS have a comprehensive lending library and there are telescopes available for loan to members.

Fees: $25 adult, $30 family, $15 student /pensioner, $22 country member. Also a $5 joining fee.
Address: PO Box 204, Morningside Qld 4170
Contact: Tony Surma (07) 3274-5073
Internet: www.ozemail.com.au/~nwilliam/bas/bas.html

BUNDABERG ASTRONOMICAL SOCIETY

Meetings are held at Alloway Observatory on every Friday of each month at 7:30pm; the first Friday are general meetings (not held in January). The society publishes a bi-monthly journal and ephemeris. Field nights are generally held once a month.

Fees: $30 adult and $15 junior and $20 country (also joining fee for full members).
Address: PO Box 586, Bundaberg QLD 4670
Contact: Karlene Galway (07) 4159-9674u

CAIRNS ASTRONOMY GROUP

Hold monthly meetings at Bob's place (see below)
Address: 18 Yurongi St., Caravonica Qld 4878
Contact: Bob Dollery (070) 58-1180

MT. ISA ASTRONOMY GROUP

The society 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 near the new moon. They have an observatory at this location. Public star parties are held annually.

Fees: $35 per year
Address: PO Box 1556, Mount Isa Qld 4825
Contact: (07) 4743-2955

SOUTH EAST QUEENSLAND ASTRONOMICAL SOCIETY

The society meets at Kedron State High School on the 3rd Monday of each month, at 7:30pm. The Newsletter "Universal Times" is published quarterly.

Address: PO Box 516, Strathpine Qld 4600
Contact: Patrick Scharf (07) 38690659
Internet: www.ozemail.com.au/~mhorn/seqas.html

SOUTHERN ASTRONOMICAL SOCIETY

Meetings are held at Ormeau State School monthly at 7:30pm. The society holds regular public field nights and monthly astrocamps at a dark sky location. It also produces a bimonthly newsletter..

Fees: $28 adult and $21 student.
Address: PO Box 867, Beenleigh Qld 4207
Contact: Kevin Dixon (07) 5537-3852
email: Zac Pujic pujic@biosci.ug.oz.au
Internet: www.sas.org.au

SUN COAST ASTRONOMICAL SOCIETY

Monthly meetings are held at Caloundra State High (except December and January) at 7:30pm. There is a bi-monthly newsletter. Observing nights are held at their new site at Mapleton, near Nambour.

Address: PO Box 166, Kenilworth QLD 4574
Contact: Elaine Clark (07) 5441-5788

TOWNSVILLE ASTRONOMY GROUP

Meet on the last Wednesday of each month at 7pm at Kirwan State High. Meetings are followed by observing sessions. There is a monthly newsletter.

Address: 21 Gladys St., Kelso Qld 4815.
Contact: Richard Free (077) 89-2214

SOUTH AUSTRALIA

ASTRONOMICAL SOCIETY OF SOUTH AUSTRALIA

Meetings are held on the 1st Wednesday of each month (except January) at the University of South Australia, Levels Campus. The society maintains two observatories. The Heights Observatory at Heights School, Modbury, houses a 300mm telescope. The society's country site is Stockport Observatory, 80km north of Adelaide, which has a 0.5m telescope. Public education is important to the ASSA with various lectures and observing nights. The society publishes a monthly newsletter and

yearly ephemeris. Public field nights are held monthly at Stockport Observatory, the Heights Observatory, and at Douglas Scrub.

Fees: $34 adult (metropolitan), $10 spouse and $26 concession (student country,pensioner)
Address: GPO Box 199, Adelaide SA 5001
Contact: Trish Ellin, Secretary (08) 8272-7352 AH
Email: assa@gist.net.au
Internet: http://www.gist.net.au/assa

TASMANIA

ASTRONOMICAL SOCIETY OF TASMANIA (AST)

Meetings are held at the Hutchins School, Sandy Bay, on the last Tuesday of each month (except December). The September meeting is held at Launceston Planetarium. In line with the society's aim of promoting interest in astronomy, it runs two public nights in Hobart per year (at the Canopus Hill Observatory) and two in Launceston (at the Launceston Planetarium), usually in May and September. Presentations are made to school and community groups. The society also offers an observatory at Sandy Bay and a library.

Fees: $30 family, $28 full, $25 country (joining fee $5) and $18 concession (joining fee $2).
Address: The Secretary, Mr. M. Mulcahy, PO Box 1654, Hobart Tas 7001
Contact: Karenne Barnes (03) 6344-7100 (northern Tasmania)
Merv Mulcahy (03) 6244-2226 (Hobart)
Email: peter@vision.net.au
Internet: www.vision.net.au/~peter/AST/index.html

VICTORIA

ALBURY WODONGA ASTRONOMICAL SOCIETY

The society has occasional meetings at Wodonga High and holds regular viewing nights at the observatory at the school.

Address: 1 Poplar St., Wodonga VIC 3690
Contact: John Hills (02) 6024-7255

ASTRONOMICAL SOCIETY OF GEELONG

Holds a general meeting the last Friday of each month, plus meetings every other Friday. The venue is the Geelong Showgrounds, Rest Room, Geelong. The society publishes an occasional newsletter and holds regular viewing nights for schools and community groups as required.

Fees: $30 adult, $45 family, $15 junior/concession.
Address: PO Box 1799, Geelong Vic 3220
Contact: Frank Baker, President (015) 345 070 or
Robert Cowdell, Secretary (03) 5255-2702.

ASTRONOMICAL SOCIETY OF FRANKSTON (ASF)

Meetings are friendly and held on the 3rd Wednesday of each month, except December, at 8pm, at The Peninsula School, Wooralla Drive, Mt.Eliza. Visitors are always welcome. The Society is the second largest in Victoria with a membership of around 100. They have: a bimonthly newsletter, a library and book section, Specialist sections providing guidance in a wide range of active Astronomical interests, regular Social events, field expeditions, and regular viewing nights at the Society's dark sky property on the Mornington Peninsula (1.5 hours drive south of Melbourne). An Observatory is currently under construction at this site. All age groups, levels of experience and socioeconomic background are represented within the ASF. Each year a public "Winter Lecture series in Astronomy" is held. The ASF is renowned for its dedicated "Astronomy on the Move" viewing nights and presentations which have captivated and educated schools, the public and community groups for decades. The Society caters exclusively for all such schools and groups in the South East Victoria peninsula zone bounded by Moorabbin, Dandenong and Tooradin.

Fees: $30 adult, $25 concession, $20 student, $40 family, $35 family concession, $10 newsletter only.

Fees: $30 adult, $25 concession, $20 student, $40 family, $35 family concession, $15 newsletter only.
Address: PO Box 596, Frankston VIC 3199
Contact: Richard Pollard on (mobile) 0417 396 807
Internet: www.peninsula.starway.net.au/~aggro/

ASTRONOMICAL SOCIETY OF VICTORIA (ASV)

The ASV is the largest astronomical society in Australia with numerous specialist sections catering to a wide range of astronomical interests. They offer: a fleet of new Celestron telescopes for borrowing by new members, clubrooms and an observatory equipped with a 20 inch telescope at suburban Burwood, a dark sky site near the town of Heathcote (90 mins drive north of Melbourne) with newly built sleeping quarters and toilet facilities (the 7th Annual Star-Be-Cue will be held there in December), an extensive library, monthly members' nights on the telescopes of Old Melbourne Observatory, a bi-monthly magazine, a Yearbook, Skyline (see Astro. Courses etc. page) and ASV events. General Meetings in 1998 will be held on the 2nd Wednesday of each month, except January, at the Fire Brigade Training College theatrette (cr Victoria & Burnley Streets, Abbotsford).

Fees: Ordinary members $35, Country members $24, Junior (Under 19) $24 (a joining fee of $20 applies to all excepting juniors.))
Address: GPO Box 1059J, Melbourne VIC 3001
Contact: Ms Linda Mockridge (Public Relations Officer) (03) 9596 5884
Internet: www.gsat.net.au/astrovic/

BALLARAT ASTRONOMICAL SOCIETY

The Society was founded in 1958 and since then has been the custodian of the Ballarat Municipal Observatory, which was founded in 1886. Through the Observatory it has had the use of three historic telescopes; the Jelbart - a 5" refractor, The Oddie - an 8" Newtonian, and The Baker Great Equatorial Telescope - a 26" Newtonian, which was commissioned in 1888. In addition there is a 14" Celestron Schmidt-Cassegrain telescope. The Society holds a General Meeting on the second Friday of each month and various activities are available on the other Friday evenings. These include telescope making, observing and computing. A Cosmology Discussion Group meets on the third Sunday of each month. Society membership is open to anyone over the age of 10 years. The BAS publish a quarterly journal and yearbook and hold regular public viewing nights.

Fees: $24 adult and $16 junior (plus a joining fee).
Address: PO Box 284, Ballarat VIC 3353
Contact: (03) 5332-7526 (Society info and Observatory tour bookings))

THE BENDIGO DISTRICT ASTRONOMICAL SOCIETY

The society meets at the BRiT (3rd Floor of McCrae St Campus) at 8pm on the 4th Wednesday of each month (excluding December). A monthly newsletter is published and regular field nights are held around Bendigo.

Fees: $28 adult, $15 concession and $40 family..
Address PO Box 123, Golden Square, Bendigo VIC 3555
Contact: Ian Dean (03) 5448 4563
Internet: www.bendigo.net.au/~rbath/index.htm

LATROBE VALLEY ASTRONOMICAL SOCIETY

Meets at Monash University (Room 5N148), Switchback Rd., Churchill, on the 2nd Tuesday of each month at 7:30pm (except December and January). They publish a bi-monthly newsletter and are active in public education, conducting demonstrations for schools, church and youth groups.

Fees: $25 adult, $13 associate
Address: PO Box 80, Glengarry VIC 3854
Contact: Secretary, Martin Swanson (03) 5148 0317 fax (03) 5148 0277

NORTHERN TERRITORY

ALICE SPRINGS ASTRONOMICAL SOCIETY

The society holds meetings on the 2nd Monday of each month at the Motor Registry Office 'METEL Centre'. Two star viewing nights are held each month, at their dark sky site 6 km east of Alice Springs, on Saturdays closest to New Moon.

Address: Box 739, Alice Springs NT 0871
Contact: Karl Kramer, president (08) 8952-6426
Email: kkramer@ozemail.com.au
Internet: http://www.ozemail.com.au/~kkramer/astalice.html

DARWIN ASTRONOMY GROUP

Meetings are held monthly on Saturday nights during the dry season (various sites). There are no fees.

Address: PO 19, Kestrel Crt, Wulagi 0812
Contact: Glenn Lang (089) 27-0749 (H) Alan Cairncross (089) 27-3273 (H)

GLOSSARY

AEST Australian Eastern Standard Time.

ACST Australian Central Standard Time.

Albedo The ratio of light reflected from a solar system object to that received by it. (A complete reflection gives an albedo of 1.0 or 100 percent).

Algol A variable star of a class known as eclipsing variables. Algol's brightness fluctuates every 69 hours as it is eclipsed by its invisible companion.

Almanac A set of tables giving positions of Sun, Moon & planets at various times, plus other astronomical information; an Ephemeris.

Altazimuth co-ordinates 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 or radians.

Angular separation The angular distance between two celestial bodies measured in degrees.

Aphelion The point in an orbit of a comet, planet or minor planet 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***

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 co-ordinate 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 stars Stars which never set. To determine which stars are circumpolar from a particular place, subtract the observer's latitude from 90°. This provides the minimum declination a star 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 a superior planet is said to be in conjunction it is with the Sun (unless stated otherwise).

Conjunction - Inferior When the Earth, an inferior planet (Mercury or Venus) and the Sun are in a line in that order.

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 whole Universe.

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 co-ordinate 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 similar 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. If the eccentricity equals zero, you have a circle.

Eclipse When one object passes into the shadow of another.

Eclipse of the Moon When the Moon passes into the shadow cone 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. 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 elongation of Mercury and Venus occur when the planets are at their most 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 co-ordinate 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 March 21st, and autumnal or fall equinox about September 22nd (northern hemisphere seasons).

Galactic equator The great circle along the line of the Milky Way, marking the central plane of our ***galaxy***.

Galaxy A large disk or ball of billions of stars and ***nebulae***. They are the largest individual structures in the Universe.

Galilean satellites The four brightest satellites of Jupiter; Io, Europa, Ganymede, and Callisto, named after their discoverer, Galileo Galilei (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 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*.

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 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 9,460,529,700,000 km).

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 2.52. 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). The faintest visible to the unaided are 6 (in dark skies).

Magnitude - absolute The apparent magnitude a star would have if it were placed at 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 of an 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 Small rocky objects which revolve around the Sun. Most lie between the orbits of Mars and Jupiter in the asteroid belt.

Minute of arc An angular measure (each degree is divided in 60 minutes of arc).

Mira A variable star in the constellation of Cetus, with a range in brightness from 2nd to 10th magnitude, and a mean period of 331 days. Known as Mira the Wonderful, it is the brightest and most famous of the long period pulsating variables.

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.

Omega Centauri A globular star cluster in the constellation of Centaurus. Globulars are made up of tens of thousands of stars and form a shell around our galaxy. Omega Centauri and 47 Tucanae are two of the finest examples of these objects.

Open star cluster A loose association 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 arc second.

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.

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 its latter stages of 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 A configuration that 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 which occurs near opposition (outer planets) or near inferior conjunction (inner planets).

Right ascension (R.A.) Part of the equatorial co-ordinate 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 similar to lines of longitude on the Earth but is measured in hours (24hrs = 360°).

Second of arc An angular measure. Each degree contains 3600 seconds of arc, and each ***minute of arc*** contains 60 seconds.

Sidereal time A method of keeping time which uses the motion of the stars rather than the Sun. One sidereal day is equal to 23hrs56m4s of normal solar time.

Small Magellanic Cloud Satellite galaxy to our own Milky Way system, 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 this continuous spectrum, a star normally shows a distinctive set of dark and light lines which are characteristic of its composition.

Synodic period The period of a planet's orbit with respect to the 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 primary.

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 A time system measured on the Meridian of Greenwich, it is 10 hours less than Australian Eastern Standard Time (AEST).

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 a radiant 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

A, α	Alpha	E, ε	Epsilon	I, ι	Iota	N, ν	Nu	P, ρ	Rho	Φ,φ	Phi
B, β	Beta	Z, ζ	Zeta	K, κ	Kappa	Ξ, ξ	Xi	Σ, σ	Sigma	X, χ	Chi
Γ, γ	Gamma	H, η	Eta	Λ, λ	Lambda	O, o	Omicron	T, τ	Tau	Ψ, ψ	Psi
Δ, δ	Delta	Θ,θ, ϑ	Theta	M, μ	Mu	Π, π	Pi	Y, υ	Upsilon	Ω, ω	Omega

INDEX

Entries which refer to diagrams or tables are in **bold** type.

There is no one who has not gazed on the beauty of the night sky and wondered:

What is that bright star ?
Why do some "stars" move from night to night ?
Which planet is that ?

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 1998 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. (Well… warm clothes and clear skies would also help)

FEATURES INCLUDE:

- Realistic views of the sky, easily identifying the planets from the stars.
- Guide to the best times to observe the planets.
- When to see Shooting Stars (Meteor showers).
- Easy to read monthly rise/set charts.
- Public observatories in Australia.
- Amateur astronomical societies.
- Comet Hale-Bopp - a spectacular visitor!
- Are there planets around other stars?
- Returning comets.
- and much more …


COMET HALE-BOPP
April 1997

Quasar Publishing has been producing yearbooks since 1991 and ASTRONOMY 1998 continues to build on the high standard established over the last 8 years. The authors have had many years of experience in observational astronomy, astronomical publications, public education and the amateur astronomical community.

For the beginner, trying to get into the hobby of astronomy is like moving to a new town; everything is either unfamiliar or just plain unknown. . . After just a little practice with this celestial tourist guide, you'll know the sky better than you know the streets around your house. For the cost of a paperback novel, Astronomy 1996 offers the beginner a comprehensive guide to celestial events for 1996.

Sky and Space Magazine

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