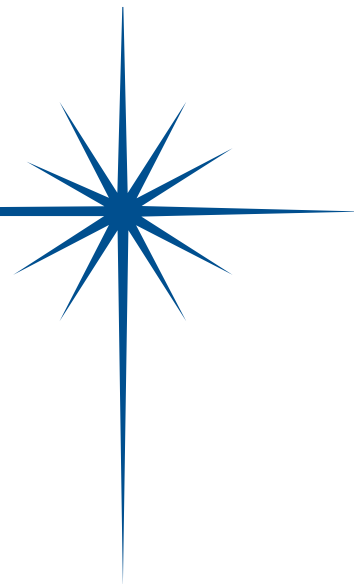


ASTRONOMY

1993

EASTERN AUSTRALIAN EDITION



**A PRACTICAL GUIDE
TO THE NIGHT SKY
FOR 1993**

GLENN DAWES PETER NORTHFIELD KEN WALLACE

1993

JANUARY

SUN	MON	TUE	WED	THUR	FRI	SAT
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3	4	5	6	7	8 ☉	9
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SEPTEMBER

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APRIL

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MAY

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NOVEMBER

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21 ☾	22	23	24	25	26	27
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JUNE

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DECEMBER

SUN	MON	TUE	WED	THUR	FRI	SAT
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19	20	21 ☾	22	23	24	25
26	27	28	29 ☉	30	31	

● New Moon

☾ First Quarter

☉ Full Moon

● Last Quarter

ASTRONOMY

1993

A PRACTICAL GUIDE
TO THE NIGHT SKY
FOR 1993

G. DAWES P. NORTHFIELD K. WALLACE

QUASAR PUBLISHING
1992

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Peter Northfield
Ken Wallace

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TABLE OF CONTENTS

Introduction	4	Venus	
Acknowledgements	4	Rise & Set	84
Let Us (Not) See The Light.....	5	Geocentric Position	85
The role of the amateur	5	Mars	
Notes on using this book.....	6	Rise & Set, Geocentric Position	86
Part 1 Explanation.....	6	Finder Chart	84
		Opposition	87
PART 1 - MONTHLY SECTION		Jupiter	
January	8	Rise & Set, Geocentric Position	88
February	12	Finder Chart	88
March	17	Longitude of Central Meridian	89
April	21	Satellite Events.....	90
May	26	Eclipse Coordinates	93
June	31	Saturn	
July	36	Rise & Set, Geocentric Position	94
August	41	Finder Chart	94
September	46	Longitude of Central Meridian	95
October	51	Rings	95
November	55	Satellites	96
December	60	Uranus/Neptune/Pluto	
		Geocentric Position	98
PART 2 - SOLAR SYSTEM		Rise & Set	98
Part 2 Explanation	63	Finder Chart (Uranus & Neptune)	99
Solar System Data: The Planets	66	Satellites of Uranus	99
Solar System Data: Satellites	67	Satellite of Neptune	99
Declinations of Sun and Planets Diagram	68	Pluto Finder Chart	100
Planetary Angular Size Diagram	68	Meteor Showers	101
Meridian Passage of Sun and Planets Diagram	69	Minor Planets	102
Magnitudes of Planets and Asteroids	69	Comets	104
Eclipses	70		
Sun		PART 3 - APPENDICES	
Geocentric Position	72	A Rise & Set time corrections for other locations	106
Rise, Set & Twilight	73	B Julian Date	107
Physical Ephemeris	73	C Sidereal Time	108
Moon		D Hours of R. A./Constellations on the Meridian.....	113
Geocentric Position	74	E Places of Astronomical Interest	114
Rise & Set and Phase.....	75	F Astronomical Courses, sources of Information	115
Lunar Occultations Introduction	76	G Astronomical Societies	116
Lunar Occultations for Sydney	77	H Sun & Planet Rise & Set Times for Melbourne	112
Lunar Occultations for Melbourne	78	Sun & Planet Rise & Set Times for Brisbane	113
Lunar Occultations for Brisbane	79	Sun & Planet Rise & Set Times for Adelaide	114
Lunar Occultations for Adelaide	80	Sun & Planet Rise & Set Times for Hobart	115
Map	81	Moon Rise & Set Times for Melbourne	116
Mercury		Moon Rise & Set Times for Brisbane	116
Geocentric Position	82	Moon Rise & Set Times for Adelaide	117
Transit of Mercury	83	Moon Rise & Set Times for Hobart	117
Rise & Set	84	Glossary	118
		Index	120

INTRODUCTION TO 1993 EDITION

The predecessors to this publication, ASTRONOMY 1991 and 1992, were designed specifically for Sydney. ASTRONOMY 1993 has expanded on this work to encompass the Eastern States ie. New South Wales, Victoria, Queensland, South Australia and Tasmania. Although the information in parts 1 and 2 has been calculated for Sydney, appendices have now been included to cover data, for other cities, which is particularly location “sensitive”. As usual, correction factors and simple equations have been presented to help the “non city” dwellers in tailoring times for their locations. All other information, unless otherwise indicated in the relevant introduction, is common to anywhere in Australia (if not the World). Care must be taken to check for any time zone differences.

A brief “word” to the novice. Astronomy, like any science, may seem to be “swamped” in jargon. Where ever possible, in this publication, the use of these words has been kept to a minimum. However, where they are necessary, astronomical terms are either 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.

This year, for the first time, a Western Australian edition has been produced for Perth Observatory. These two editions (“Eastern” and “Western”) represent a truly national approach in the preparation of these “user-friendly” yearbooks. This “Australia-wide” coverage has never been previously attempted by any single organisation.

For more information on “ASTRONOMY 1993, Western Australian Edition”, contact Perth Observatory on (09) 293 8255 (ph) or (09) 293 8138 (fax).

ACKNOWLEDGEMENTS

The information required for this yearbook was adapted from the following sources:

- Interactive Computing Ephemeris (US Naval Observatory)
- Astronomical Almanac for the Year 1993. (US Naval / Royal Greenwich Observatories)
- Voyager, the Interactive Desktop Planetarium (Carina Software)
- Sky Atlas 2000.0 (Cambridge and Sky Publishing)
- Southern Astronomy Magazine (various issues)
- Observational Astronomy for Amateurs (Sidgwick)
- International Occultation Timing Association (IOTA)
- Uranometria 2000.0 (Vol II - The Southern Hemisphere to +6°)
- Hubble Guide Star Catalogue
- Norton’s Star Atlas
- The Solar System (Reidy, Wallace)
- Sky and Telescope Magazine (various issues)
- NAPO Meteor Observer’s Guide
- COMETS, Vagabonds of Space (D. A. Seargent)

The authors would like to recognise the contributions from the following individuals:

- Our thanks go to Ben Pawlutschenko for permission to use his Lunar map.
- Walter I. Nissen Jr. (IOTA) and Jeff Wood (meteor shower data)

The cover photograph “Moonrise over Bethanga”, was taken by R. T. Price. Thanks Robert!

LET US (NOT) SEE THE LIGHT

We who live in suburbia (the majority of Australians) are constantly under threat from pollution. The “greenies” are always present to remind us of the dangers to our health and environment by air and water pollutants. Obviously, it would be idealistically nice to return to a pre-industrial revolution like environment, ie. a more natural state. However, we tend to overlook a more subtle and equally unnatural state; that of light pollution. Another off-shoot of our mechanised civilisation.

Every night, millions of kilowatts of electricity is wasted by being directed into the sky. This misplaced light reflects off particles in the air, causing the sky at night, in and around our cities to glow. This "urban sky glow" (USG), threatens to rob us all of our common heritage; our view of the universe. It is fading away; buried in this glare.

We all have seen this effect whilst driving into a city. In some cases, we can see the metropolis coming from hundreds of kilometres away! Another way of appreciating the effect of this glow is to compare the number of stars visible and your view of the Milky Way (if you still can see it from home), at new Moon compared to that at full. It is a shame the Moon is not our only light polluter. Under a truly dark sky some of the star patterns, shown in the “sky views” in this book, would be difficult to pick, due to the multitude of fainter stars that would be visible. In fact, under these conditions, approximately 3,000 stars (on average) should be visible to the unaided, dark adapted, eye at any time. A good test for a dark sky is how clouds look. They should be black and not white, from reflected light, as we see from the suburbs.

The “sky glow” is not the only problem this stray light causes. Street lights shining through your bedroom window or even onto your property is an invasion of your privacy. The glare from street lighting, when you are driving, can even be hazardous.

Obviously we need lights. But careful controls, will not only help stem our view of the heavens fading, but will also lead to a saving in electricity. Extra power which is consuming our precious natural resources. It has been estimated that this waste costs Australia \$150 million extra each year. That’s just the cost of the light creating the sky glow. It does not include the light which we shut out with our window blinds every night. The extra coal we burn (at an efficiency of only 32%), to create this electricity, generates pollutants which are pumped into the atmosphere. This therefore enhances the chance of a greenhouse effect as well as contributing to the acid rain problem and illnesses for all life in the food chain. Just the kind of problems which concern the green lobby ! How often have you heard an environmentalist speak out against this unnecessary waste of energy and our natural resources ?

Often this problem is caused by poorly designed light fittings or insufficient thought has gone into their placement. Some designs are so bad, that it is not unusual for only 20-40% of the light output actually reaching their intended targets. They then have to put in a higher wattage unit to compensate !

Steps that could be taken to minimise this problem are:

1. The use of full-cutoff lanterns for street-lighting. This more effectively directs the light where it is needed - on the road. Less light is thrown off to the sides and there is no glare for the motorist.
2. The more extensive use of Low Pressure Sodium (LPS) lights (these give off the yellow coloured light). They are more energy efficient, having a running cost of one third compared to that for the more popular High Pressure Mercury lights (the blue ones). It is interesting that in a recent survey in the U.S.A. city of Tucson, 88% of people preferred the LPS to the Mercury or High pressure Sodium lamps. The LPS appears to be a more natural, softer, light compared to the harsher high pressure lights.
3. Advertising and outside lighting on buildings should be “downward” only. There could also be a curfew, sometime late in the evening, with all such lighting being extinguished.
4. The use of motion activated security lights. Hence removing the necessity of having industrial sites (which often cover many hectares) being floodlit from dusk till dawn.

Those wishing more information should contact the "Association Against Obtrusive Lighting (AAOL)". They need help from as many people as possible.

The Secretary, AAOL Queensland Branch, PO Box 363, Springwood QLD 4127 or

The Secretary, AAOL Victorian Branch, PO Box 1023, Croydon VIC 3136

The problem of “sky glow” is increasing dramatically. Our urban sprawl continues and more arterial links and roads are created to service these new areas. Our local councils need to be educated. After all, how many forms of pollution are there that actually saves money to combat them?

This glow threatens to block the flow of interest and wonderment to our children and the generations to come. There is nothing more breathtaking than a winter’s evening with the Milky Way stretching across the sky from horizon to horizon. May this not become something that people of the future read about in books, or look at in photographs from the past. It is up to us to act now.

Wishing you clear skies and many hours of enjoyable observing.

Glenn Dawes

Peter Northfield

Ken Wallace
(October 1992)

NOTES ON THE USE OF THIS YEARBOOK.

LOCATION The information in part 1 and 2, of this handbook, has been calculated for Sydney, NSW, with the exception of Lunar Occultation data.

Longitude = 151° 15'E, Latitude = 33° 54'S.

The Lunar occultation predictions (pp 76-80) as well as the rise & set times for the Sun, Moon and planets (pp 112-117) are tabulated for **Sydney, Melbourne, Brisbane, Adelaide** (C.A.S.T.) and **Hobart** (rise/sets only)

Unless specifically stated in the text, the data is generally **useful for most of Australia** (in particular the eastern states). Where it is appropriate, correction factors have been included for locations other than Sydney.

TIME The times used are in Eastern Australian Standard Time or EAST unless otherwise indicated. EAST is the mean solar time on the meridian of longitude of 150° E. No adjustments are made in this book for Daylight savings, also known as "Summer Time". When daylight savings is in force, the time is one hour ahead of EAST, you will need to add one hour to any EAST time for the correct local time. The 24 hr clock is often used eg 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 2 of this book, eg for rise/set times.

In some areas, it was convenient to use decimal hours. eg 5.3hr is the same as 5hr 18min or 5:18hr.

UNIVERSAL TIME, or UT, is based on the mean time for the meridian of Greenwich, England reckoned from midnight. UT is therefore equivalent to Greenwich Mean Time (GMT). EAST is 10 hours ahead of UT. For example, midnight UT, or 0 hr, is equal to 10:00hr or 10:00am EAST.

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 not measured in degrees, as is longitude, but in hours. The 360 degrees, for once around the sky, are broken up into 24 hour divisions. Each hour is further divided, like a clock, into minutes and seconds. Declination does not use north or south. 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, as is the case of 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 counterparts.

RISE AND SET TIMES. Where listed rise and set times for various objects are given in EAST. The only exception being the data for Adelaide (see appendix H) which uses Central Australian Standard Time (CAST). The times given are for when the upper limb of the object is coincident with the theoretical "true horizon. Atmospheric refraction is taken into account.

THE "POSITION" TABLES. All Right Ascensions and Declinations have been calculated for 0 hr UT of date listed, Epoch 2000. All positions are "geocentric". This means they have been calculated for the position of the centre of the Earth. There is no taking into account the parallax effect of the observer being located on the surface of the Earth. With the exception of the Moon, this slight shift is certainly insignificant.

It is quite normal, in tables of astronomical data, to come across dates such as the 0th or 32nd day of the month. The 0th day is just the last day of the previous month. The 32nd, for a 31 day month, would be the first day of the following month.

USE OF SCALE ON BACK COVER. Printed on the rear cover of this book is a scale divided into 8.7mm divisions. If the scale is held 500mm (half a metre) from the eye, each division will be equivalent to one degree of arc in the sky. The reader can also calibrate the open hand, clenched fist or thumb at arm's length using the scale for rough estimations in the field. The average adult hand (open wide) held at an approximate distance of 500mm from the eye, will correspond to an angular sweep of about 20 to 25°; a clenched fist approximately 8 to 12°

OBSERVING WITH THIS BOOK To help preserve your night vision it is recommended, when using any book or atlas under the night sky, that a red filter (cellophane) be placed over the end of your torch.

BRIGHTNESS OF STARS Throughout this book the brightness of stars are given by their magnitude. See glossary for explanation.

PART 1 MONTHLY SECTION

EXPLANATION

Part 1 of this publication is designed as a quick reference section for the novice or serious amateur astronomer who wishes knowledge on daily events, without the need to refer to lengthy complicated tables. For convenience and ease of use, the information has been segregated into monthly sections. Precise data, like the exact rise/set time or position (RA and Declination) of a planet is contained in part 2.

When using part 1, it is important to remember that all times are expressed in Eastern Australian Standard Time and **NO ALLOWANCE HAS BEEN MADE FOR DAYLIGHT SAVING TIME.**

TWILIGHT when twilight is referred to in the text, it is Astronomical and not Civil Twilight. Astronomical twilight begins or ends when the Sun is 18° below the horizon (about an hour and a half before sunrise or after sunset), Civil twilight begins or ends when the Sun is 6° below the horizon (about 30 minutes before sunrise and after sunset).

Measuring Distances Between Celestial Bodies as seen in the Sky.

Whilst the need for any mathematical ability is not essential to use these pages, it will aid the novice if they have some knowledge of angular measurement. Astronomers express the distance between celestial bodies by angles, or degrees of arc. To understand distances in angular measurement all you need to remember is that there are 360 degrees [°] in a circle. Each degree is then divided up in a similar way to "hours", the measurement of time, ie 60 minutes ['] in a degree and 60 seconds ["] in a minute. This is the same scale as used to define Declination. In fact, if two bodies have the same RA, their angular separation is equal to the difference between their declinations. When the position of a celestial object is defined as being 30' (30 minutes of arc) away from another, it simply means the separation distance, measured on the celestial sphere, is half of one degree or about one diameter of the Moon or Sun. It is an interesting exercise to go out on nights when there are conjunctions and doing your own measurements of the objects' separations and comparing your results with the predictions in this book. The scale on the back cover should assist in this venture (see also description above) and the "Sky View" diagrams will help in sorting out the planets from the brighter stars.

CONJUNCTIONS, OPPOSITIONS AND ELONGATIONS. These terms are used often in part 1 and are fully explained (with diagrams) on page 65.

Each monthly chapter in part 1 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 for 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 morning and evening astronomical twilight.

The “MOON” and “PLANETS” Text. This provides information on lunar phenomena and details of each planet. Emphasis is placed on their suitability for observation and any interesting conjunctions and configurations with the Moon, other planets and bright stars.

"JUPITER, CONFIGURATION OF SATELLITES". This shows diagrammatically the patterns the four major moons of Jupiter make as they oscillate from side-to-side (east-west) of the planet. Each complete period represents one orbit of the satellite. The horizontal date line represents 10:00am EAST (0hr UT). The close pair of parallel vertical lines represents the position of Jupiter. It is interesting to compare the times each Moon passes over these lines with the satellites transit times given in the “Daily Events” (see below). The same can be done with the occultation times ie the line disappears behind Jupiter.

The "Phases of the Eclipses" (below the configurations diagram) shows the positions of the eclipse events for each satellite for the month relative to Jupiter. See page 90 for an expanded explanation.

The "APPEARANCE OF THE PLANETS" diagram. This provides the reader with a telescopic illustration of each planet drawn to the same scale. Under each image is the date and the planet's angular diameter. Phases are also shown for Mercury, Venus and Mars.

The “DAILY 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.
- The Events of Jupiter's Major Satellites. This year all the phenomena of the four major moons have been incorporated into the “Daily Events”. All the Jovian satellite events have been reduced to only those observable when Jupiter is in the night sky (including twilight). A detailed explanation, including a diagram, is presented on page 90. A corresponding “coded” summary of all the events for the year follows on pp 91-93 (the more traditional ephemerides approach).

The “SKY VIEWS” Diagrams. These are designed to help the novice find the planets with no other help other than these drawings. The date/time of each diagram has been carefully chosen to show the most interesting configurations of the planets and Moon which will appeal to the aesthetic taste of most amateurs. Some general “sky views” have also been presented. Often, the times chosen correspond to about one hour (or even down to 30 minutes) before sunrise ("morning sky" diagrams) or after sunset ("evening sky" diagrams). Although, astronomically speaking, this would still be considered “twilight”, this is sometimes necessary to catch the planets when they are close to the Sun. This is especially relevant for Mercury which never wanders more than 30° from the Sun. The “night sky” diagrams look in any direction during the night (outside of twilight). The “Sky Views” include :

- All stars down to 4th magnitude.
- The constellations are labelled (capital letters) and each represented by dashed lines joining key stars (as per convention in some astronomy atlases and books).
- Some prominent stars and bright clusters / nebulae are named (italic, lower case).
- The Moon (showing approximate phase) and the planets (except for Neptune, Uranus and Pluto).

Although only stars down to 4th magnitude are shown, the positions of some fainter stars are sometimes indicated in the constellation “dashed” lines. Where ever there is a bend, or the end of a line, there is a star.

When using these "windows to the sky" it is important to keep in mind that the horizon shown is theoretical (eg looking out over the ocean). You will soon learn to make mental adjustments for local hills, buildings and trees etc. The scale has been kept constant and the view is approximately 37° in azimuth (along the horizon) by 49° in altitude (a

10° reference scale is also marked). Sometimes the altitude of an object of interest is such that the field of view is not large enough to include the horizon.

Uranus and Neptune have been excluded, from the “Sky Views”, for they are not generally considered to be naked eye objects. Uranus would certainly need “dark sky” conditions to be visible to the unaided eye. Neptune will always need at least binoculars. In either case, because of the many faint stars of similar brightness close by, the finder chart, on page 99, would be needed to identify these outer worlds. Pluto would need at least a 20cm telescope to glimpse this faint distant member of our Solar System. It also is not marked on the “sky views”; however a suitably detailed finder chart can be found on page 100.

Although the sky is presented as a “negative”, ie black stars with a white (grey) sky, the phase of the Moon is presented as it appears in the sky. That is, the Sun lit portion is white.

These diagrams were designed for the unaided eye, but binoculars can be very useful. They can help in finding :

- stars/ planets during twilight
- fainter stars, stars dimmed by the nearby Moon, stars close to the horizon, or
- separating planets and stars during close conjunctions.

The “sky views” are useful for more than just the date/time as indicated on the drawings. On the same evening, the star pattern will move towards the west (as the Earth rotates to the east). If you are looking towards the north, the sky will appear to rotate slowly anti-clockwise, to the south - clockwise. During the year, the Sun's apparent motion (due to the Earth orbiting the Sun) takes it once around the sky relative to the stars. This results in the stars visible (above the horizon), at any one time, being the same one month from now but 2 hours earlier (of course the planets will have moved). Compare the “sky view” for February 10 (11:00pm) with that for March 10 (9:00pm). The "Hours of Right Ascension/ Constellations on the Meridian" diagram (see page 107) can be used as a reference for when the sky (stars visible) will appear the same. For example from the diagram, the hour of RA (sidereal time) on February 10 at 11:00pm is just over 8 hours. Following this diagonal (parallel to the RA lines) shows the equivalent time for other dates (of course the planets/Moon may have moved).

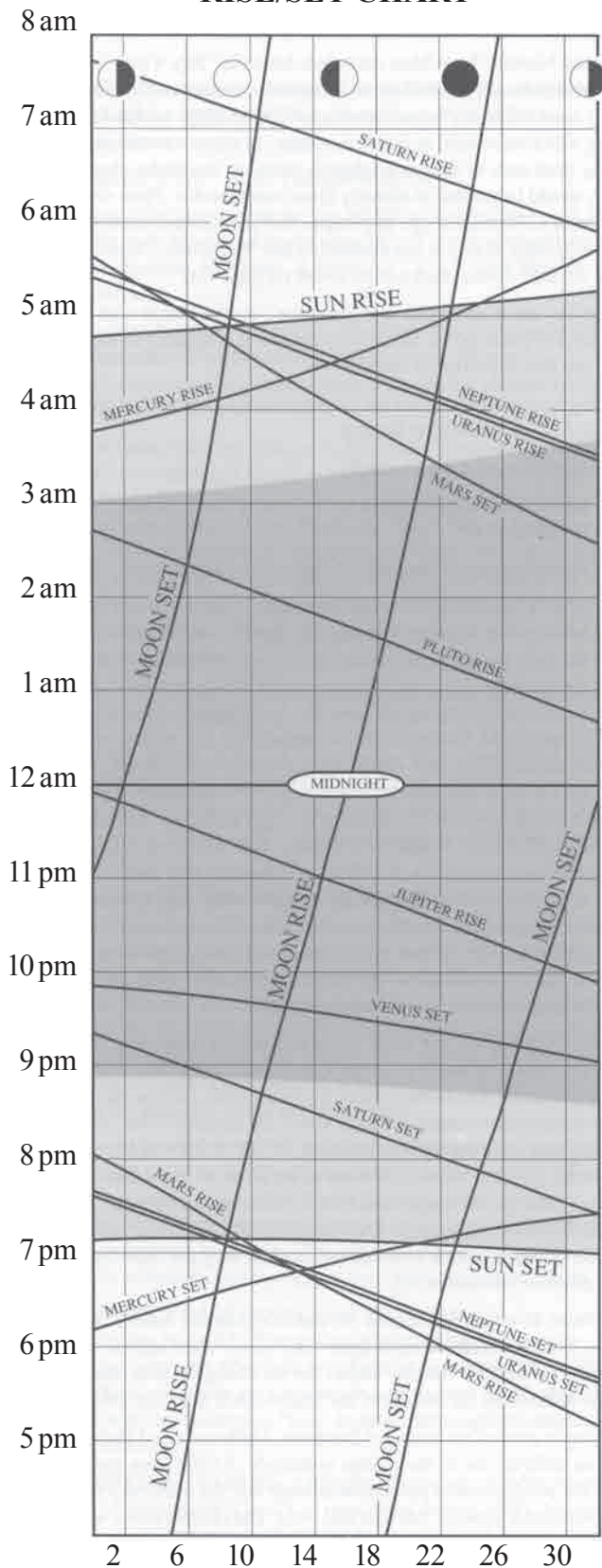
Using the “Sky Views” for other cities in Eastern Australia. The main factor, effecting which stars are visible from any place, is the observer's latitude. The further north, the more stars, familiar to our northern hemisphere friends, are seen above the horizon. The “sky views” are optimised for Sydney (latitude 33° 54' S). If you were in Brisbane (lat. 27° 30' S) you could see to the north 6° more than from Sydney (Sydney to the south would see 6° more than Brisbane). 6° being the difference in latitude. The “pointers” and the entire “Southern Cross” are not circumpolar from Queensland, as they are from Sydney (see diagram for December 13).

To determine an approximate time in Adelaide (Central Australian Standard Time) corresponding to these “sky views”, add approx. 20mins to the times given. This roughly allows for the change in time zone and longitude differences (at this scale, the latitude shift has little effect).

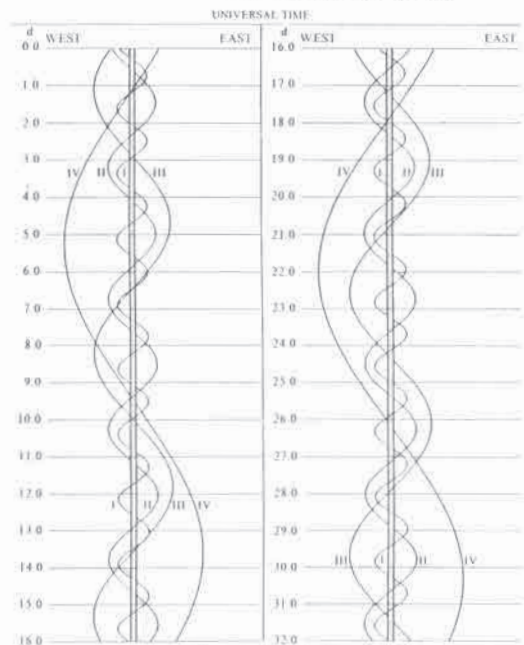
Converting to equivalent times for Brisbane, Melbourne and Hobart is a little more difficult due to the change in latitude. As one goes south in latitude, the south celestial pole gains altitude and the entire sky tilts. It is most noticeable looking due east and west. The rise/set times will vary depending on the declination of an object of interest. This is the same with “sky views”. The equivalent times will vary depending on which direction one is looking. For “sky views” showing a planet or the Moon, the correct time would be within about plus/minus 30 minutes. To get a more accurate estimate for an eastern view, compare the rise time for your city for a planet or the Moon marked on the “sky view” to the rise time for Sydney (see part 2). For western views, compare the “set” times. Add the difference in time to that of the “Sky View”.

JANUARY

RISE/SET CHART

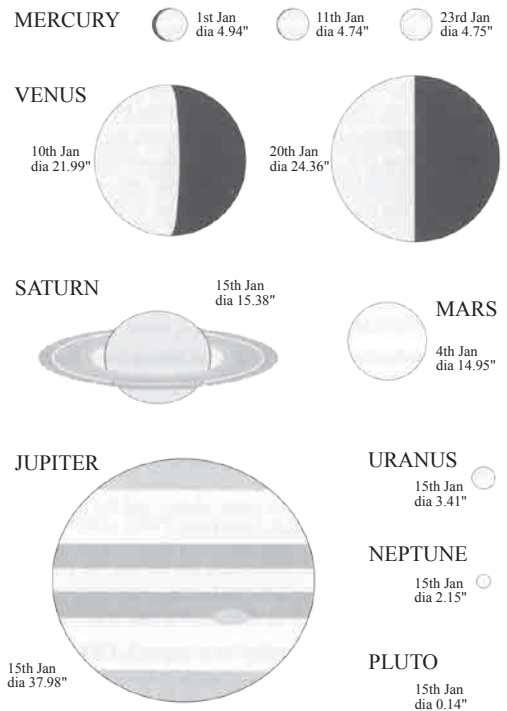


CONFIGURATIONS OF SATELLITES I-IV FOR JANUARY



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



JANUARY

THE MOON

- 1st First quarter, 1:38pm.
- 8th Full Moon, 10:37pm.
- 10th Moon at perigee (closest to Earth)
- 15th Last quarter, 2:01 pm.
- 23th New Moon, 4:27am (Lunation number 867).
- 26th Moon at apogee (most distant from Earth).
- 31st First quarter, 9:20am.

THE PLANETS

MERCURY at near full phase and magnitude -0.5, is visible an hour before sunrise at the beginning of the month, but is rapidly lost in the Sun's glare as it moves towards superior conjunction to become an evening object during the later part of January. Observation of this elusive planet would be best left until greatest western elongation during March/April.

VENUS begins the month high in the western evening sky shining at magnitude -4.3, with Saturn 11° below and southward. Saturn gradually moves away from Venus to become lost in the Sun's glare as the month progresses. Greatest elongation east of the Sun occurs on the 20th. With Venus moving towards inferior conjunction on the 1st April it's size and brightness are increasing, from a 20" diameter gibbous phase on the 1st to a 28" crescent on the 31st, and the magnitude ranges from -4.3 to -4.5. On three consecutive days at 8pm the thin crescent Moon will appear nearby Venus (altitude 15°) making a splendid sight, on the 26th the 3 day old Moon will be 9° to the west of Venus at 6°30' altitude. On the 27th, the 4 day old Moon will appear 6° north of Venus at 12° altitude (see sky view diagram). On the 28th, the 5 day old Moon will appear 15° north of Venus at an altitude of 17°.

MARS comes to opposition on the 3rd, providing it's best show since the November 1990 apparition. As far as oppositions go this is a poor one with the disc barely reaching 15" (smaller than Saturn), however it is still worthy of telescope time if for no other reason than there will scarcely be a better one until early next century (see page 87 for full details). Mars begins the month in the northern sky 4° from 1st magnitude Beta Geminorum (Pollux), forming a right angle triangle with 2nd magnitude Alpha Geminorum (Castor) (see sky view diagram), ending the month 2° from 3rd magnitude Epsilon Geminorum. On the 8th, the Full Moon will appear in the north eastern evening sky 5°30' above Mars (see sky view diagram). The planet never appears more than about 30° above the northern horizon during this opposition and observations should be left until the planet has gained enough altitude (transit happens around midnight), as large apertures, high magnification and good seeing will be required to see any detail. The magnitude range for the red planet will be -1.5 at opposition down to -0.9 at months end.

JUPITER in the constellation of Virgo at -2.2 magnitude, rises mid month around 11pm to dominate the eastern sky. The planet's disc is steadily increasing in size, now around 38", as it nears opposition on 31st March. On three consecutive nights at 1 am the Moon, Jupiter and 1st magnitude Alpha Virginis (Spica) form interesting close associations in the east; on the 14th the 21 day old Moon appears 12° above Jupiter with Spica 10° to the south. On the 15th, the 22 day old Moon appears 6°30' south of Jupiter with Spica forming a triangle (see sky view diagram). On the 16th the three appear in a straight line, Jupiter 10° north of Spica and the Moon 8° south of Spica.

SATURN is only visible in the evening twilight as it moves towards conjunction in February, then becoming a morning object as it moves westward of the Sun. Early in the month Saturn will be seen low on the western horizon with Venus 11° above in the north.

URANUS & NEPTUNE are in conjunction with the Sun on the 8th and 9th respectively and then are lost in morning twilight until February.

PLUTO rises around 2am in the morning sky. Attempts to photograph or observe the planet would be best left until next month when some altitude above the horizon is gained before the start of astronomical twilight. Pluto is situated throughout the year in Libra, near the Serpens Caput border.

METEOR SHOWERS

The **PUPPID/VELIDS** are visible from late evening till dawn. There's no single date of maximum activity, but several spread from 15th October to 22nd January. The expected Zenith Hourly Rate (ZHR) is from 10 to 15 and the meteors typically have medium speed. The radiant is nearby the beautiful 2nd magnitude multiple star Gamma Velorum.

The **COMA BERENICIDS** peak on 17th December, and are active with a ZHR of 5 from 12th December until 23rd January. The shower is observable from around 2am until dawn. The radiant in an area of the constellation Coma Berenices devoid of stars, produces very swift meteors.

The **QUADRANTIDS** are a strong and consistent shower of medium speed, but difficult for southern observers. Best seen between 1st to 5th January, with maximum activity on the 3rd. The radiant is below the early morning northeastern horizon. The ZHR is around 100.

The **DELTA CANCRIDS** are best observed around 3am in the northwestern sky. The radiant is centred near 4th magnitude Delta Cancri and produces a ZHR of 5 slow meteors. The showers' duration is from 5th to 24th January with maximum activity on the 14th.

The **ALPHA CRUCIDS**, with their radiant near Acrux (Alpha Crucis) are circumpolar, but best left until the Southern Cross gains some altitude late in the evening. Duration from 6th to 28th January with maximum activity on the 19th. A ZHR of 5 swift meteors can be expected.

The **ALPHA CARINIDS** are ideal for evening observers, with Canopus (Alpha Carina) high in the sky. The period of activity is between 24th January and 9th February, maximum next month on the 1st. The shower produces slow meteors with a ZHR of 7.

The **THETA CENTAURIDS** do not have any real peak in activity, and the shower extends from 23rd January through to 12th March. The expected ZHR is around 6. Best observed from mid evening until the beginning of astronomical twilight. The radiant is near 2nd magnitude Theta Centauri and produces very swift meteors.

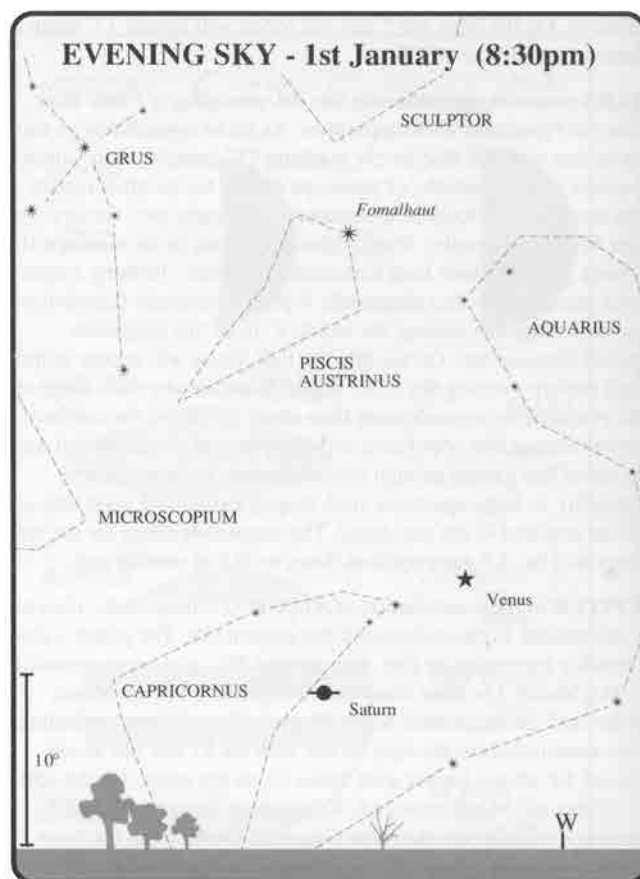
The **ALPHA CENTAURIDS** shower has a radiant near our solar systems' nearest stellar neighbour, the multiple star system of Alpha Centauri. A ZHR of between 5 to 30 very swift meteors can be expected from 28th January to 21st February, with a peak next month on the 8th. Being circumpolar, the shower is visible throughout the night.

JANUARY

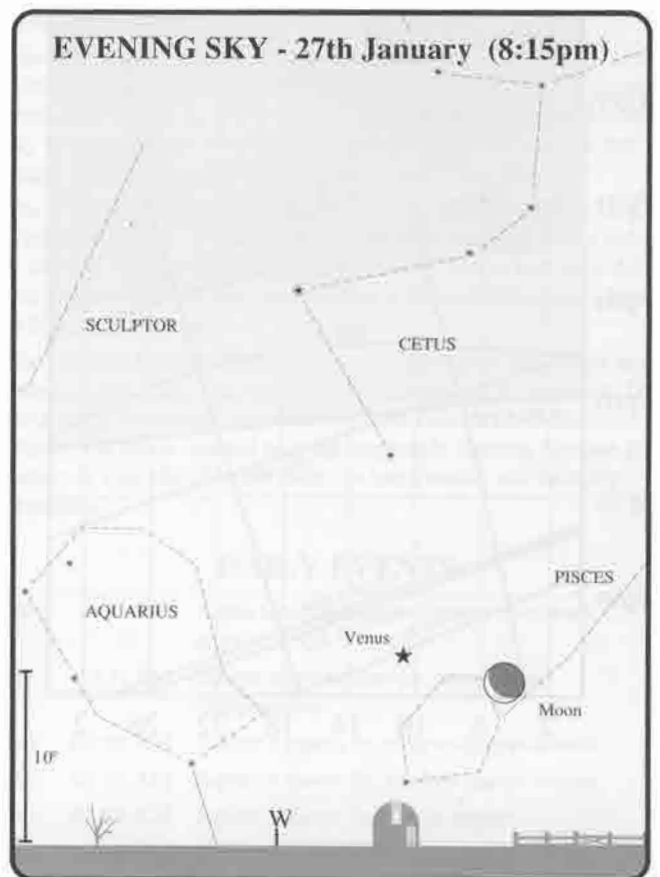
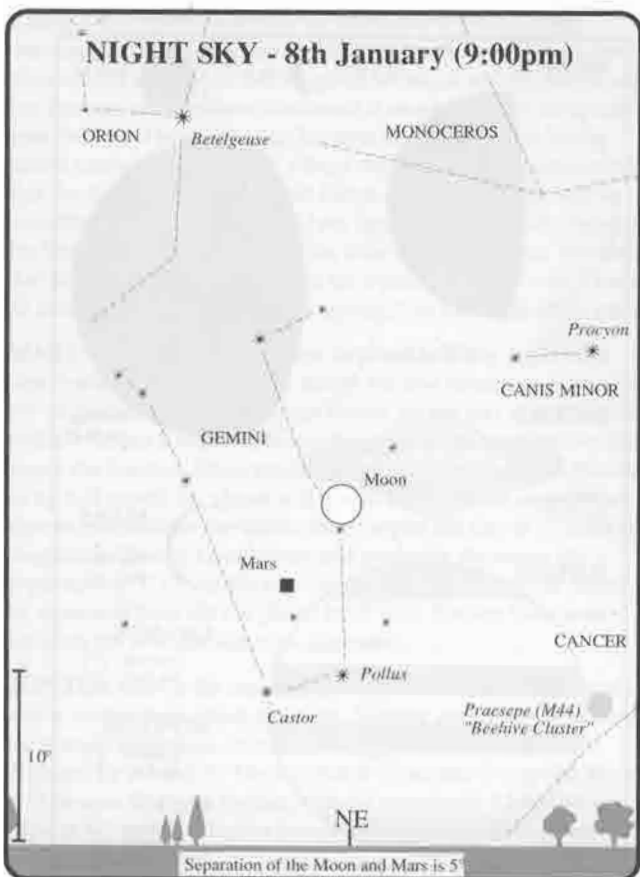
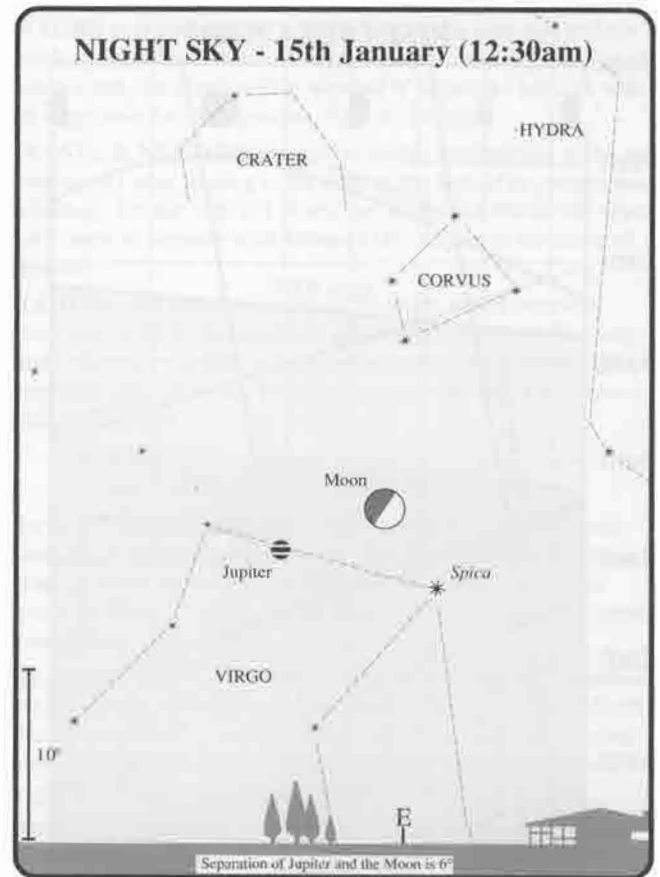
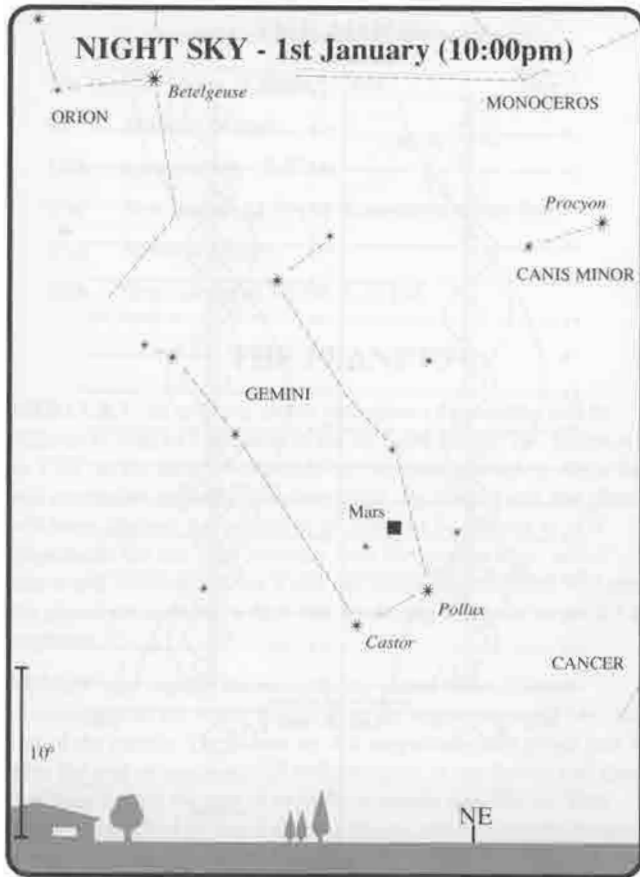
DAILY EVENTS

1st	2 PM	First quarter Moon.
3rd		Quadrantids meteor shower maximum activity.
3rd	02:34 AM	Jupiter's moon, Ganymede, eclipse reappearance.
3rd	04:39 AM	Jupiter's moon, Ganymede, occultation disappearance.
3rd	04:42 AM	Jupiter's moon, Io, shadow transit begins.
3rd	12 AM	Mars closest approach.
4th	01:50 AM	Jupiter's moon, Io, eclipse disappearance.
4th	1 PM	Earth at perihelion.
5th	12:24 AM	Jupiter's moon, Io, transit begins.
5th	01:23 AM	Jupiter's moon, Io, shadow transit ends.
5th	02:35 AM	Jupiter's moon, Io, transit ends.
5th	11:44 PM	Jupiter's moon, Io, occultation reappearance.
6th	01:48 AM	Jupiter's moon, Europa, shadow transit begins.
6th	04:16 AM	Jupiter's moon, Europa, transit begins.
6th	04:19 AM	Jupiter's moon, Europa, shadow transit ends.
7th		Mercury at aphelion.
8th	01:48 AM	Jupiter's moon, Europa, occultation reappearance.
8th	9 AM	Mars at opposition.
8th	7 PM	Uranus in conjunction with the Sun.
8th	11 PM	Full Moon.
8th	11 PM	Mars 6° North of the Moon.
9th	8 AM	Neptune in conjunction with the Sun.
10th	03:30 AM	Jupiter's moon, Ganymede, eclipse disappearance.
10th	10 PM	Moon at perigee.
11th	03:43 AM	Jupiter's moon, Io, eclipse disappearance.
12th	01:03 AM	Jupiter's moon, Io, shadow transit begins.
12th	02:16 AM	Jupiter's moon, Io, transit begins.
12th	03:16 AM	Jupiter's moon, Io, shadow transit ends.
12th	04:27 AM	Jupiter's moon, Io, transit ends.
13th	01:36 AM	Jupiter's moon, Io, occultation reappearance.
13th	04:21 AM	Jupiter's moon, Europa, shadow transit begins.
14th		Delta Cancri meteor shower maximum activity.
14th	01:06 AM	Jupiter's moon, Ganymede, transit ends.
14th	11:23 PM	Jupiter's moon, Europa, eclipse disappearance.
15th	12 AM	Jupiter 7° north of the Moon.
15th	04:20 AM	Jupiter's moon, Europa, occultation reappearance.
15th	2 PM	Last quarter Moon.
19th		Alpha Crucids meteor shower maximum activity.
19th	02:57 AM	Jupiter's moon, Io, shadow transit begins.
19th	04:08 AM	Jupiter's moon, Io, transit begins.
20th		Venus at ascending node.
20th	12:04 AM	Jupiter's moon, Io, eclipse disappearance.
20th	2 AM	Venus greatest elongation East (47°).
20th	03:27 AM	Jupiter's moon, Io, occultation reappearance.
20th	10:36 PM	Jupiter's moon, Io, transit begins.
20th	11:37 PM	Jupiter's moon, Io, shadow transit ends.
21st	12:20 AM	Jupiter's moon, Ganymede, shadow transit ends.
21st	12:46 AM	Jupiter's moon, Io, transit ends.
21st	02:19 AM	Jupiter's moon, Ganymede, transit begins.
21st	4 AM	Vesta 0°.1 South of the Moon.
21st	04:54 AM	Jupiter's moon, Ganymede, transit ends.
22nd	01:59 AM	Jupiter's moon, Europa, eclipse disappearance.
23rd	4 AM	New Moon.

23rd	10:33 PM	Jupiter's moon, Europa, transit begins.
23rd	10:42 PM	Jupiter's moon, Europa, shadow transit ends.
24th	12:56 AM	Jupiter's moon, Europa, transit ends.
24th	2 AM	Mercury in superior conjunction.
24th	2 AM	Pallas in conjunction with the Sun.
26th	04:50 AM	Jupiter's moon, Io, shadow transit begins.
26th	6 AM	Uranus 1 °.1 South of Neptune.
26th	8 PM	Moon at apogee.
27th		Mercury at greatest latitude South.
27th	01:57 AM	Jupiter's moon, Io, eclipse disappearance.
27th	3 PM	Venus 5° South of the Moon.
27th	11:18 PM	Jupiter's moon, Io, shadow transit begins.
28th	12:26 AM	Jupiter's moon, Io, transit begins.
28th	01:20 AM	Jupiter's moon, Ganymede, shadow transit begins.
28th	01:31 AM	Jupiter's moon, Io, shadow transit ends.
28th	02:37 AM	Jupiter's moon, Io, transit ends.
28th	04:17 AM	Jupiter's moon, Ganymede, shadow transit ends.
28th	11:45 PM	Jupiter's moon, Io, occultation reappearance.
29th	04:34 AM	Jupiter's moon, Europa, eclipse disappearance.
29th	11 PM	Jupiter stationary.
30th	10:45 PM	Jupiter's moon, Europa, shadow transit begins.
31st	01:00 AM	Jupiter's moon, Europa, transit begins.
31st	01:16 AM	Jupiter's moon, Europa, shadow transit ends.
31st	03:23 AM	Jupiter's moon, Europa, transit ends.
31st	9 AM	First quarter Moon.
31st	10:33 PM	Jupiter's moon, Ganymede, occultation reappearance.

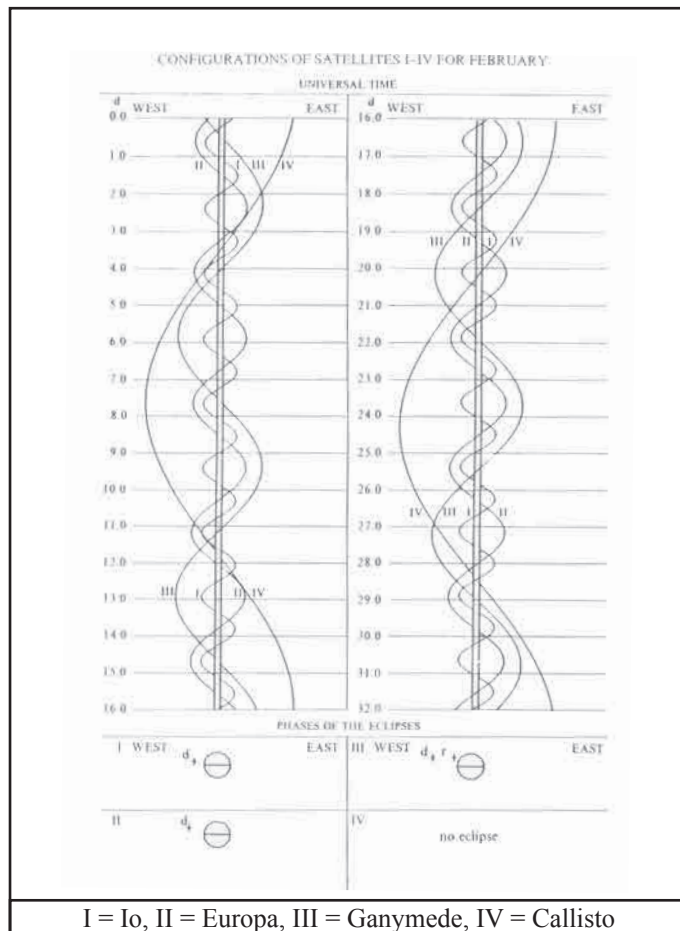
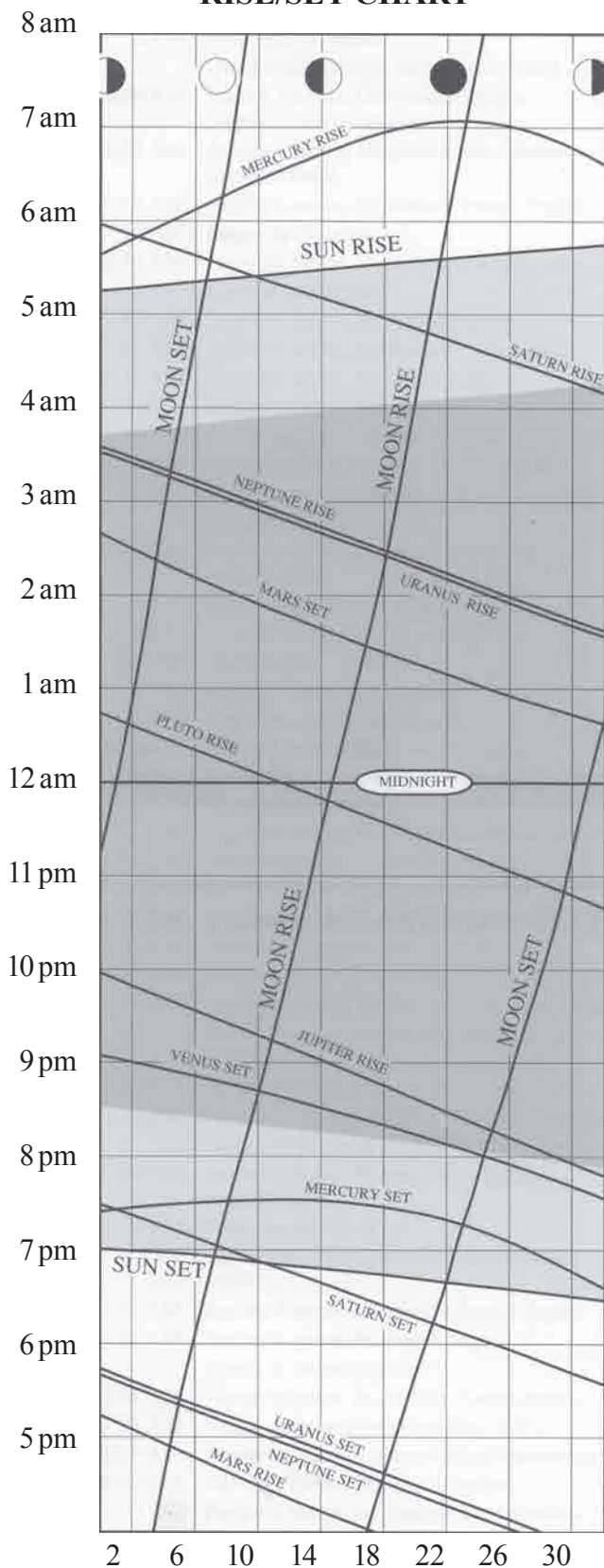


JANUARY



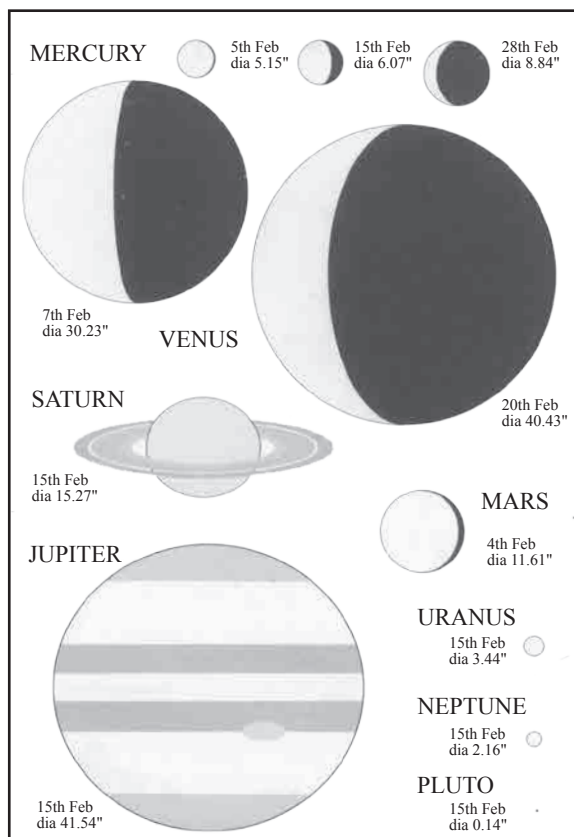
FEBRUARY

RISE/SET CHART



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



FEBRUARY

THE MOON

- 7th Full Moon, 9:55am.
- 8th Moon at perigee.
- 14th Last quarter, 12:57am.
- 21st New Moon, 11:05pm (Lunation number 868).
- 23th Moon at apogee.
- 25th Occultation of Venus, 1:22 pm.

THE PLANETS

MERCURY, an evening object throughout the month, will be difficult to find as it remains in the twilight. On the 1st, Saturn will be $1^{\circ}30'$ to the north of Mercury but the close proximity to the Sun will render the apparition unobservable. By mid month, the planet will have attained a diameter of $6''$ and will be shining at -1.0 magnitude. On the 23rd Mercury sets 10 minutes after, and 4° above and westward of the 2 day old moon. March/April will see the planet presented in a dark sky producing an easier target for the beginner.

VENUS' size rapidly increases as the planet nears inferior conjunction on 1st April, from $28''$ at the beginning to $41''$ by the end of the month. The planet, at -4.6 magnitude, sets about half hour after the end of astronomical twilight early in the month and about half hour before the end of twilight at month end. On the 25th Venus is occulted by the 3 day old Moon, considering the brightness and the angular separation from the Sun (40°), this event will provide the amateur with an ideal opportunity to locate the planet in broad daylight. A word of warning, the usual method of offsetting from the Sun using setting circles or 'sweeping' to find Mercury or Venus in daylight should only be attempted if you are fully conversant with this procedure. Please consult a recognised text, experienced amateur or astronomical society if unsure. Irreparable eye damage and blindness can result if using any form of optical aid near the Sun. The occultation happens at 1.22pm when Venus makes contact with the dark side of the lunar limb (bearing in mind that the dark side of a 3 day old Moon in broad daylight will be invisible), and reappears at 2.51 pm from the bright limb. Times are for Sydney. Check the occultation tables for other cities. For those that miss the event, at 7.30pm in the evening twilight with Venus at an altitude of 5° , the Moon will appear 2° to the north of the planet.

MARS observers will have their last chance at any significant observations early this month before the disc decreases to less than $10''$ in diameter. Throughout the month, by the end of astronomical twilight (about 8.30pm), Mars will appear in the northern sky 28° above the horizon. Observations are best carried out from this time as by mid month the planet will transit the meridian around 9pm and start to lose altitude thereafter. Mars begins the month 2° from 3rd magnitude Epsilon Geminorum and gradually decreases the separation to $1^{\circ}15'$ by the end. On the 4th, the 12 day old Moon will be separated from the red planet by 5° with Epsilon Geminorum between the two (see sky view diagram).

JUPITER rises in the east soon after astronomical twilight ends, and is visible throughout the night. Nearing opposition next month, the planets magnitude increases from -2.2 to -2.4 , as does its diameter by almost $3''$. On the 10th at 11pm the 19 day old Moon will be seen 6° above Jupiter, with 1st magnitude Alpha Virginis (Spica) 10° south of Jupiter forming a right angle triangle (see sky view diagram). On the following day, Jupiter, Spica and the Moon will appear in a straight line separated by 10° and 3° respectively.

SATURN is in conjunction with the Sun on the 10th and will not be visible until mid month when it appears in the morning

twilight. At month's end, the planet will be situated 6° above the horizon with 3rd magnitude Delta Capricorni $1^{\circ}30'$ to the south.:

URANUS & NEPTUNE are now available to observers in the early morning sky after passing to the west of the Sun, after conjunction, in January. On the 18th at 4.30am, the 26 day old Moon will appear $2^{\circ}40'$ north of Neptune with Uranus $1^{\circ}10'$ further to the south of Neptune.

PLUTO by mid month rises before midnight and is therefore, observable until the beginning of astronomical twilight. The only bright reference star that will aid in the location of Pluto is 4th magnitude Mu Serpentis. The chart on page 100 will aid further in finding the planet.

METEOR SHOWERS

The **ALPHA CARINIDS** are ideal for evening observers, with Canopus (Alpha Carina) high in the sky. The period of activity is between 24th January and 9th February, with a maximum this month on the 1st. The shower produces slow meteors with a zenith hourly (ZHR) rate of 7.

The **THETA CENTAURIDS** do not have any real peak in activity, and the shower extends from 23rd January through to 12th March. The expected ZHR is around 6. Best observed from mid evening until the beginning of astronomical twilight. The radiant is near 2nd magnitude Theta Centauri and produces very swift meteors.

The **ALPHA CENTAURIDS** shower has a radiant near our solar systems' nearest stellar neighbour, the multiple star system of Alpha Centauri. An hourly rate of between 5 to 30 very swift meteors can be expected from 28th January to 21st February, with a peak next month on the 8th. Being circumpolar, the shower is visible throughout the night.

The **OMICRON CENTAURIDS** have maximum activity on 12th February. The shower has a ZHR of 5 swift meteors, with a duration from 31st January to 19th February. It is well placed in the southern sky for evening and morning observers, with the radiant near 5th magnitude Omicron Centauri (about 5° from Delta Crucis).

The **VIRGINIDS** extend from 1st February through to 30th May, with several peaks of maximum activity over the period. The radiant is near 1st magnitude Alpha Virginis (Spica), and is best seen from late evening and into the morning hours. The expected rate is from 1 to 5 slow meteors per hour.

The **GAMMA NORMIDS** reach a maximum peak of activity next month on the 12th. 3 to 10 very swift meteors can be expected. The duration of the shower lasts between 25th February and 22nd March, and being situated near 4th magnitude Gamma Normae the radiant is well placed in the south for late evening and morning observers.

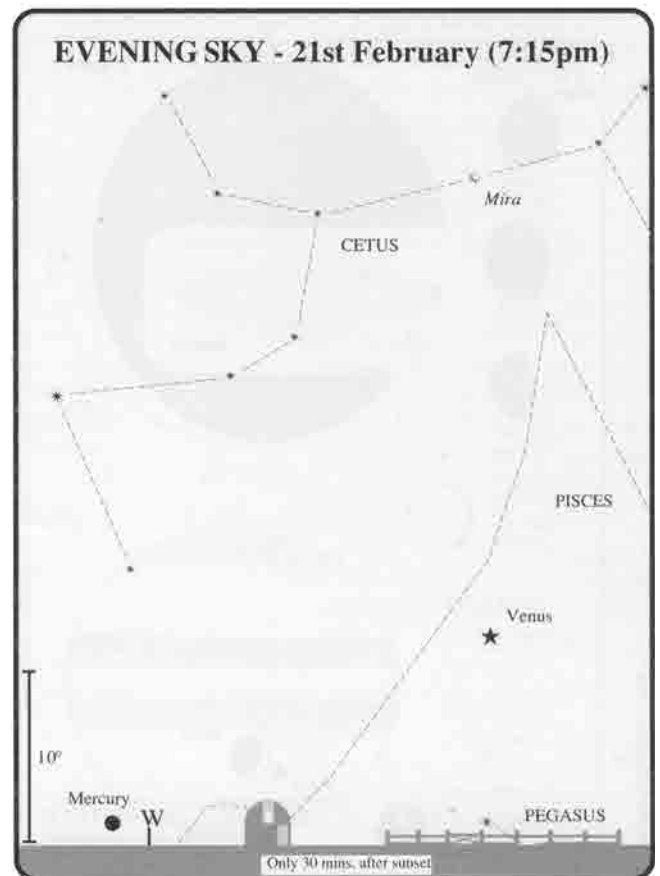
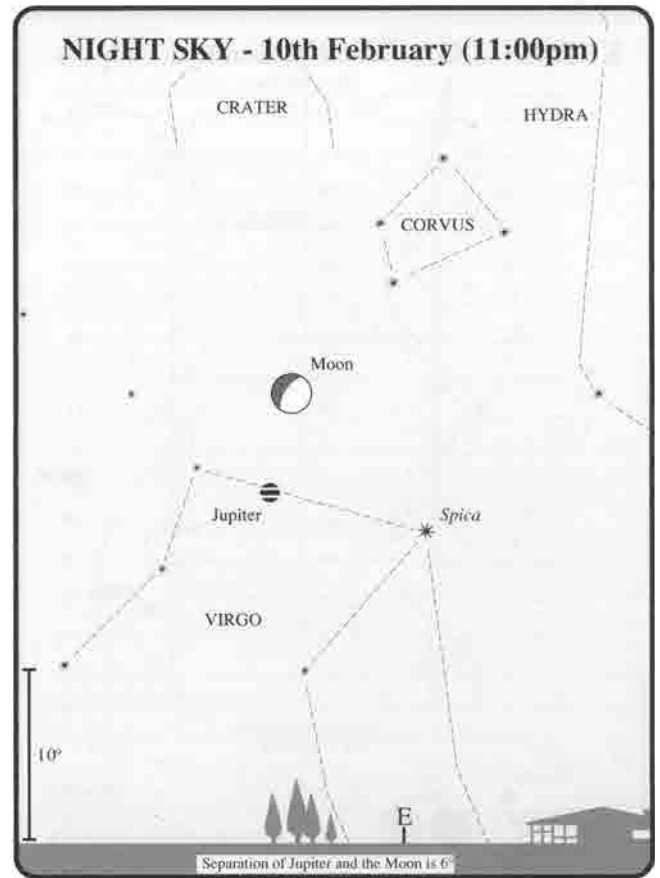
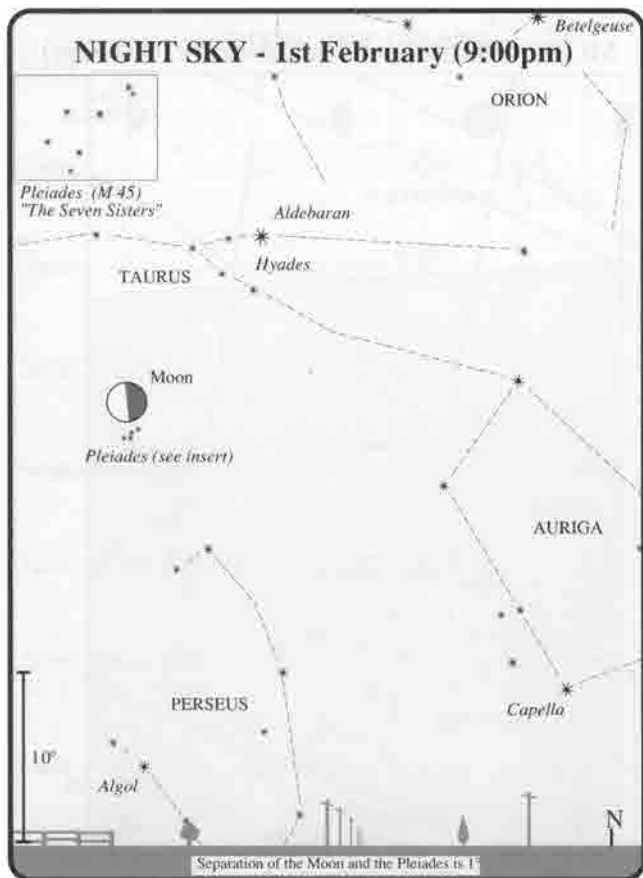
DAILY EVENTS

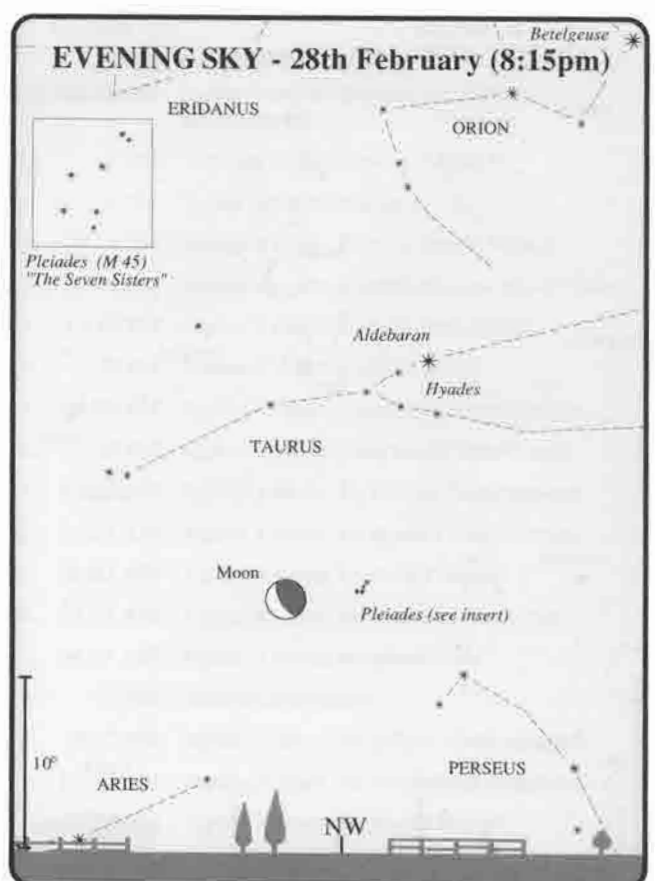
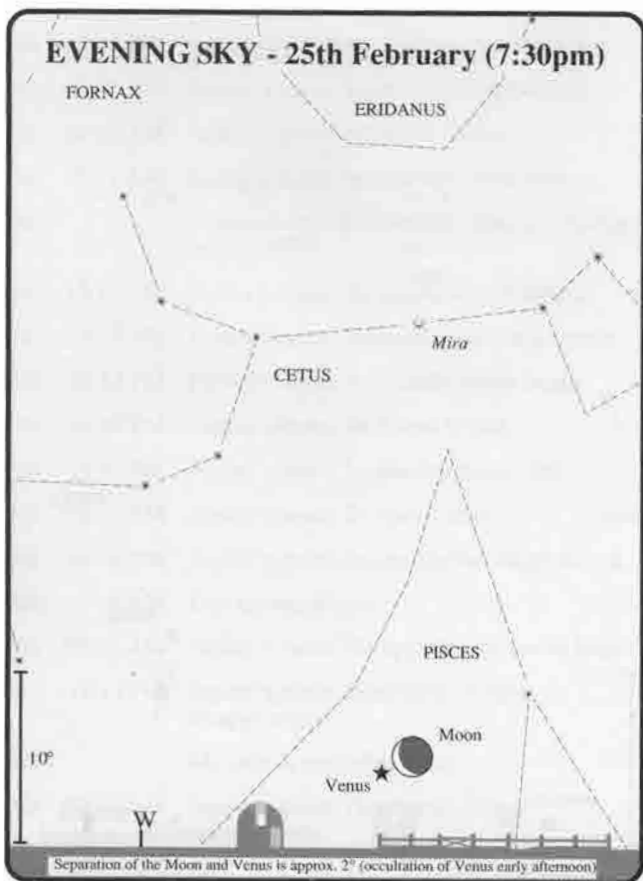
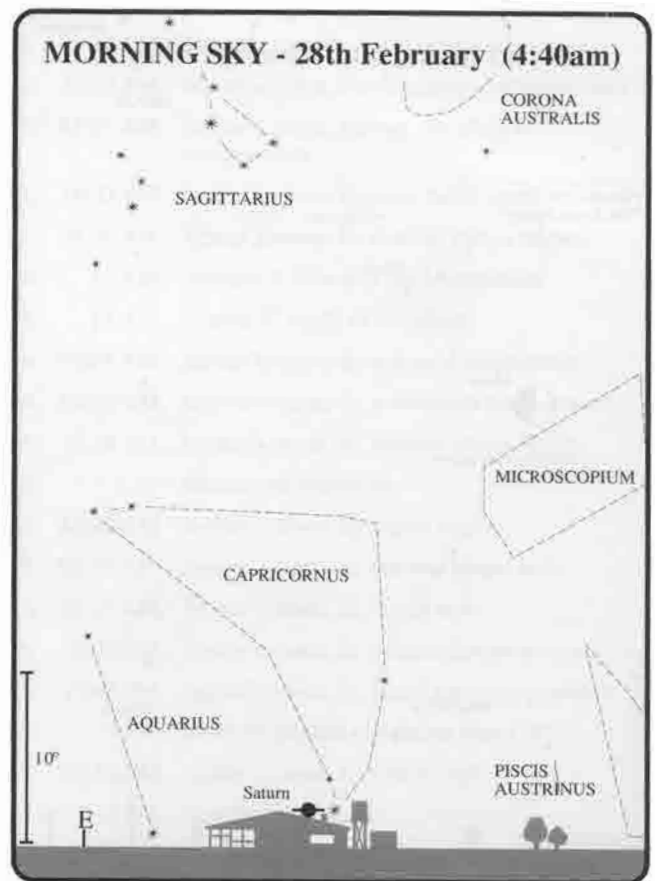
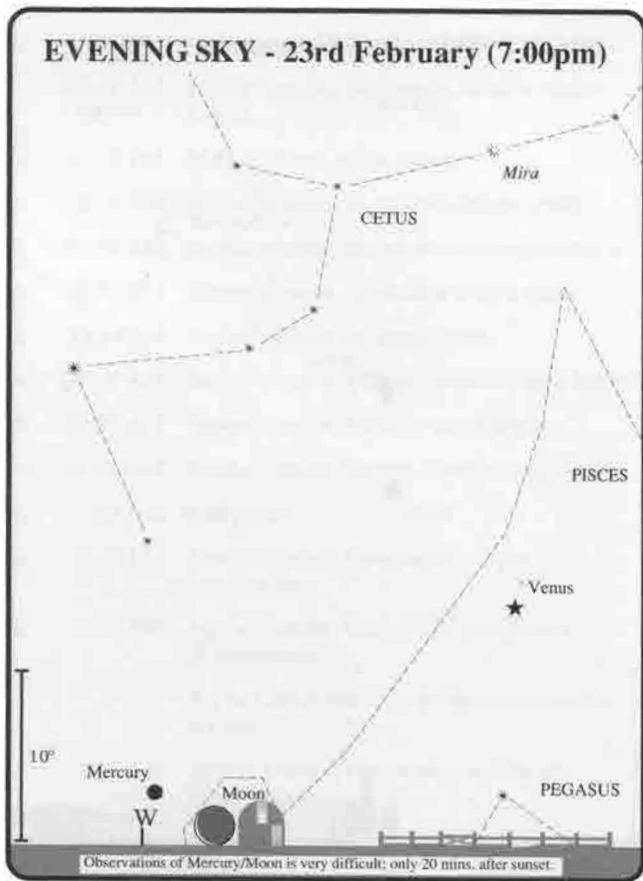
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|-----|----------|---|
| 1st | | Alpha Carinids meteor shower maximum activity. |
| 1st | 10:31 PM | Jupiter's moon, Europa, occultation reappearance. |
| 3rd | 03:50 AM | Jupiter's moon, Io, eclipse disappearance. |
| 4th | 01:11 AM | Jupiter's moon, Io, shadow transit begins. |
| 4th | 02:15 AM | Jupiter's moon, Io, transit begins. |
| 4th | 3 AM | Juno stationary. |
| 4th | 03:24 | AM Jupiter's moon, Io, shadow transit ends. |

FEBRUARY

4th	04:26 AM	Jupiter's moon, Io, transit ends.	15th	9 PM	Mars stationary.
4th	05:18 AM	Jupiter's moon, Ganymede, shadow transit begins.	15th	11:01 PM	Jupiter's moon, Europa, eclipse disappearance.
4th	8 PM	Mars 6° North of the Moon.	16th	03:17 AM	Jupiter's moon, Europa, occultation reappearance.
4th	10:18 PM	Jupiter's moon, Io, eclipse disappearance.	17th	09:21 PM	Jupiter's moon, Europa, transit ends.
5th	01:34 AM	Jupiter's moon, Io, occultation reappearance.	18th	04:58 AM	Jupiter's moon, Io, shadow transit begins.
5th	09:52 PM	Jupiter's moon, Io, shadow transit ends.	18th		LOAM Neptune 2° South of the Moon.
5th	10:53 PM	Jupiter's moon, Io, transit ends.	18th	11 AM	Uranus 3° South of the Moon.
7th	01:19 AM	Jupiter's moon, Europa, shadow transit begins.	19th	02:05 AM	Jupiter's moon, Io, eclipse disappearance.
7th	03:25 AM	Jupiter's moon, Europa, transit begins.	19th	05:08 AM	Jupiter's moon, Io, occultation reappearance.
7th	03:49 AM	Jupiter's moon, Europa, shadow transit ends.	19th	11:26 PM	Jupiter's moon, Io, shadow transit begins.
7th	10 AM	Full Moon.	20th		Mercury at perihelion.
7th	10:17 PM	Jupiter's moon, Ganymede, eclipse reappearance.	20th	12:17 AM	Jupiter's moon, Io, transit begins.
7th	11:38 PM	Jupiter's moon, Ganymede, occultation disappearance.	20th	01:39 AM	Jupiter's moon, Io, shadow transit ends.
8th		Alpha Centaurids meteor shower maximum activity.	20th	02:27 AM	Jupiter's moon, Io, transit ends.
8th	02:11 AM	Jupiter's moon, Ganymede, occultation reappearance.	20th	08:33 PM	Jupiter's moon, Io, eclipse disappearance.
8th	6 AM	Moon at perigee.	20th	11:35 PM	Jupiter's moon, Io, occultation reappearance.
9th	12:55 AM	Jupiter's moon, Europa, occultation reappearance.	21st	7 PM	Mercury greatest elongation East (18°).
10th	2 AM	Saturn in conjunction with the Sun.	21st	08:54 PM	Jupiter's moon, Io, transit ends.
10th	10 PM	Jupiter 6° North of the Moon.	21st	11 PM	New Moon.
11th	03:05 AM	Jupiter's moon, Io, shadow transit begins.	22nd	03:16 AM	Jupiter's moon, Ganymede, eclipse disappearance.
11th	04:03 AM	Jupiter's moon, Io, transit begins.	23rd		Venus at perihelion.
11th	05:17 AM	Jupiter's moon, Io, shadow transit ends.	23rd	01:35 AM	Jupiter's moon, Europa, eclipse disappearance.
12th		Omicron Centaurids meteor shower maximum activity.	23rd	4 AM	Moon at apogee.
12th	12:12 AM	Jupiter's moon, Io, eclipse disappearance.	23rd	05:37 AM	Jupiter's moon, Europa, occultation reappearance.
12th	03:21 AM	Jupiter's moon, Io, occultation reappearance.	23rd	5 PM	Mercury 3° South of the Moon.
12th	09:33 PM	Jupiter's moon, Io, shadow transit begins.	24th	8 PM	Venus greatest brilliancy.
12th	10:30 PM	Jupiter's moon, Io, transit begins.	24th	09:18 PM	Jupiter's moon, Europa, transit begins.
12th	11:45 PM	Jupiter's moon, Io, shadow transit ends.	24th	10:14 PM	Jupiter's moon, Europa, shadow transit ends.
13th	12:41 AM	Jupiter's moon, Io, transit ends.	24th	11:41 PM	Jupiter's moon, Europa, transit ends. \
13th	09:48 PM	Jupiter's moon, Io, occultation reappearance.	25th	2 PM	Venus 0°.5 North of the Moon.
14th	1 AM	Last quarter Moon.	25th	08:20 PM	Jupiter's moon, Ganymede, transit begins.
14th	03:53 AM	Jupiter's moon, Europa, shadow transit begins.	25th	10:49 PM	Jupiter's moon, Ganymede, transit ends.
14th	11:17 PM	Jupiter's moon, Ganymede, eclipse disappearance.	26th	03:58 AM	Jupiter's moon, Io, eclipse disappearance.
15th		Mercury at ascending node.	27th	01:20 AM	Jupiter's moon, Io, shadow transit begins.
15th	02:14 AM	Jupiter's moon, Ganymede, eclipse reappearance.	27th	02:03 AM	Jupiter's moon, Io, transit begins.
15th	03:12 AM	Jupiter's moon, Ganymede, occultation disappearance.	27th	03:32 AM	Jupiter's moon, Io, shadow transit ends.
			27th	04:13 AM	Jupiter's moon, Io, transit ends.
			27th	7 PM	Mercury stationary.
			27th	10:27 PM	Jupiter's moon, Io, eclipse disappearance.
			28th	01:20 AM	Jupiter's moon, Io, occultation reappearance.
			28th	08:29 PM	Jupiter's moon, Io, transit begins.
			28th	10:00 PM	Jupiter's moon, Io, shadow transit ends.
			28th	10:40 PM	Jupiter's moon, Io, transit ends.

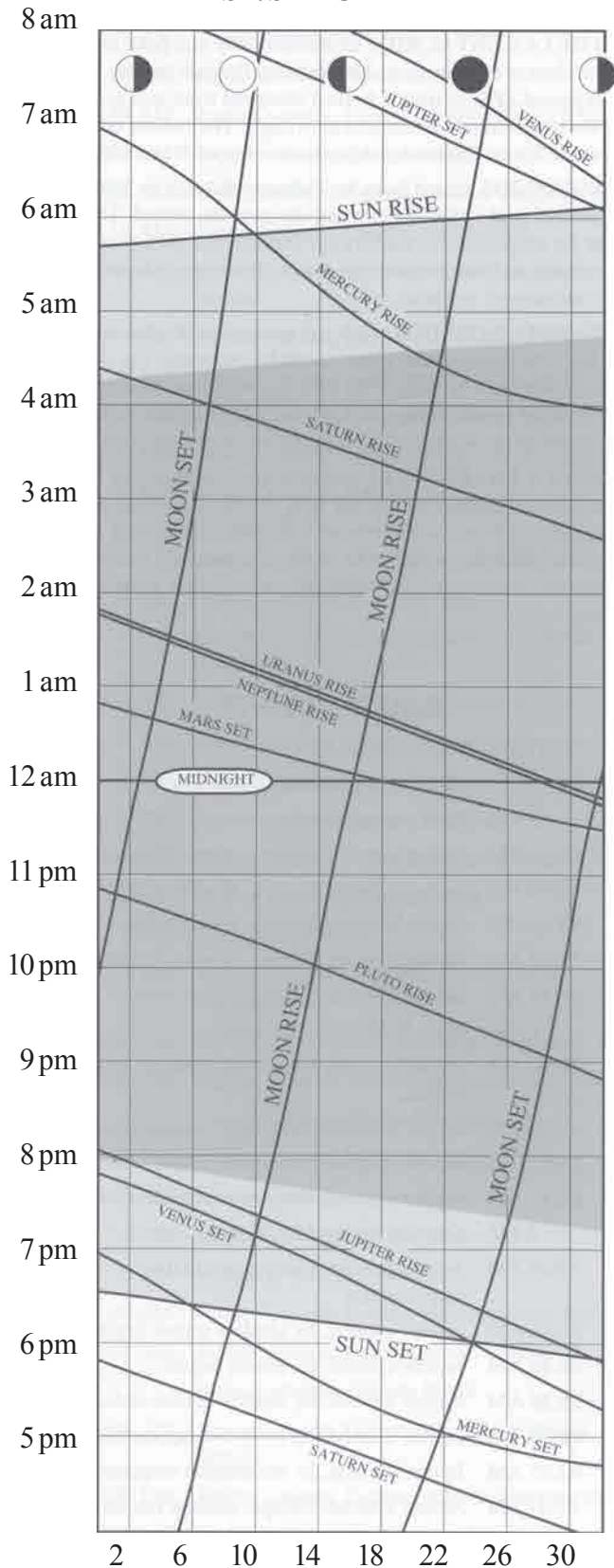
FEBRUARY



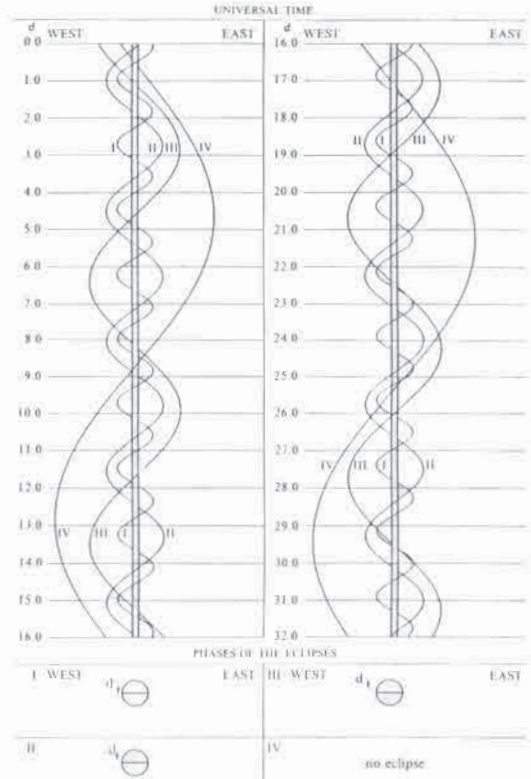


MARCH

RISE/SET CHART

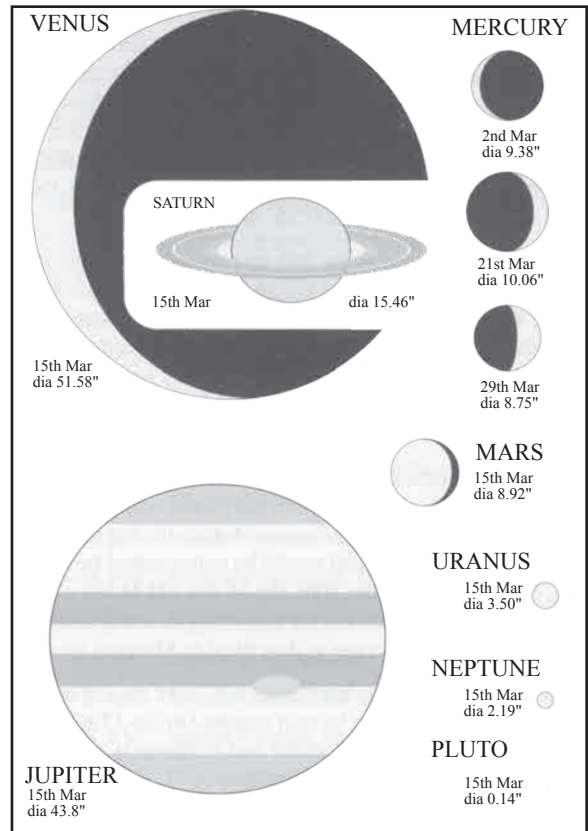


CONFIGURATIONS OF SATELLITES I-IV FOR MARCH



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



MARCH

THE MOON

- 2nd First quarter, 1:46am.
- 8th Moon at perigee.
- 8th Full Moon, 7:46pm.
- 15th Last quarter, 2:16pm.
- 22th Moon at apogee.
- 23rd New Moon, 5:14pm (Lunation number 869)
- 31st First quarter, 2:10pm.

THE PLANETS

MERCURY is in inferior conjunction on the 9th and moves from the evening into the morning sky. As Mercury approaches greatest western elongation next month, March 20th through to April 30th provides the best time to observe the planet in the morning sky during the entire year. At 5.00am on the 21st, Mercury will be situated 6° above the eastern horizon, with Saturn a further 15° directly above, and the 27 day old Moon 7°30' above and north of Mercury (see sky view diagram). The later half of the month sees Mercury as a crescent at around 1st magnitude. On the 28th at 4.30am with Mercury 5° above the horizon, 4th magnitude Lambda Aquarii will be south of the planet with a separation of only 0°05' (see sky view diagram).

VENUS remains brilliant in the western evening sky early in the month, appearing as a slender crescent low to the horizon. The planet becomes more difficult to see as it nears the Sun mid month, prior to inferior conjunction on April 1st. Venus' disc increases in size to 59", larger than Jupiter at opposition, at this time Venus will be invisible between the Earth and the Sun with it's night side facing us.

MARS begins it's westward motion again this month after been in retrograde motion since December. It's magnitude drops to 0.5 by months end, and the disc decreases from 10" to 8". Three times during the month Mars will appear close to the waxing Moon after the end of astronomical twilight (around 7.30pm); on the 3rd the 9 day old Moon will be 7° to the west (see sky view diagram). On the 4th the 10 day old Moon will be 9° to the east of the planet. On the 31st, the 8 day old Moon will be 6°30' west of Mars.

JUPITER rises in the east as the Sun sets and is visible the entire night. Opposition occurs on the 31st when the disc reaches a diameter of 44" and -2.5 magnitude. On the 9th, in the early evening sky the 16 day Moon will be 9°45' north of Jupiter, and on the following evening 9° to the south, 4° above Spica (see sky view diagram). The large angular diameter, during opposition, provides an idea target for small apertures.

SATURN in Capricornus at 0.9 magnitude, dominates the early morning sky. By the end of the month the planet will only reach an altitude of 20° above the eastern horizon before the beginning of astronomical twilight, and April would be better suited for telescopic observation. On the 20th, the 26 day old Moon will appear 7° north of the planet. On the following morning another interesting configuration occurs as described in Mercury above.

URANUS & NEPTUNE, in Sagittarius will have moved into a favourable observing position by mid month. On the 17th at 4am the 24 day old Moon will appear 6° above and northwards of the pair, and on the 18th, 7° below and northwards.

PLUTO rises around 10pm and transits the meridian at 4am mid month.

METEOR SHOWERS

The **THETA CENTAURIDS** do not have any real peak in activity, and the shower extends from 23rd January through to 12th March. The expected ZHR is around 6. Best observed from mid evening until the beginning of astronomical twilight. The radiant is near 2nd magnitude Theta Centauri and produces very swift meteors.

The **VIRGINIDS** extend from 1st February through to 30th May, with several peaks of maximum activity over the period. The radiant is near 1st magnitude Alpha Virginis (Spica), and is best seen from late evening and into the morning hours. The expected rate is from 1 to 5 slow meteors per hour.

The **GAMMA NORMIDS** reach a maximum peak of activity on the 14th. 3 to 10 very swift meteors can be expected. The duration of the shower lasts between 25th February and 22nd March, and being situated near 4th magnitude Gamma Normae the radiant is well placed in the south for late evening and morning observers.

The **DELTA PAVONIDS** are visible from 11th March to 16th April, with a maximum of activity next month on the 6th. The hourly rate is 13 very swift meteors with their radiant near 4th magnitude Delta Pavo. Although Pavo is circumpolar, morning observation is recommended when the constellation gains greatest altitude.

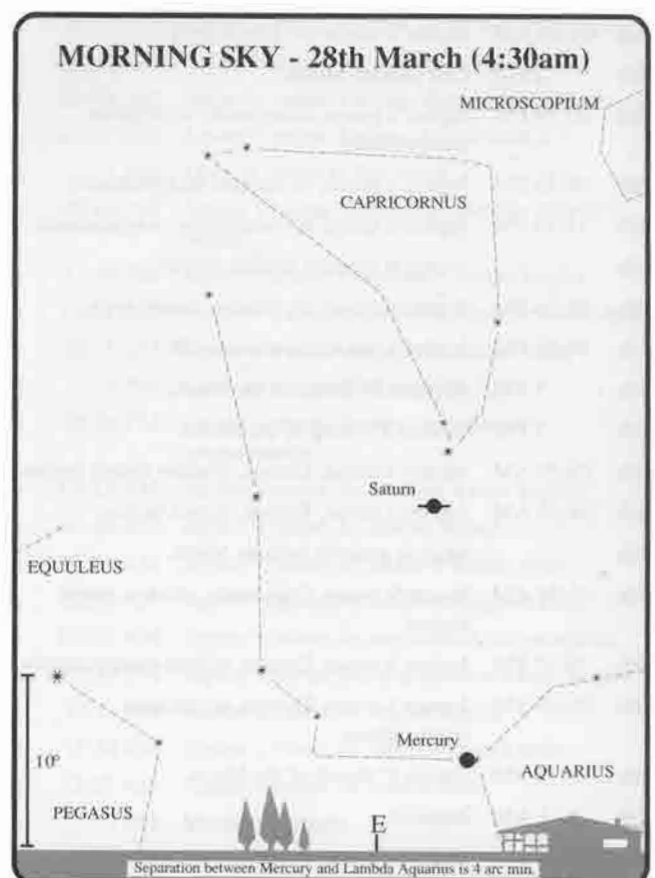
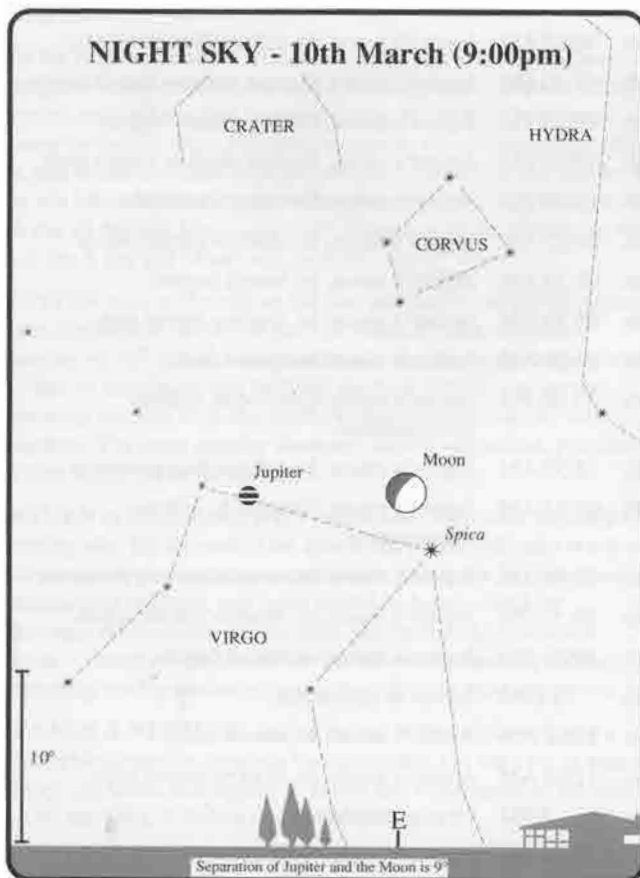
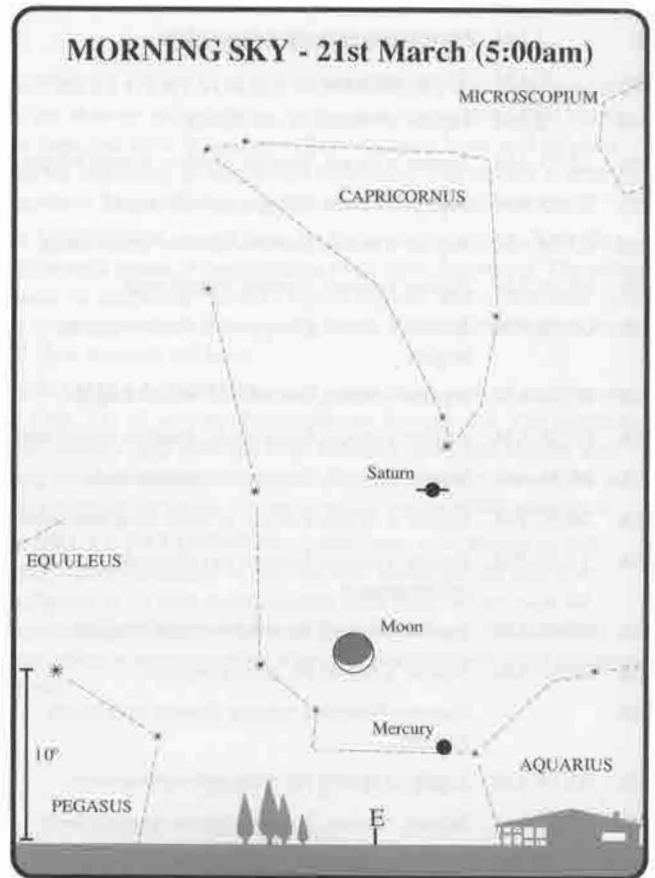
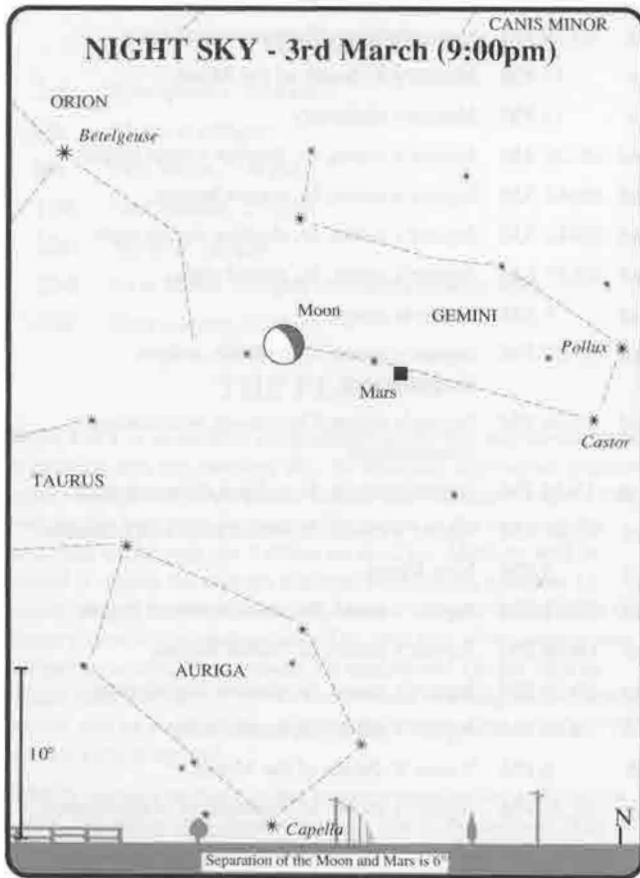
DAILY EVENTS

- | | | |
|-------|----------|---|
| 2 1st | 11 PM | Pluto stationary. |
| 2nd | | Mercury at greatest latitude North. |
| 2nd | 2 AM | First quarter Moon. |
| 2nd | 04:10 AM | Jupiter's moon, Europa, eclipse disappearance. |
| 3rd | 10:19 PM | Jupiter's moon, Europa, shadow transit begins. |
| 3rd | 11:36 PM | Jupiter's moon, Europa, transit begins. |
| 4th | 12:49 AM | Jupiter's moon, Europa, shadow transit ends. |
| 4th | 01:59 AM | Jupiter's moon, Europa, transit ends. |
| 4th | 7 AM | Mars 5° North of the Moon. |
| 4th | 09:08 PM | Jupiter's moon, Ganymede, shadow transit begins. |
| 4th | 11:44 PM | Jupiter's moon, Ganymede, transit begins. |
| 5th | 12:01 AM | Jupiter's moon, Ganymede, shadow transit ends. |
| 5th | 02:13 AM | Jupiter's moon, Ganymede, transit ends. |
| 5th | 6 PM | Ceres in conjunction with the Sun. |
| 5th | 09:04 PM | Jupiter's moon, Europa, occultation reappearance. |
| 6th | 03:13 AM | Jupiter's moon, Io, shadow transit begins. |
| 6th | 03:48 AM | Jupiter's moon, Io, transit begins. |
| 6th | 05:26 AM | Jupiter's moon, Io, shadow transit ends. |
| 7th | 12:20 AM | Jupiter's moon, Io, eclipse disappearance. |
| 7th | 03:05 AM | Jupiter's moon, Io, occultation reappearance. |
| 7th | 09:41 PM | Jupiter's moon, Europa, shadow transit begins. |
| 7th | 10:14 PM | Jupiter's moon, Io, transit begins. |
| 7th | 11:54 PM | Jupiter's moon, Io, shadow transit ends. |
| 8th | 12:25 AM | Jupiter's moon, Io, transit ends. |
| 8th | 7 PM | Moon at perigee. |
| 8th | 8 PM | Full Moon. |
| 8th | 09:32 PM | Jupiter's moon, Io, occultation reappearance. |

MARCH

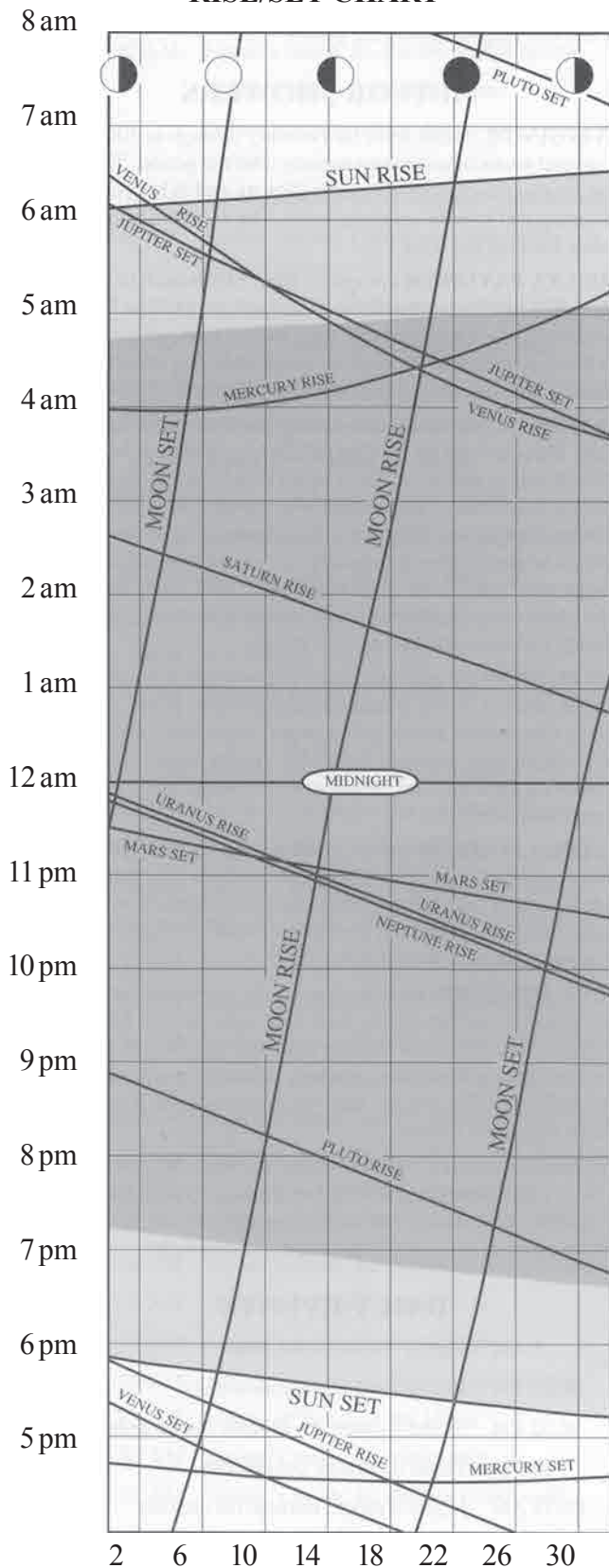
9th	2 PM	Mercury in inferior conjunction.	21st	07:39 PM	Jupiter's moon, Europa, transit ends.
10th	7 AM	Venus stationary.	21st	11:00 pm	Mercury 4° South of the Moon.
10th	2 PM	Jupiter 6° North of the Moon.	21st	11 PM	Mercury stationary.
11th	12:53 AM	Jupiter's moon, Europa, shadow transit begins.	22nd	01:29 AM	Jupiter's moon, Io, shadow transit begins.
11th	01:53 AM	Jupiter's moon, Europa, transit begins.	22nd	01:42 AM	Jupiter's moon, Io, transit begins.
11th	03:24 AM	Jupiter's moon, Europa, shadow transit ends.	22nd	03:41 AM	Jupiter's moon, Io, shadow transit ends.
11th	04:16 AM	Jupiter's moon, Europa, transit ends.	22nd	03:53 AM	Jupiter's moon, Io, transit ends.
12th	01:06 AM	Jupiter's moon, Ganymede, shadow transit begins.	22nd	5 AM	Moon at apogee.
12th	03:04 AM	Jupiter's moon, Ganymede, transit begins.	22nd	07:07 PM	Jupiter's moon, Ganymede, eclipse disappearance.
12th	03:58 AM	Jupiter's moon, Ganymede, shadow transit ends.	22nd	10:36 PM	Jupiter's moon, Ganymede, occultation reappearance.
12th	05:34 AM	Jupiter's moon, Ganymede, transit ends.	22nd	1 0:36 PM	Jupiter's moon, Io, eclipse disappearance.
12th	08:02 PM	Jupiter's moon, Europa, eclipse disappearance.	23rd	01:00 AM	Jupiter's moon, Io, occultation reappearance.
12th	11:20 PM	Jupiter's moon, Europa, occultation reappearance.	23rd	5 PM	New Moon.
13th	05:06 AM	Jupiter's moon, Io, shadow transit begins.	23rd	07:57 PM	Jupiter's moon, Io, shadow transit begins.
13th	05:32 AM	Jupiter's moon, Io, transit begins.	23rd	08:08 PM	Jupiter's moon, Io, transit begins.
14th		Gamma Normids meteor shower maximum activity.	23rd	10:10 PM	Jupiter's moon, Io, shadow transit ends.
14th	02:14 AM	Jupiter's moon, Io, eclipse disappearance.	23rd	10:19 PM	Jupiter's moon, Io, transit ends.
14th	04:50 AM	Jupiter's moon, Io, occultation reappearance.	24th	6 PM	Venus 4° North of the Moon.
14th	11:35 PM	Jupiter's moon, Io, shadow transit begins.	24th	07:26 PM	Jupiter's moon, Io, occultation reappearance.
14th	11:58 PM	Jupiter's moon, Io, transit begins.	26th		Mercury at descending node.
15th	01:47 AM	Jupiter's moon, Io, shadow transit ends.	27th	01:11 AM	Jupiter's moon, Europa, eclipse disappearance.
15th	02:09 AM	Jupiter's moon, Io, transit ends.	27th	03:49 AM	Jupiter's moon, Europa, occultation reappearance.
15th	2 PM	Last quarter Moon.	28th	06:02 AM	Jupiter's moon, Io, eclipse disappearance.
15th	07:18 PM	Jupiter's moon, Ganymede, occultation reappearance.	28th	07:22 PM	Jupiter's moon, Europa, shadow transit begins.
15th	08:42 PM	Jupiter's moon, Io, eclipse disappearance.	28th	07:31 PM	Jupiter's moon, Europa, transit begins.
15th	11:16 PM	Jupiter's moon, Io, occultation reappearance.	28th	09:52 PM	Jupiter's moon, Europa, shadow transit ends.
16th		Venus at greatest latitude North.	28th	09:55 PM	Jupiter's moon, Europa, transit ends.
16th	08:16 PM	Jupiter's moon, Io, shadow transit ends.	29th	03:22 AM	Jupiter's moon, Io, shadow transit begins.
16th	08:35 PM	Jupiter's moon, Io, transit ends.	29th	03:26 AM	Jupiter's moon, Io, transit begins.
17th	5 PM	Neptune 2° South of the Moon.	29th	05:35 AM	Jupiter's moon, Io, shadow transit ends.
17th	7 PM	Uranus 3° South of the Moon.	29th	05:36 AM	Jupiter's moon, Io, transit ends.
18th	03:29 AM	Jupiter's moon, Europa, shadow transit begins.	29th	11:06 PM	Jupiter's moon, Ganymede, eclipse disappearance.
18th	04:09 AM	Jupiter's moon, Europa, transit begins.	30th	12:30 AM	Jupiter's moon, Io, eclipse disappearance.
19th		Mars at greatest latitude North.	30th	01:57 AM	Jupiter's moon, Ganymede, eclipse reappearance.
19th	05:04 AM	Jupiter's moon, Ganymede, shadow transit begins.	30th	02:44 AM	Jupiter's moon, Io, occultation reappearance.
19th	10:37 PM	Jupiter's moon, Europa, eclipse disappearance.	30th	09:51 PM	Jupiter's moon, Io, shadow transit begins.
20th	01:35 AM	Jupiter's moon, Europa, occultation reappearance.	30th	09:51 PM	Jupiter's moon, Io, transit begins.
20th	6 PM	Saturn 6° South of the Moon.	30th	10 PM	Jupiter at opposition.
21st	1 AM	Equinox.	31st	12:02 AM	Jupiter's moon, Io, transit ends.
21st	04:08 AM	Jupiter's moon, Io, eclipse disappearance.	31st	12:03 AM	Jupiter's moon, Io, shadow transit ends.
21st	07:16 PM	Jupiter's moon, Europa, shadow transit ends.	31st	2 PM	First quarter Moon.
			31st	06:58 PM	Jupiter's moon, Io, occultation disappearance.
			31st	09:12 PM	Jupiter's moon, Io, eclipse reappearance.

MARCH

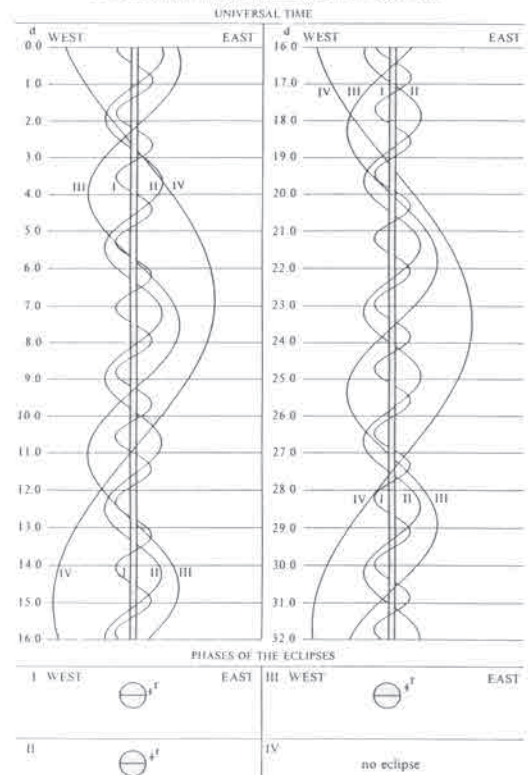


APRIL

RISE/SET CHART

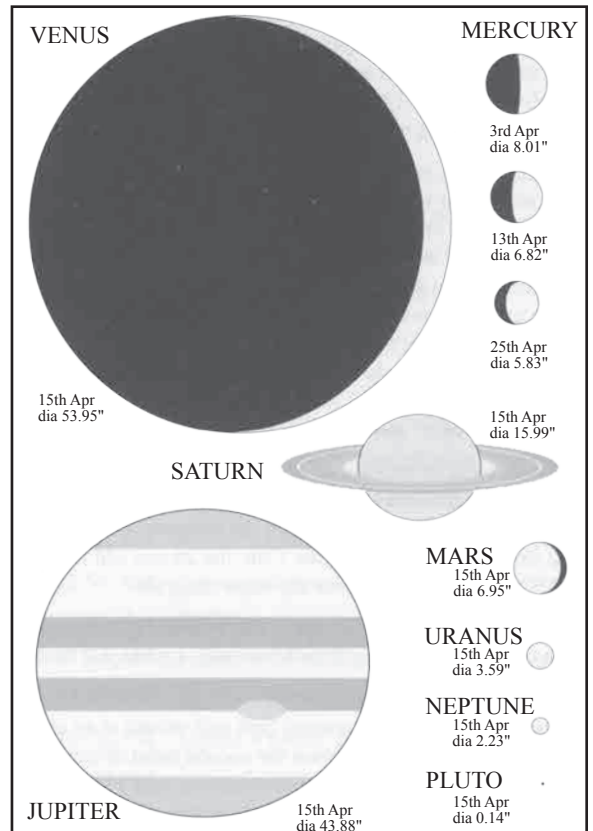


CONFIGURATIONS OF SATELLITES I-IV FOR APRIL



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



THE MOON

- 6th Moon at perigee (closest to Earth).
- 7th Full Moon, 4:43 am.
- 14th Last quarter, 5:39 am.
- 18th Moon at apogee (most distant from Earth).
- 22th New Moon, 9:49 am (Lunation number 870).
- 29th First quarter, 10:40 pm.

THE PLANETS

MERCURY, in a dark sky before twilight throughout the month can be seen to excellent advantage. It will be the last favourable time for observation in the morning sky for the rest of the year. The planet increases in brightness from the beginning to the end of the month (0.5 to -0.6 magnitude). On the 19th at 5 am, Mercury will be T° above the eastern horizon with Venus 7° to the north at 6° altitude. Also a 27 day old Moon is slightly further north at 15° altitude. The trio appear on the following night with the planets in much the same position but with the 27 day old Moon $2^{\circ}20'$ below Venus, with Mercury 7° to the south (see sky view diagram).

VENUS undergoes inferior conjunction on the 1st and remains close to the Sun until mid month. Sightings early in the month will show a very thin crescent, gradually waxing until the disc is 20% illuminated. On the 20th at 5 am, Venus, at -4.4 magnitude, makes a striking sight with the 27 day old Moon, like a jewel above the cusps, separated by $2^{\circ}20'$ the planet at an altitude of 7° and the Moon at $4^{\circ}30'$ (see sky view diagram). Inferior conjunctions of Venus only happen every 584 days, the last on 22nd August 1991 and the next on 2nd November 1994.

MARS remains bright at 1st magnitude in the northeastern evening sky. On the 1st, Mars and Pollux, separated by 6° form a triangle with the 9 day old Moon 10° above the pair (see sky view diagram). On the 8th at 8.30 pm, Mars at an altitude of 21° appears 8° north of the 6 day Moon. On the 29th, Mars is situated 9° equidistant from the 7 day Moon and 1st magnitude Pollux, the trio forming a straight line.

JUPITER rises prior to sunset during April and will be visible most of the night. By mid month Jupiter will be 27° above the eastern horizon at the end of astronomical twilight (7 pm), meridian transit happens around 11 pm at an altitude of 57° , and therefore, provides comfortable evening viewing when at it's best. Jupiter maintains it's dominance of the eastern evening sky early in the month at -2.5 magnitude, dropping slightly to -2.4 on the 12th, and it's post opposition size shrinks only 1" to 43" by months end. On the 6th, the full Moon will be 6° south of Jupiter (see sky view diagram).

SATURN will be at an altitude of 40° in the eastern morning sky by mid month, before the onset of astronomical twilight. The planet's magnitude remains constant at 0.9 with the diameter of the disc increasing slightly to 16.34". On the 17th, the 25 day old Moon appears $6^{\circ}50'$ north of Saturn (see sky view diagram).

URANUS & NEPTUNE, $1^{\circ}30'$ apart, rise before 11 pm by mid month. On the 13th, the last quarter Moon will appear just over 3° north of the pair.

PLUTO transits the meridian around 2 am mid month at an altitude of 60° . For those keen to track down the second most distant planet at 13.7 magnitude, the only bright reference star near Pluto is 4th magnitude Mu Serpentis. Pluto, due to it's highly elliptical orbit is at present closer to the Sun than Neptune. This year, Pluto is about 0.4 of an astronomical unit nearer the Sun than

Neptune. The situation will be resolved in 1999 when Pluto crosses Neptune's orbit to again become the outermost planet. The finder chart on page 100 will help in finding the planet.

METEOR SHOWERS

The **VIRGINIDS** extend from 1st February through to 30th May, with several peaks of maximum activity over the period. The radiant is near 1st magnitude Alpha Virginis (Spica), and is best seen from late evening and into the morning hours. The expected rate is from 1 to 5 slow meteors per hour.

The **DELTA PAVONIDS** are visible from 11th March to 16th April, with a maximum of activity this month on the 6th. The hourly rate is 13 very swift meteors with their radiant near 4th magnitude Delta Pavo. Although Pavo is circumpolar, morning observation is recommended when the constellation gains greatest altitude.

The **LYRIDS** are visible in the morning sky from about 2 am to twilight. They are best on the 21st or 22nd April with an hourly rate of 20, with minor activity a day or so on each side; the shower's duration is from 16th to 25th April. The radiant is near 1st magnitude Alpha Lyra (Vega), the 5th brightest star in the sky. The Lyrids are bright, swift and generally leave luminous trains. Although best from the northern hemisphere the Lyrids are still worthy of observation, they can vary greatly in intensity, and the maximum rate may only last an hour or so.

The **PI PUPPIDS** are a periodic shower and the hourly rate of 40 very slow meteors is only produced during certain years, at other times the rate may be as low as 3 or 4 per hour. Best seen from the end of twilight until midnight from 15th to 28th April, with the peak of activity on the 23rd. The radiant near 3rd magnitude Pi Puppis generates very slow meteors.

The **ALPHA BOOTIDS** are active from 14th April to 12th May, reaching a peak of activity this month on the 28th. The shower's radiant is centred near 1st magnitude Arcturus (Alpha Bootis), producing very slow meteors, and is observable from late evening to early morning in the northern sky.

The **ETA AQUARIDS** are considered to be associated with Halley's Comet, and are visible from 19th April to 28th May, in the eastern sky from the end of twilight until mid morning. A peak of 50 meteors per hour is sometimes reached, with maximum activity next month on the 4th. The radiant, near 4th magnitude Eta Aquarii, produces very swift meteors.

The **SCORPID/SAGITTARIDS** occur between 15th April and 25th July, with several peaks of maximum activity over the period. A maximum zenith hourly rate of 10 slow meteors can be expected, and observation is best from about 10 pm until twilight.

DAILY EVENTS

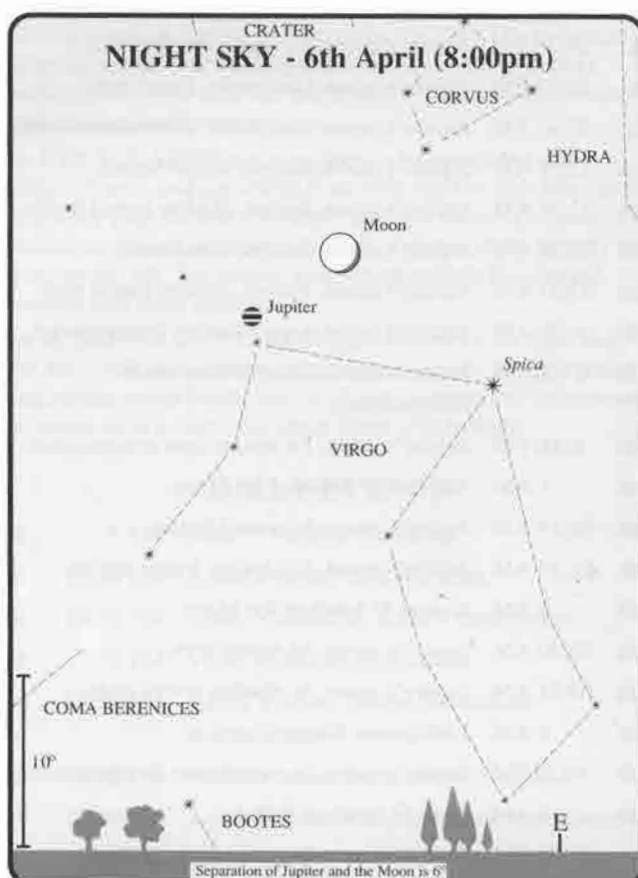
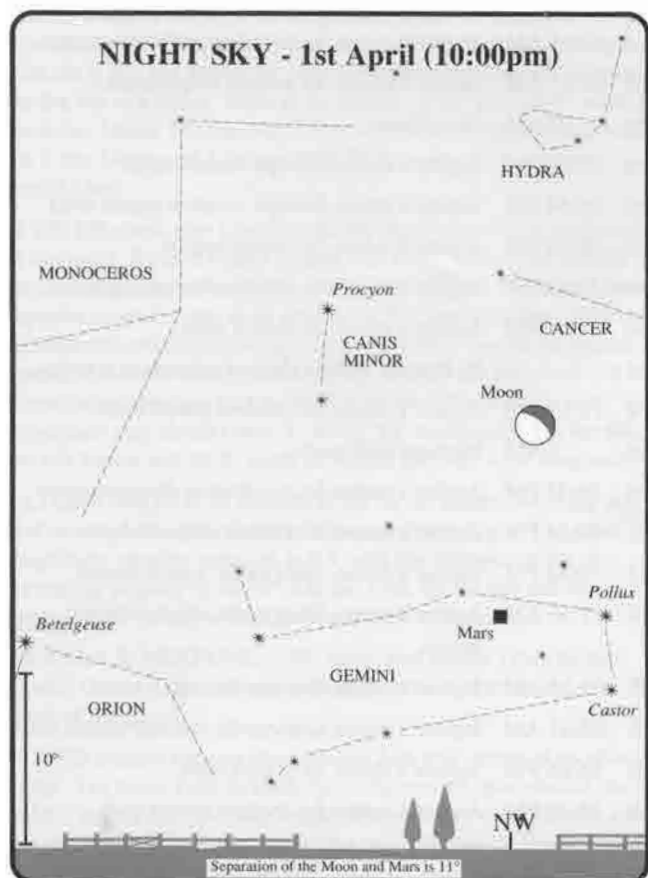
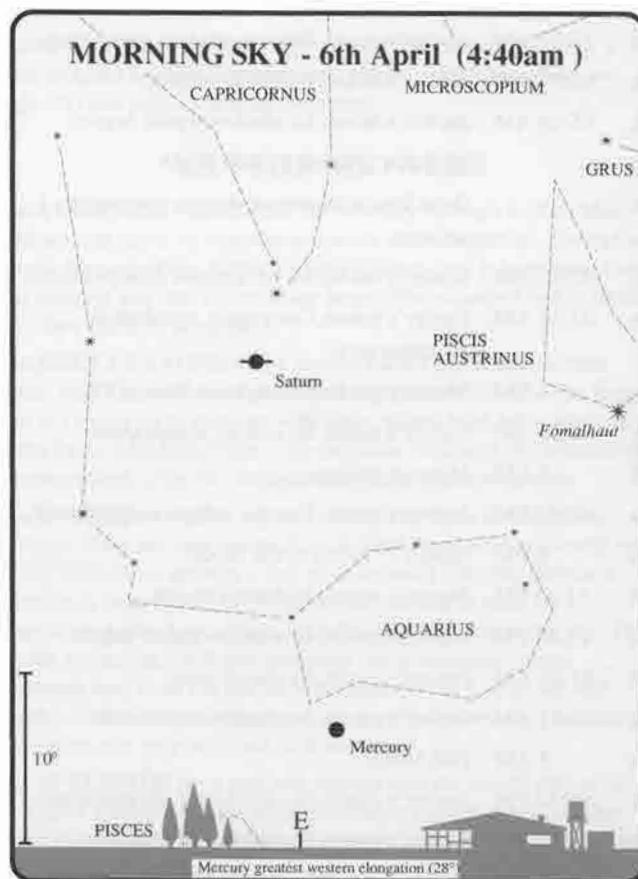
- | | | |
|-----|----------|--|
| 1st | 5 AM | Mars 5° North of the Moon. |
| 1st | 06:28 PM | Jupiter's moon, Io, transit ends. |
| 1st | 06:32 PM | Jupiter's moon, Io, shadow transit ends. |
| 1st | 11 PM | Venus in inferior conjunction. |
| 3rd | 03:39 AM | Jupiter's moon, Europa, occultation disappearance. |
| 4th | 09:45 PM | Jupiter's moon, Europa, transit begins. |
| 4th | 09:58 PM | Jupiter's moon, Europa, shadow transit begins. |
| 5th | | Mercury at aphelion. |
| 5th | 12:10 AM | Jupiter's moon, Europa, transit ends. |

APRIL

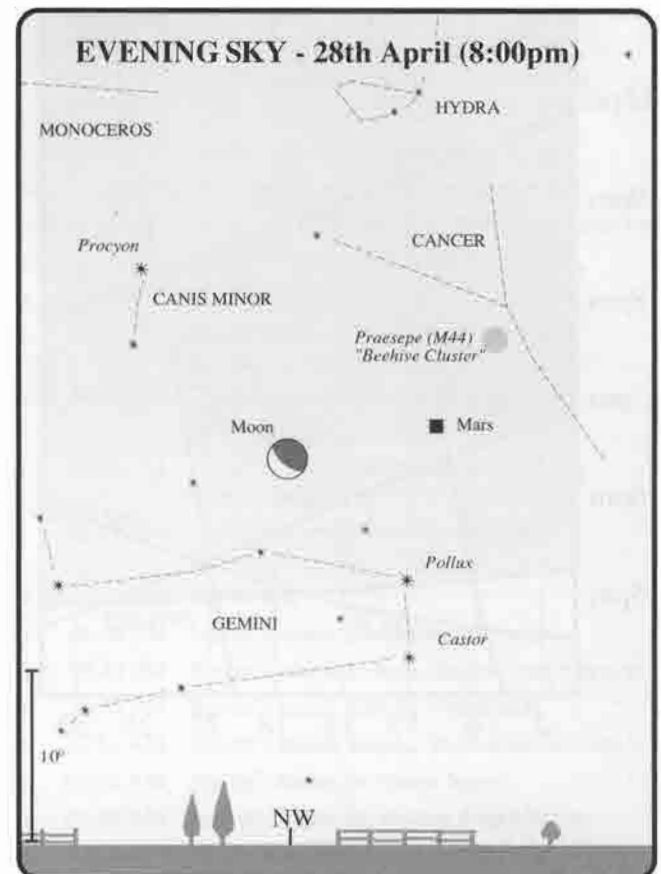
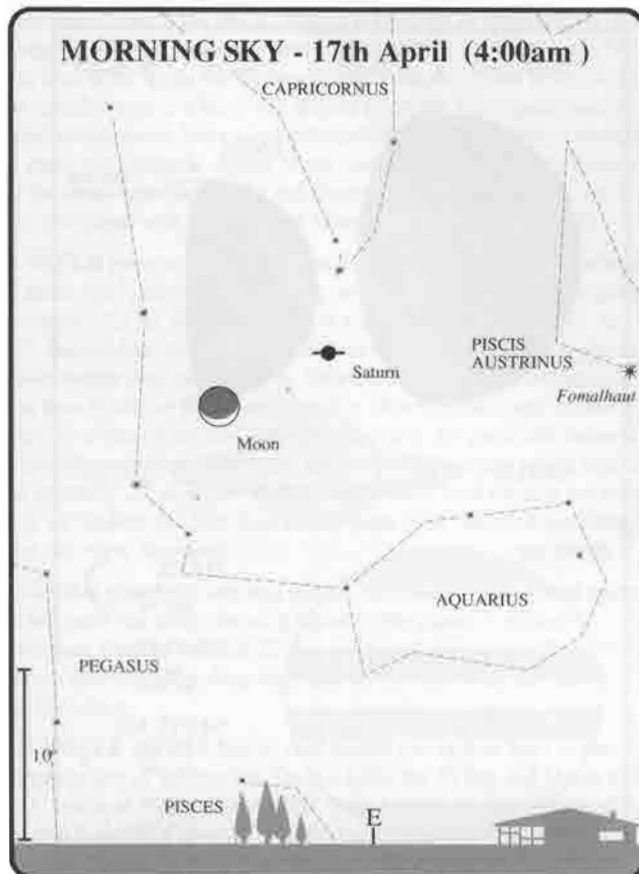
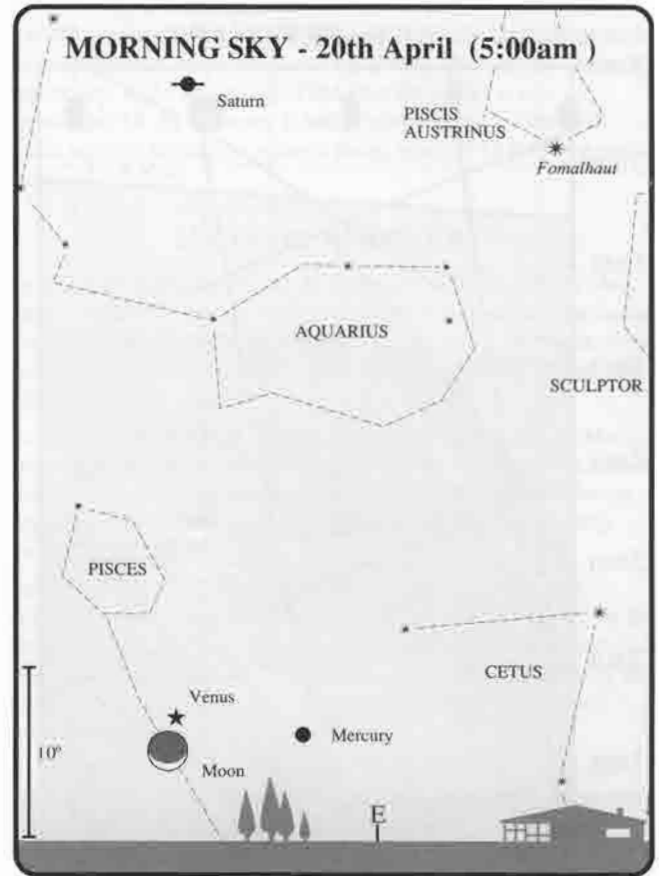
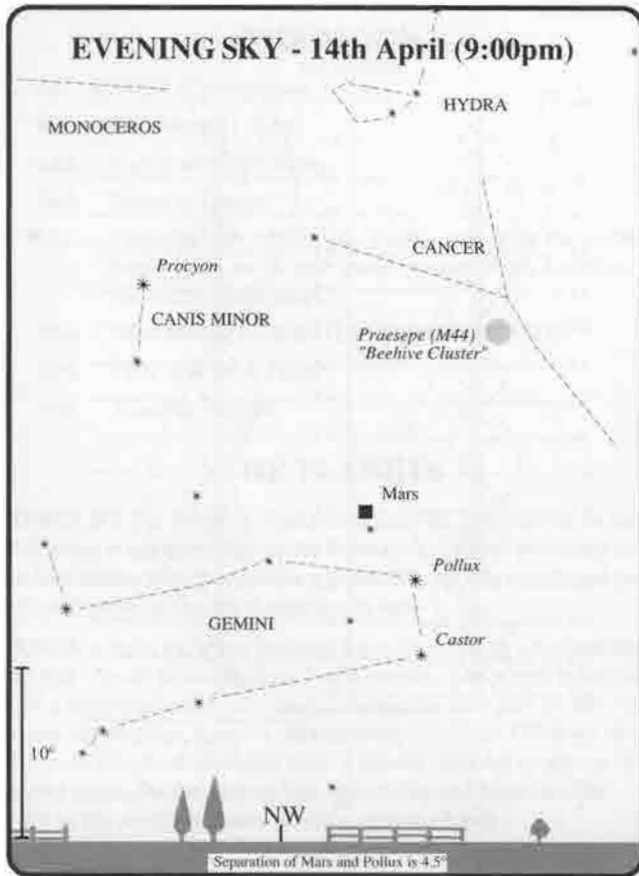
5th	12:27 AM	Jupiter's moon, Europa, shadow transit ends.	15th	08:07 PM	Jupiter's moon, Io, shadow transit begins.
5th	05:09 AM	Jupiter's moon, Io, transit begins.	15th	09:56 PM	Jupiter's moon, Io, transit ends.
5th	05:16 AM	Jupiter's moon, Io, shadow transit begins.	15th	10:19 PM	Jupiter's moon, Io, shadow transit ends.
6th		Jupiter at greatest latitude North.	16th	07:24 PM	Jupiter's moon, Ganymede, transit begins.
6th		Delta Pavonids meteor shower maximum activity.	16th	07:29 PM	Jupiter's moon, Io, eclipse reappearance.
6th	02:16 AM	Jupiter's moon, Io, occultation disappearance.	16th	08:57 PM	Jupiter's moon, Ganymede, shadow transit begins.
6th	02:35 AM	Jupiter's moon, Ganymede, occultation disappearance.	16th	9 PM	Mercury 8° South of Venus.
6th	4 AM	Mercury greatest elongation West (28°).	16th	10:02 PM	Jupiter's moon, Ganymede, transit ends.
6th	04:38 AM	Jupiter's moon, Io, eclipse reappearance.	16th	11:45 PM	Jupiter's moon, Ganymede, shadow transit ends.
6th	5 AM	Moon at perigee.	17th	6 AM	Saturn 7° South of the Moon.
6th	07:32 PM	Jupiter's moon, Europa, eclipse reappearance.	18th	3 PM	Moon at apogee.
6th	8 PM	Jupiter 7° North of the Moon.	19th	02:17 AM	Jupiter's moon, Europa, transit begins.
6th	11:35 PM	Jupiter's moon, Io, transit begins.	19th	03:10 AM	Jupiter's moon, Europa, shadow transit begins.
6th	11:45 PM	Jupiter's moon, Io, shadow transit begins.	19th	04:43 AM	Jupiter's moon, Europa, transit ends.
7th	01:46 AM	Jupiter's moon, Io, transit ends.	20th	3 AM	Venus 0°.5 South of the Moon.
7th	01:57 AM	Jupiter's moon, Io, shadow transit ends.	20th	12 PM	Venus stationary.
7th	5 AM	Full Moon.	20th	2 PM	Mercury 8° South of the Moon.
7th	08:42 PM	Jupiter's moon, Io, occultation disappearance.	20th	09:15 PM	Jupiter's moon, Europa, occultation disappearance.
7th	11:06 PM	Jupiter's moon, Io, eclipse reappearance.	21st	12:41 AM	Jupiter's moon, Europa, eclipse reappearance.
8th	06:01 PM	Jupiter's moon, Io, transit begins.	21st	03:04 AM	Jupiter's moon, Io, transit begins.
8th	06:13 PM	Jupiter's moon, Io, shadow transit begins.	21st	03:33 AM	Jupiter's moon, Io, shadow transit begins.
8th	08:12 PM	Jupiter's moon, Io, transit ends.	22nd		Lyrids meteor shower maximum activity.
8th	08:26 PM	Jupiter's moon, Io, shadow transit ends.	22nd	12:11 AM	Jupiter's moon, Io, occultation disappearance.
9th	06:43 PM	Jupiter's moon, Ganymede, transit ends.	22nd	02:55 AM	Jupiter's moon, Io, eclipse reappearance.
9th	07:47 PM	Jupiter's moon, Ganymede, shadow transit ends.	22nd	10 AM	New Moon.
12th	12:01 AM	Jupiter's moon, Europa, transit begins.	22nd	05:52 PM	Jupiter's moon, Europa, transit ends.
12th	12:34 AM	Jupiter's moon, Europa, shadow transit begins.	22nd	06:58 PM	Jupiter's moon, Europa, shadow transit ends.
12th	02:26 AM	Jupiter's moon, Europa, transit ends.	22nd	09:30 PM	Jupiter's moon, Io, transit begins.
12th	03:03 AM	Jupiter's moon, Europa, shadow transit ends.	22nd	10:02 PM	Jupiter's moon, Io, shadow transit begins.
13th	04:00 AM	Jupiter's moon, Io, occultation disappearance.	22nd	11:41 PM	Jupiter's moon, Io, transit ends.
13th	07:00 PM	Jupiter's moon, Europa, occultation disappearance.	23rd		Pi Puppids meteor shower maximum activity.
13th	10:06 PM	Jupiter's moon, Europa, eclipse reappearance.	23rd	12:13 AM	Jupiter's moon, Io, shadow transit ends.
14th	1 AM	Neptune 3° South of the Moon.	23rd	7 AM	Neptune stationary.
14th	01:19 AM	Jupiter's moon, Io, transit begins.	23rd	06:38 PM	Jupiter's moon, Io, occultation disappearance.
14th	01:39 AM	Jupiter's moon, Io, shadow transit begins.	23rd	09:24 PM	Jupiter's moon, Io, eclipse reappearance.
14th	3 AM	Uranus 4° South of the Moon.	23rd	10:44 PM	Jupiter's moon, Ganymede, transit begins.
14th	03:30 AM	Jupiter's moon, Io, transit ends.	24th	12:56 AM	Jupiter's 1110011, Ganymede, shadow transit begins.
14th	03:51 AM	Jupiter's moon, Io, shadow transit ends.	24th	01:24 AM	Jupiter's 1110011, Ganymede, transit ends.
14th	6 AM	Last quarter Moon.	24th	03:43 AM	Jupiter's moon, Ganymede, shadow transit ends.
14th	10:27 PM	Jupiter's moon, Io, occultation disappearance.	24th	06:08 PM	Jupiter's 1110011, Io, transit ends.
15th	1 AM	Mars 5° South of Pollux.	24th	06:42 PM	Jupiter's moon, Io, shadow transit ends.
15th	01:01 AM	Jupiter's moon, Io, eclipse reappearance.	25th		Mars at aphelion.
15th	07:45 PM	Jupiter's moon, Io, transit begins.	25th		Mercury at greatest latitude South.

APRIL

- 26th 10 PM Uranus stationary.
- 27th 05:48 PM Jupiter's moon, Ganymede, eclipse reappearance.
- 27th 11:31 PM Jupiter's moon, Europa, occultation disappearance.
- 28th Alpha Bootids meteor shower maximum activity.
- 28th 03:15 AM Jupiter's moon, Europa, eclipse reappearance.
- 29th 01:57 AM Jupiter's moon, Io, occultation disappearance.
- 29th 10 AM Mars 6° North of the Moon.
- 29th 05:44 PM Jupiter's moon, Europa, transit begins.
- 29th 07:06 PM Jupiter's moon, Europa, shadow transit begins.
- 29th 08:11 PM Jupiter's moon, Europa, transit ends.
- 29th 09:34 PM Jupiter's moon, Europa, shadow transit ends.
- 29th 11 PM First quarter Moon.
- 29th 11:16 PM Jupiter's moon, Io, transit begins.
- 29th 11:56 PM Jupiter's moon, Io, shadow transit begins.
- 30th 01:27 AM Jupiter's moon, Io, transit ends.
- 30th 02:07 AM Jupiter's moon, Io, shadow transit ends.
- 30th 08:24 PM Jupiter's moon, Io, occultation disappearance.
- 30th 11:19 PM Jupiter's moon, Io, eclipse reappearance.

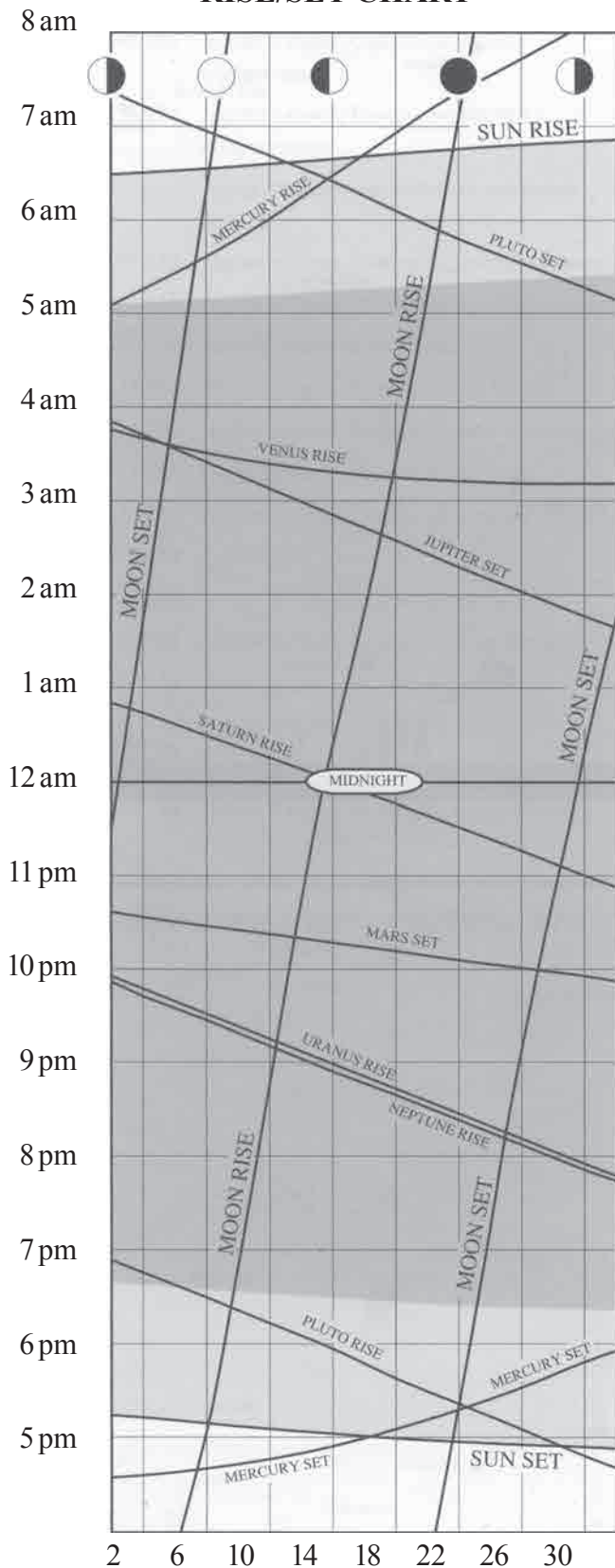


APRIL

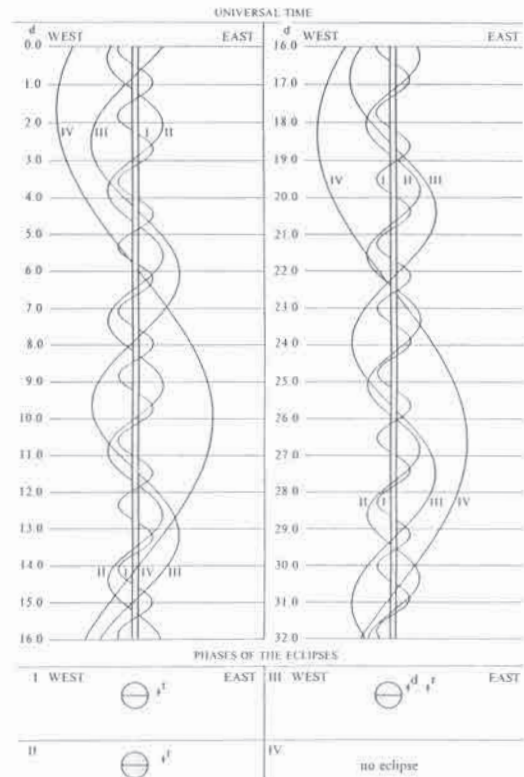


MAY

RISE/SET CHART

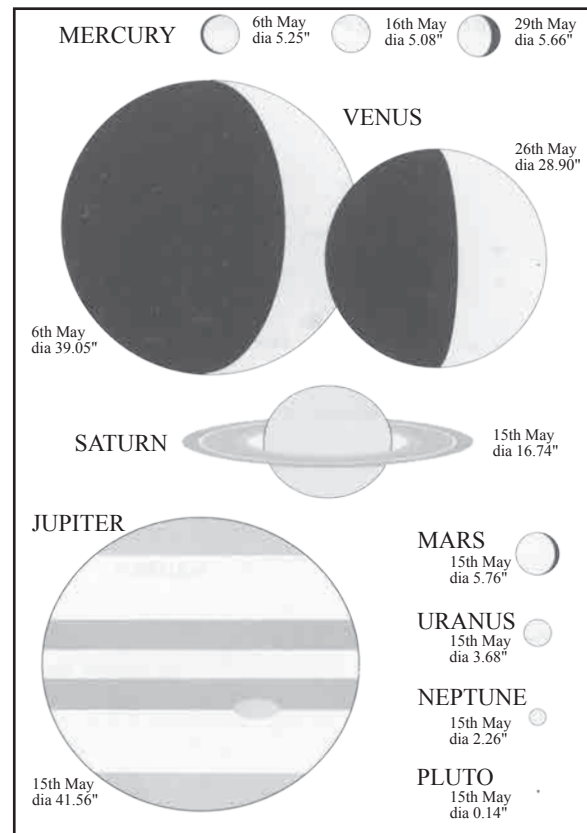


CONFIGURATIONS OF SATELLITES I-IV FOR MAY



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



THE MOON

- 4th Moon at perigee.
- 6th Full Moon, 1:34pm.
- 13th Last quarter, 10:20pm.
- 16th Moon at apogee.
- 21st Partial eclipse of the Sun, Visible only from the northern hemisphere as the path travels across North America, the Arctic and Europe.
- 22th New Moon, 12:06am (Lunation number 871).
- 29th First quarter, 4:21 am.
- 31st Moon at perigee.

THE PLANETS

MERCURY is a morning object until superior conjunction on the 16th when it again appears in the evening sky. Close proximity to the Sun means that observation will be difficult this month and best left until greatest eastern elongation in June.

VENUS is in an excellent position for early morning observations, and will remain so for the next 3 or 4 months. The planet is brilliant at -4.5 magnitude, dropping by 0.1 during the later part of the month, the angular diameter decreases rapidly from 42" down to 27", with the phase changing from a slender crescent to almost first quarter stage. On the 18th at 5am, the 26 day old Moon will be 5°30' to the north of Venus (see sky view diagram).

MARS becomes less than interesting as a telescopic object this month as it's diameter drops below 6". After evening astronomical twilight, Mars is still prominent at 1st magnitude about 30° above the northwestern horizon. The planet spends the month nearby the open star cluster M44 (NGC2632, the Beehive or Praesepe, in the constellation of Cancer), between the 11th and 13th Mars will be less than 0°30' from the cluster. Under dark sky, M44 is visible to the unaided eye as a hazy one degree diameter fuzzy patch and a small telescope or binoculars will resolve the cluster into a myriad of stars; the aesthetic appeal of the Beehive will be greatly enhanced by the close presence of the red planet. On the 27th at 7pm, the 6 day old Moon will be 6° east of Mars (see sky view diagram).

JUPITER transits the meridian at 8.45pm mid month, at an altitude of almost 50°; perfect for evening observers. The planet's magnitude averages -2.3 for the month, and it's diameter drops from 43" to 40". Jupiter has two close approaches by the Moon in the evening northeastern sky; on the 3rd at 7pm the 25 day old Moon appears less than 6° above the planet (see sky view diagram) and on the 30th, 7° to the north (see sky view diagram). Of particular interest, is the 4th magnitude white star Eta Virginis (Zaniah) which begins the month 1°25' from the planet. By the 20th both objects are close at 0°15' and on the 31st Zaniah is a mere 0°05' north of the planet (see sky view diagram).

SATURN rises by 12am mid month, but observation would better be left until the early morning hours as the planet's altitude increases. On the 14th the 22 day old Moon will appear 8° north of Saturn (see sky view diagram), and on the following day about 10°30' distant.

URANUS & NEPTUNE by mid month rise before 9pm in the constellation of Sagittarius. On the 10th, the 20 day old Moon will be 5° north of Neptune and 6°30' from Uranus in the evening sky, the trio forming a straight line. By the beginning of astronomical twilight (5am), the separation between the Moon and Neptune will have decreased to 3°30'.

PLUTO is at opposition on the 15th and is visible throughout night. The magnitude of Pluto does not vary greatly from opposition to conjunction, at the beginning of the year the planet was at magnitude 13.8, by February it had brightened to 13.7 and will remain so until September when it drops again to 13.8 for the rest of the year.

METEOR SHOWERS

The **VIRGINIDS** extend from 1st February through to 30th May, with several peaks of maximum activity over the period. The radiant is near 1st magnitude Alpha Virginis (Spica), and is best seen from late evening and into the morning hours. The expected rate is from 1 to 5 slow meteors per hour.

The **ALPHA BOOTIDS** are active from 14th April to 12th May and reached their peak last month on the 28th. The shower's radiant is centred near 1st magnitude Arcturus (Alpha Bootis), producing very slow meteors, and is observable from late evening to early morning in the northern sky.

The **ETA AQUARIDS** are considered to be associated with Halley's Comet, and are visible from 19th April to 28th May, in the eastern sky from the end of twilight until mid morning. A peak of 50 meteors per hour is sometimes reached, with maximum activity this month on the 4th. The radiant, near 4th magnitude Eta Aquarii, produces very swift meteors.

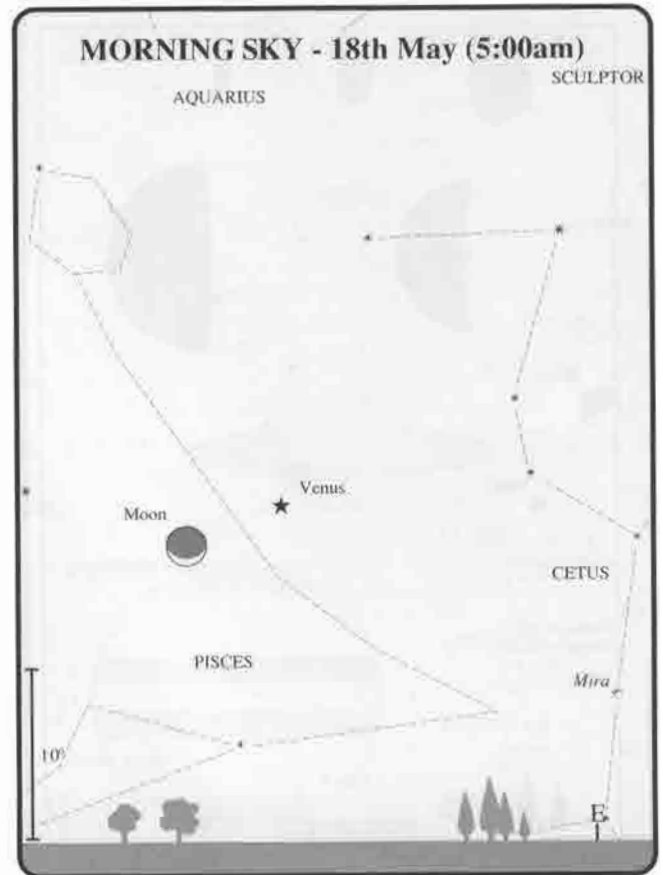
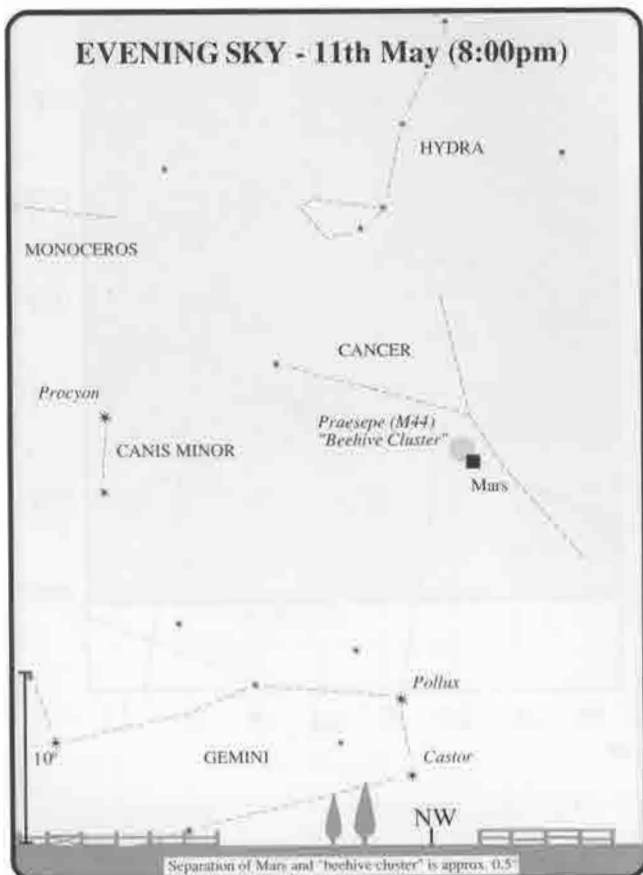
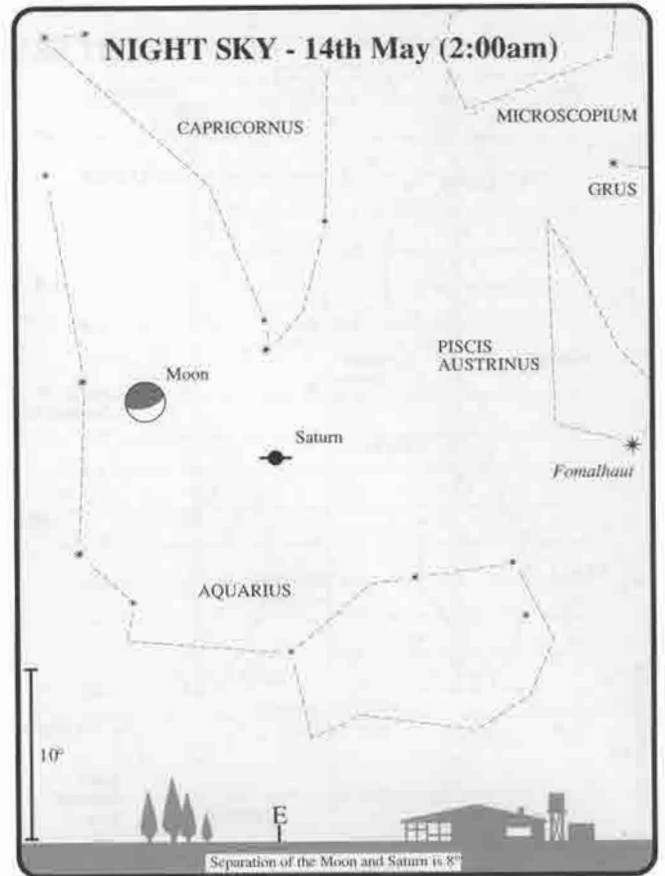
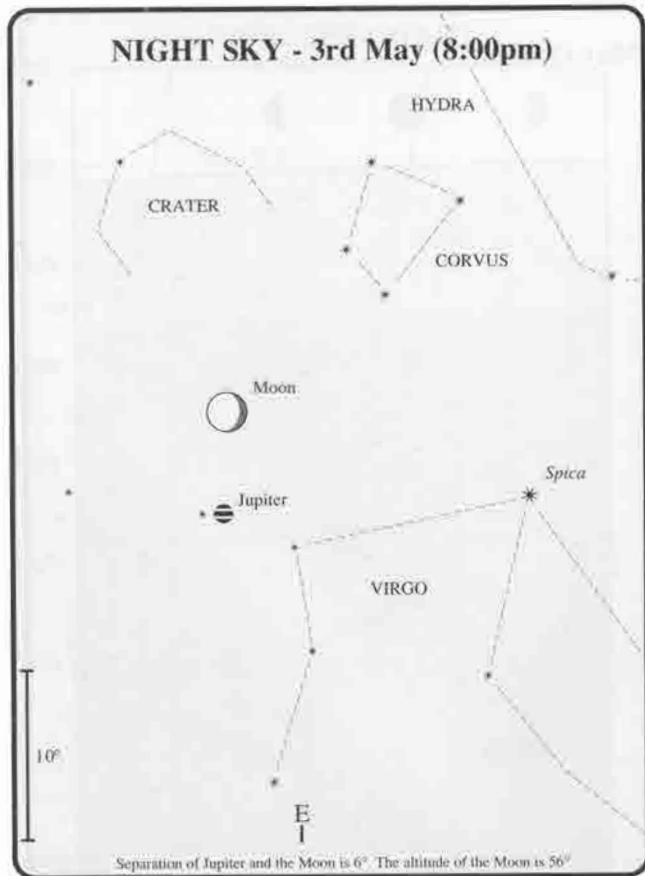
The **SCORPID/SAGITTARIDS** occur between 15th April and 25th July, with several peaks of maximum activity over the period. A maximum zenith hourly rate of 10 slow meteors can be expected. and observation is best from about 10pm until twilight.

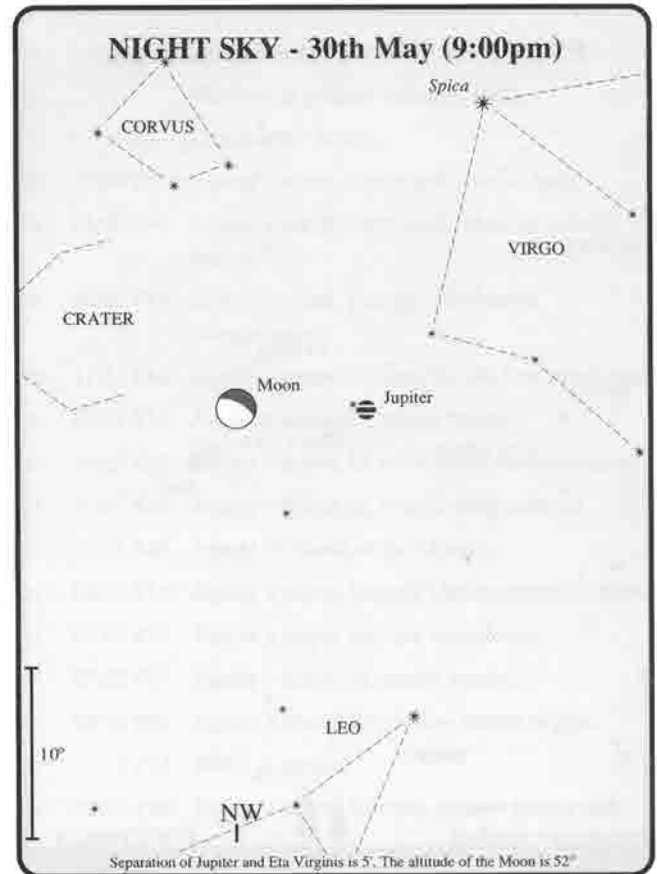
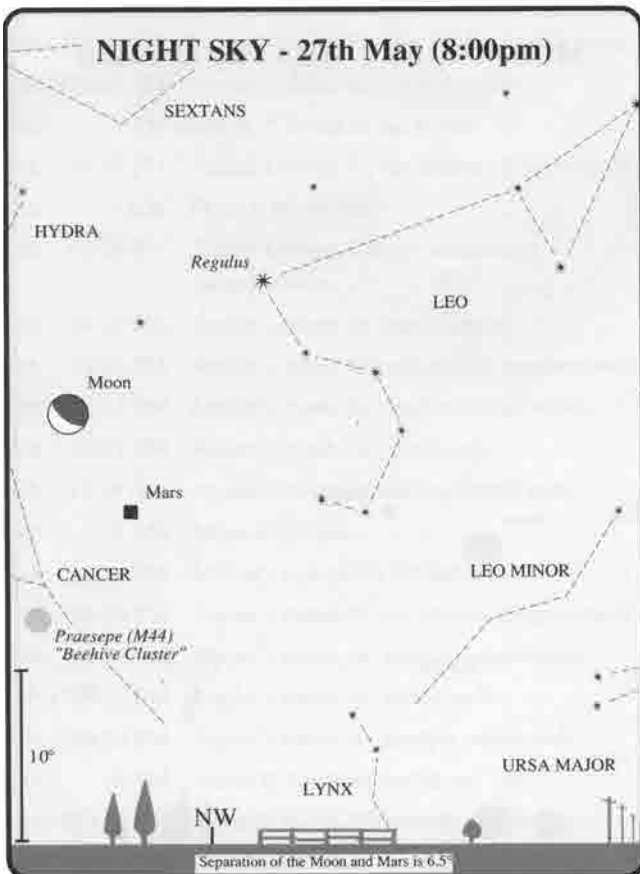
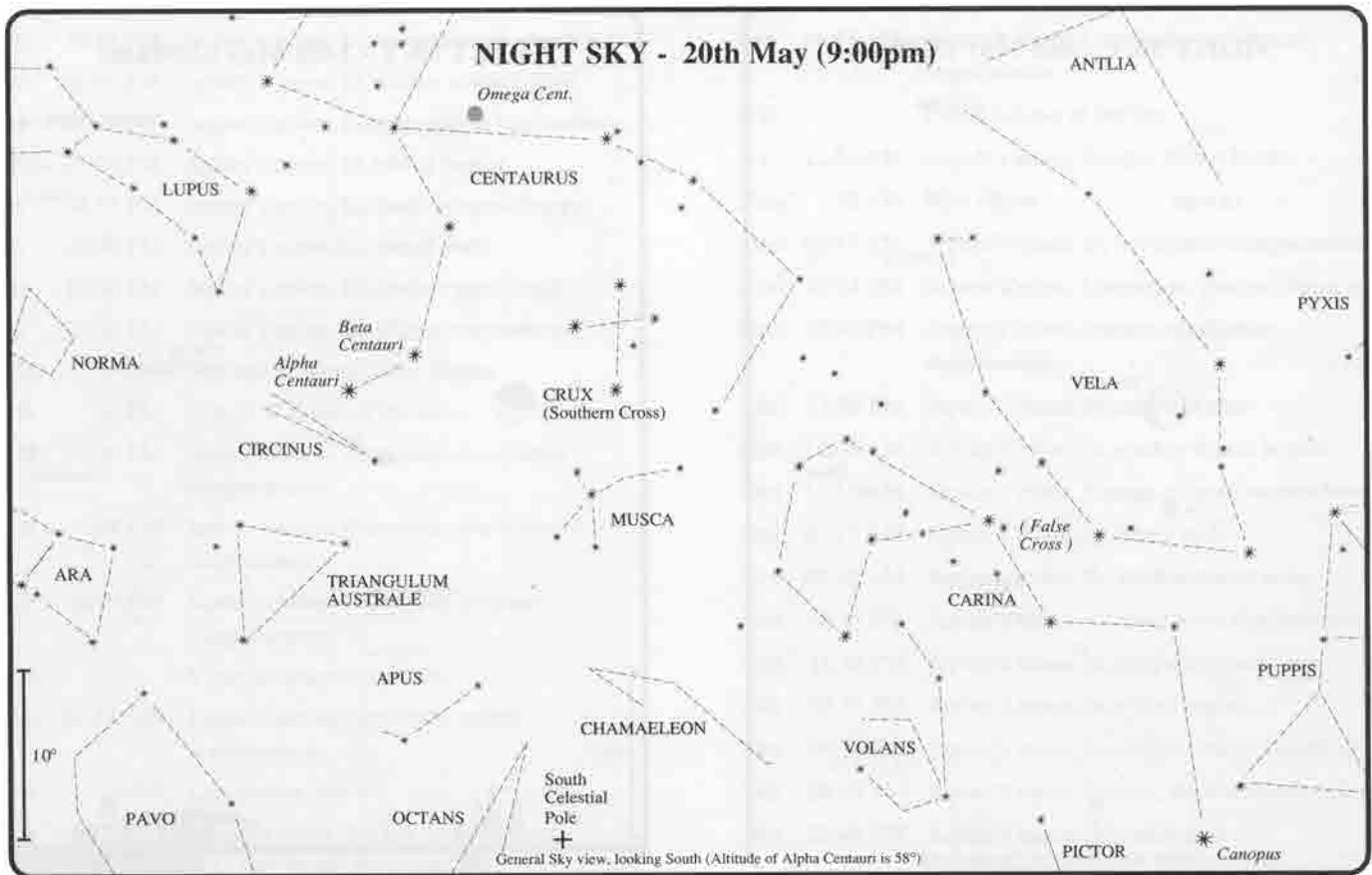
DAILY EVENTS

- 1st 02:06 AM Jupiter's moon, Ganymede, transit begins.
- 1st 05:42 PM Jupiter's moon, Io, transit begins.
- 1st 06:24 PM Jupiter's moon, Io, shadow transit begins.
- 1st 07:53 PM Jupiter's moon, Io, transit ends.
- 1st 08:36 PM Jupiter's moon, Io, shadow transit ends.
- 2nd 05:47 PM Jupiter's moon, Io, eclipse reappearance.
- 4th Eta Aquarids meteor shower maximum activity.
- 4th 1 AM Jupiter 7° North of the Moon.
- 4th 10 AM Moon at perigee.
- 4th 06:38 PM Jupiter's moon, Ganymede, occultation reappearance.
- 4th 07:00 PM Jupiter's moon, Ganymede, eclipse disappearance.
- 4th 09:46 PM Jupiter's moon, Ganymede, eclipse reappearance.
- 5th 01:49 AM Jupiter's moon, Europa, occultation disappearance.
- 6th 2 PM Full Moon.
- 6th 08:04 PM Jupiter's moon, Europa, transit begins.
- 6th 09:43 PM Jupiter's moon, Europa, shadow transit begins.
- 6th 10:32 PM Jupiter's moon, Europa, transit ends.
- 7th 12:11 AM Jupiter's moon, Europa, shadow transit ends.
- 7th 01:02 AM Jupiter's moon, Io, transit begins.
- 7th 01:50 AM Jupiter's moon, Io, shadow transit begins.
- 7th 03:13 AM Jupiter's moon, Io, transit ends.
- 7th 2 PM Venus greatest brilliancy.

7th	10:11 PM	Jupiter's moon, Io, occultation disappearance.	19th	01:43 AM	Jupiter's moon, Ganymede, occultation reappearance.
8th	01:13 AM	Jupiter's moon, Io, eclipse reappearance.	21st		Partial eclipse of the Sun.
8th	07:06 PM	Jupiter's moon, Europa, eclipse reappearance.	21st	12:51 AM	Jupiter's moon, Europa, transit begins.
8th	07:29 PM	Jupiter's moon, Io, transit begins.	22nd	12 AM	New Moon.
8th	08:19 PM	Jupiter's moon, Io, shadow transit begins.	22nd	01:47 AM	Jupiter's moon, Io, occultation disappearance.
8th	09:40 PM	Jupiter's moon, Io, transit ends.	22nd	07:34 PM	Jupiter's moon, Ganymede, shadow transit ends.
8th	10:30 PM	Jupiter's moon, Io, shadow transit ends.	22nd	07:42 PM	Jupiter's moon, Europa, occultation disappearance.
9th	07:43 PM	Jupiter's moon, Io, eclipse reappearance.	22nd	11:06 PM	Jupiter's moon, Io, transit begins.
11th	9 AM	Neptune 3° South of the Moon.	23rd	12:08 AM	Jupiter's moon, Io, shadow transit begins.
11th	12 PM	Uranus 4° South of the Moon.	23rd	12:15 AM	Jupiter's moon, Europa, eclipse reappearance.
11th	07:20 PM	Jupiter's moon, Ganymede, occultation disappearance.	23rd	01:17 AM	Jupiter's moon, Io, transit ends.
11th	10:08 PM	Jupiter's moon, Ganymede, occultation reappearance.	23rd	02:18 AM	Jupiter's moon, Io, shadow transit ends.
11th	10:59 PM	Jupiter's moon, Ganymede, eclipse disappearance.	23rd	08:15 PM	Jupiter's moon, Io, occultation disappearance.
12th		Venus at descending node.	23rd	11:32 PM	Jupiter's moon, Io, eclipse reappearance.
12th	01:44 AM	Jupiter's moon, Ganymede, eclipse reappearance.	24th	05:33 PM	Jupiter's moon, Io, transit begins.
13th	10 PM	Last quarter Moon.	24th	06:36 PM	Jupiter's moon, Io, shadow transit begins.
13th	10:27 PM	Jupiter's moon, Europa, transit begins.	24th	06:43 PM	Jupiter's moon, Europa, shadow transit ends.
14th		Mercury at ascending node.	24th	07:44 PM	Jupiter's moon, Io, transit ends.
14th	12:20 AM	Jupiter's moon, Europa, shadow transit begins.	24th	08:47 PM	Jupiter's moon, Io, shadow transit ends.
14th	12:55 AM	Jupiter's moon, Europa, transit ends.	25th	06:01 PM	Jupiter's moon, Io, eclipse reappearance.
14th	02:48 AM	Jupiter's moon, Europa, shadow transit ends.	26th	4 PM	Juno 1 °.2 South of the Moon.
14th	02:50 AM	Jupiter's moon, Io, transit begins.	27th	5 PM	Mars 7° North of the Moon.
14th	5 PM	Saturn 7° South of the Moon.	29th		Mercury at greatest latitude North.
14th	11:58 PM	Jupiter's moon, Io, occultation disappearance.	29th	4 AM	First quarter Moon.
15th	9 AM	Pluto at opposition.	29th	07:04 PM	Jupiter's moon, Ganymede, transit ends.
15th	05:19 PM	Jupiter's moon, Europa, occultation disappearance.	29th	08:50 PM	Jupiter's moon, Ganymede, shadow transit begins.
15th	09:17 PM	Jupiter's moon, Io, transit begins.	29th	10:07 PM	Jupiter's moon, Europa, occultation disappearance.
15th	09:40 PM	Jupiter's moon, Europa, eclipse reappearance.	29th	11:32 PM	Jupiter's moon, Ganymede, shadow transit ends.
15th	10:13 PM	Jupiter's moon, Io, shadow transit begins.	30th	12:55 AM	Jupiter's moon, Io, transit begins.
15th	11:28 PM	Jupiter's moon, Io, transit ends.	30th	10:05 PM	Jupiter's moon, Io, occultation disappearance.
16th	12:24 AM	Jupiter's moon, Io, shadow transit ends.	31st	01:27 AM	Jupiter's moon, Io, eclipse reappearance.
16th	8 AM	Moon at apogee.	31st	7 AM	Jupiter 7° North of the Moon.
16th	1 PM	Mercury in superior conjunction.	31st	06:53 PM	Jupiter's moon, Europa, shadow transit begins.
16th	06:26 PM	Jupiter's moon, Io, occultation disappearance.	31st	07:02 PM	Jupiter's moon, Europa, transit ends.
16th	09:37 PM	Jupiter's moon, Io, eclipse reappearance.	31st	07:23 PM	Jupiter's moon, Io, transit begins.
17th	05:55 PM	Jupiter's moon, Io, transit ends.	31st	08:31 PM	Jupiter's moon, Io, shadow transit begins.
17th	06:53 PM	Jupiter's moon, Io, shadow transit ends.	31st	9 PM	Moon at perigee.
18th	10 AM	Venus 6° South of the Moon.	31st	09:20 PM	Jupiter's moon, Europa, shadow transit ends.
18th	10:53 PM	Jupiter's moon, Ganymede, occultation disappearance.	31st	09:34 PM	Jupiter's moon, Io, transit ends.
19th		Mercury at perihelion.	31st	10:41 PM	Jupiter's moon, Io, shadow transit ends.

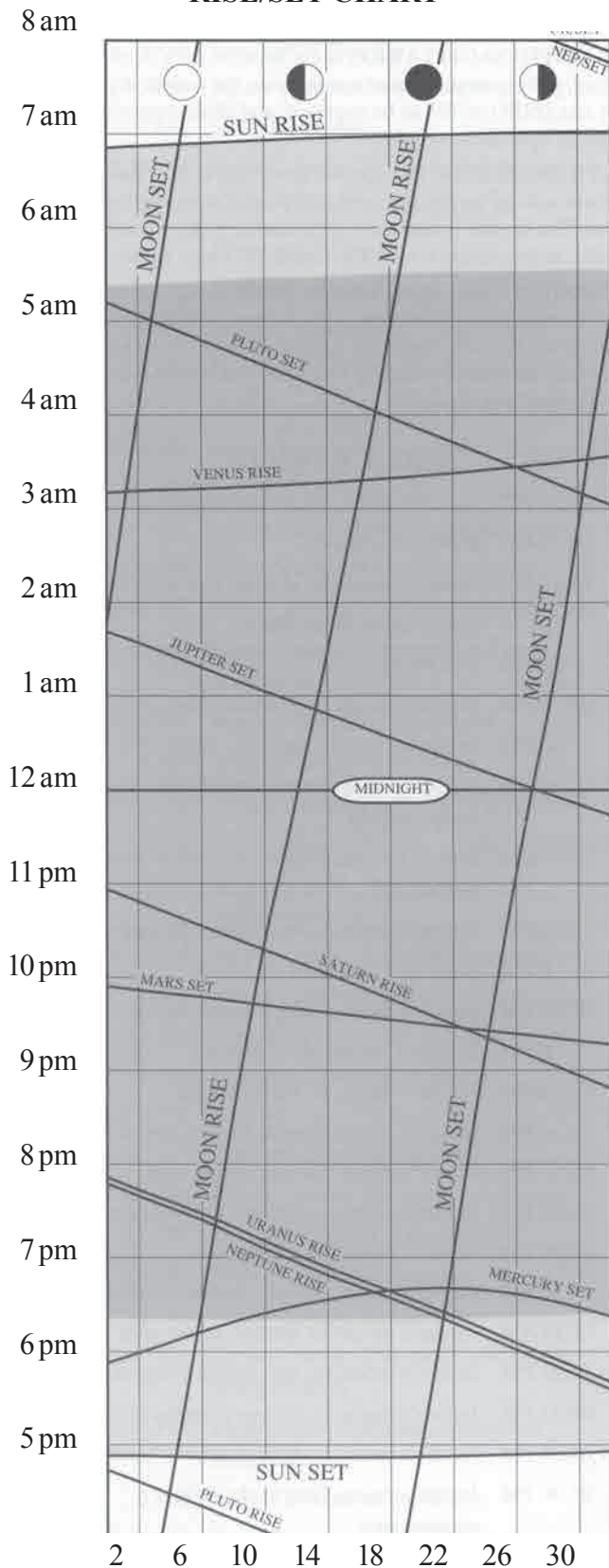
MAY



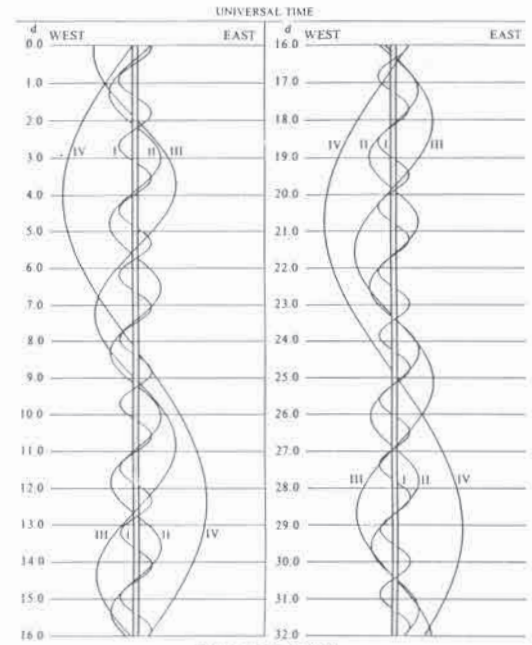


JUNE

RISE/SET CHART

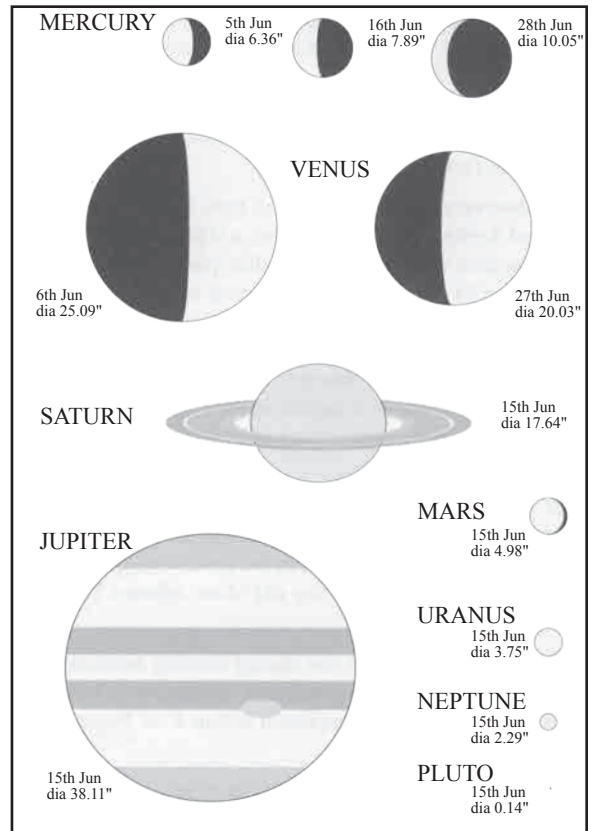


CONFIGURATIONS OF SATELLITES I-IV FOR JUNE



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



JUNE

THE MOON

- 4th Full Moon, 11:02pm.
Total eclipse of the Moon, 8:10pm. Visible across Australia (see page 70 for details).
- 12th Last quarter, 3:36pm.
- 13th Moon at apogee.
- 20th New Moon, 11:52pm (Lunation number 872).
- 26th Moon at perigee.
- 27th First Quarter, 8:43am.

THE PLANETS

MERCURY reaches greatest elongation east of the Sun (25°) on the 18th, the best conditions for observation would be from the 10th to 26th June. Mercury's magnitude is 0.5 at eastern elongation, and it's altitude before the end of evening astronomical twilight is about 7° , with the Sun $13^\circ 30'$ below the horizon. From the 15th to the 22nd Mercury will be situated less than 7° from 1st magnitude Beta Geminorum (Pollux). On the 8th, the planet will make an interesting telescopic object when it will be very close ($0^\circ 03'$) from 3rd magnitude Epsilon Geminorum (see sky view diagram).

VENUS reaches greatest elongation west of the Sun (46°) on the 10th. The planet remains very prominent in the early eastern morning sky, it's phase changing from first quarter to gibbous during the month. Before the beginning of astronomical twilight (around 5am) the 25 day old Moon will be situated 8° north of Venus on the 16th (see sky view diagram), and on the following morning 9° below.

MARS moves from Cancer into Leo this month, spending much of the time near 1st magnitude Alpha Leonis (Regulus). Still bright in the early evening northwestern sky the planet's diameter drops to below 5" in June and it's magnitude falls to 1.5. Mars begins the month 12° below and south of 1.35 magnitude Regulus, the pair come to within $0^\circ 50'$ on the 22nd and 23rd, and at month's end Mars will be 5° above and northwards of the star. On the 24th the 5 day old Moon will appear $6^\circ 30'$ south of Mars, with Regulus between the two (see sky view diagram).

JUPITER observers will be in for a real treat this month as Zaniah (see May) and Jupiter reach their closest at $0^\circ 04'$ on the 2nd. The 4th magnitude star then moves into the satellite plane. The sky view diagram on page 34 illustrates the interesting star/planet/satellite configurations from the 23rd May to the 14th June. By the 20th, order will be restored with the star more than $30'$ away from the planet and no longer causing disarray. On the 26th the 7 day old Moon will appear 11° south of Jupiter in the evening northwestern sky, and on the following night closer at 8° above and to the north (see sky view diagram).

SATURN, in Aquarius rises prior to 10pm mid month. At magnitude 0.7 the planet is very prominent in the east, its only rivals been the 1st magnitude stars Altair, in the northwest and Fomalhaut, to the south. On the 11th, the 21 day old Moon appears 7° north of Saturn (see sky view diagram).

URANUS & NEPTUNE both rise during evening astronomical twilight this month as they move towards opposition in July. On the 7th, the 18 day old Moon will approach within 4° of Neptune and $4^\circ 45'$ of Uranus.

PLUTO rises before sunset throughout the month and is visible until about 4am. 4th magnitude Mu Serpentis remains the brightest field star at a separation of 3° early in the month.

METEOR SHOWERS

The **SCORPID/SAGITTARIDS** occur between 15th April and 25th July, with several peaks of activity over the period. A zenith hourly rate (ZHR) of 10 can be expected, and observations best from about 8pm until twilight.

The **LYRIDS** (June) can be expected from 11th to 21st June, with maximum activity on the 16th, and a ZHR of 5 slow moving meteors. The shower is best seen in the northern sky around midnight, as the radiant is near 1st magnitude Alpha Lyrae (Vega).

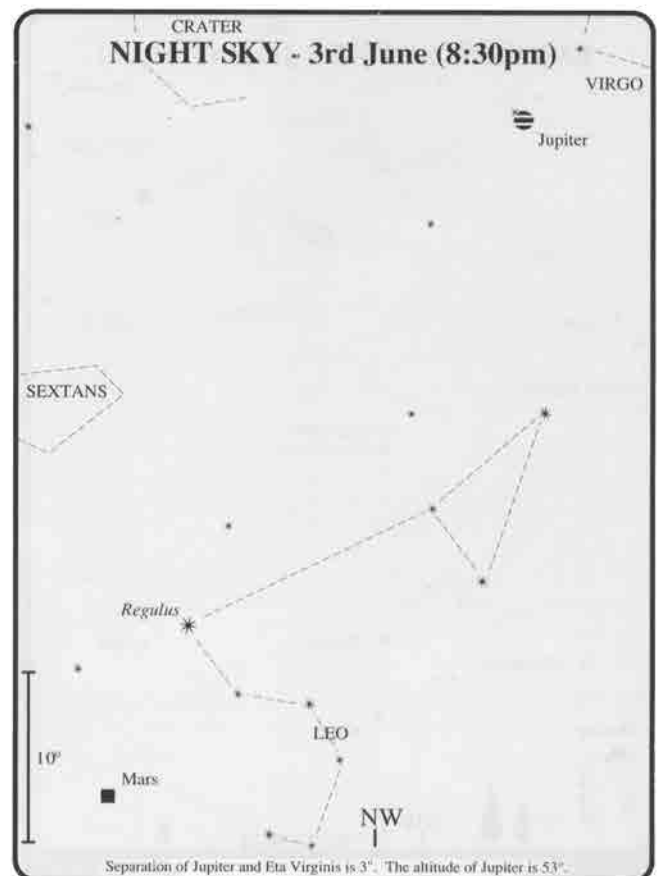
The **BOOTIDS** (June) appear only on 28th June, with no activity either side of this date. These very slow meteors with a ZHR of 2 have a radiant near 4th magnitude Lambda Bootis. Because of the low altitude the shower would be best observed between 7 to 10pm low in the northern sky.

DAILY EVENTS

- | | | |
|------|----------|--|
| 1st | 07:56 PM | Jupiter's moon, Io, eclipse reappearance. |
| 2nd | 2 AM | Jupiter stationary. |
| 2nd | 05:10 PM | Jupiter's moon, Io, shadow transit ends. |
| 4th | | Total eclipse of the Moon. |
| 4th | 11 PM | Full Moon. |
| 5th | 07:56 PM | Jupiter's moon, Ganymede, transit begins. |
| 5th | 10:48 PM | Jupiter's moon, Ganymede, transit ends. |
| 6th | 12:34 AM | Jupiter's moon, Europa, occultation disappearance. |
| 6th | 12:49 AM | Jupiter's moon, Ganymede, shadow transit begins. |
| 6th | 11:57 PM | Jupiter's moon, Io, occultation disappearance. |
| 7th | 6 PM | Neptune 3° South of the Moon. |
| 7th | 07:02 PM | Jupiter's moon, Europa, transit begins. |
| 7th | 8 PM | Uranus 4° South of the Moon. |
| 7th | 09:14 PM | Jupiter's moon, Io, transit begins. |
| 7th | 09:30 PM | Jupiter's moon, Europa, shadow transit begins. |
| 7th | 09:33 PM | Jupiter's moon, Europa, transit ends. |
| 7th | 10:25 PM | Jupiter's moon, Io, shadow transit begins. |
| 7th | 11:26 PM | Jupiter's moon, Io, transit ends. |
| 7th | 11:57 PM | Jupiter's moon, Europa, shadow transit ends. |
| 8th | 12:36 AM | Jupiter's moon, Io, shadow transit ends. |
| 8th | 06:25 PM | Jupiter's moon, Io, occultation disappearance. |
| 8th | 09:51 PM | Jupiter's moon, Io, eclipse reappearance. |
| 9th | 04:54 PM | Jupiter's moon, Io, shadow transit begins. |
| 9th | 05:39 PM | Jupiter's moon, Ganymede, eclipse reappearance. |
| 9th | 05:54 PM | Jupiter's moon, Io, transit ends. |
| 9th | 06:40 PM | Jupiter's moon, Europa, eclipse reappearance. |
| 9th | 07:04 PM | Jupiter's moon, Io, shadow transit ends. |
| 10th | 11 PM | Venus greatest elongation West (46°). |
| 11th | 3 AM | Saturn 7° South of the Moon. |

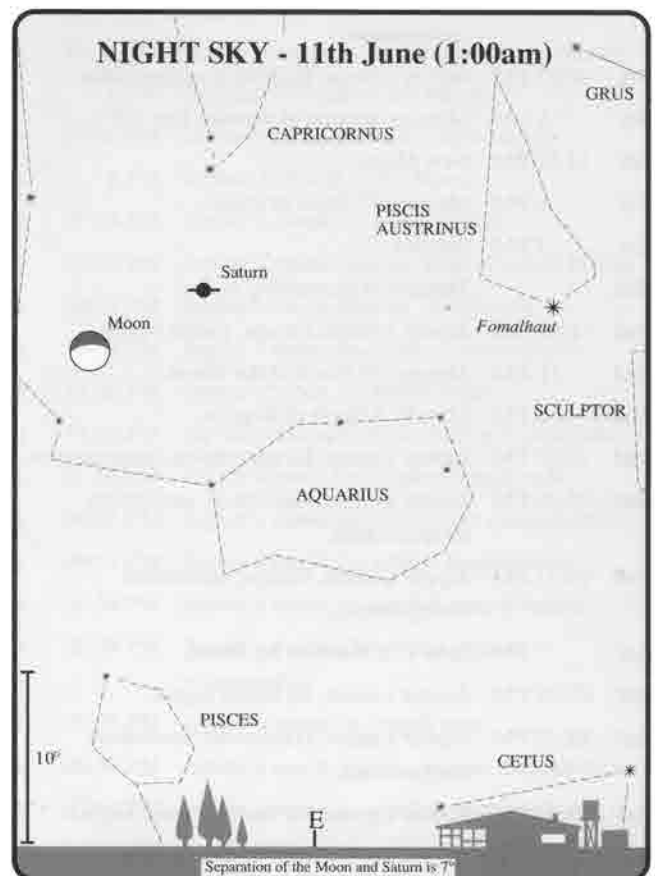
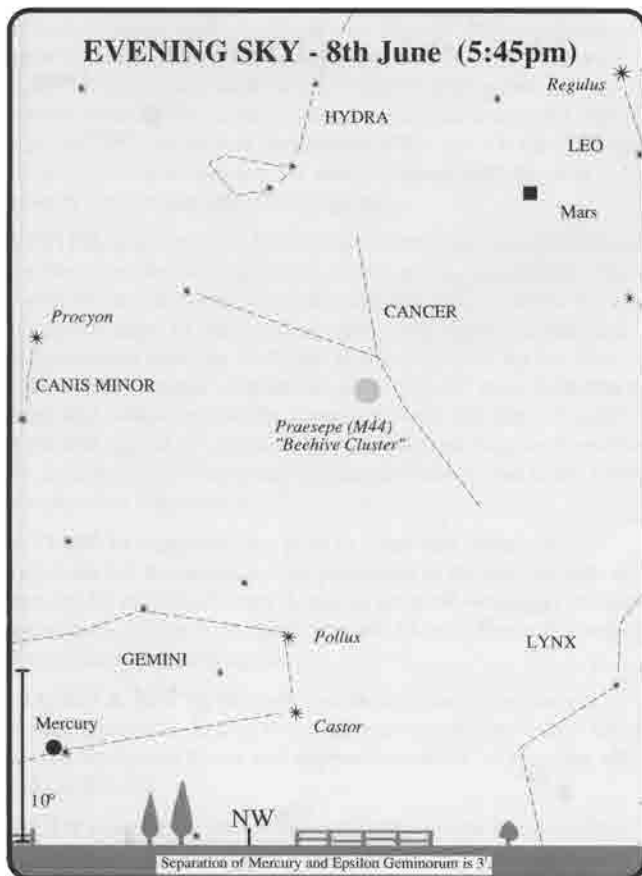
JUNE

11th	10 AM	Saturn stationary.	23rd	09:23 PM	Jupiter's moon, Europa, eclipse disappearance.
12th	4 PM	Last quarter Moon.	23rd	09:40 PM	Jupiter's moon, Io, transit ends.
12th	11:45 PM	Jupiter's moon, Ganymede, transit begins.	23rd	10:53 PM	Jupiter's moon, Io, shadow transit ends.
13th	2 AM	Moon at apogee.	23rd	10:56 PM	Jupiter's moon, Ganymede, eclipse disappearance.
14th	09:35 PM	Jupiter's moon, Europa, transit begins.	23rd	11:49 PM	Jupiter's moon, Europa, eclipse reappearance.
14th	11:07 PM	Jupiter's moon, Io, transit begins.	24th	7 PM	Pallas stationary.
15th		Venus at aphelion.	24th	08:10 PM	Jupiter's moon, Io, eclipse reappearance.
15th		Jupiter at aphelion.	25th	3 AM	Mars 7° North of the Moon.
15th	12:05 AM	Jupiter's moon, Europa, transit ends.	25th	05:22 PM	Jupiter's moon, Io, shadow transit ends.
15th	12:08 AM	Jupiter's moon, Europa, shadow transit begins.	25th	06:31 PM	Jupiter's moon, Europa, shadow transit ends.
15th	12:20 AM	Jupiter's moon, Io, shadow transit begins.	26th	3 AM	Moon at perigee.
15th	08:18 PM	Jupiter's moon, Io, occultation disappearance.	27th	9 AM	First quarter Moon.
15th	11:46 PM	Jupiter's moon, Io, eclipse reappearance.	27th	2 PM	Jupiter 7° North of the Moon.
16th		Lyrids meteor shower maximum activity.	28th		Bootids meteor shower maximum activity.
16th	05:35 PM	Jupiter's moon, Io, transit begins.	30th	09:23 PM	Jupiter's moon, Io, transit begins.
16th	06:49 PM	Jupiter's moon, Io, shadow transit begins.	30th	09:25 PM	Jupiter's moon, Europa, occultation disappearance.
16th	06:57 PM	Jupiter's moon, Ganymede, eclipse disappearance.	30th	09:39 PM	Jupiter's moon, Ganymede, occultation disappearance.
16th	07:46 PM	Jupiter's moon, Io, transit ends.	30th	10:38 PM	Jupiter's moon, Io, shadow transit begins.
16th	8 PM	Venus 6° South of the Moon.	30th	11:34 PM	Jupiter's moon, Io, transit ends.
16th	08:59 PM	Jupiter's moon, Io, shadow transit ends.			
16th	09:15 PM	Jupiter's moon, Europa, eclipse reappearance.			
16th	09:38 PM	Jupiter's moon, Ganymede, eclipse reappearance.			
17th	06:15 PM	Jupiter's moon, Io, eclipse reappearance.			
18th	3 AM	Mercury greatest elongation East (25°).			
20th	11:52 PM	New Moon.			
21st	6 PM	Mercury 7° South of Pollux.			
21st	7 PM	Solstice.			
22nd		Mercury at descending node.			
22nd	12:09 AM	Jupiter's moon, Europa, transit begins.			
22nd	11 AM	Mercury 4 ° North of the Moon.			
22nd	8 PM	Mars 0° 8 North of Regulus.			
22nd	10:12 PM	Jupiter's moon, Io, occultation disappearance.			
23rd	05:40 PM	Jupiter's moon, Ganymede, occultation disappearance.			
23rd	06:51 PM	Jupiter's moon, Europa, occultation disappearance.			
23rd	7 PM	Juno I 0.1 North of the Moon.			
23rd	07:28 PM	Jupiter's 1110011, Io, transit begins.			
23rd	08:37 PM	Jupiter's moon, Ganymede, occultation reappearance.			
23rd	08:43 PM	Jupiter's moon, Io, shadow transit begins.			
23rd	09:22 PM	Jupiter's moon, Europa, occultation reappearance.			

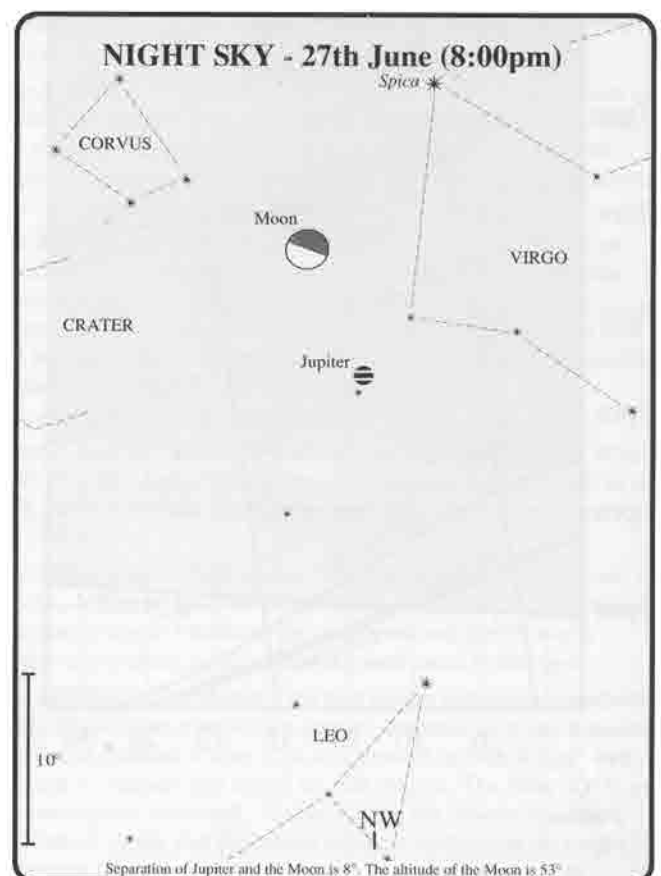
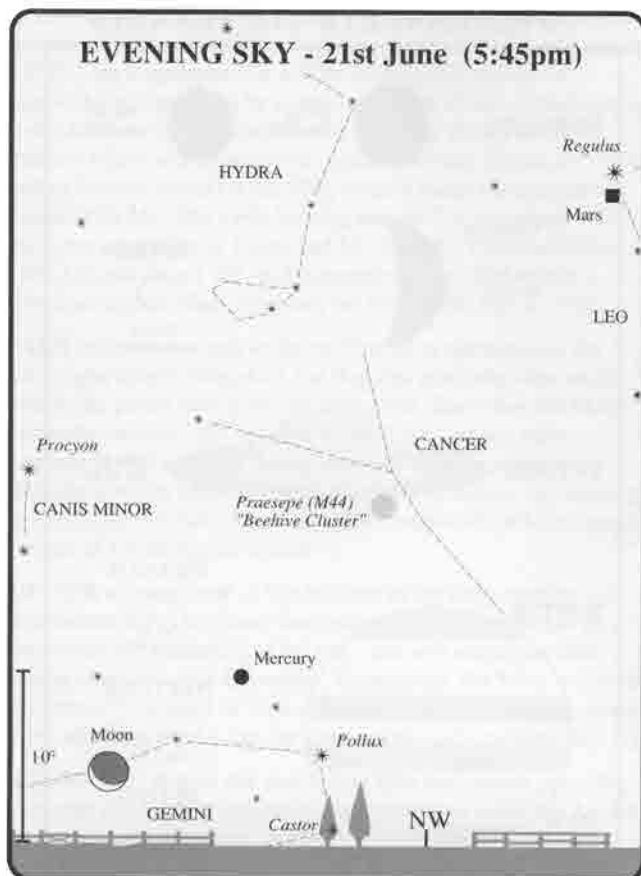
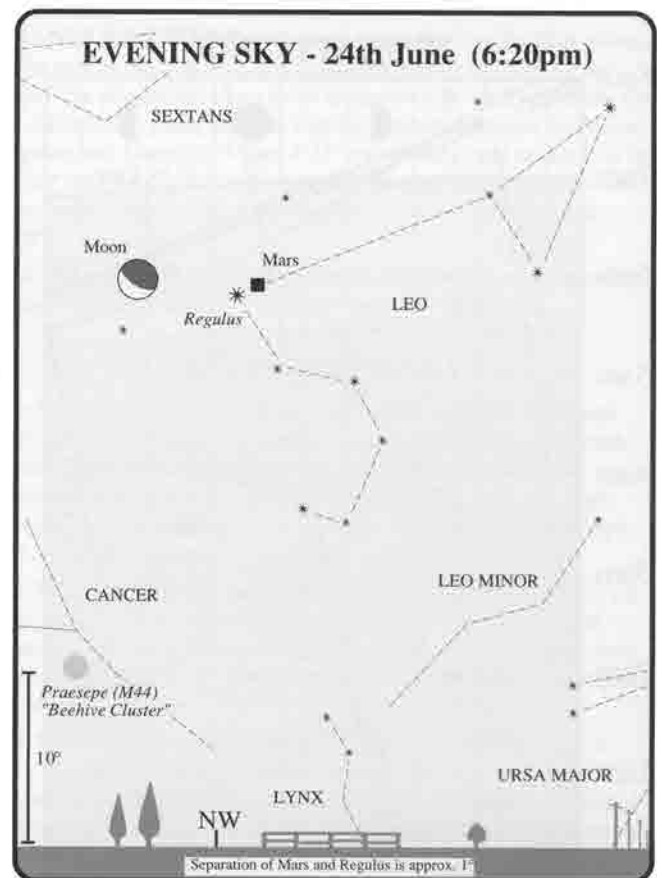
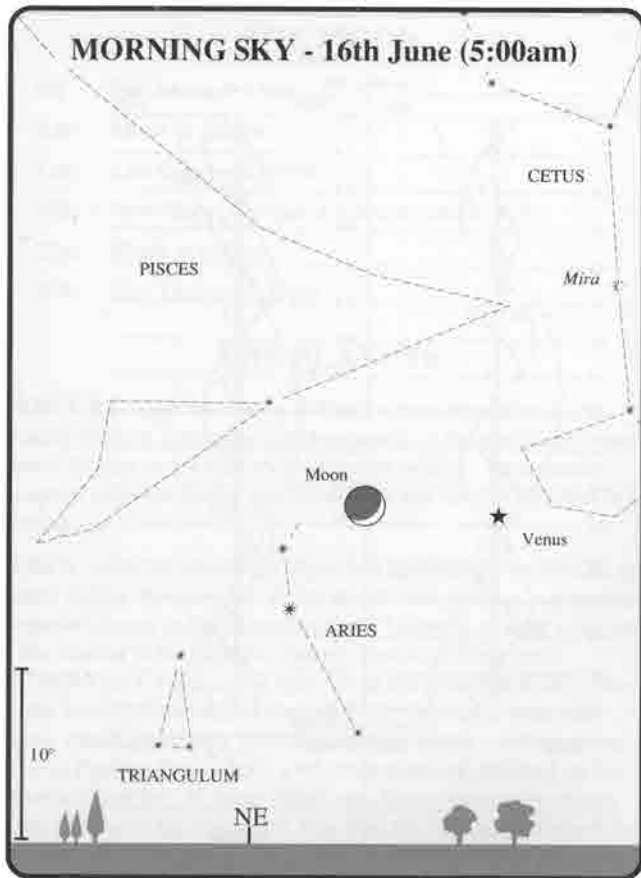


JUNE

JUPITER'S SATELLITES and ETA VIRGINIS - 8.00pm	
23rd May Sep = 0°10'	
25th May Sep = 0°08'	
27th May Sep = 0°06'	
29th May Sep = 0°05'	
31st May Sep = 0°05'	
2nd June Sep = 0°04'	
4th June Sep = 0°04'	
6th June Sep = 0°04'	
8th June Sep = 0°06'	
10th June Sep = 0°09'	
12th June Sep = 0°13'	
14th June Sep = 0°17'	
η = Eta Virginis I = Io II = Europa III = Ganymede IV = Callisto	

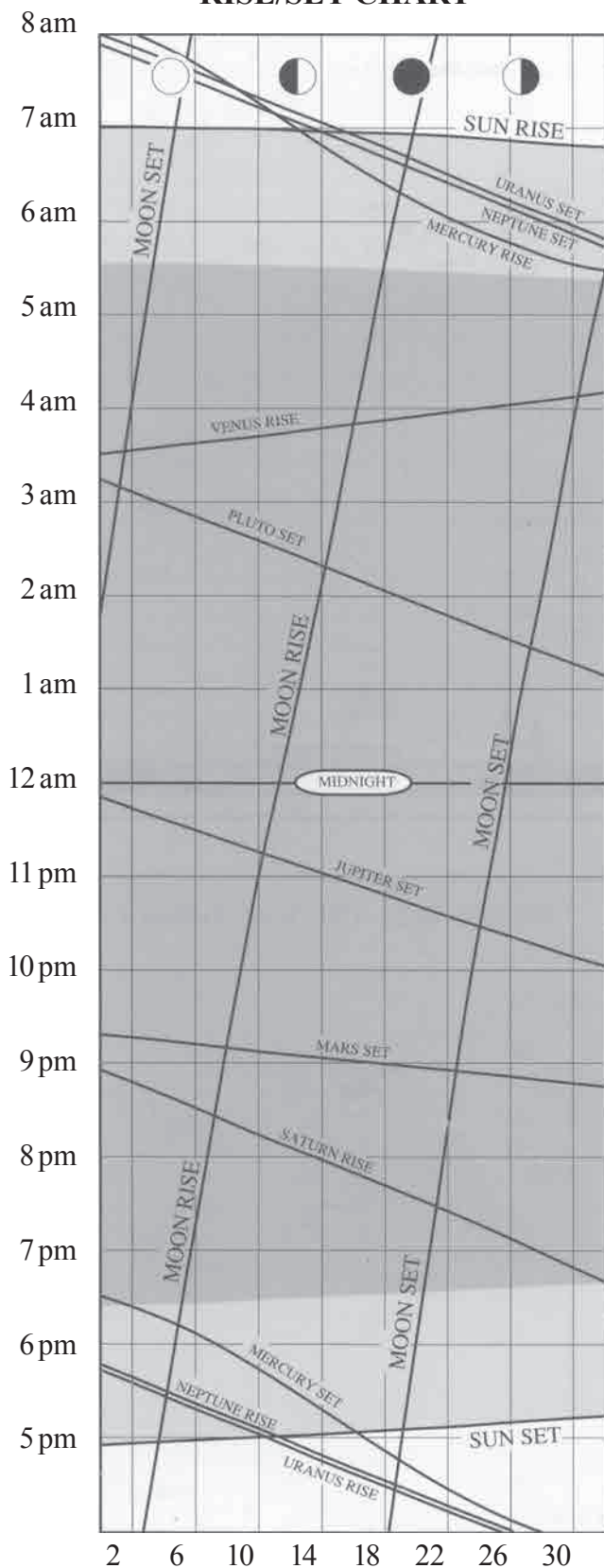


JUNE

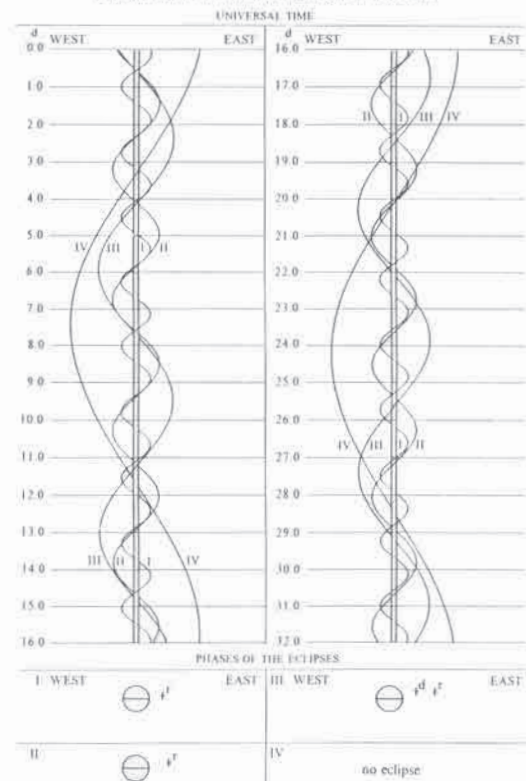


JULY

RISE/SET CHART

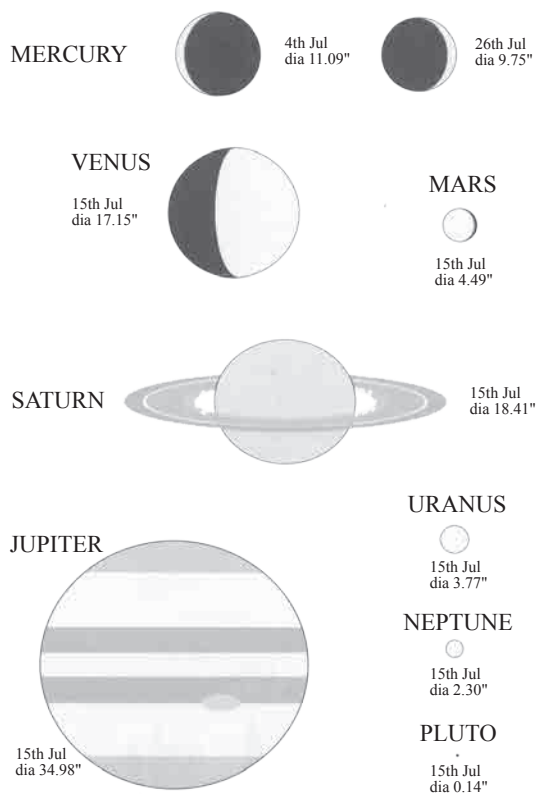


CONFIGURATIONS OF SATELLITES I-IV FOR JULY



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



THE MOON

- 4th Full Moon, 9:45am.
- 10th Moon at apogee.
- 12th Last Quarter, 8:49am.
- 19th New Moon, 9:24pm (Lunation number 873).
- 22nd Moon at perigee.
- 26th First Quarter, 1:25pm.

THE PLANETS

MERCURY again becomes a difficult object, appearing in the evening twilight during the first two weeks of the month, and then spends the last two weeks in the morning twilight. Observation prospects improve during late September and most of October in the evening sky.

VENUS makes an interesting sight as it approaches the Hyades star cluster during the early part of the month. The Hyades, a prominent V-shaped cluster in the constellation of Taurus is thought to be one of the nearest of the galactic clusters. Readers of last years ASTRONOMY 1992 would have noted the presence of Mars near Alpha Tauri (Aldebaran) in August 1992. This apparition with Venus should be equally spectacular as the planet comes extremely close to Epsilon Tauri (Ain), a 4th magnitude star situated on the opposite tip of the 'V' from Aldebaran. Venus begins the month about 16° above the horizon at 5am with the Hyades just above the horizon, 12° below and to the south. By mid month Venus loses about 4° of altitude and the Hyades, rising earlier each evening move upwards to intermingle with the planet. On the 10th a trapezium is formed with Venus, Gamma, Alpha and Epsilon. From the 10th on, some appealing sights will be seen, including the above mentioned close approach by Venus to Ain on the 14th, at a distance of 0°07', 4th magnitude Ain will be swamped in Venus' -4 magnitude brilliance and be a striking sight with the reddish/orange giant Aldebaran 3° eastward. On the 16th, the 26 day old thin Crescent Moon will appear 4°40' north of Venus. Venus also visits another famous object on the 27th, when it forms the apex of a triangle with M1 (The Crab Nebula) and the 3rd magnitude star Zeta Tauri; the separation of Venus and M1 is 0°40', Venus and Zeta 0°35', M1 and Zeta 1°10' (at 8th magnitude the Crab is only a telescopic object). (See sky views for 10th, 14th, 16th & 27th).

MARS begins the month in the early evening northeastern sky 5° from Alpha Leonis (Regulus), but Regulus gradually slips away beneath the planet setting earlier each night. The 4 day old Moon approaches within 7°20' of Mars on the 23rd (see sky view diagram). It will be noted during the month that Jupiter moves gradually towards Mars, this will culminate in a close approach by the two planets in early September. The magnitude of Mars remains constant at 1.6 during the month.

JUPITER at magnitude -1.9 is brilliant in the early evening northeastern sky. The planet has resided in the constellation of Virgo since the beginning of the year, and will remain so until passing into Libra mid-December. On the 24th, the 5 day old Moon will appear 5°45' west of Jupiter. By mid-month Jupiter sets around 11pm, allowing ample time for comfortable early evening viewing.

SATURN rises almost due east before 8pm mid-month providing almost the entire night for observing. Opposition occurs in August and the planet's brightness increases slightly from 0.7 to 0.5 during the month. On the 7th, the 18 day old Moon appears 7° north of Saturn (see sky view diagram).

URANUS & NEPTUNE both reach opposition on the 12th, rising in the east as the Sun sets, and remaining visible throughout the night. The planets have two close approaches by the Full Moon. On the 5th in the evening sky, the angular distance between the Moon, Neptune and Uranus is 3° and 4°25' respectively, and on the 31st the 13 day old Moon again is 5° and 5°45' away from the pair (closest approach to Neptune happens about 5 am on the 1st August at 3°20').

PLUTO is situated about 45° above the horizon after astronomical twilight ends and is visible until the early morning hours.

METEOR SHOWERS

The **SCORPID/SAGITTARIDS** occur between 15th April and 25th July, with several peaks of activity over the period. A zenith hourly rate (ZHR) of 10 slow meteors can be expected, and observation prospects are good during the entire night, although probably best around midnight when the constellations of Scorpio and Sagittarius are near culmination.

The **PEGASIDS** (July) have a short duration, from the 7th to 11th July, with the maximum peaking on 9th July. Observable from around midnight to the beginning of twilight. The (ZHR) is 8 very swift meteors per hour, with the radiant near 3rd magnitude Alpha Pegasi.

The **PHOENICIDS** (July) are active from 24th June through to 18th July, with maximum activity on 11th July. Seen to best advantage from about midnight to dawn, with an expected ZHR of 5 swift meteors, the radiant is near 4th magnitude Gamma Phoenicis.

The **PISCIS AUSTRINIDS** with a ZHR of 8, are observable from about 8pm to the beginning of twilight. The radiant is centred near 1st magnitude Alpha Piscis Austrini (Fomalhaut) which culminates in the early morning sky. The shower of medium speed meteors is visible from 9th July through to 17th August, with maximum activity on the 28th.

The **ALPHA CAPRICORNIDS**, noted for bright, slow meteors are visible late evening in the eastern sky until dawn in the west. They are visible from 3rd July through to 25th August with a peak in activity on 30th July. The hourly rate is 8, and the radiant is centred near 4th magnitude Alpha Capricornus.

The **DELTA AQUARIDS** (S) are one of the strongest and most consistent of the southern showers. The range of activity of these medium speed meteors extends from 8th July through to 19th August, with maximum this month on the 29th. The radiant is near 3rd magnitude Delta Aquarii, and the shower is visible late evening in the eastern sky until dawn in the west.

The **DELTA AQUARIDS** (N) occur from 15th July to 25th August, reaching maximum activity next month on the 12th. With a ZHR of 5, the shower of medium speed meteors is northwards of the DELTA AQUARIDS (S), but the same observing time can be applied.

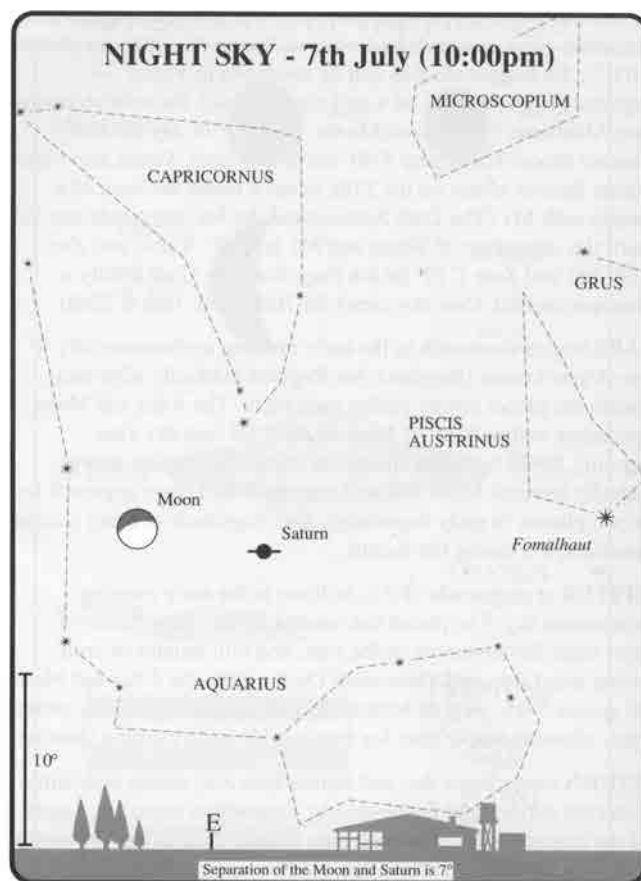
The **IOTA AQUARIDS** (S) reach maximum activity next month on the 5th, with their duration extending from 15th July to 25th August. The hourly rate is 3 medium speed meteors, and the shower is visible late evening in the eastern sky until dawn in the west.

The **PERSEIDS** are probably the best known and most dependable of the showers, records of their activity date back over one thousand years. The duration is from 17th July through to 24th August, and the peak is reached next month on 12th August. The ZHR is 100 and the meteors are very swift. Unfortunately, the shower's northerly declination means that the radiant is below the horizon for southern observers, however a watch should be kept northwards from midnight to dawn.

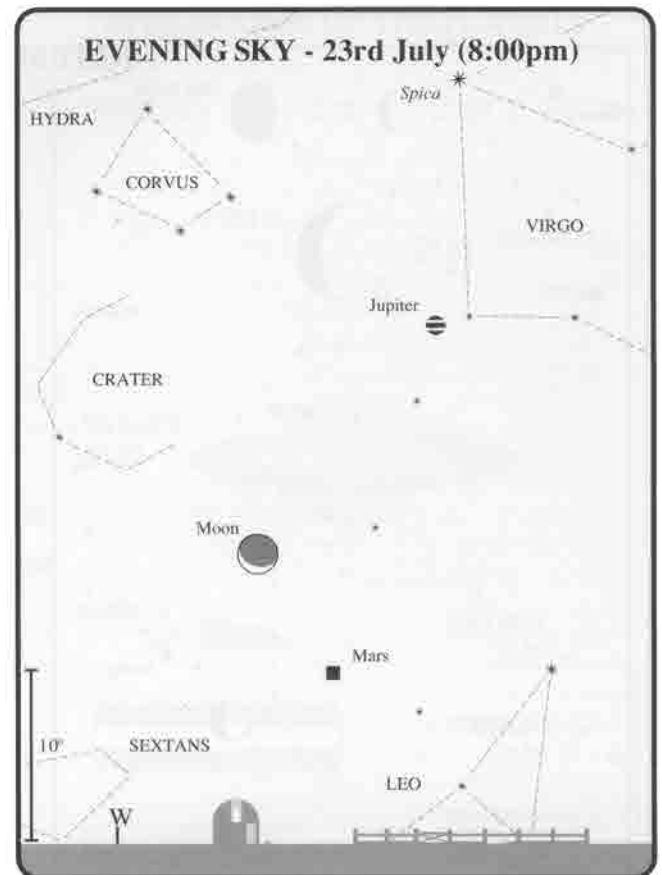
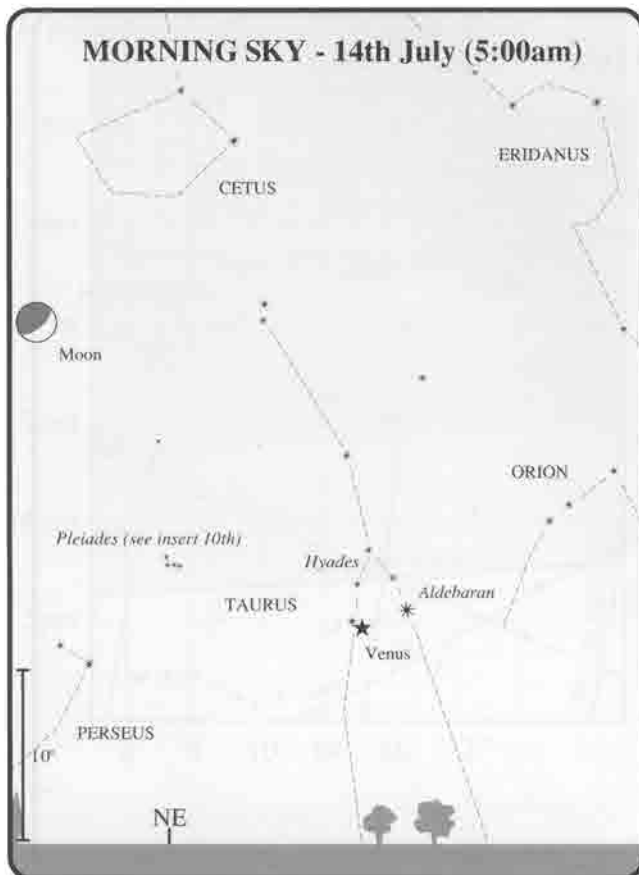
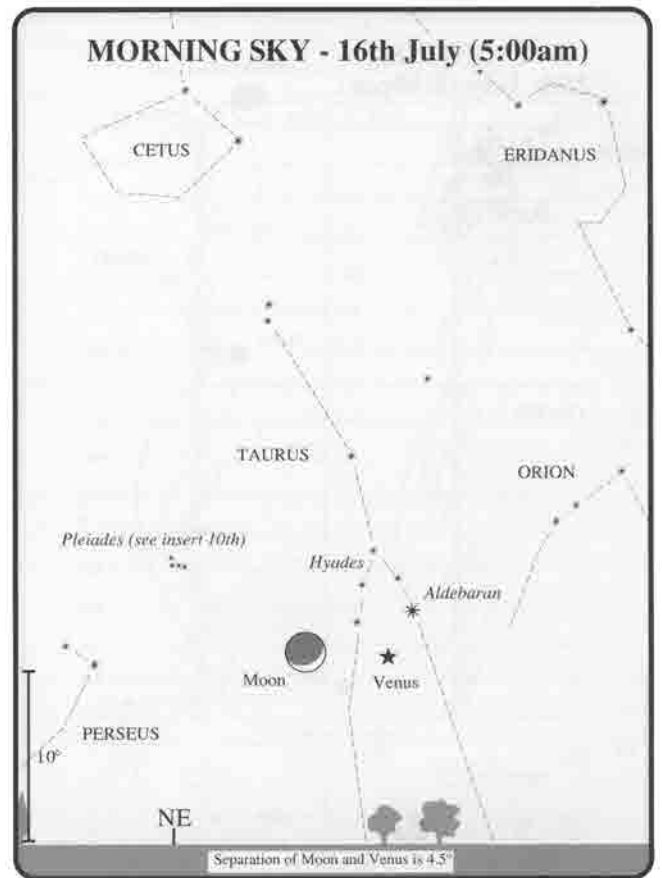
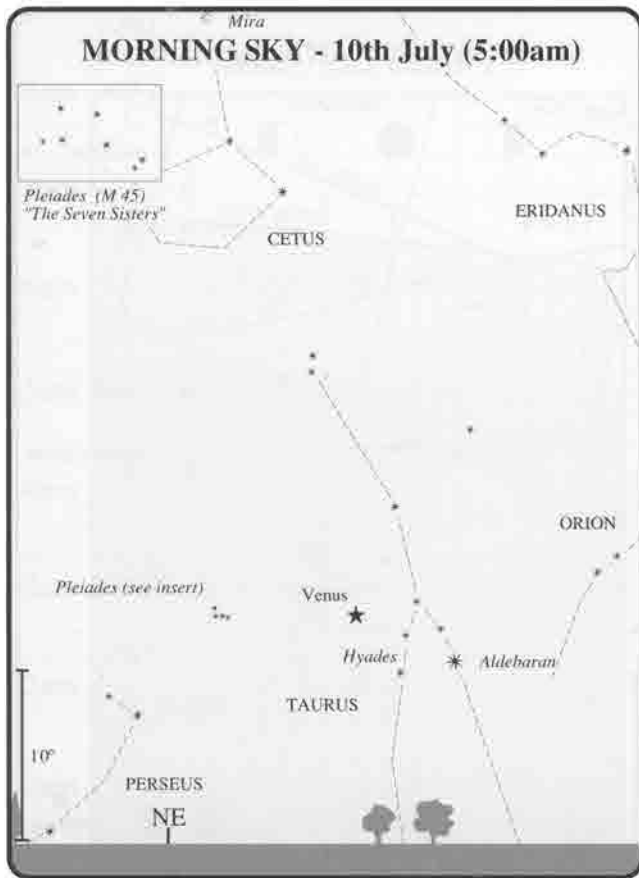
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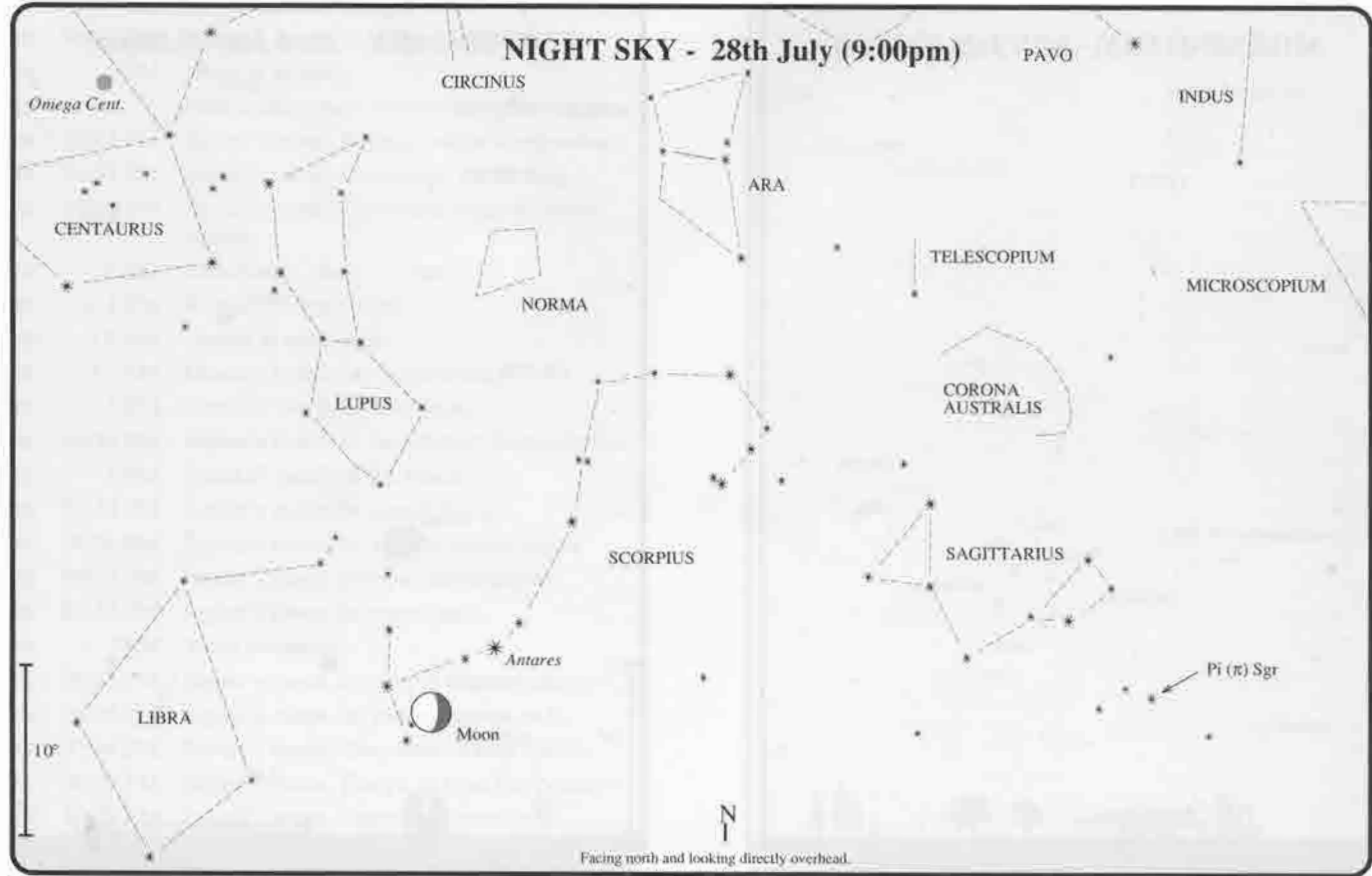
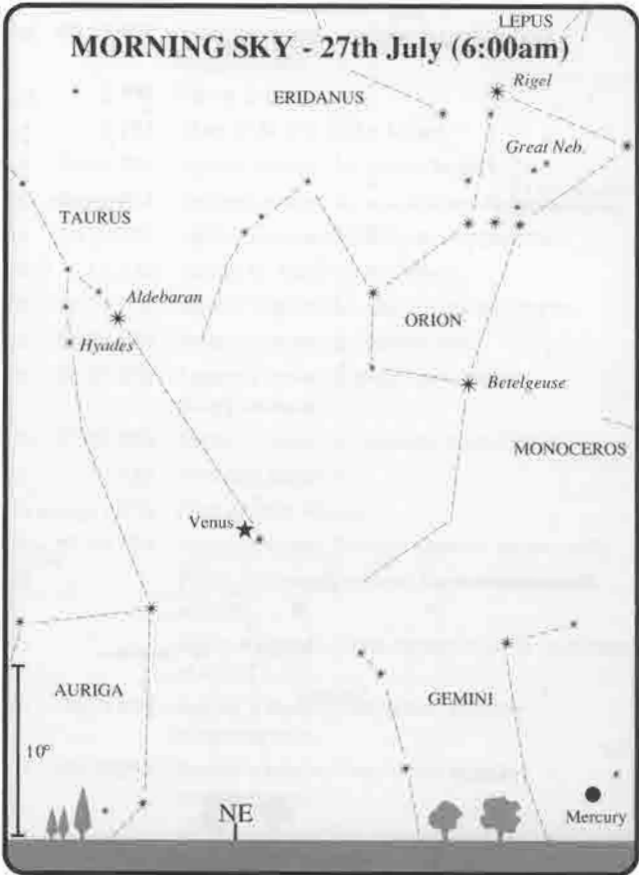
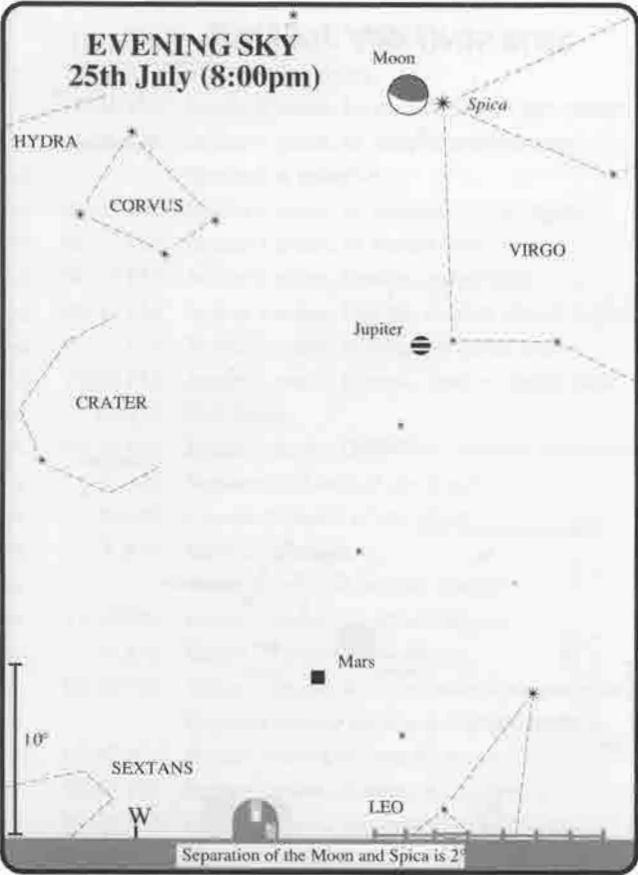
DAILY EVENTS

1 st	9 AM	Mercury Stationary.	22nd	05:32 PM	Jupiter's moon, Ganymede, eclipse reappearance.
1 st	06:36 PM	Jupiter's moon, Io, occultation disappearance.	22nd	6 PM	Moon at perigee.
1 st	10:06 PM	Jupiter's moon, Io, eclipse reappearance.	23rd	1 PM	Mars 6° North of the Moon.
2nd		Mercury at aphelion.	23rd	09:41 PM	Jupiter's moon, Io, transit begins.
2nd	05:07 PM	Jupiter's moon, Io, shadow transit begins.	24th	06:56 PM	Jupiter's moon, Io, occultation disappearance.
2nd	06:03 PM	Jupiter's moon, Io, transit ends.	24th	10:20 PM	Jupiter's moon, Io, eclipse reappearance.
2nd	06:37 PM	Jupiter's moon, Europa, transit ends.	25th	12 AM	Jupiter 6° North of the Moon.
2nd	06:43 PM	Jupiter's moon, Europa, shadow transit begins.	25th	05:19 PM	Jupiter's moon, Io, shadow transit begins.
2nd	07:17 PM	Jupiter's moon, Io, shadow transit ends.	25th	06:22 PM	Jupiter's moon, Io, transit ends.
2nd	09:08 PM	Jupiter's moon, Europa, shadow transit ends.	25th	06:38 PM	Jupiter's moon, Europa, occultation disappearance.
4th	10 AM	Full Moon.	25th	07:29 PM	Jupiter's moon, Io, shadow transit ends.
4th	07:24 PM	Jupiter's moon, Ganymede, shadow transit ends.	26th	12 AM	Mercury stationary.
5th	1 AM	Neptune 3° South of the Moon.	26th	1 PM	First quarter Moon.
5th	3 AM	Uranus 4° South of the Moon.	27th	06:18 PM	Jupiter's moon, Europa, shadow transit ends.
5th	8 AM	Earth at aphelion.	28th		Piscis Austrinus meteor shower maximum activity.
7th		Venus at greatest latitude South.	29th		Delta Aquarids South meteor shower maximum activity.
7th	11:18 PM	Jupiter's moon, Io, transit begins.	29th	06:55 PM	Jupiter's moon, Ganymede, eclipse disappearance.
8th	9 AM	Saturn 7° South of the Moon.	29th	09:30 PM	Jupiter's moon, Ganymede, eclipse reappearance.
8th	08:32 PM	Jupiter's moon, Io, occultation disappearance.	30th		Alpha Capricornids meteor shower maximum activity.
9th		Pegasids meteor shower maximum activity.	31 st	08:55 PM	Jupiter's moon, Io, occultation disappearance
9th	05:47 PM	Jupiter's moon, Io, transit begins.			
9th	06:45 PM	Jupiter's moon, Europa, transit begins.			
9th	07:01 PM	Jupiter's moon, Io, shadow transit begins.			
9th	07:56 PM	Jupiter's moon, Io, transit ends.			
9th	09:11 PM	Jupiter's moon, Io, shadow transit ends.			
9th	09:17 PM	Jupiter's moon, Europa, transit ends.			
9th	09:20 PM	Jupiter's moon, Europa, shadow transit begins.			
10th	06:30 PM	Jupiter's moon, Io, eclipse reappearance.			
10th	9 PM	Moon at apogee.			
11 th		Phoenicids meteor shower maximum activity.			
11 th	06:15 PM	Jupiter's moon, Europa, eclipse reappearance.			
11 th	06:31 PM	Jupiter's moon, Ganymede, transit ends.			
11 th	08:46 PM	Jupiter's moon, Ganymede, shadow transit begins.			
12th	9 AM	Last quarter Moon.			
12th	1 PM	Neptune at opposition.			
13th	12 AM	Uranus at opposition.			
15th	11 AM	Mercury in inferior conjunction.			
15th	5 PM	Venus 3° North of Aldebaran.			
15th	10:29 PM	Jupiter's moon, Io, occultation disappearance.			
16th	1 PM	Venus 2° South of the Moon.			
16th	07:44 PM	Jupiter's moon, Io, transit begins.			
16th	08:56 PM	Jupiter's moon, Io, shadow transit begins.			
16th	09:27 PM	Jupiter's moon, Europa, transit begins.			
16th	09:55 PM	Jupiter's moon, Io, transit ends.			
17th	7 PM	Vesta stationary.			
17th	08:25 PM	Jupiter's moon, Io, eclipse reappearance.			
18th	05:35 PM	Jupiter's moon, Io, shadow transit ends.			
18th	07:44 PM	Jupiter's moon, Ganymede, transit begins.			
18th	08:49 PM	Jupiter's moon, Europa, eclipse reappearance.			
18th	10:38 PM	Jupiter's moon, Ganymede, transit ends.			
19th	9 PM	New Moon			
22nd		Mercury at greatest latitude South.			



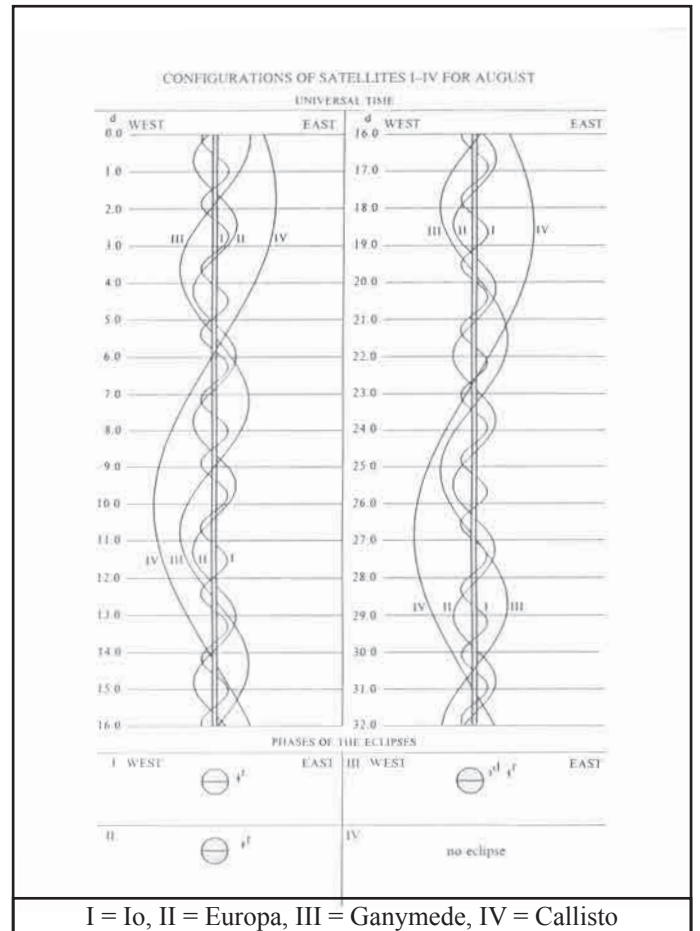
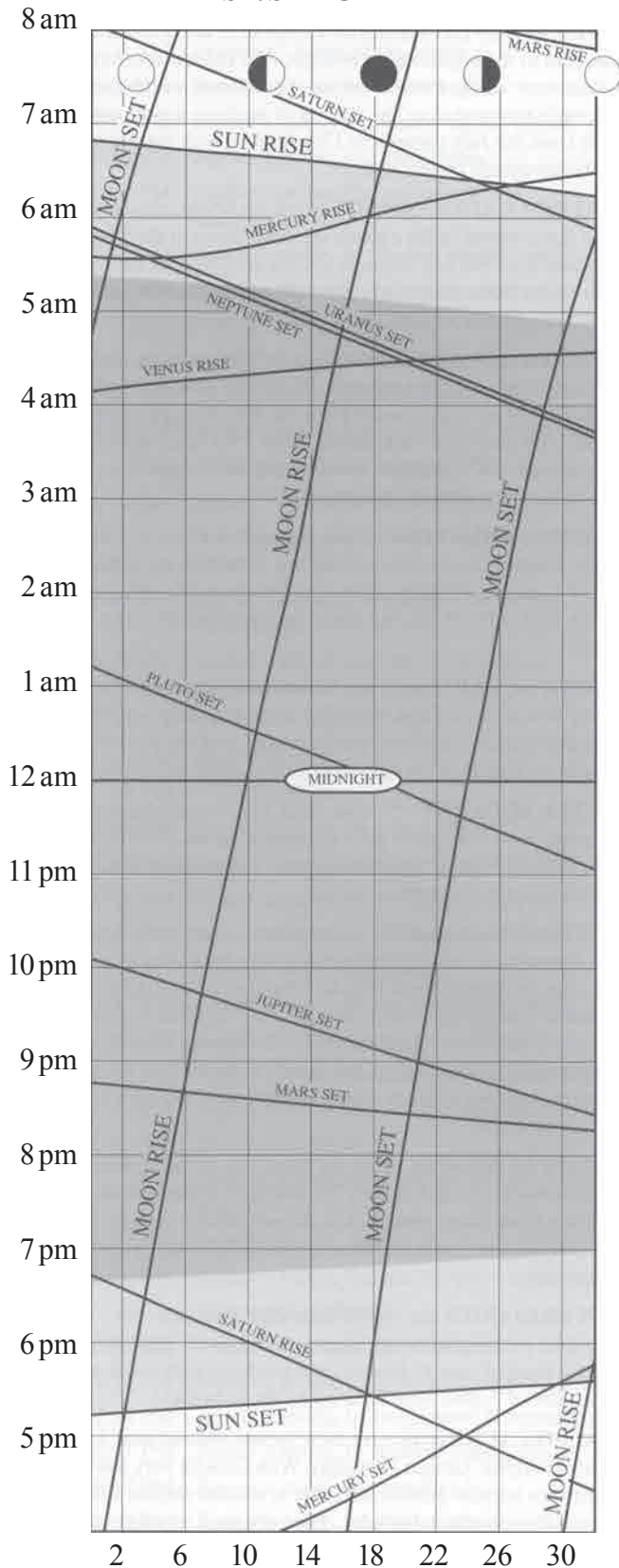
JULY



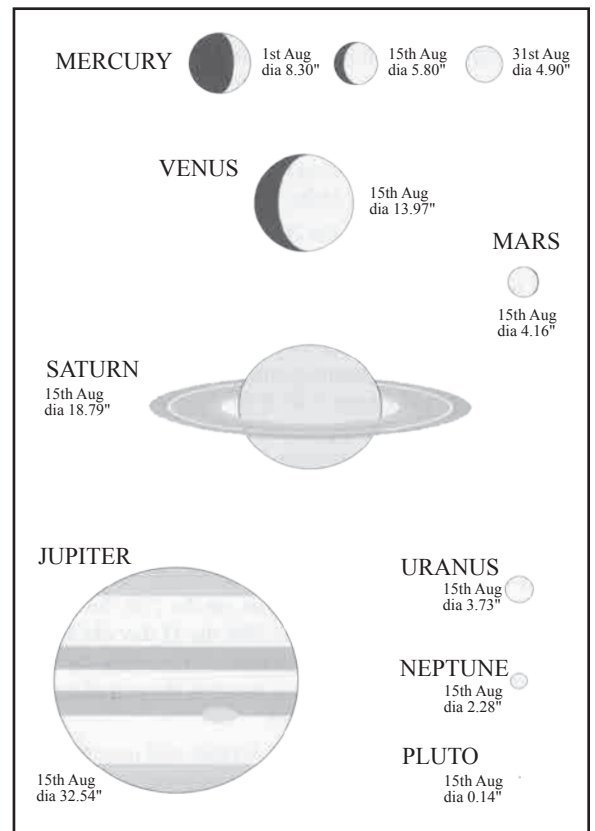


AUGUST

RISE/SET CHART



APPEARANCE OF THE PLANETS



THE MOON

- 2nd Full Moon, 10:10pm.
- 7th Moon at apogee (most distant from Earth).
- 11th Last Quarter, 1:19am.
- 18th New Moon, 5:28am (Lunation number 874).
- 19th Moon at perigee (closest to Earth).
- 24th First Quarter, 7:57pm.

THE PLANETS

MERCURY is a disappointing object this month, spending most of the time in the morning twilight; moving closer to the Sun each day until it reaches superior conjunction on the 29th. Best observing prospects occur late next month and most of October. **VENUS** at magnitude -4.0, appears in the telescope as a waxing gibbous moon, rising before the beginning of astronomical twilight. On the 15th, the 26 day old thin crescent Moon appears 3° north of the planet (see sky view diagram). Venus spends the last half of the month within 10° of Beta Geminorum (Pollux), with closest approach of 7°20' on the 22nd. The planet makes two close approaches to deep sky objects during the month; on the 20th Venus is just 0°15' from NGC2392 (the Eskimo Nebula), and on the 21st 1° from the open star cluster NGC2420. On the 27th at the beginning of twilight, Caster, Pollux and Venus form a straight line low on the horizon (see sky view diagram).

MARS in Virgo, can be seen low in the western sky at mag. 1.7, setting around 8.30pm. On the 7th, Mars moves a very close 0°05' to the 4th magnitude star Beta Virginis (Zavijava). On the 20th the 3 day old Moon will be 5°40' south of the planet with Jupiter 8° above and northwards (see sky view diagram), the following evening also provides another interesting configuration (see Jupiter). Jupiter steadily moves closer to Mars each evening and by month's end they are separated by 3°. Closest approach occurs early next month.

JUPITER observers can catch their last reasonable glimpse of the giant planet this month as it moves closer to conjunction with the Sun in October. On the 21st the 4 day old crescent Moon will be 6°24' above and south of the planet, Mars 7° below and south of Jupiter forms a triangle with the pair; 1st magnitude Alpha Virginis (Spica) sits above the trio creating a trapezium. Jupiter moves gradually each night towards Mars, ending the month 2°45' apart.

SATURN is at opposition on the 20th, rising in the east as the Sun sets in the west and therefore, visible during the entire night. The planet has two close approaches by the Moon, on the 3rd in the eastern evening sky the 16 day old Moon will be 8°15' north and on the following evening the Moon will be 10° below and to the north. On the 30th, again in the eastern evening sky, the 13 day old Moon will be 9°25' north, and on the 31st 8°50' below and northwards (see sky view diagram). At opposition Saturn's magnitude reaches 0.3" and the globe 18.8" in diameter, the rings at this time measure 42.85" on the major axis and 8.75" on the minor.

URANUS & NEPTUNE are visible most of night, setting around the time of morning twilight. Three approaches by the Moon happen in the early evening eastern sky during the month. On the 1st the 14 day old Moon appears 9° below the pair, on the 27th the 10 day old Moon is above and north, and on the 28th the 11 day old Moon is 8°40' below the two. Uranus at magnitude 5.6 nears a star of similar brightness (6.0) in Sagittarius towards the end of the month, on the 31st the pair come within 0°15'.

PLUTO transits the meridian around 5.45pm mid month and sets at midnight. August and September are the last months this year to obtain a glimpse or opportunity to photograph the 13.7 magnitude planet.

METEOR SHOWERS

The **PISCIS AUSTRINIDS** with a ZHR of 8, are observable from about 7pm to the beginning of twilight. The radiant is centred near 1st magnitude Alpha Piscis Austrini (Fomalhaut) which culminates in the early morning sky. The shower of medium speed meteors is visible from 9th July through to 17th August, with maximum activity last month on the 28th.

The **ALPHA CAPRICORNIDS**, noted for bright, slow meteors are visible late evening in the eastern sky until dawn in the west. They are visible from 3rd July through to 25th August with their peak last month on the 30th. The hourly rate is 8, and the radiant is centred near 4th magnitude Alpha Capricornus.

The **DELTA AQUARIDS (S)** are one of the strongest and most consistent of the southern showers. The range of activity of these medium speed meteors extends from 8th July through to 19th August, with maximum this month on the 29th. The radiant is near 3rd magnitude Delta Aquarii, and the shower is visible late evening in the eastern sky until dawn in the west.

The **DELTA AQUARIDS (N)** occur from 15th July to 25th August, reaching maximum activity this month on the 12th. With a ZHR of 5, the shower of medium speed meteors is northwards of the DELTA AQUARIDS (S), but the same observing time can be applied.

The **IOTA AQUARIDS (S)** reach maximum activity this month on the 5th, with their duration extending from 15th July to 25th August. The hourly rate is 3 medium speed meteors, and the shower is visible late evening in the eastern sky until dawn in the west.

The **IOTA AQUARIDS (N)** span from 11th August through to 20th September, with maximum activity happening on 20th August. The hourly rate is 3, and the shower is visible late evening in the eastern sky until dawn in the west.

The **PERSEIDS** are probably the best known and most dependable of the showers, records of their activity date back over one thousand years. The duration is from 17th July through to 24th August, and the peak is reached this month on the 12th. The ZHR is 100 and the meteors are very swift. Unfortunately, the shower's northerly declination means that the radiant is below the horizon for southern observers, however a watch should be kept northwards from midnight to dawn.

The **KAPPA CYGNIDS** suffer the same fate as the PERSEIDS with their northerly declination. The duration of these slow moving meteors is from 3rd August to 31st August, with a peak on the 18th. The hourly rate is 5, and the shower is best observed in the evening northern sky.

The **PI ERIDANIDS** are visible from 20th August to 5th September, peaking with maximum activity on the 28th August. The radiant is centred near Pi Eridani, and produces very swift meteors with a ZHR of 7. Best seen from midnight to twilight.

The **ALPHA AURIGIDS** have their radiant centred near 1st magnitude Alpha Aurigae (Capella). With Capella very low to the northeastern horizon around 4am, this is another shower that's best observed from northern latitudes. The very swift members of this stream are active from 24th August to 5th September, with the peak next month on the 1st, the ZHR rate is 15.

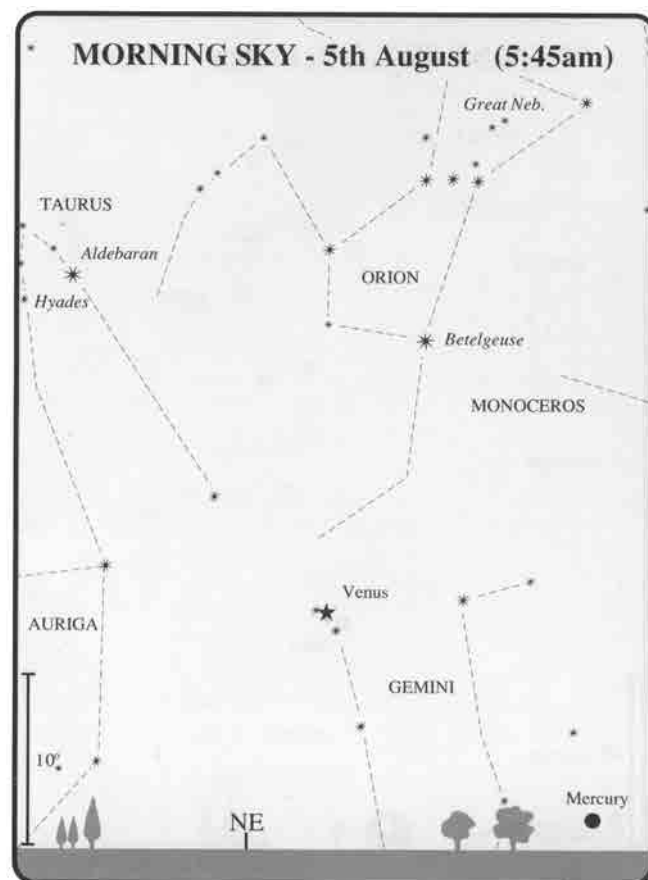
The **PISCIDS** can be seen from about 9pm until dawn, activity begins around 15th August and extends through to 14th October, with maximum activity next month on the 24th. A ZHR of 3 very slow meteors can be expected.

AUGUST

DAILY EVENTS

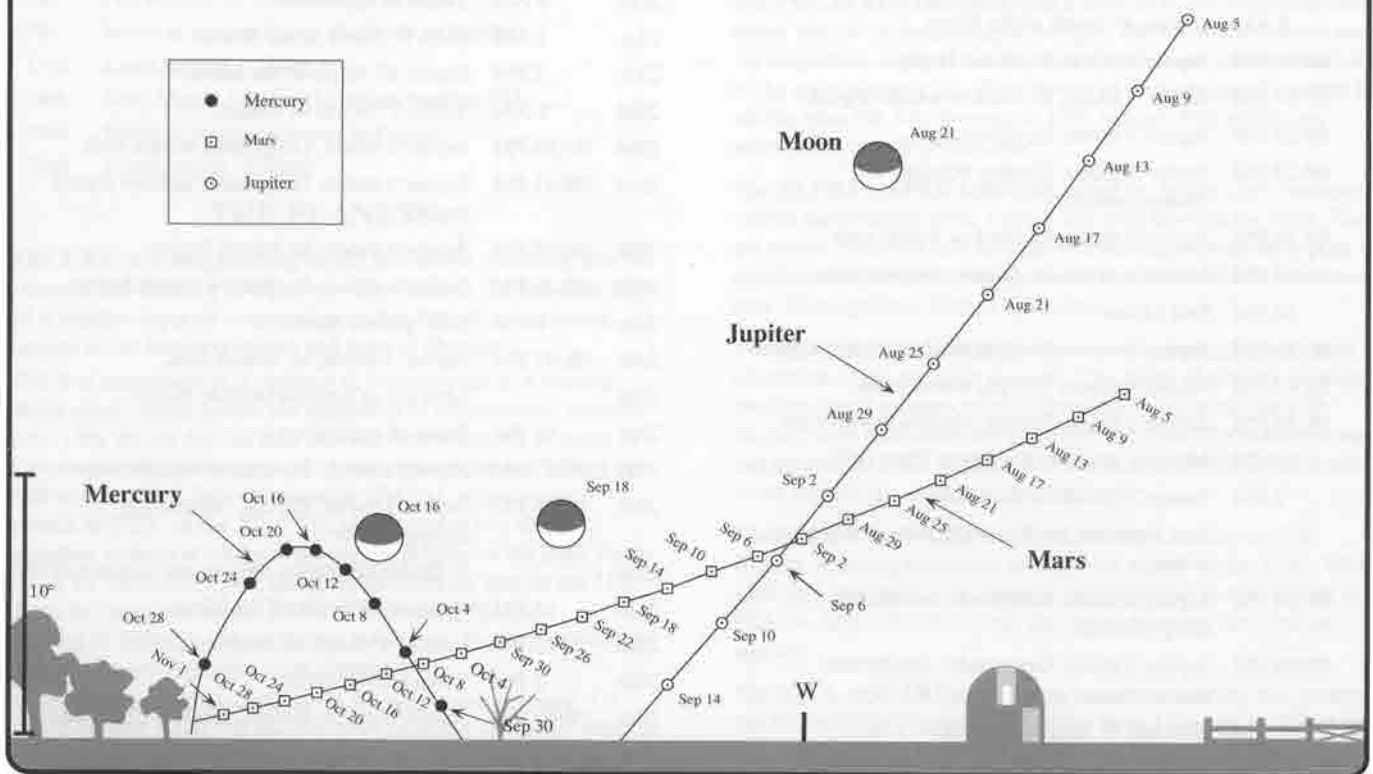
1st	7 AM	Neptune 3° South of the Moon.
1st	8 AM	Uranus 4° South of the Moon.
1st	06:08 PM	Jupiter's moon, Io, transit begins.
1st	07:14 PM	Jupiter's moon, Io, shadow transit begins.
1st	08:20 PM	Jupiter's moon, Io, transit ends.
1st	09:20 PM	Jupiter's moon, Europa, occultation disappearance.
1st	09:24 PM	Jupiter's moon, Io, shadow transit ends.
2nd	06:44 PM	Jupiter's moon, Io, eclipse reappearance.
2nd	10 PM	Full Moon.
3rd	06:31 PM	Jupiter's moon, Europa, shadow transit begins.
3rd	06:47 PM	Jupiter's moon, Europa, transit ends.
3rd	08:55 PM	Jupiter's moon, Europa, shadow transit ends.
4th	12 PM	Mercury greatest elongation West (1 9°).
4th	2 PM	Saturn 7° South of the Moon.
5th		Iota Aquarids South meteor shower maximum activity.
5th	06:24 PM	Jupiter's moon, Ganymede, occultation disappearance.
5th	09:20 PM	Jupiter's moon, Ganymede, occultation reappearance.
6th	12 PM	Mercury 8° South of Pollux.
7th	11 AM	Pluto stationary.
7th	2 PM	Moon at apogee.
8th	08:06 PM	Jupiter's moon, Io, transit begins.
8th	09:08 PM	Jupiter's moon, Io, shadow transit begins.
9th	05:24 PM	Jupiter's moon, Io, occultation disappearance.
9th	08:39 PM	Jupiter's moon, Io, eclipse reappearance.
10th		Mercury at ascending node.
10th	05:47 PM	Jupiter's moon, Io, shadow transit ends.
10th	07:01 PM	Jupiter's moon, Europa, transit begins.
10th	09:08 PM	Jupiter's moon, Europa, shadow transit begins.
10th	09:32 PM	Jupiter's moon, Europa, transit ends.
11th	1 AM	Last quarter Moon.
12th		Delta Aquarids North meteor shower maximum activity.
12th		Perseids meteor shower maximum activity.
12th	05:50 PM	Jupiter's moon, Europa, eclipse reappearance.
15th		Mercury at perihelion.
15th	12 PM	Venus 2° North of the Moon.
16th	07:14 PM	Jupiter's moon, Ganymede, shadow transit ends.
16th	07:24 PM	Jupiter's moon, Io, occultation disappearance.
17th	05:31 PM	Jupiter's moon, Io, shadow transit begins.
17th	06:47 PM	Jupiter's moon, Io, transit ends.
17th	07:42 PM	Jupiter's moon, Io, shadow transit ends.
18th		Kappa Cygnids meteor shower maximum activity.
18th	5 AM	New Moon.
19th	5 PM	Moon at perigee.
19th	08:25 PM	Jupiter's moon, Europa, eclipse reappearance.

20th		Iota Aquarids North meteor shower maximum activity.
20th	9 AM	Saturn at opposition.
21st	2 AM	Mars 5° North of the Moon.
21st	2 PM	Jupiter 6° North of the Moon.
23rd	9 AM	Venus 7° South of Pollux.
23rd	07:54 PM	Jupiter's moon, Ganymede, transit ends.
23rd	08:41 PM	Jupiter's moon, Ganymede, shadow transit begins.
24th	06:35 PM	Jupiter's moon, Io, transit begins.
24th	07:26 PM	Jupiter's moon, Io, shadow transit begins.
24th	8 PM	First quarter Moon.
24th	08:47 PM	Jupiter's moon, Io, transit ends.
25th		Mercury at greatest latitude North.
25th	12 PM	Pallas at opposition.
25th	06:57 PM	Jupiter's moon, Io, eclipse reappearance.
26th	06:54 PM	Jupiter's moon, Europa, occultation disappearance.
28th		Pi Eridanids meteor shower maximum activity.
28th	12 PM	Neptune 3° South of the Moon.
28th	12 PM	Uranus 4° South of the Moon.
28th	2 PM	Vesta at opposition.
28th	06:04 PM	Jupiter's moon, Europa, shadow transit ends.
29th	6 PM	Mercury in superior conjunction.
31st	4 PM	Saturn 7° South of the Moon.

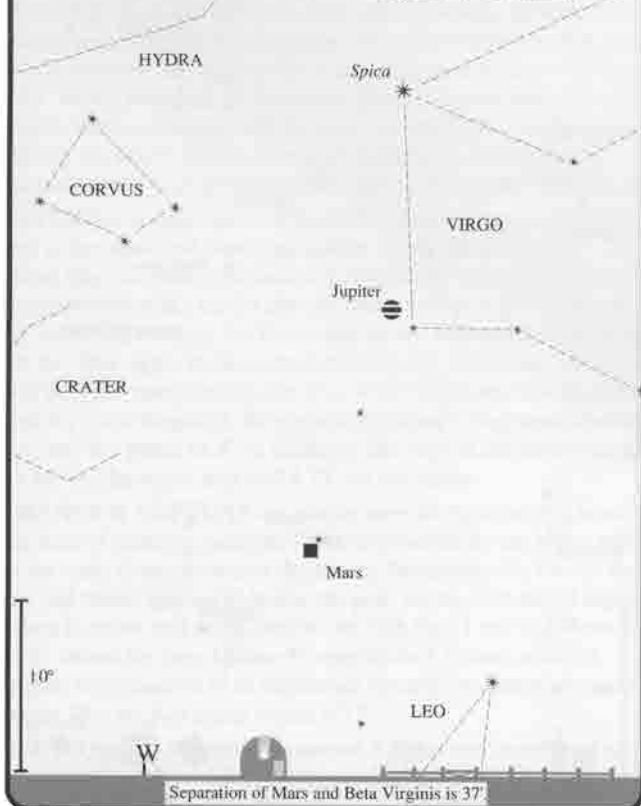


AUGUST

EVENING SKY - Mercury, Jupiter and Mars (7:30pm)

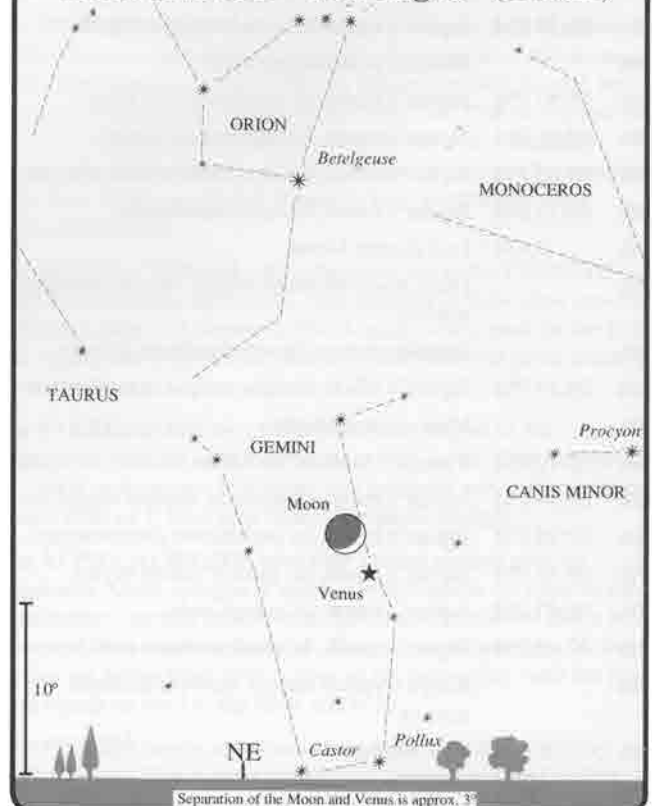


EVENING SKY - 6th August (7:30pm)



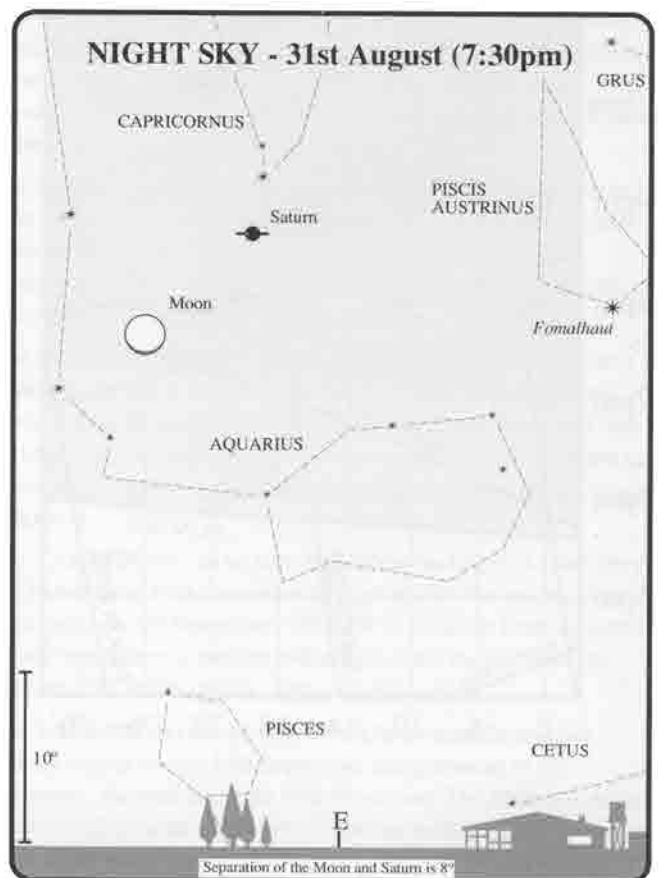
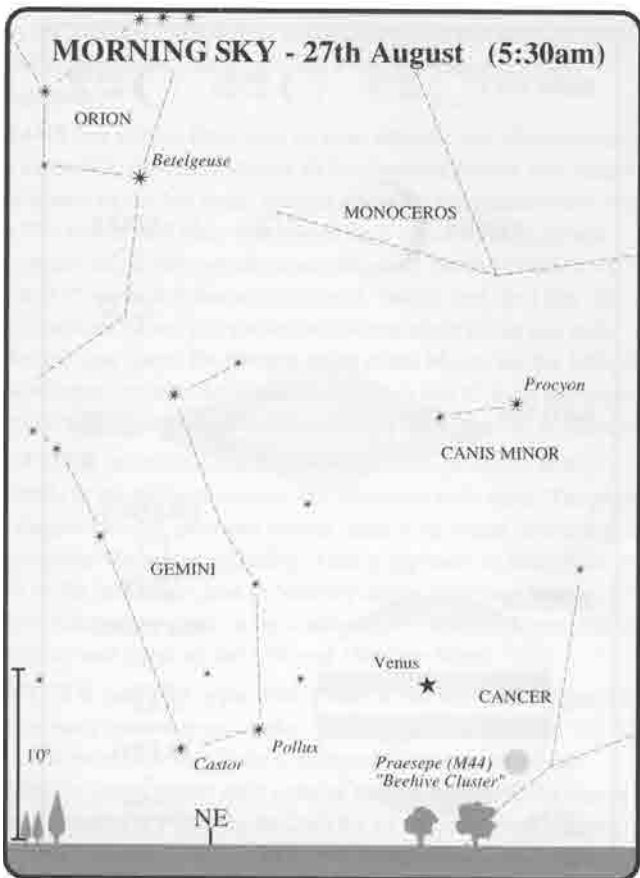
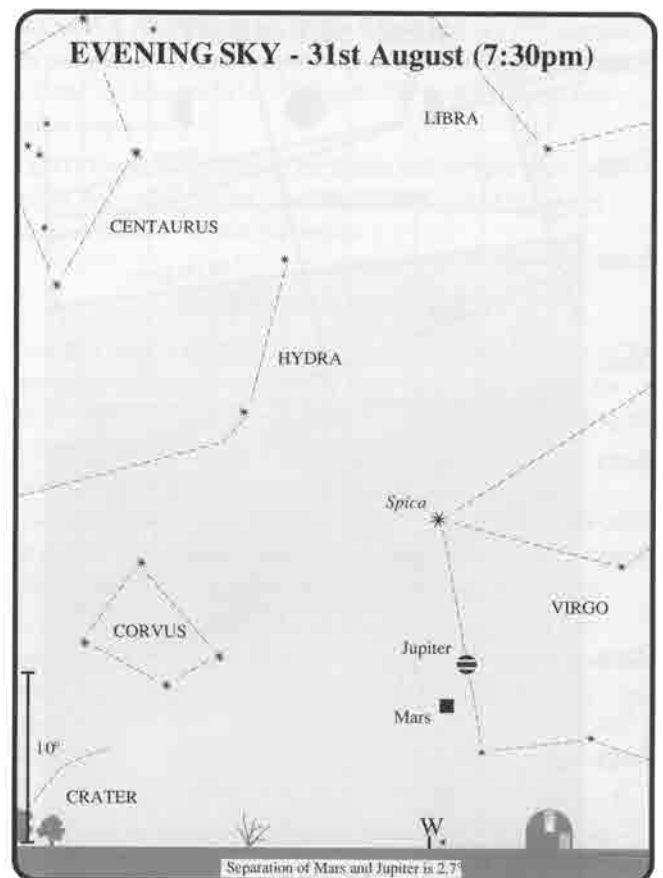
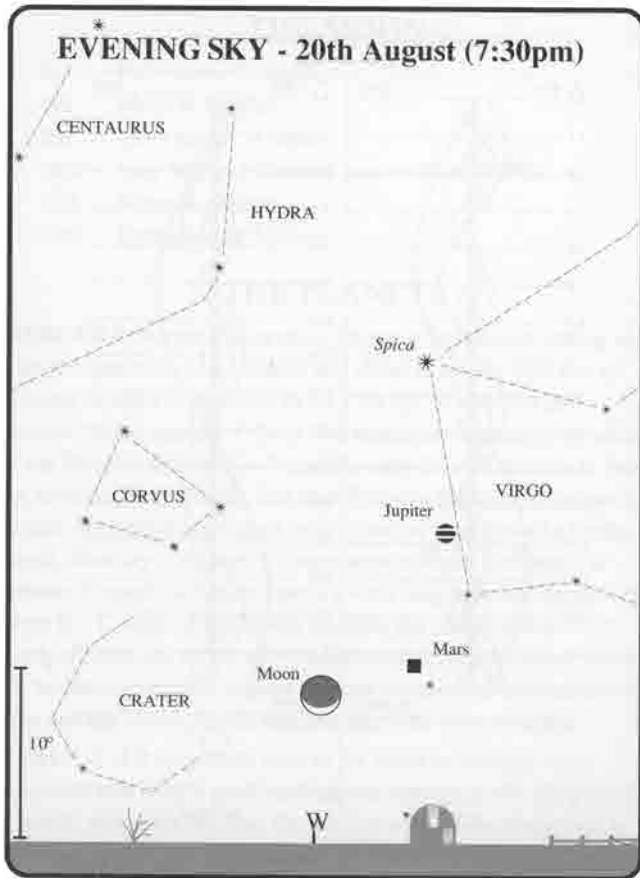
Separation of Mars and Beta Virginis is 37°

MORNING SKY - 15th August (5:40am)



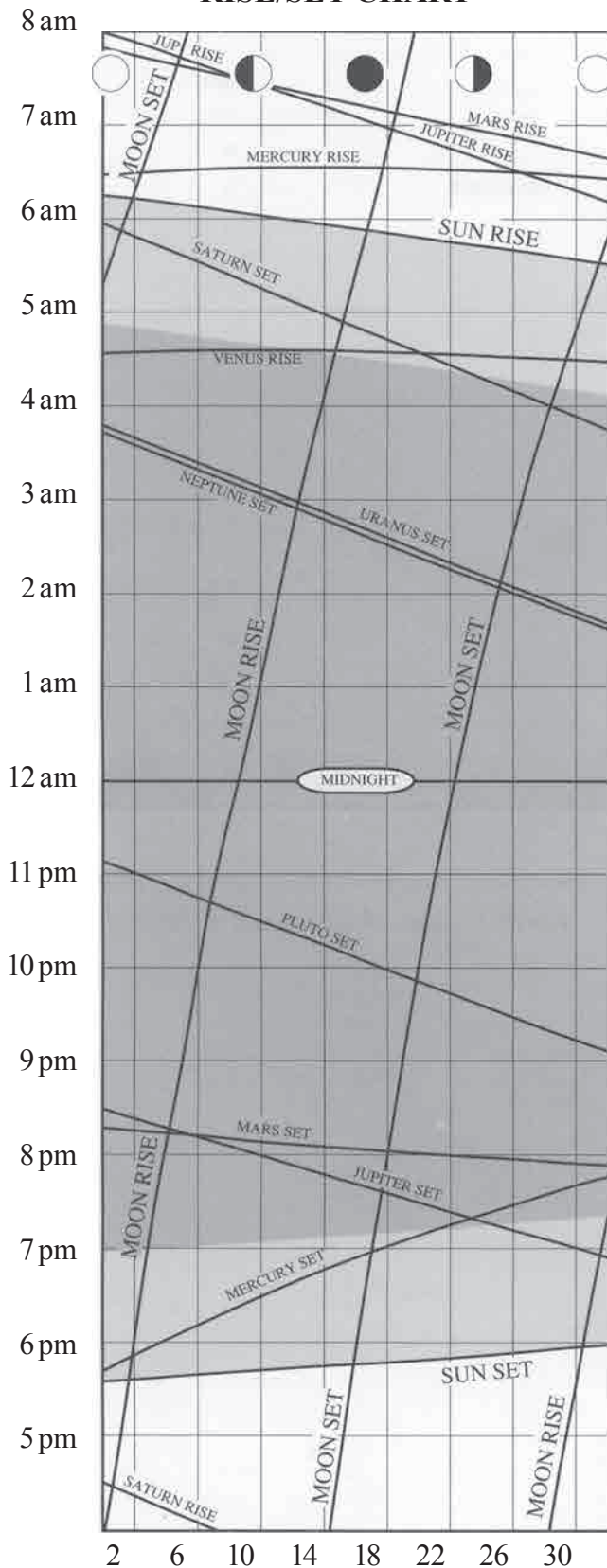
Separation of the Moon and Venus is approx. 3°

AUGUST

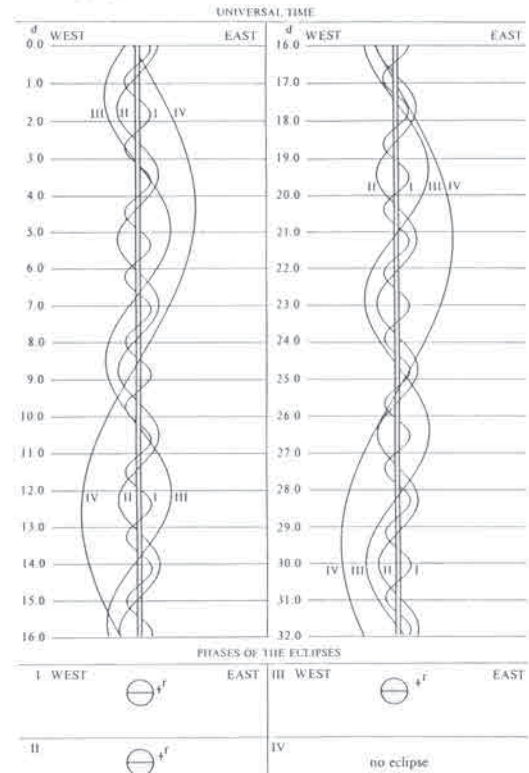


SEPTEMBER

RISE/SET CHART

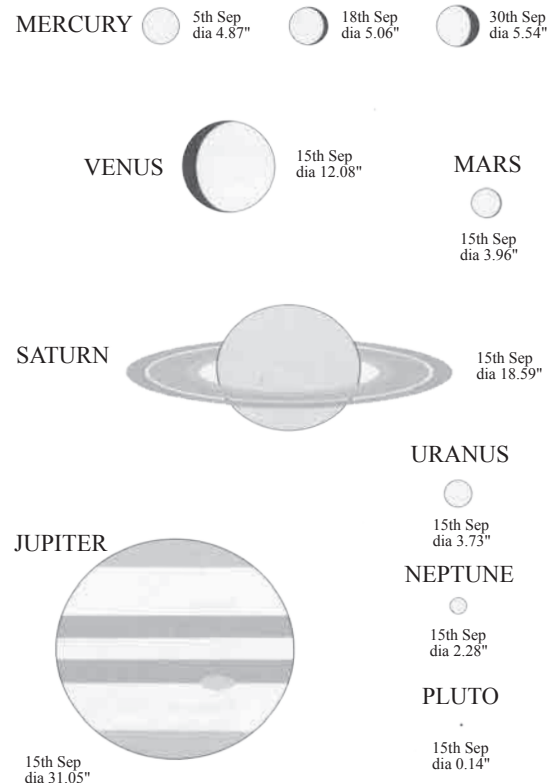


CONFIGURATIONS OF SATELLITES I-IV FOR SEPTEMBER



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



SEPTEMBER

THE MOON

- 1st Full Moon, 12:33pm.
- 4th Moon at apogee.
- 9th Last Quarter, 4:26pm.
- 16th New Moon, 1:10pm (Lunation number 875).
- 17th Moon at perigee.
- 23rd First Quarter, 5:32am.

THE PLANETS

MERCURY becomes an evening object in September, setting just after the Sun early in the month and about half hour after end of evening twilight at the end. On the 17th the 30 hour old thin crescent Moon appears 4° from -0.4 magnitude Mercury; the altitude of the Moon at this time is 7° and Mercury 5° , with the Sun 9° below the horizon. Interestingly, less than 9° above Mercury to the north is Jupiter, with Mars (separated by 2° from 1st mag. Spica) a further 5° above. Mercury continues its busy month on the 23rd when it appears 2° south of Jupiter (see sky view diagram), and on the 26th when it's 1° north of Spica. On the 30th, the planet will be $3^\circ 35'$ south of Mars. As all the above mentioned alignments occur low on the horizon in twilight, a good western horizon and binoculars will help and the search should start no later than about 6.30pm.

VENUS at -4.0 magnitude rises in the morning twilight, and observers will need a good northeastern outlook as the planet at 5am is just 4° above the horizon. On the 2nd and 3rd the planet will be less than 2° above M44, the Beehive cluster (see sky view diagram). On the 4th, Venus approaches within a close $0^\circ 07'$ of the 4th magnitude star Delta Cancri (Asellus Australis). On the 14th, the 27 day old Moon will be 5° above the planet (see sky view diagram). On the 21st, 1st mag. Alpha Leonis (Regulus) will be $0^\circ 39'$ south of Venus, and on the following night even closer (see sky view diagrams).

MARS sets around 8pm, only an hour after the end of astronomical twilight. The following should all be observed around 7pm before the planet loses too much altitude. On three consecutive days (5th to 7th) Jupiter and Mars will be within 1° of each other; closest approach on the 6th (see sky view diagram). On the 17th Mars is within 2° north of Spica with Jupiter 5° below, and the 1 day old thin crescent Moon just above the horizon south of the trio with Mercury just above the horizon south of the Moon. On the 18th, the show improves with the Moon above Spica and 4° from Mars (see sky view diagram). The month ends with Mars 3° north of Mercury.

JUPITER becomes a less than perfect telescope object as its altitude in the western evening sky decreases each night. The planet, at magnitude -1.8 , provides several interesting visual spectacles throughout the month including, a close approach to Mars from the 5th to 7th (see Mars), and to Mercury on the 23rd (see Mercury). Jupiter also plays a role in the configuration with the Moon, Mars, Mercury and Spica on the 17th and 18th (see Mars).

SATURN, now past opposition, makes a fine telescopic object high in the early eastern evening sky. Saturn begins the month $2^\circ 50'$ from the 3rd magnitude star Delta Capricorni (Deneb Algiedi) and gradually draws nearer each evening until at the end of the month the separation is $1^\circ 20'$. On the 26th the 11 day old Moon comes within 11° of the planet, and on the 27th the 12 day old Moon will be 8° away (see sky view diagram).

URANUS & NEPTUNE are visible high in the sky (77° altitude) as they transit the meridian around 7.30pm mid month. On the 24th, the 9 day old Moon will be $3^\circ 30'$ and $4^\circ 35'$ from Neptune and Uranus respectively.

PLUTO sets at 11pm early in the month and by 9pm at the end, leaving September the last good opportunity to find the planet before conjunction in mid November.

METEOR SHOWERS

The **IOTA AQUARIDS** (N) span from 11th August through to 20th September, with maximum activity happening last month on the 20th. The hourly rate is 3, and the shower is visible late evening in the eastern sky until dawn in the west.

The **PI ERIDANIDS** are visible from 20th August to 5th September, peaking with maximum activity last month on the 28th. The radiant is centred near Pi Eridani, and produces very swift meteors with a ZHR of 7. Best seen from midnight to twilight.

The **ALPHA AURIGIDS** have their radiant centred near 1st magnitude Alpha Aurigae (Capella). With Capella very low on the northeastern horizon around 4am. This is another shower that's best observed from northern latitudes. The very swift members of this stream are active from 24th August to 5th September, with the peak this month on the 1st, the ZHR rate is 15.

The **PISCIDS** can be seen from about 9pm until dawn, activity begins around 15th August and extends through to 14th October, with maximum activity this month on the 24th. A ZHR of 3 very slow meteors can be expected.

The **KAPPA AQUARIDS** are visible from 8th to 30th September, reaching maximum activity on the 20th. The hourly rate of 3 very slow meteors, is centred near 5th magnitude Kappa Aquarii. The shower is observable all night, although probably best when Kappa culminates around 10.30pm.

The **CAPRICORNIDS** (Oct) are visible from 20th September to 14th October, peaking next month on the 3rd. The shower of very slow meteors, with a ZHR of 3, is best observed from end of twilight until mid morning. The radiant is near the 4th magnitude star Alpha 2 Capricorni.

The **SIGMA ORIONIDS** reach a maximum peak of activity next month on the 5th. 3 very slow meteors per hour can be expected. The duration of the shower lasts between 10th September and 26th October. The shower is well placed for observers from midnight to dawn, and is centred on 4th magnitude Sigma Orionis (near Orion's belt stars).

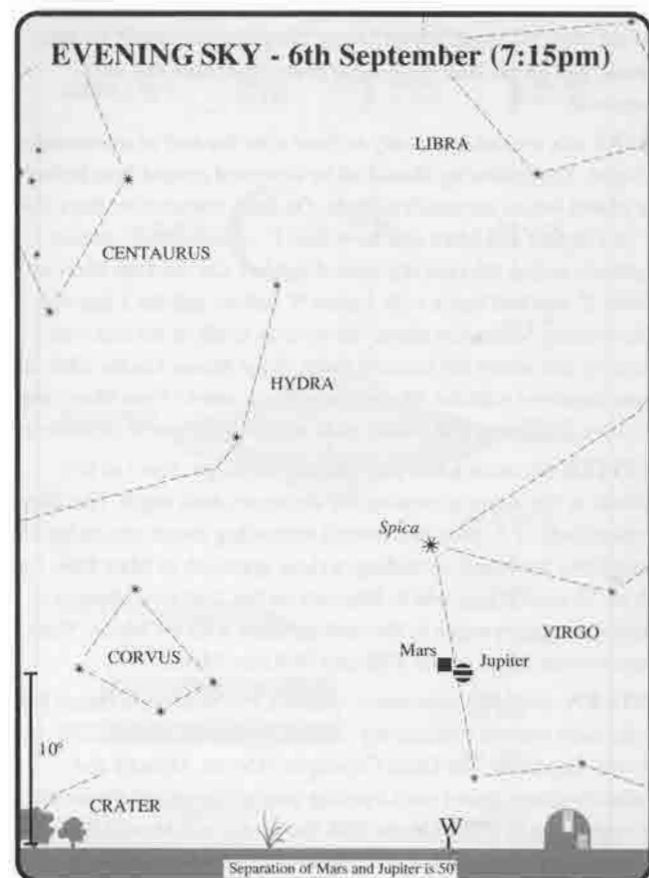
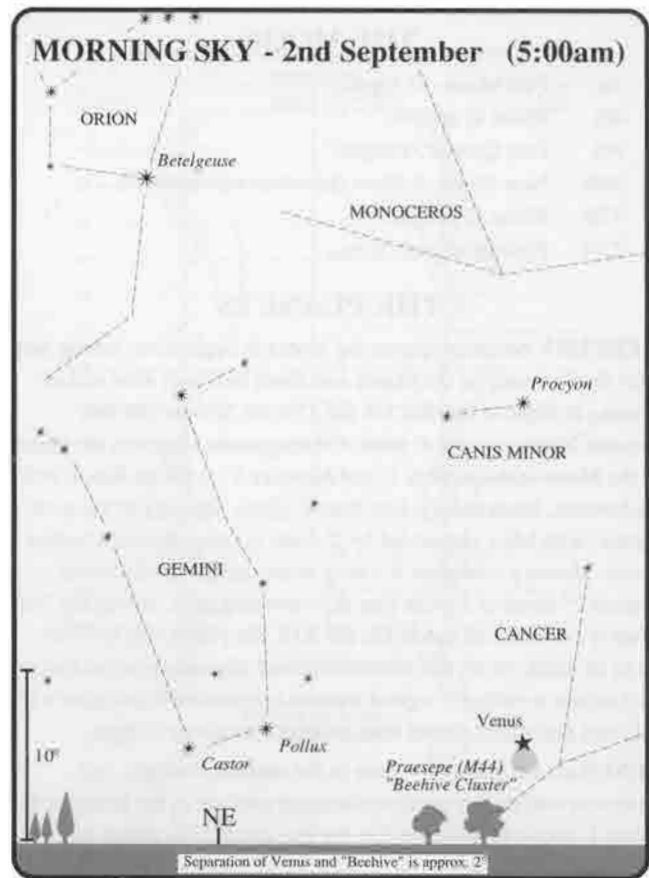
The **TAURIDS** (S) can be seen from about midnight to dawn, they are visible from 15th September through to 26th November, the peak being on 3rd November. The ZHR is 12; aside from a slightly slower speed there's nothing to distinguish the shower from the northern TAURIDS (below) with a similar radiant.

The **TAURIDS** (N) can be seen from about midnight to dawn, activity begins around 13th September and continues to 1st December, the peak being on 13th November. The ZHR is 8; aside from a slightly faster speed there's nothing to distinguish the shower from its southern counterpart (above). The radiant is near the famous Pleiades.

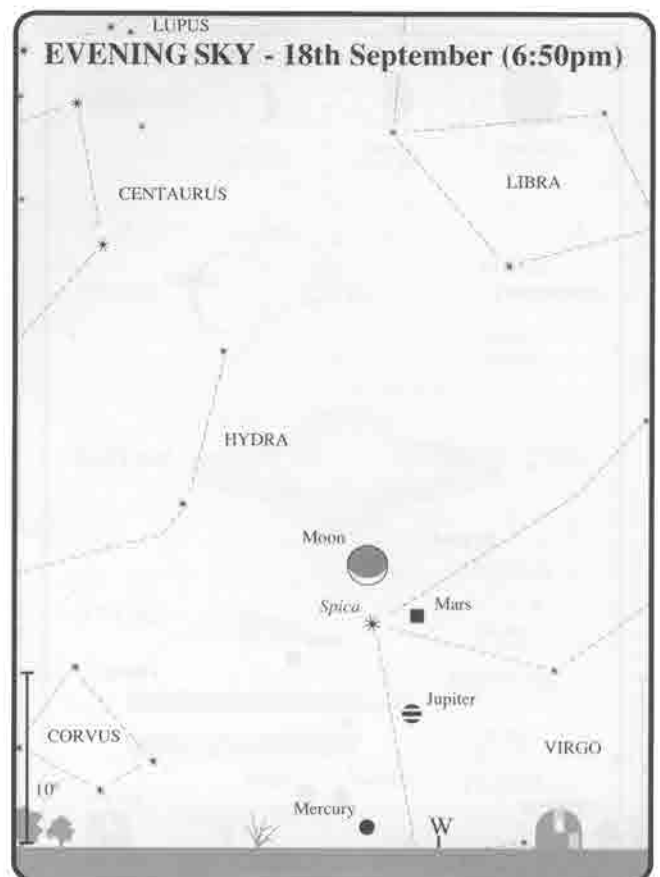
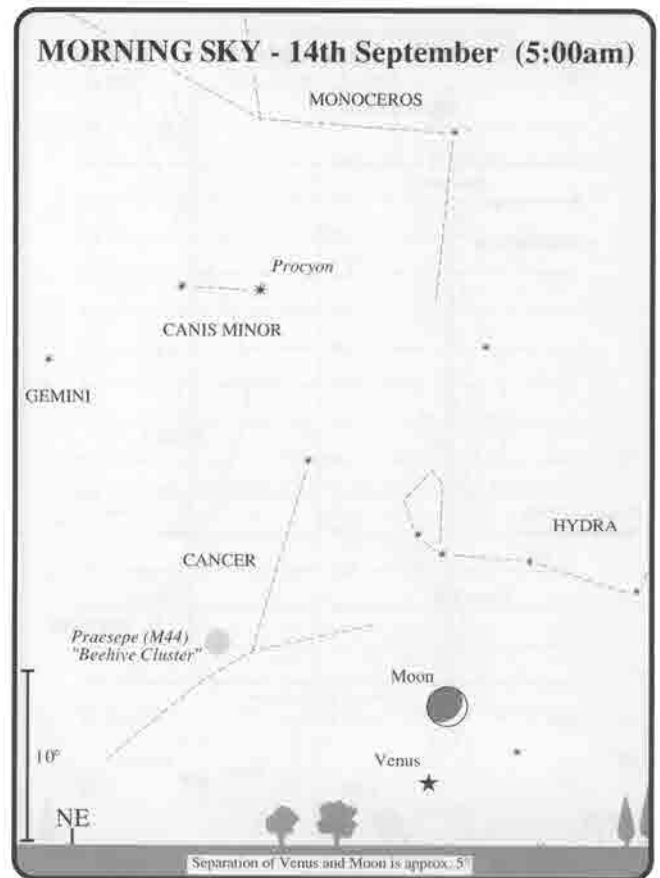
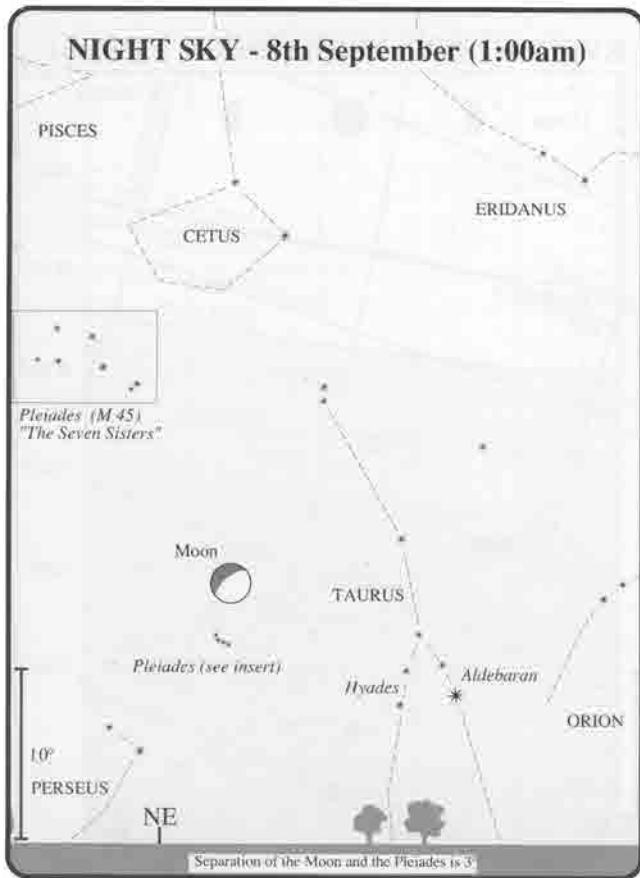
SEPTEMBER

DAILY EVENTS

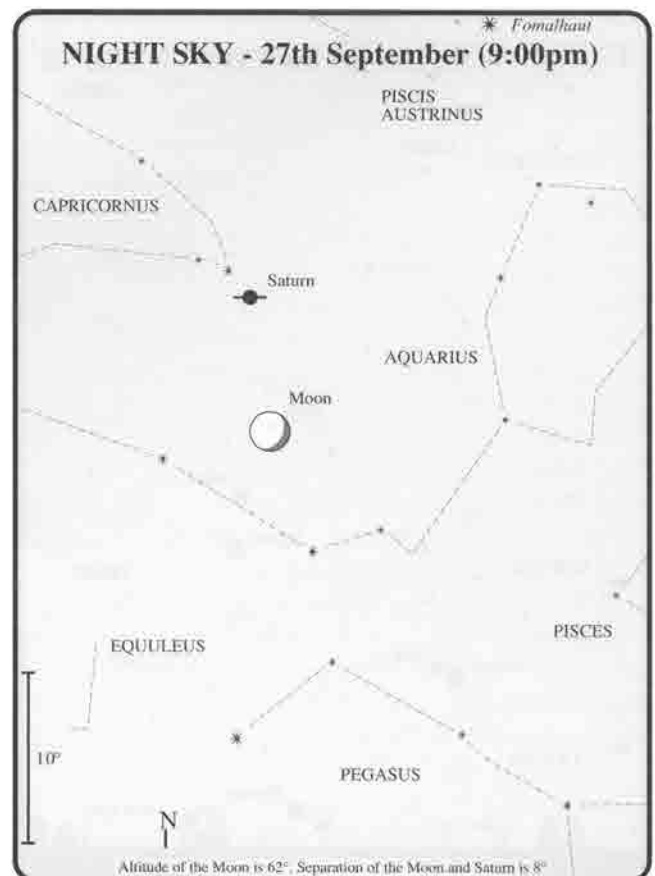
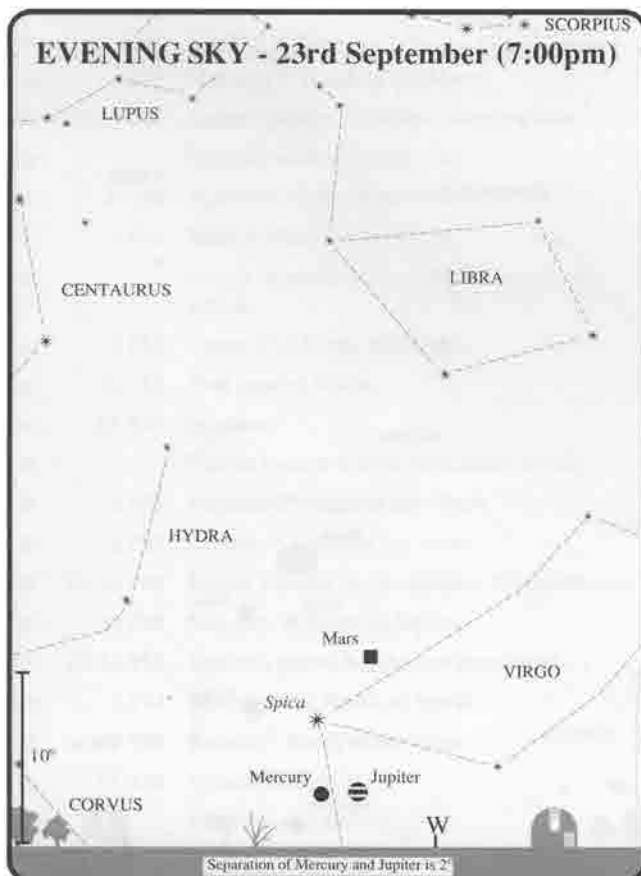
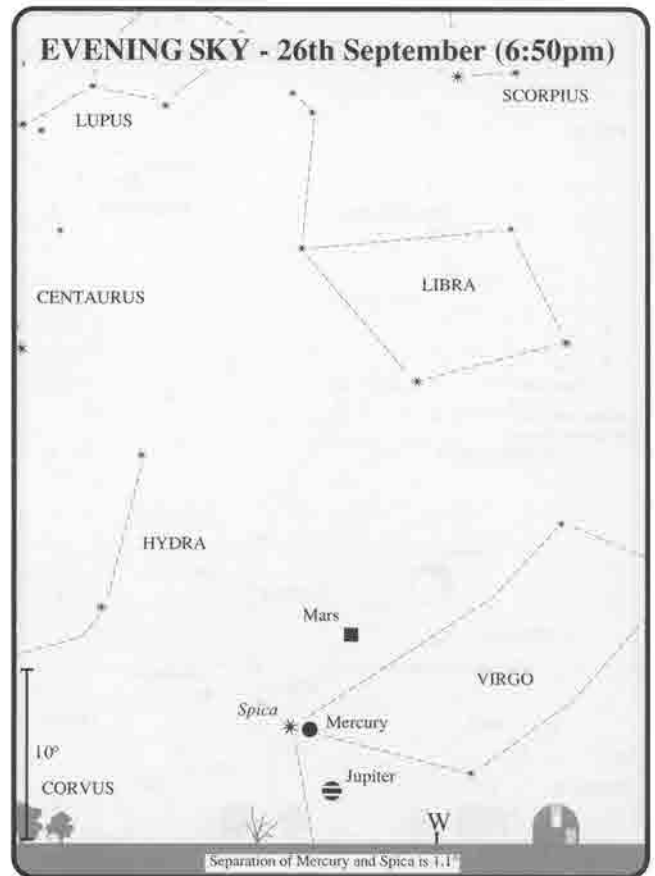
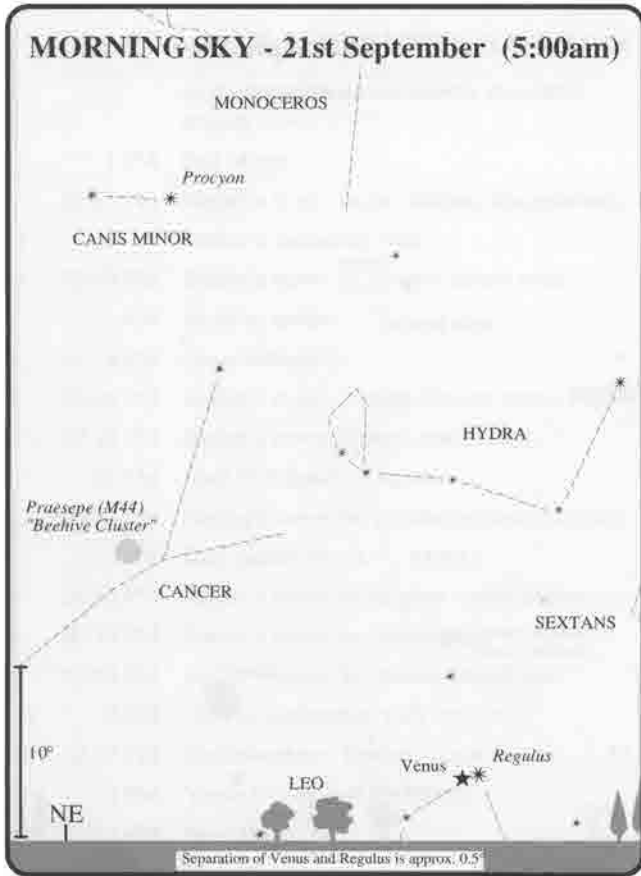
1st		Alpha Aurigids meteor shower maximum activity.
1st	1 PM	Full Moon.
1st	05:55 PM	Jupiter's moon, Io, occultation disappearance.
2nd		Venus at ascending node.
2nd	05:59 PM	Jupiter's moon, Io, shadow transit ends.
4th	3 AM	Moon at apogee.
4th	2 PM	Ceres stationary.
4th	06:16 PM	Jupiter's moon, Europa, shadow transit begins.
4th	07:19 PM	Jupiter's moon, Europa, transit ends.
7th	10 AM	Mars 0°.9 South of Jupiter.
8th	07:56 PM	Jupiter's moon, Io, occultation disappearance.
9th	4 PM	Last quarter Moon.
9th	05:43 PM	Jupiter's moon, Io, shadow transit begins.
9th	07:17 PM	Jupiter's moon, Io, transit ends.
9th	07:54 PM	Jupiter's moon, Io, shadow transit ends.
10th	2 PM	Juno in conjunction with the Sun.
11th	07:37 PM	Jupiter's moon, Europa, transit begins.
14th	1 PM	Venus 6° North of the Moon.
16th	1 PM	New Moon.
16th	07:06 PM	Jupiter's moon, Io, transit begins.
16th	07:38 PM	Jupiter's moon, Io, shadow transit begins.
16th	8 PM	Mars 2° North of Spica.
17th	1 AM	Moon at perigee.
17th	6 PM	Mercury 5° North of the Moon.
17th	07:10 PM	Jupiter's moon, Io, eclipse reappearance.
18th		Mercury at descending node.
18th	8 AM	Jupiter 5° North of the Moon.
18th	4 PM	Mars 4° North of the Moon.
20th		Kappa Aquarids meteor shower maximum activity.
21st	4 PM	Venus 0°.4 North of Regulus.
23rd	6 AM	First quarter Moon.
23rd	10 AM	Equinox.
24th		Piscids meteor shower maximum activity.
24th	5 PM	Neptune 3° South of the Moon.
24th	5 PM	Uranus 4° South of the Moon.
24th	06:28 PM	Jupiter's moon, Io, occultation disappearance.
24th	10 PM	Mercury 2° South of Jupiter.
25th	06:11 PM	Jupiter's moon, Io, shadow transit ends.
26th	6 PM	Mercury 1°.1 North of Spica.
27th	7 PM	Saturn 7° South of the Moon.
28th	12 AM	Uranus stationary.
28th		Mercury at aphelion.
28th	07:03 PM	Jupiter's moon, Ganymede, shadow transit ends.
30th	1 PM	Neptune stationary.



SEPTEMBER

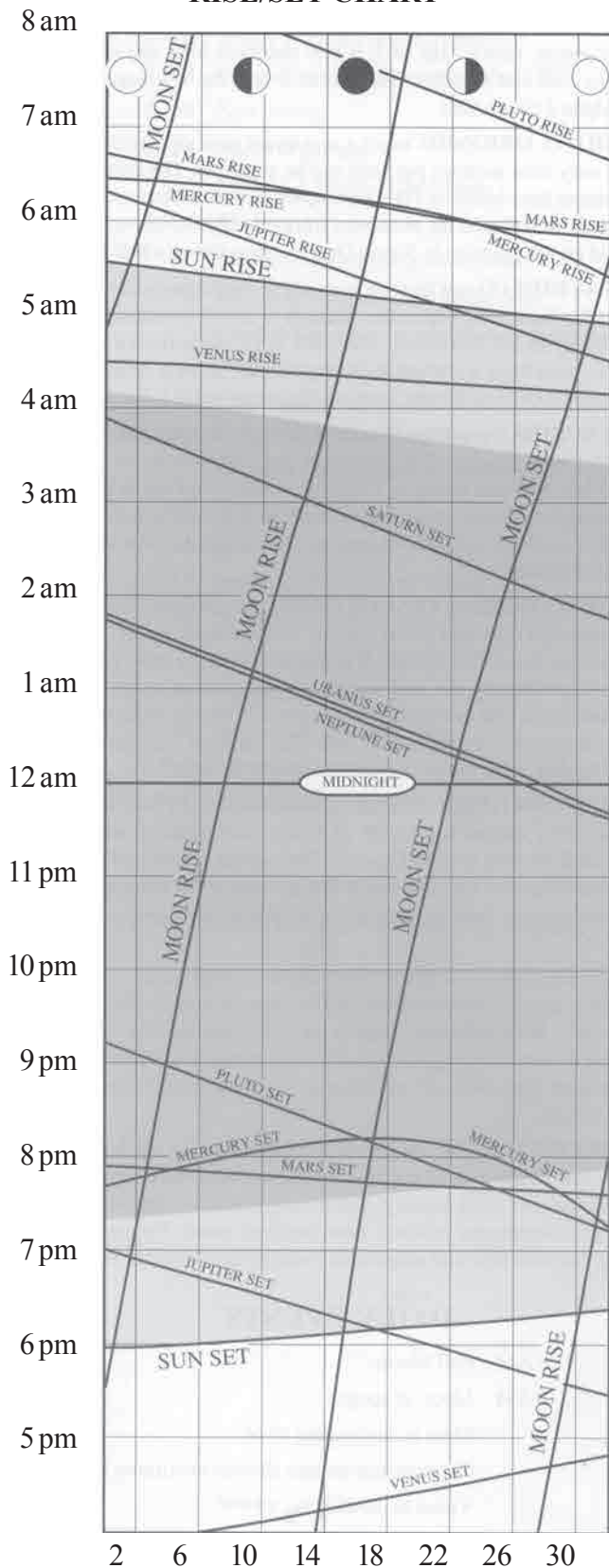


SEPTEMBER

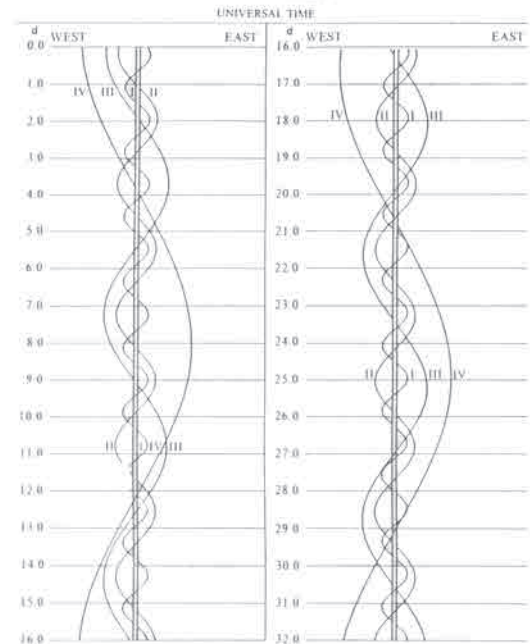


OCTOBER

RISE/SET CHART



CONFIGURATIONS OF SATELLITES I-IV FOR OCTOBER

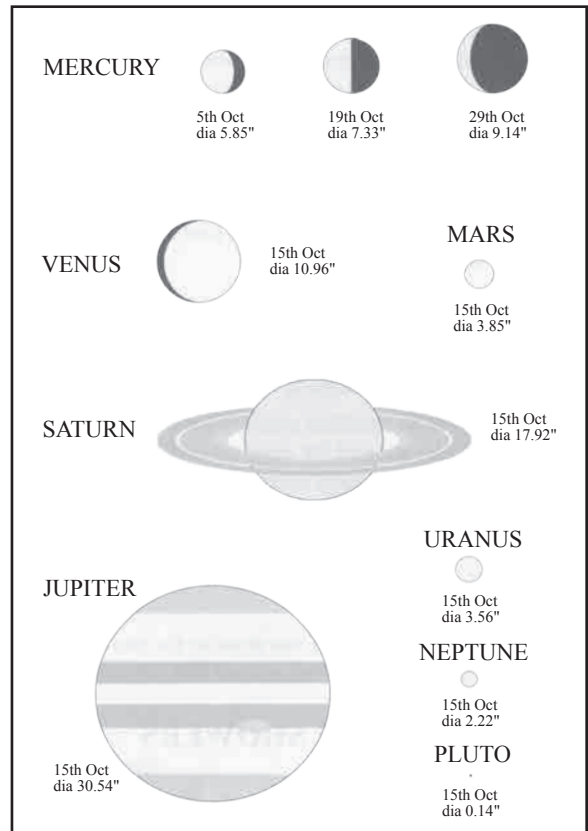


PHASES OF THE ECLIPSES



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



OCTOBER

THE MOON

1st	Full Moon, 4:54am
1st	Moon at apogee.
9th	Last Quarter, 5:35am.
15th	New Moon, 9:36pm (Lunation number 876). Moon at perigee.
22nd	First Quarter, 6:52pm.
28th	Moon at apogee.
30th	Full Moon, 10:38pm.

THE PLANETS

MERCURY at magnitude -0.1, is at it's best in the evening sky this month, with greatest elongation east of the Sun (25°) occurring on the 14th. Each evening Mercury gains a little altitude, moving away from the Sun, until mid month when the planet swings back toward the Sun, heading to inferior conjunction in November. The arc Mercury describes in the sky is interesting, on it's upward rise the planet intersects the path of Mars (moving southward on an oblique angle); on it's course downwards Mercury again crosses the path of Mars (this time a further 10° south in azimuth). The two closest approaches of the planets happen on the 4th and 29th with a separation of 2° at each event, and are best observed around 7pm (see sky view diagram). On the 17th at 6.30pm the 2 day old thin crescent Moon will be 2°15' from Mercury; Mars and nearby 3rd magnitude Alpha 2 Librae appear directly below and form a trapezium (see sky view diagram).

VENUS rises just one hour before sunrise, but at magnitude -3.9 will be easily visible. On the 14th, the Moon will be 5° south of Venus (see sky view diagram). On three occasions during the month Venus will come close to three 4th magnitude stars as follows; on the 7th, 20th and 31st, Venus will be 20', 11' and 20' from Sigma Leonis, Eta Virginis and Theta Virginis respectively.

MARS presents its last opportunity for visual observation this month. At magnitude 1.5 and a diameter of 3.85", the tiny planet sets near the end of astronomical twilight. Mars has two close approaches to Mercury as described in the Mercury section. On the 17th at 7.00pm the 2 day old thin crescent Moon will be 5°50' above Mars with Mercury to the south of the Moon, 3rd magnitude Alpha 2 Librae appears 1°15' north of Mars; the four objects forming a trapezium (see sky view diagram).

JUPITER is in conjunction with the Sun on the 18th, and is only visible very early in the month low to the horizon in evening twilight; then the planet is too close to the Sun for observation and reappears in the morning twilight in November.

SATURN is again in an excellent position for observation this month being at an elevation of 70° after the end of astronomical twilight. On the 24th in the early evening sky, Saturn will transit the meridian with the 9 day old Moon 7° below (see sky view diagram).

URANUS & NEPTUNE are visible high in the western evening sky in Sagittarius. On the 21st, the 6 day old moon will be 5° from Uranus and 4° from Neptune.

PLUTO by the end of the month sets prior to the end of twilight, effectively ending further observation until Feb./March next year.

METEOR SHOWERS

The **PISCIDS** can be seen from about 9pm until dawn, activity begins around 15th August and extends through to 14th October, the peak being last month on the 24th. A ZHR of 3 very slow meteors can be expected.

The **CAPRICORNIDS** (Oct) are visible from 20th September to 14th October, peaking on the 3rd of this month. The shower of very slow meteors, with a ZHR of 3, is best observed from end of twilight until mid morning. The radiant is near the 4th magnitude star Alpha 2 Capricorni.

The **SIGMA ORIONIDS** reach a maximum peak of activity on the 5th. 3 very slow meteors per hour can be expected. The duration of the shower lasts between 10th September and 26th October. The shower is well placed for observers from midnight to dawn, and is centred on 4th magnitude Sigma Orionis (near Orion's belt stars).

The **TAURIDS** (S) can be seen from about midnight to dawn, they are visible from 15th September through to 26th November, the peak being on 3rd November. The ZHR is 12; aside from a slightly slower speed there's nothing to distinguish the shower from the northern TAURIDS (below) with a similar radiant.

The **TAURIDS** (N) can be seen from about midnight to dawn, activity begins around 13th September and continues to 1st December, the peak being on 13th November. The ZHR is 8; aside from a slightly faster speed there's nothing to distinguish the shower from it's southern counterpart (above). The radiant is near the famous Pleiades.

The **DRACONIDS** (or **GIACOBINIDS**) are a periodic shower that has formerly (1933 and 1946) reached an estimated rate of 5000 meteors per hour! The stream is associated with the short period comet Giacobini-Zinner, and activity can range from storm, modest or nonexistent. The northerly declination will see the radiant below the northeastern horizon around 7pm. The duration lasts from 6th to 10th October, with the peak expected on 9th October.

The **EPSILON GEMINIDS** have maximum activity on 19th October. The shower has a ZHR of 5 very swift meteors, with a duration from 14th to 27th October. The radiant is centred near 3rd magnitude Epsilon Geminorum and is best observed from about 1am till twilight. Epsilon culminates at 5am 30° above the northern horizon.

The **ORIONIDS** are best seen from about midnight until dawn. The shower's duration extends from 2nd October through to 7th November, with maximum activity on 22nd October. The Orionids provide a prominent display that reach an intensity of 30 very swift meteors per hour, with the radiant near 2nd magnitude Gamma Geminorum.

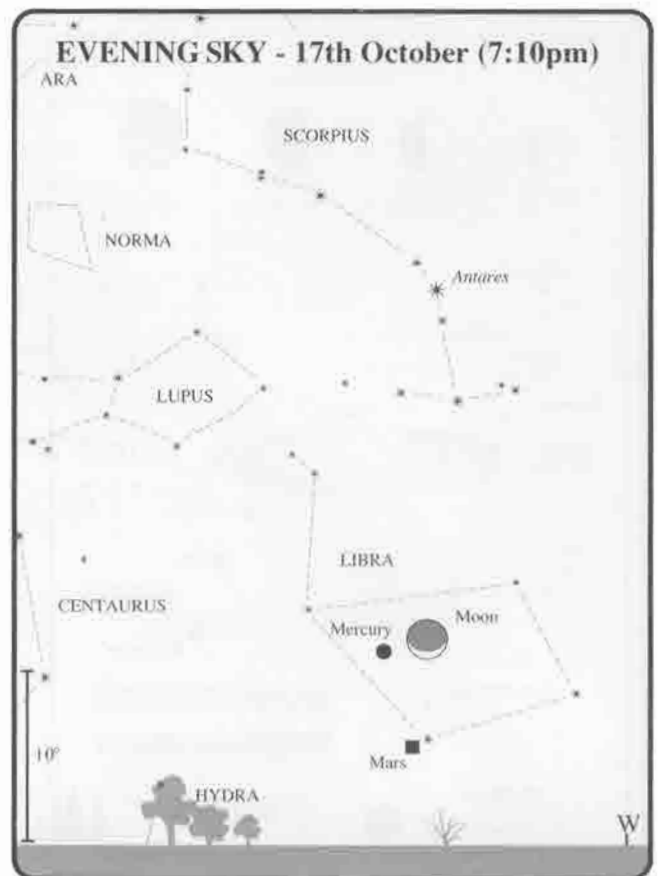
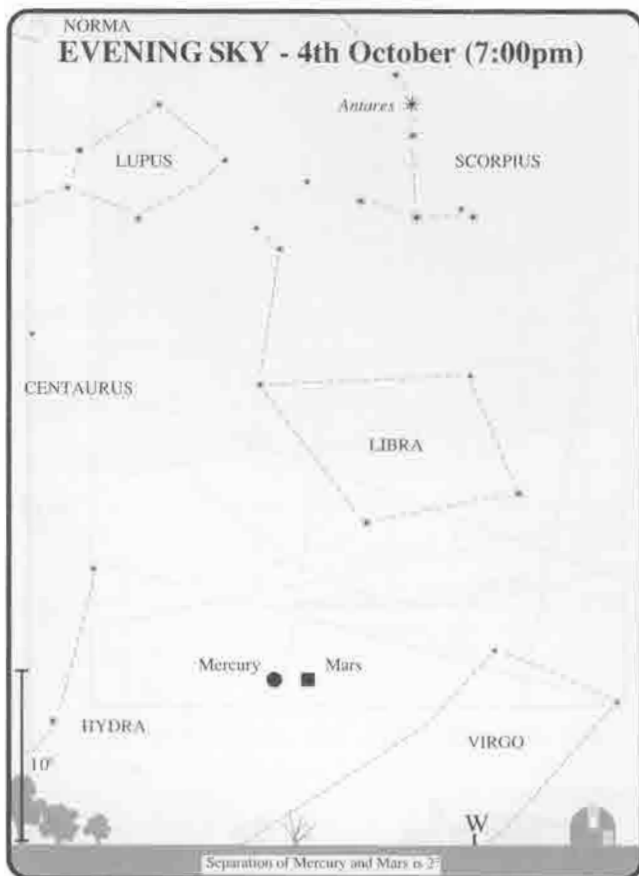
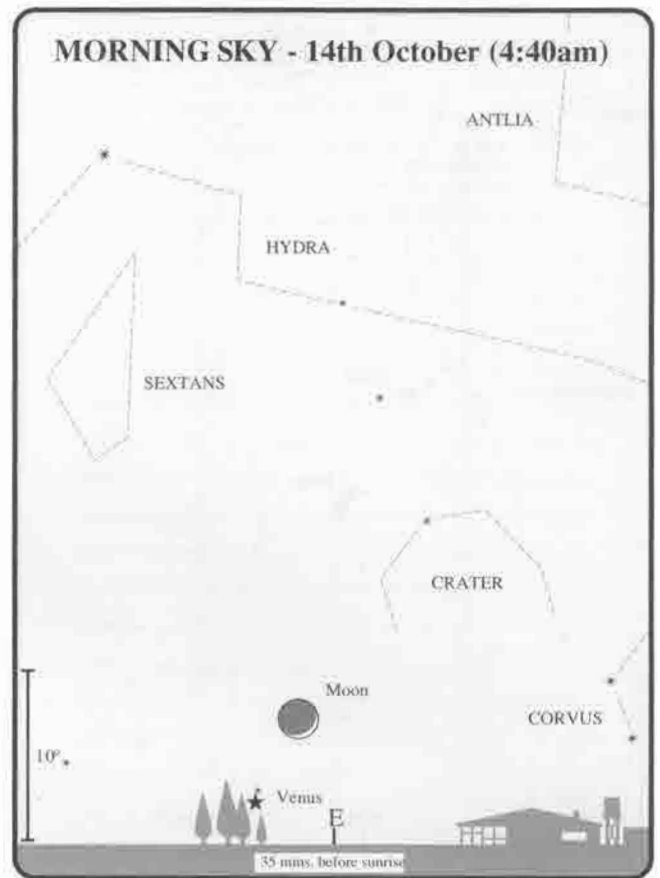
The **PUPPID/VELIDS** are visible from late evening till dawn. There's no single date of maximum activity, but several spread from 15th October to 22nd January. The expected hourly rate is from 10 to 15 and the meteors typically have medium speed. The radiant is nearby the beautiful 2nd magnitude multiple star Gamma Velorum.

DAILY EVENTS

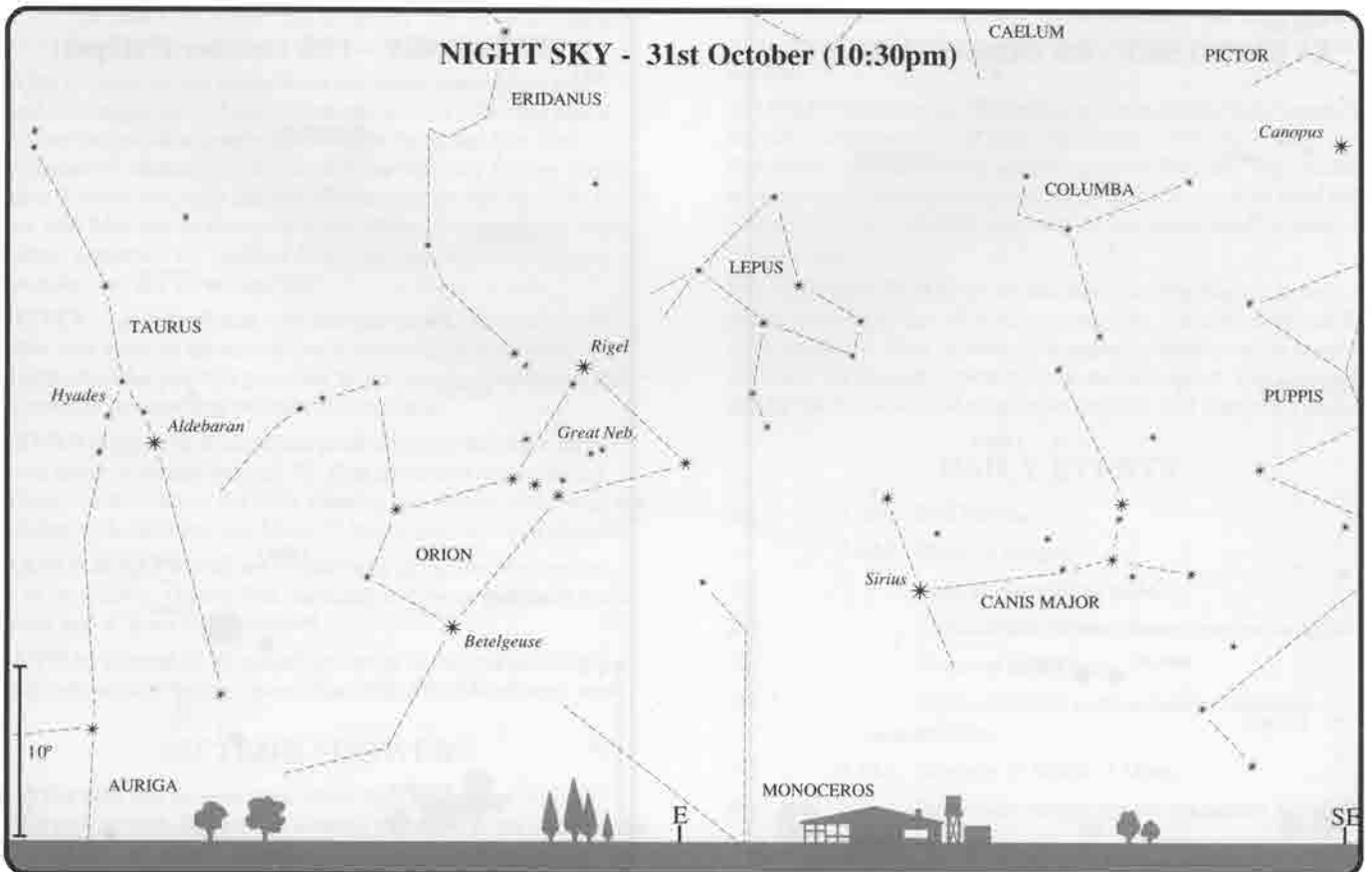
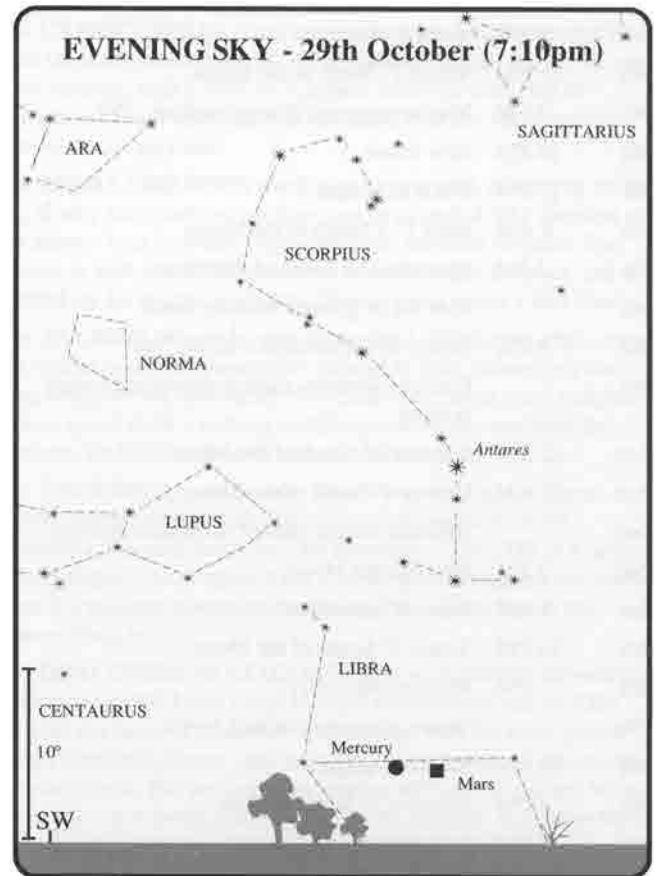
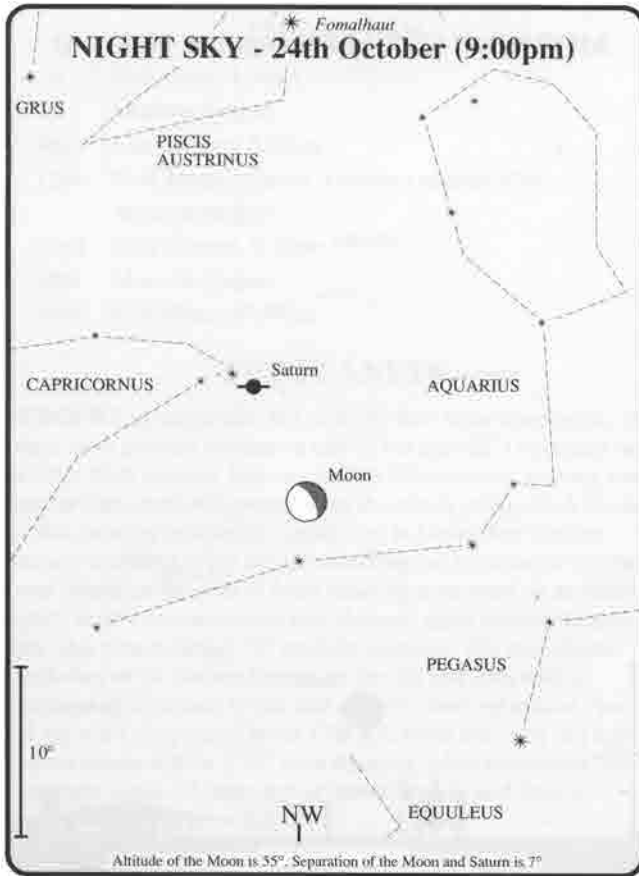
1st	5 AM	Full Moon.
1st	7 AM	Moon at apogee.
3rd		Mars at descending node.
3rd		Capricornids meteor shower maximum activity.
5th		Venus at perihelion.
5th		Sigma Orionids meteor shower maximum activity.
7th	3 AM	Mercury 2° South of Mars.
9th		Draconids meteor shower maximum activity.
9th	6 AM	Last quarter Moon.
13th	11 AM	Pallas stationary.

OCTOBER

13th	8 PM	Vesta stationary.
14th	11 AM	Venus 7° North of the Moon.
14th	2 PM	Mercury greatest elongation East (25°).
15th	10 PM	New Moon.
15th	10 PM	Moon at perigee.
17th	8 AM	Mars 1°.7 North of the Moon.
17th	3 PM	Mercury 10.7 South of the Moon.
18th		Mercury at greatest latitude South.
18th	8 PM	Jupiter in conjunction with the Sun.
19th		Epsilon Geminids meteor shower maximum activity.
22nd	12 AM	Neptune 3° South of the Moon.
22nd	12 AM	Uranus 4° South of the Moon.
22nd		Orionids meteor shower maximum activity.
22nd	7 PM	First quarter Moon.
23rd	5 AM	Ceres at opposition.
24th	11 PM	Saturn 7° South of the Moon.
26th	1 PM	Mercury stationary.
27th		Venus at greatest latitude North.
28th	10 AM	Moon at apogee.
28th	4 PM	Mercury 2° South of Mars.
28th	8 PM	Saturn stationary.
30th	11 PM	Full Moon.

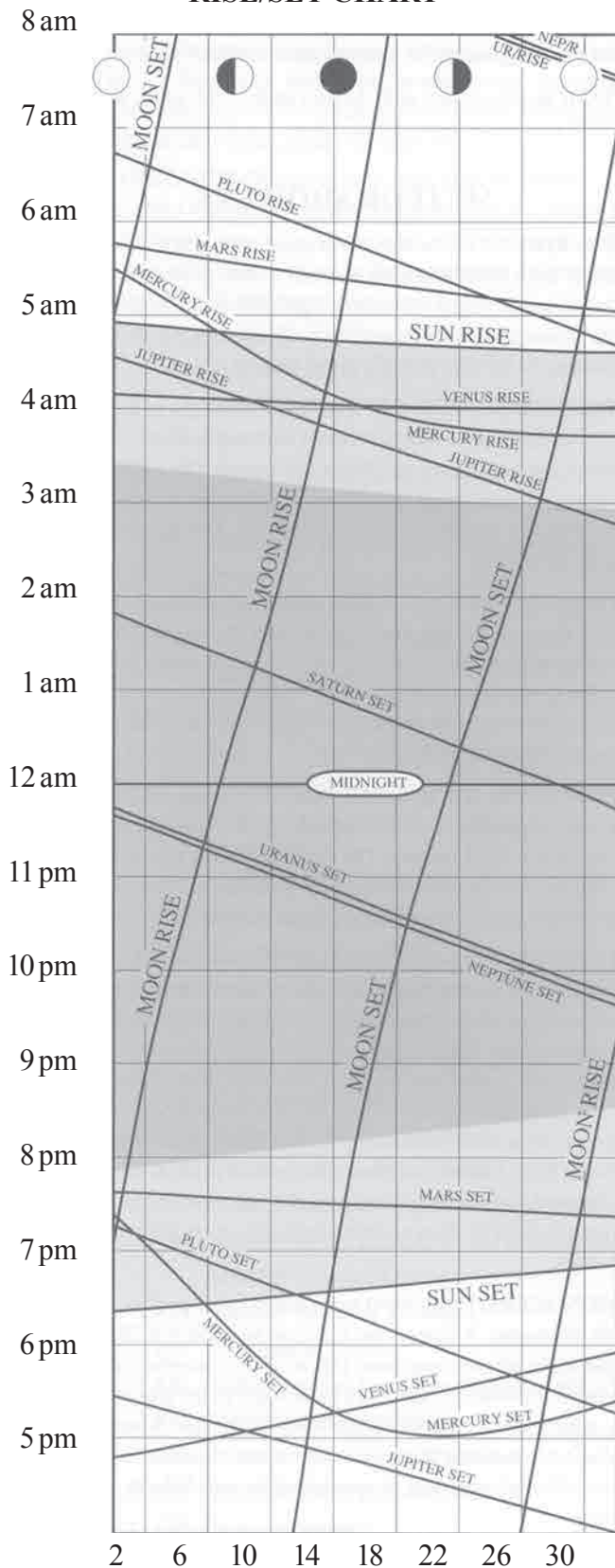


OCTOBER

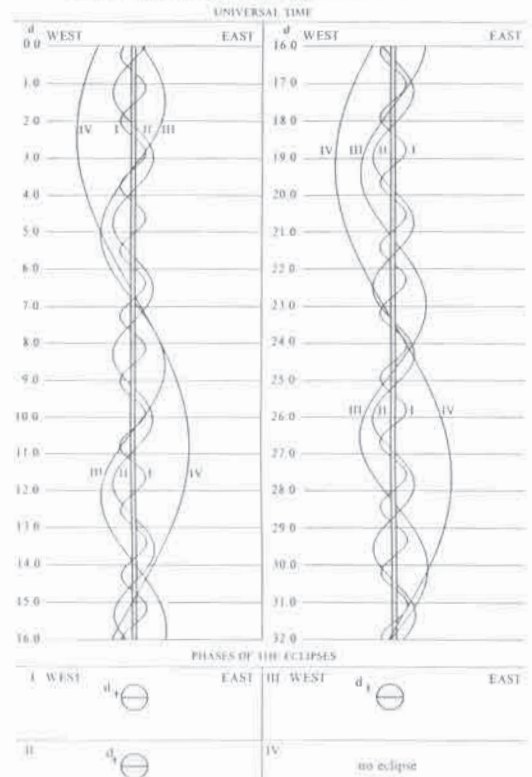


NOVEMBER

RISE/SET CHART

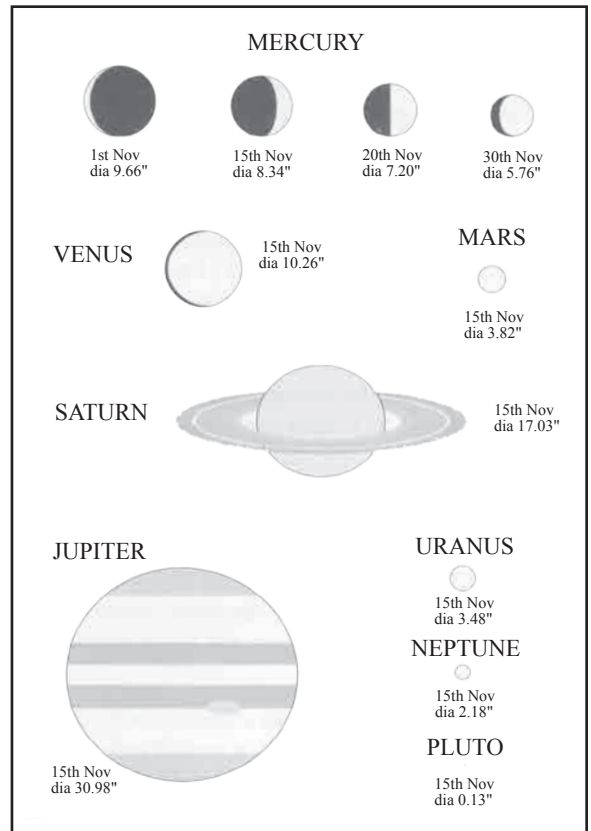


CONFIGURATIONS OF SATELLITES I-IV FOR NOVEMBER



I = Io, II = Europa, III = Ganymede, IV = Callisto

APPEARANCE OF THE PLANETS



NOVEMBER

THE MOON

- 7th Last quarter, 4:36pm
12th Moon at perigee
14th New Moon, 7:34am (Lunation number 877).
Partial eclipse of the Sun, visible from some areas of Australia (see page 70 for detail).
21st First Quarter, 12:03pm
24th Moon at apogee
29th Full Moon, 4:31pm.
Total eclipse of the Moon, not visible from Australia.

THE PLANETS

MERCURY reaches inferior conjunction on the 6th and in so doing transits the disc of the Sun. This is the first transit since 1986, the next happens in 1999; see page 83 for full details. After transit the planet swings west of the Sun to become a morning twilight object, with greatest elongation west of the Sun occurring on the 22nd. On the 14th and 15th Mercury will be within 1° of Venus. Binoculars and a good eastern outlook will help here; with Mercury about 4° above the horizon, the Sun 3°30' below at 4.30am, and Jupiter a little over 5° above the pair and northwards (see sky view diagram).

VENUS becomes more difficult to find as it nears the Sun in the morning sky, with such a busy and interesting month it is a shame that the planet is in twilight; the events listed can be seen around 4.30am when Venus is about 4° above the horizon with the Sun approximately the same distance below. On the 4th and 5th Venus comes within 4° of 1st magnitude Alpha Virginis (Spica) with Jupiter rising below and to the south. The separation of Spica increases as Venus and Jupiter draw nearer to each other, until on the 9th the two planets are a close 0°22' apart. On the following morning, Venus and Jupiter can still be seen within 1° of each other. On the 12th an interesting configuration happens when Mercury, Venus, Jupiter, Spica and the 27 day old Moon form a line sloping northwards from the east. Starting from Mercury at an altitude of 2° above the horizon the separation of each object is as follows; Mercury/Venus 4°20', Venus/Jupiter 3°05', Jupiter/Spica 7°15', Spica/Moon 3°35'. On the 13th with Mercury, Venus and Jupiter still in line the 28 day old thin crescent Moon will be seen 3°10' from Venus, the planets forming a baseline with the Moon completing a triangle (see sky view diagram). On the 14th and 15th, Venus and Mercury will be 1° apart (see Mercury).

MARS, setting in evening twilight, gradually moves toward the Sun as it approaches conjunction in December.

JUPITER, now past conjunction, appears west of the Sun in the morning twilight. On the 13th at 4.30am, the 28 day old thin crescent Moon appears 5°30' south of the planet. Jupiter also features in close approaches to Mercury and Venus as described above (see sky view diagram).

SATURN sets around 1am mid month affording comfortable evening viewing while still maintaining a good altitude. On the 20th, the 7 day old Moon appears 8° from the planet (see sky view diagram). The 3rd magnitude star close to Saturn during the month is Delta Capricorni (Deneb Algiedi).

URANUS & NEPTUNE both set around 10.30pm mid month and are observable in the early evening western sky. On the 18th, the 5 day old Moon appears 6°50' from Uranus and 6°20' from Neptune.

PLUTO is in conjunction with the Sun on the 18th and is lost from view until next year.

METEOR SHOWERS

The **TAURIDS** (S) can be seen from about midnight to dawn, they are visible from 15th September through to 26th November, the peak being on the 3rd of this month. The ZHR is 12; aside from a slightly slower speed there's nothing to distinguish the shower from the northern TAURIDS (below) with a similar radiant.

The **TAURIDS** (N) can be seen from about midnight to dawn. Activity begins around 13th September and continues to 1st December, the peak being on 13th of this month. The ZHR is 8; aside from a slightly faster speed there's nothing to distinguish the shower from its southern counterpart (above). The radiant is near the famous Pleiades.

The **ORIONIDS** are best seen from about midnight until dawn. The shower's duration extends from 2nd October through to 7th November, with maximum activity occurring last month on the 22nd. The Orionids provide a prominent display that reach an intensity of 30 very swift meteors per hour, with the radiant near 2nd magnitude Gamma Geminorum.

The **PUPPID/VELIDS** are visible from late evening till dawn. There's no single date of maximum activity, but several spread from 15th October to 22nd January. The expected hourly rate is from 10 to 15 and the meteors typically have medium speed. The radiant is near the beautiful 2nd magnitude multiple star Gamma Velorum.

The **LEONIDS**, after a storm of unbelievable intensity in 1833, were responsible for the change in scientist's attitude that meteors are not purely an atmospheric event. The shower is associated with the periodic comet Tempel-Tuttle and is best about every 33 years when the comet returns to perihelion. The years 1998-2000 should provide a good showing after a peak in 1966 when thousands of meteors per hour were recorded by United States observers. The duration is from 14th to 21st November, with a peak on the 17th. Best observed from midnight to dawn, the years leading up to 1998-2000 are expected to show an increase in activity as the comet approaches.

The **MONOCEROTIDS** (Nov) reach a maximum peak of activity on 20th November, 5 meteors per hour can be expected. The duration of the shower lasts from 15th to 25th November, and it is well placed for southern observers from 10pm in the east until dawn; transiting the meridian about 4am. The radiant is near 1st magnitude Alpha Canis Minoris (Procyon) and produces very swift meteors, although generally disappointing for unaided eye observers

The **PHOENICIDS** (Dec) are active from 28th November through to 9th December, with maximum activity next month on the 5th. Visible throughout the night the shower is in an excellent position for southern observers, with a radiant near 4th magnitude Zeta Phoenicis. The expected hourly rate is between 2 and 10 very slow meteors.

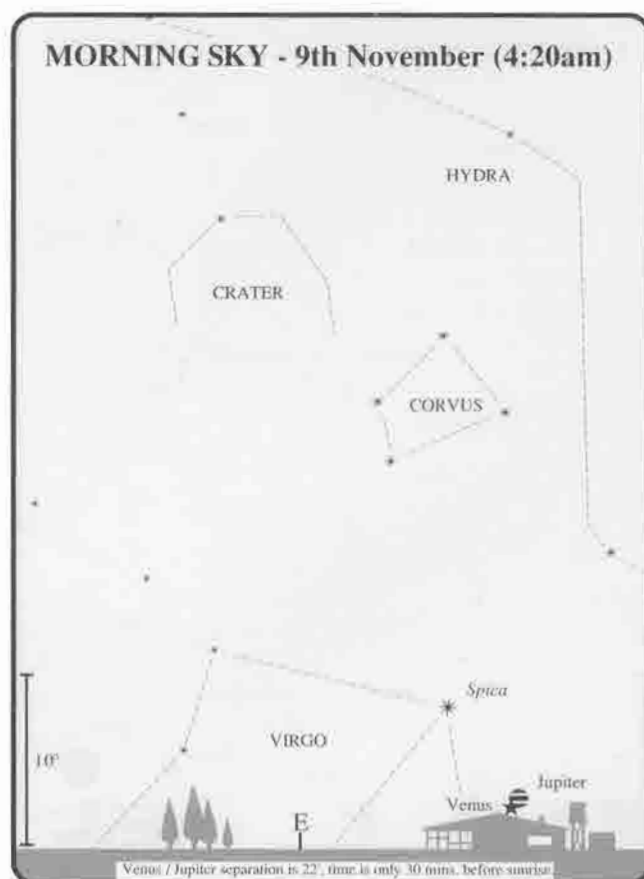
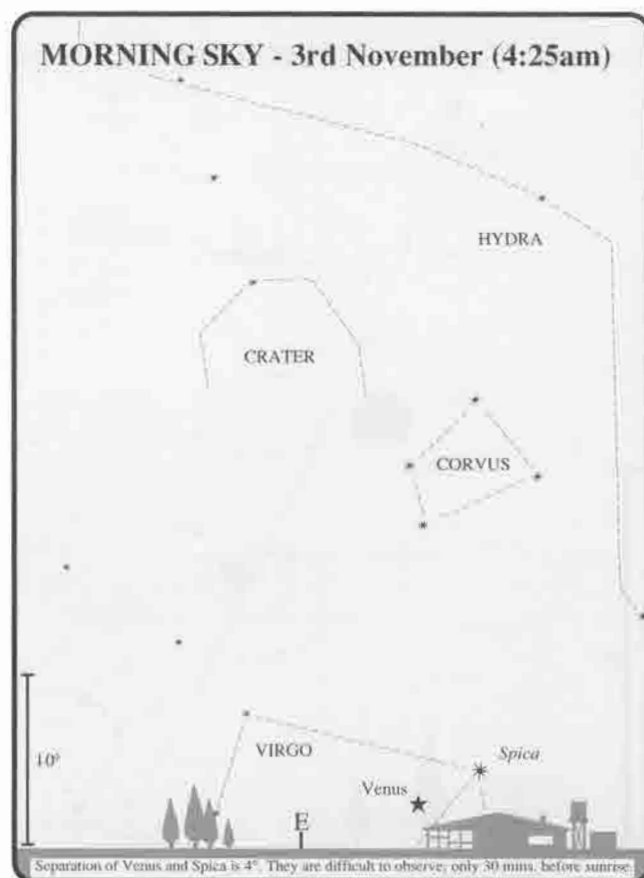
NOVEMBER

The **MONOCEROTIDS** are visible during the entire night, rising in the east, transiting the meridian around 1am and setting in the west at dawn. The approximate duration is from 27th November through to 17th December, with a peak in activity next month on the 11th, and an hourly rate of 5 medium speed meteors. The radiant is near 1st magnitude Alpha Orionis (Betelgeuse).

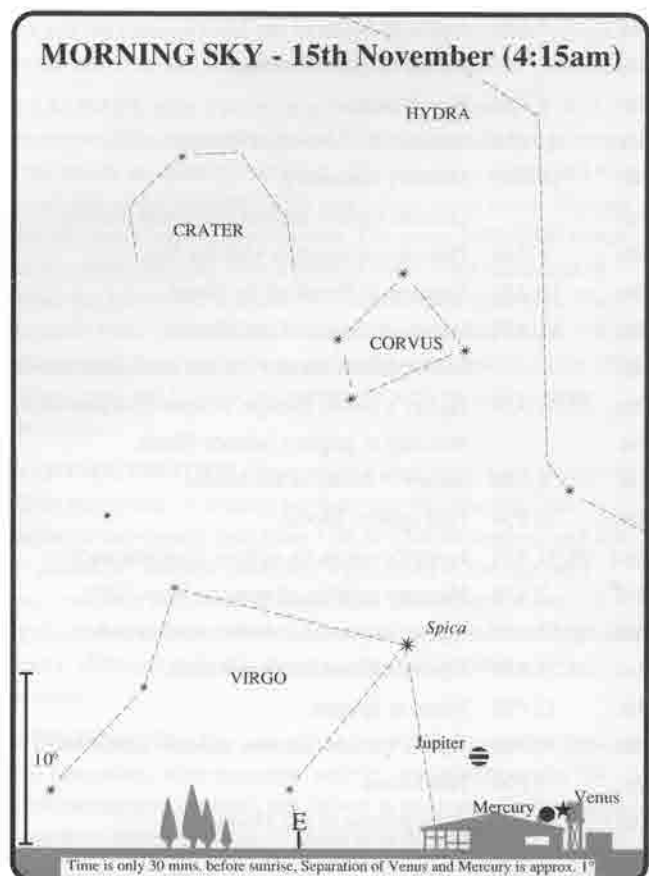
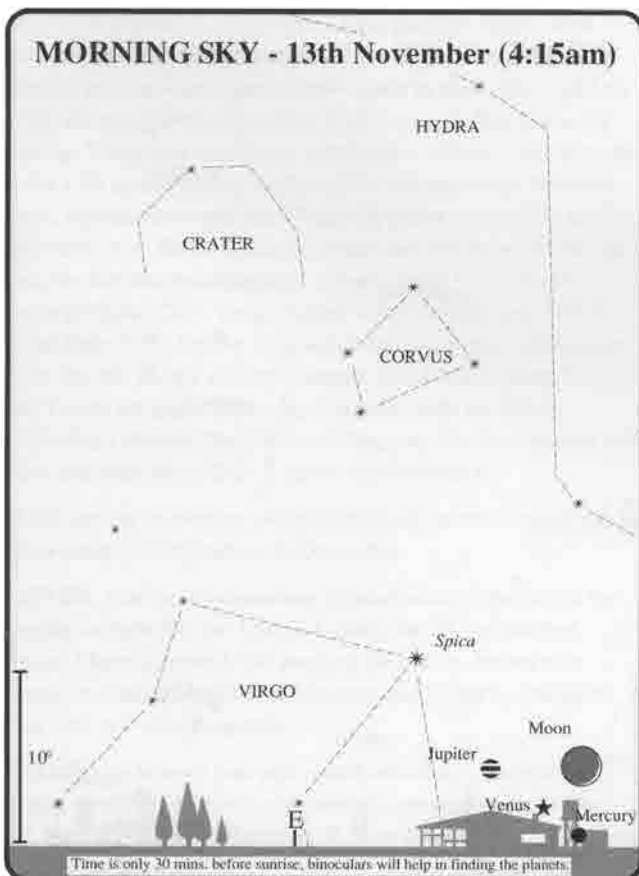
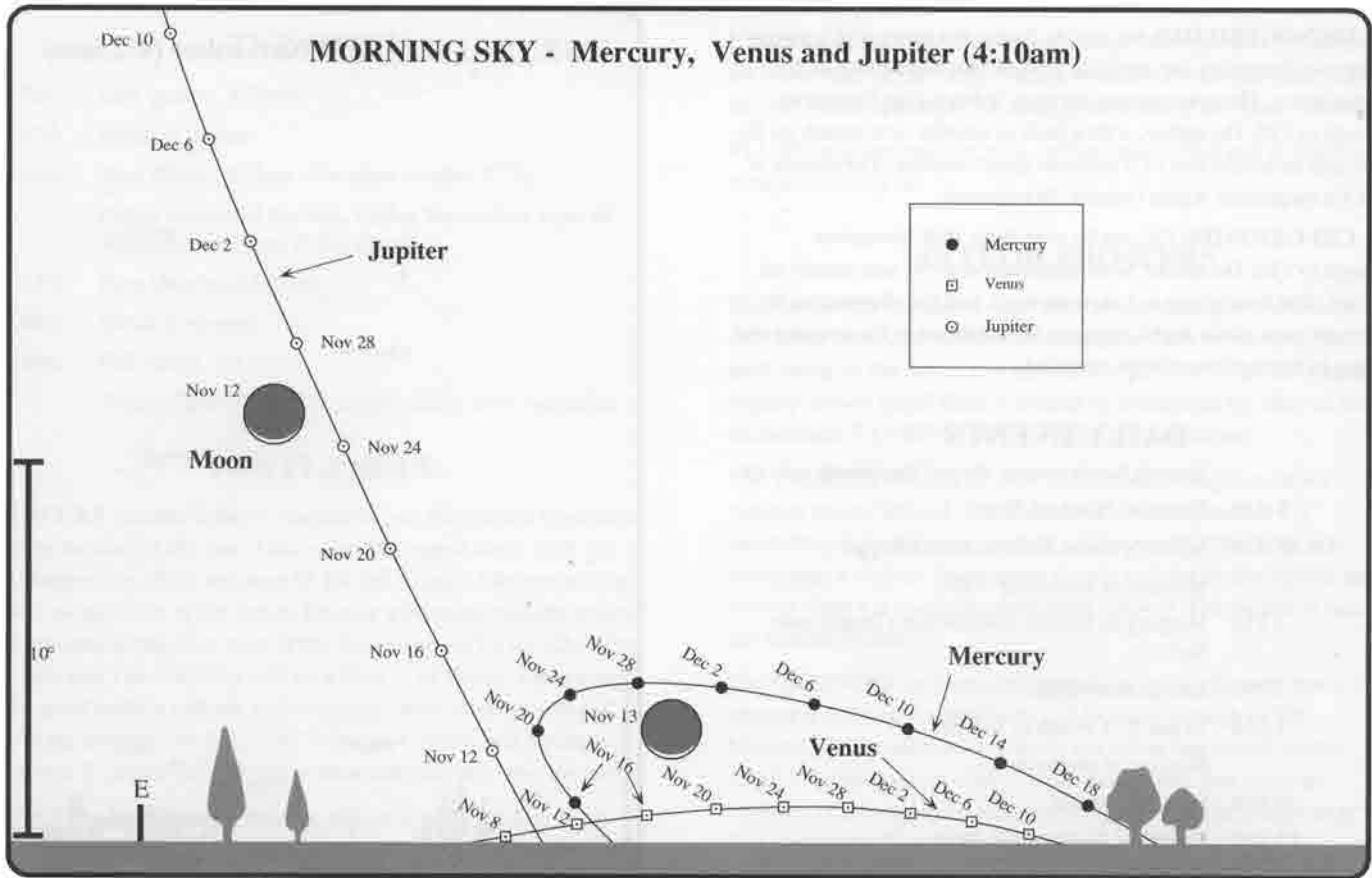
The **CHI ORIONIDS** (N) can be seen from 16th November through to 15th December, with maximum activity next month on the 2nd. The hourly rate is 3 slow meteors, and the shower can be observed most of the night, rising in the northeast in the evening and setting in the northwest in the morning.

DAILY EVENTS

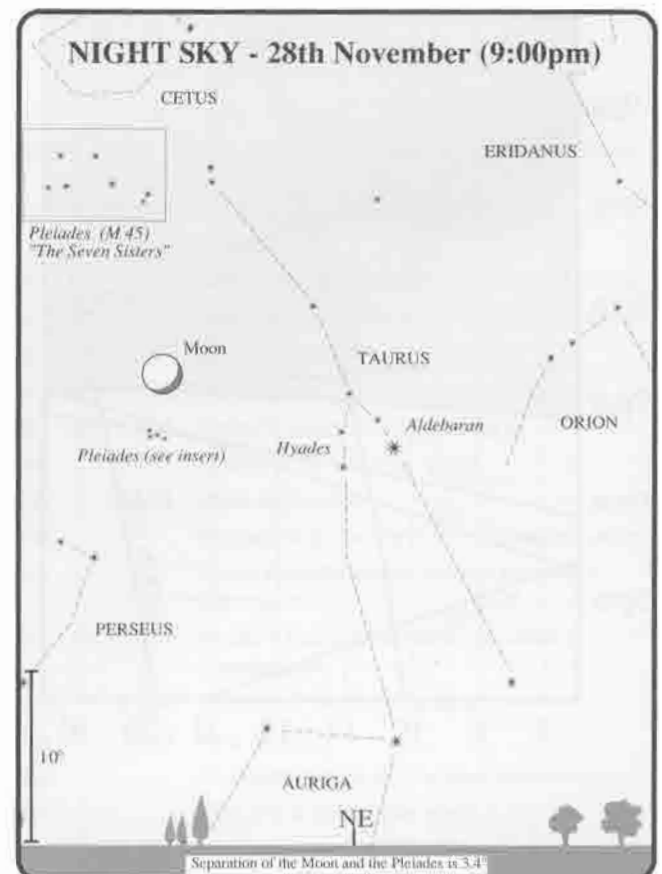
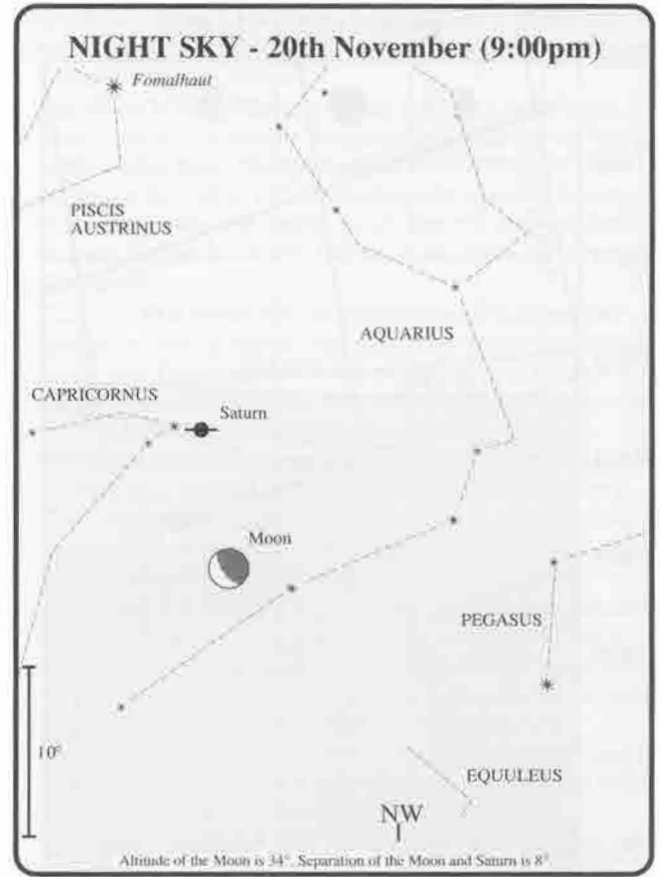
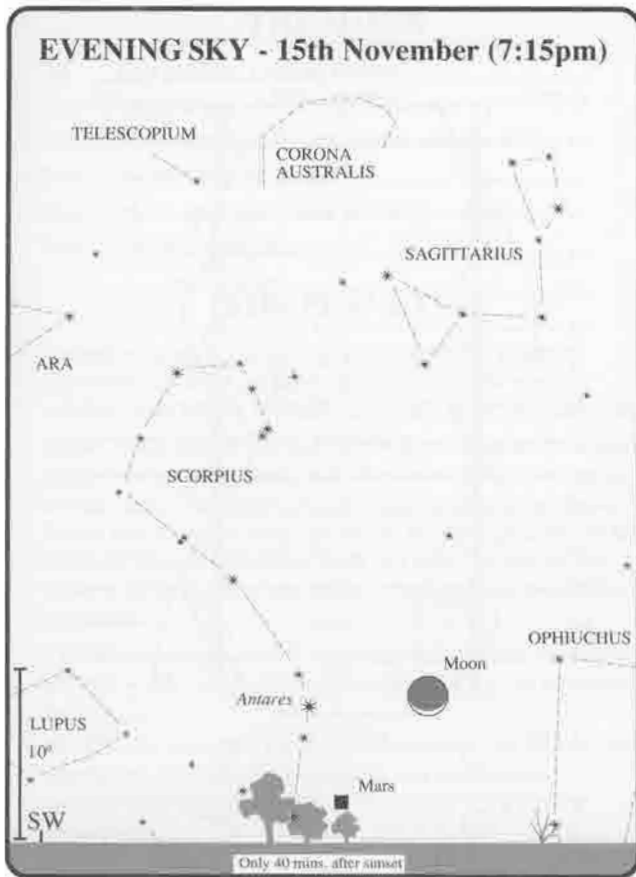
3rd		Taurids South meteor shower maximum activity.
3rd	9 AM	Venus 4° North of Spica.
4th	04:46 AM	Jupiter's moon, Europa, transit begins.
6th		Mercury at ascending node.
6th	2 PM	Mercury in inferior conjunction (Transit over Sun).
7th	5 PM	Last quarter Moon.
9th	3 AM	Venus 0°.4 North of Jupiter.
11th		Mercury at perihelion.
12th	10 PM	Moon at perigee.
13th	12 AM	Jupiter 4° North of the Moon.
13th		Taurids North meteor shower maximum activity.
13th	04:18 AM	Jupiter's moon, Europa, occultation reappearance.
13th	7 AM	Venus 4° North of the Moon.
14th		Partial eclipse of the Sun
14th	8 AM	New Moon.
14th	11 PM	Mercury 0°.7 North of Venus.
15th	10 AM	Mercury stationary.
17th		Leonids meteor shower maximum activity.
18th	4 AM	Pluto in conjunction with the Sun.
18th	10 AM	Neptune 3° South of the Moon.
18th	11 AM	Uranus 4° South of the Moon.
20th		Monocerotids meteor shower maximum activity.
20th	03:38 AM	Jupiter's moon, Europa, eclipse disappearance.
21st		Mercury at greatest latitude North.
21st	8 AM	Saturn 7° South of the Moon.
21st	12 PM	First quarter Moon.
22nd	04:32 AM	Jupiter's moon, Io, eclipse disappearance.
23rd	2 AM	Mercury greatest elongation West (20°).
23rd	03:52 AM	Jupiter's moon, Io, shadow transit ends.
23rd	04:27 AM	Jupiter's moon, Io, transit ends.
24th	11 PM	Moon at apogee.
29th	03:36 AM	Jupiter's moon, Europa, shadow transit ends.
29th	5 PM	Full Moon.
29th		Total eclipse of the Moon.
30th	03:35 AM	Jupiter's moon, Io, shadow transit begins.
30th	04:16 AM	Jupiter's moon, Io, transit begins.



NOVEMBER

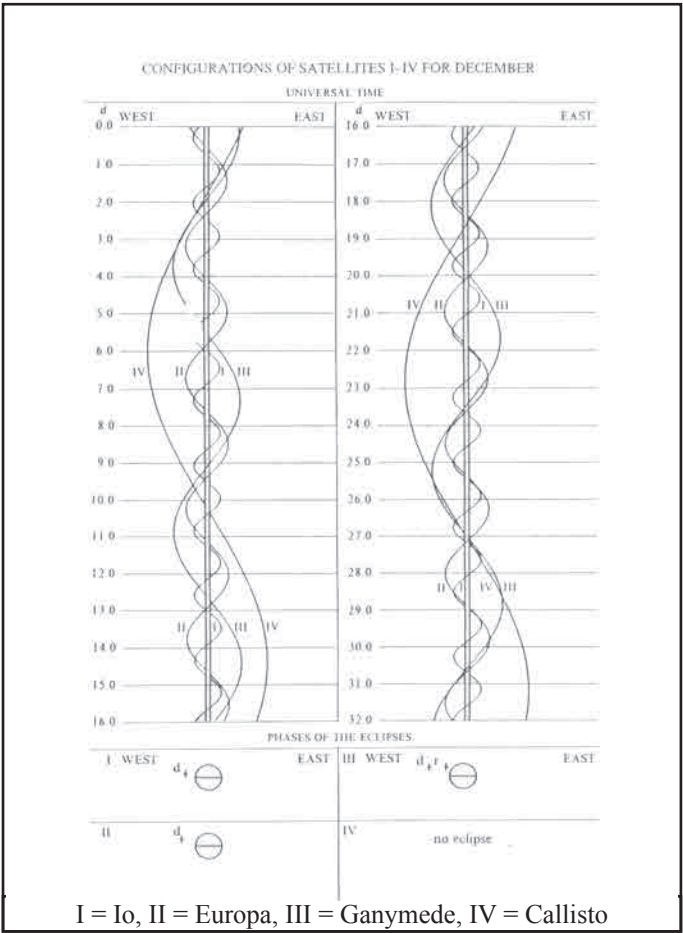
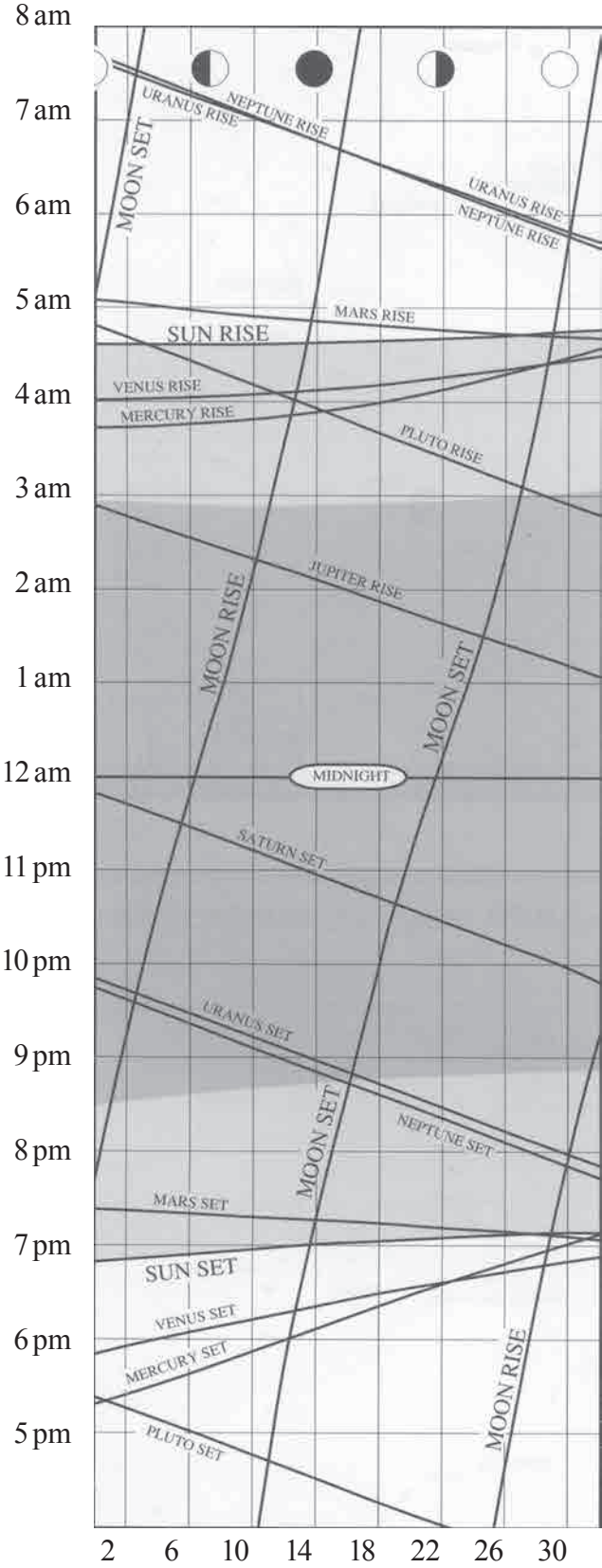


NOVEMBER

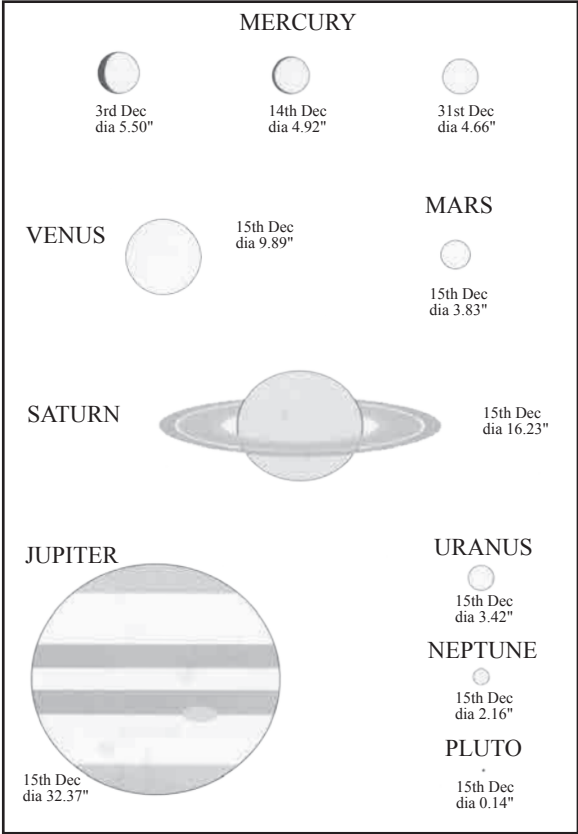


DECEMBER

RISE/SET CHART



APPEARANCE OF THE PLANETS



DECEMBER

THE MOON

- 7th Last quarter, 1:49am.
- 11th Moon at perigee (closest to Earth).
- 13th New Moon, 7:27pm (Lunation number 878).
- 21st First Quarter, 8:26am.
- 22nd Moon at apogee (most distant from Earth).
- 29th Full Moon, 9:05am.

THE PLANETS

December is not a particularly good month for planetary observers; Saturn is probably the best object for evening viewers, with Jupiter available late in the month for early risers.

MERCURY rises in the morning twilight about an hour before sunrise early in the month, and 15 minutes before the Sun at month's end. The planet has close approaches to the Moon, Venus and Antares during the month but circumstances of these incidents have been omitted from this page because of the extreme difficulty in observation in the less than favourable conditions.

VENUS at magnitude -3.9, is in a similar position to Mercury and not worthy of observation because of its close proximity to the Sun.

MARS sets soon after the Sun in the western evening sky as it approaches conjunction on the 27th and is therefore, unobservable until next year.

JUPITER rises in the eastern morning sky at 3am early in the month (at the time of beginning of astronomical twilight) and observation of the planet would be best left until month's end when two hours of dark sky will be available. On two consecutive nights the Moon will appear nearby Jupiter; on the 10th the 25 day old Moon will be 8° above and northwards, on the 11th the 26 day old Moon will be below and southwards of the planet (see sky view diagram).

SATURN observers will need to act this month for a last reasonable glimpse of the planet until next year. Early in the month at least three hours of dark sky, with Saturn at a reasonable altitude, will be available. At month's end only an hour will be available with the planet 10° above the western horizon at 9pm. On the 18th, the 5 day old Moon can be seen 8° below and north of the planet (see sky view diagram).

URANUS & NEPTUNE are visible early in the month about an hour prior to the end of astronomical twilight. On the 15th, the 2 day old Moon will be 4° from Neptune and 5°15' from Uranus in the twilight before the planets set. After that, the duo will be lost in twilight as they move toward conjunction in January 1994.

PLUTO, rising in the morning twilight will not be visible until early 1994.

METEOR SHOWERS

The **PUPPID/VELIDS** are visible from late evening till dawn. There's no single date of maximum activity, but several spread from 15th October to 22nd January. The expected hourly rate is from 10 to 15 and the meteors typically have medium speed. The radiant is near the beautiful 2nd magnitude multiple star Gamma Velorum.

The **PHOENICIDS** (Dec) are active from 28th November through to 9th December, with maximum activity this month on the 5th. Visible throughout the night the shower is in an excellent position for southern observers, with a radiant near 4th magnitude Zeta Phoenicis. The expected hourly rate is between 2 and 10 very slow meteors.

The **MONOCEROTIDS** are visible during the entire night, rising in the east, transiting the meridian around lam and setting in the west at dawn. The approximate duration is from 27th November through to 17th December, with a peak in activity this month on the 11th, and an hourly rate of 5 medium speed meteors. The radiant is near 1st magnitude Alpha Orionis (Betelgeuse).

The **CHI ORIONIDS** (N) can be seen from 16th November through to 15th December, with maximum activity this month on the 2nd. The hourly rate is 3 slow meteors, and the shower can be observed most of the night, rising in the northeast in the evening and setting in the northwest in the morning.

The **SIGMA HYDRIDS** range from 3rd to 15th December, reaching their peak on the 11th. The radiant, producing very swift meteors, is situated near the insignificant 5th magnitude star Sigma Hydrae, and is visible along the ecliptic from about 10pm until dawn. The ZHR is 5.

The **GEMINIDS** are best from about 11pm until 5am, when at their highest above the northern horizon. Visible from 7th to 17th December, peaking on the 14th. The medium speed shower is noted for its bright meteors and under good conditions will match the Perseids display (ZHR = 100), for Australian observers the Geminids are a better proposition than the Perseids because of their more southern declination. The radiant is near 2nd magnitude Alpha Geminorum (Castor).

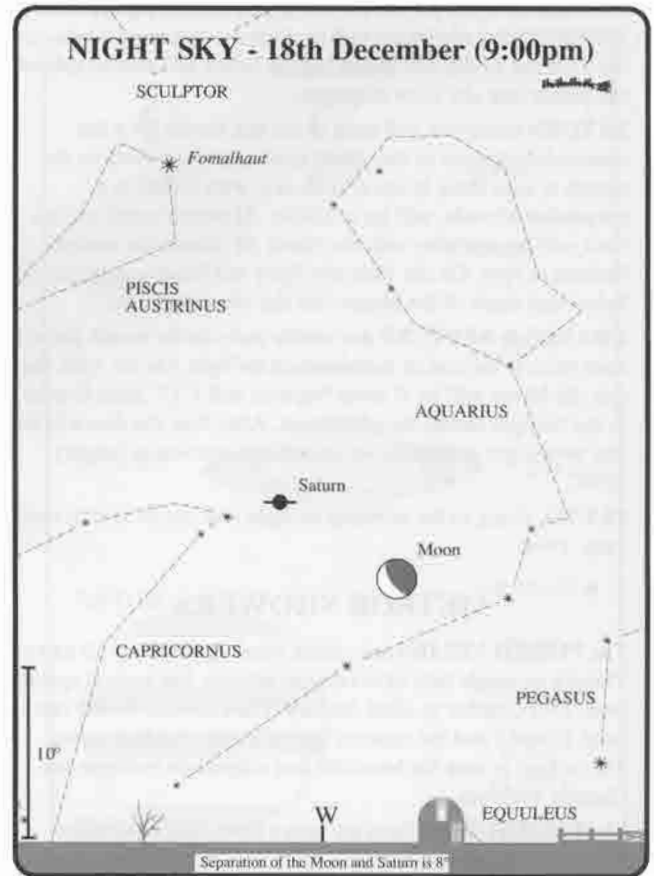
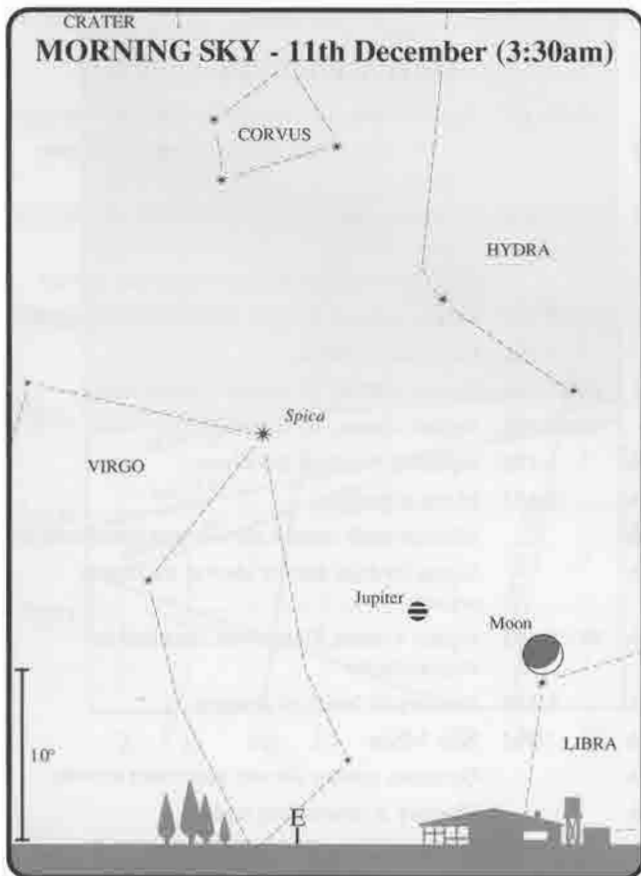
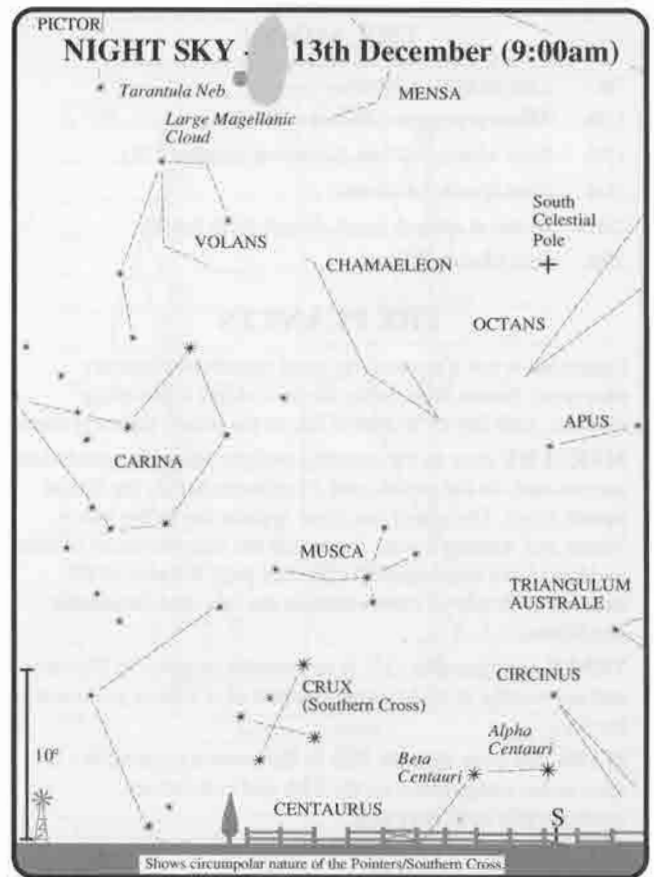
The **COMA BERENICIDS** peak on 17th December, and are active with a ZHR of 5 from 12th December until 23rd January. The shower is observable from around 2am until dawn. The radiant in an area of the constellation Coma Berenices produces very swift meteors.

DAILY EVENTS

- | | | |
|------|----------|---|
| 1st | 03:46 AM | Jupiter's moon, Io, occultation reappearance. |
| 2nd | | Chi Orionids North meteor shower maximum activity. |
| 2nd | 04:22 AM | Jupiter's moon, Ganymede, shadow transit begins. |
| 5th | | Phoenicids meteor shower maximum activity. |
| 6th | 03:47 AM | Jupiter's moon, Europa, shadow transit begins. |
| 7th | 2 AM | Last quarter Moon. |
| 8th | 02:47 AM | Jupiter's moon, Io, eclipse disappearance. |
| 9th | 02:56 AM | Jupiter's moon, Io, transit ends. |
| 10th | 6 PM | Jupiter 4° North of the Moon. |
| 11th | 12 AM | Moon at perigee. |
| 11th | | Monocerotids meteor shower maximum activity. |
| 11th | | Sigma Hydrids meteor shower maximum activity. |
| 13th | 04:14 AM | Jupiter's moon, Ganymede, occultation reappearance. |
| 13th | 8 AM | Mercury 5° North of Antares. |
| 13th | 7 PM | New Moon. |
| 14th | | Geminids meteor shower maximum activity. |
| 15th | | Mercury at descending node. |
| 15th | 10 PM | Neptune 3° South of the Moon. |
| 15th | 11 PM | Uranus 4° South of the Moon. |

DECEMBER

16th	02:45 AM	Jupiter's moon, Io, transit begins.
16th	04:02 AM	Jupiter's moon, Io, shadow transit ends.
17th		Coma Berenicids meteor shower maximum activity.
17th	02:13 AM	Jupiter's moon, Io, occultation reappearance.
17th	4 AM	Ceres stationary.
18th	8 PM	Saturn 7° South of the Moon.
19th		LAM Pallas 1 °.2 South of the Moon.
20th	02:26 AM	Jupiter's moon, Ganymede, eclipse disappearance.
21st	8 AM	First quarter Moon.
22nd		Venus at descending node.
22nd	03:18 AM	Jupiter's moon, Europa, eclipse disappearance.
22nd	6 AM	Solstice.
22nd	6 PM	Moon at apogee.
23rd	03:45 AM	Jupiter's moon, Io, shadow transit begins.
24th	02:27 AM	Jupiter's moon, Europa, transit ends.
24th	04:10 AM	Jupiter's moon, Io, occultation reappearance.
25th		Mercury at aphelion.
27th	12 PM	Mars in conjunction with the Sun.
29th	9 AM	Full Moon.
31st	02:42 AM	Jupiter's moon, Ganymede, transit ends.
31st	02:48 AM	Jupiter's moon, Europa, transit begins.
31st	02:55 AM	Jupiter's moon, Io, eclipse disappearance.
31st	03:04 AM	Jupiter's moon, Europa, shadow transit ends.



PART 2

THE SOLAR SYSTEM

EXPLANATION

GENERAL COMMENTS

The following presents brief explanations for the data (or use of the data) in part 2 of this book. In some of the sections, there are more detailed discussions (eg. Jovian Satellite events) and hence they are not covered in this introduction.

Use of Star Atlases. Over many years, the stars appear to move in the sky relative to the celestial poles. This is because the Earth's axis is slowly wobbling like a spinning top. It is called "precession". "Epoch 2000.0" refers to an object's position in relation to where the celestial poles (+ and -90° in declination) will be in the year 2000. This epoch has now been adopted by most modern star atlases. There are still atlases around which use epoch 1950.0 and it is important to check your atlas before using (or buying!) it to ensure it is 2000.0. The precession, over this 50 year period, can cause a shift of up to one degree in the apparent position of an object relative to the star field. This may not be a concern when looking for the brighter planets but high precision may be necessary to track down a 12th magnitude comet. The calculations required to convert (or "precess") positions, from one epoch to another, are not complicated considering the power of the calculators/ computers that are available today. Suggested references are "Practical Astronomy with a Calculator" (Duffett-Smith) or "Astronomical Formulae for Calculators" (Meeus).

Longitudes of Central Meridian. (pp. 87,89 and 95) All the times on the main tables (ie daily figures) are calculated for 0 hrs UT (10:00am EAST) of date. To get to your time you will need to add multiple hours/minutes from the small "Increase in Longitude" tables.

Field of View in a Telescope. All the satellite diagrams and finder charts in this book are drawn to correct sky orientation, ie 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.

Finder Charts for the Planets. No finder charts are presented for Venus, Mercury or the second half of the year for Mars. Their rapid motion, during the year, causes them to cover a very large section of the sky which is difficult to cater for adequately in the space available. Considering the brilliance of these planets, the "sky view" diagrams (see part 1) should be sufficient to act as "finders".

MOON

Rise/Set Data (pp. 75,116 and 117)

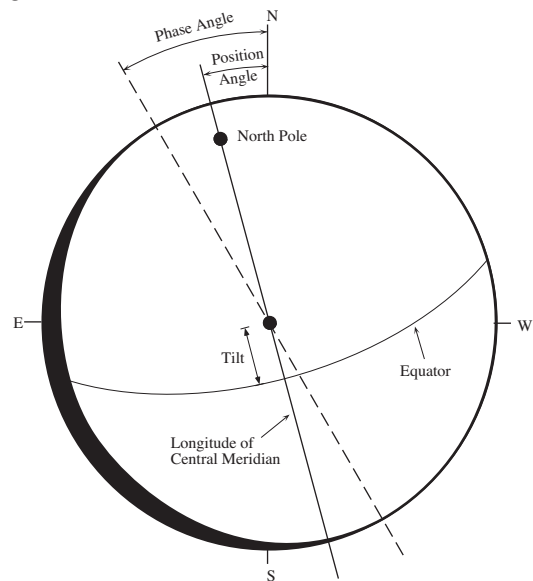
Looking at this data you will see there are some days where the Moon appears not to rise or set. The reason for this lies in its rapid daily motion from west to east. Consecutive days show the Moon to rise (or set) more than 24 hours later. Hence, if the Moon rises just before midnight on the 1st of the month, it may not rise again until after midnight on the 2nd (making it an event for the 3rd) with no rise on the 2nd.

MARS (pp. 87)

This page presents data, required by the serious amateur, to make observations/ drawings of the planet during opposition (when the planet is not in opposition it is too distant to see any features). The data is as follows:

- Phase:** The fraction of the disc of Mars illuminated by the Sun. 1.0 would be the entire disc. At opposition the "phase" is at maximum.
- Phase Angle:** The number of degrees (east of north) the "Phase" is rotated.
- Cent. Mer:** Longitude of Central Meridian is the longitude that is centred on the disc
- P.A.** The number of degrees (east of north) that Mars north pole is rotated from north.
- Tilt:** (or Sub-Earth point, latitude) is the number of degrees that Mars' north pole is tilted towards (value is positive) or away (value is negative) as seen from Earth. It is also equal to the latitude of the centre of the disc.

The diagram, below, illustrates these terms.



NOTE. Example diagram only, does not refer to any particular date

When monitoring Mars, the determination of Central Meridian, for any observation (sketch?) of the planet, is important. Knowing the longitude allows you to relate your observations to known surface features. Changes in shape or intensity of a feature can be indicative of the Martian weather patterns. It is fascinating to track the movement and development of white and yellow clouds (dust storms) as they grow and move across the surface. Such observations are mainly restricted to the time around opposition.

JUPITER and SATURN

Unlike Mars, Jupiter and Saturn are "Gas Giants" and they only allow us to view their upper atmospheric features. There is no one correct rotation period. The speed of movement of any feature depends on its latitude; hence the multiple systems used (see pp. 89 and 95). For Saturn, only the equatorial (System I) region is listed. To monitor the movement and development of any feature, amateurs often measure the time it crosses the central meridian of the planet. The longitude can then be worked out from the "longitude of central meridian" tables. It is true that features on Saturn are less obvious than those seen on Jupiter and it sometimes takes 20 to 25 cm telescopes to glimpse any details.

SATURN

The Rings The appearance of the planets diagrams in part 1, show how “open” (or face-on) the rings are for 1993. 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 “edge-on”; this last occurred in 1980. The next such period will be in 1995. At the moment the rings are starting to close up after being wide open in 1988.

The “Saturn’s Rings” table on p. 95 presents the semi-major and semi-minor axes (in arc seconds). This is the axes of the outer edge of the outer ring. The following factors can be applied (multiplied) to this data to derive the following:

Ring A : Inner edge of outer ring = 0.8932

Ring B : Outer edge of inner ring = 0.8596

Ring C: Inner edge of inner ring = 0.6726

Ring D : Inner edge of dusky ring = 0.5447

On this same table, “U” and “B” equal the Geocentric longitude and the tilt of the rings respectively.

The Satellites (pp. 96 and 97). To estimate the configuration or positions of the satellites, the “Apparent Orbits” diagram (p. 96) 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. 96) and that gives the moon’s position directly.

URANUS / NEPTUNE

Finder Chart (see p. 99). The bright star pi (π) Sagittarius (see right hand edge of star chart) has been marked on the July 28 “Sky View” diagram to act as a guide.

SATELLITES OF URANUS (see p. 99)

In regard to visual observations, Titania (III) and Oberon (IV) are the easiest to observe. However, at least a 20cm telescope, under “dark skies”, is needed to glimpse these distant bodies. The inner

satellites, I and II, are very difficult to observe. Even with today’s “hunger” for aperture, they would still be a real test for a 40cm telescope. The orbits of the satellites are currently face-on and nearly circular as seen from Earth. The orbits’ apparent minor axis (running east/west) is 83% that of the apparent major axis (north/south). For example, Oberon, at opposition, has a maximum elongation of $44''$ (see p. 67). It’s minimum elongation would be 83% of this or $36''$. The greatest northern elongation’s position angle is 10° (ie 10° towards the east). To locate the approximate position angle (degrees east of north) for a satellite, at your time of observation:

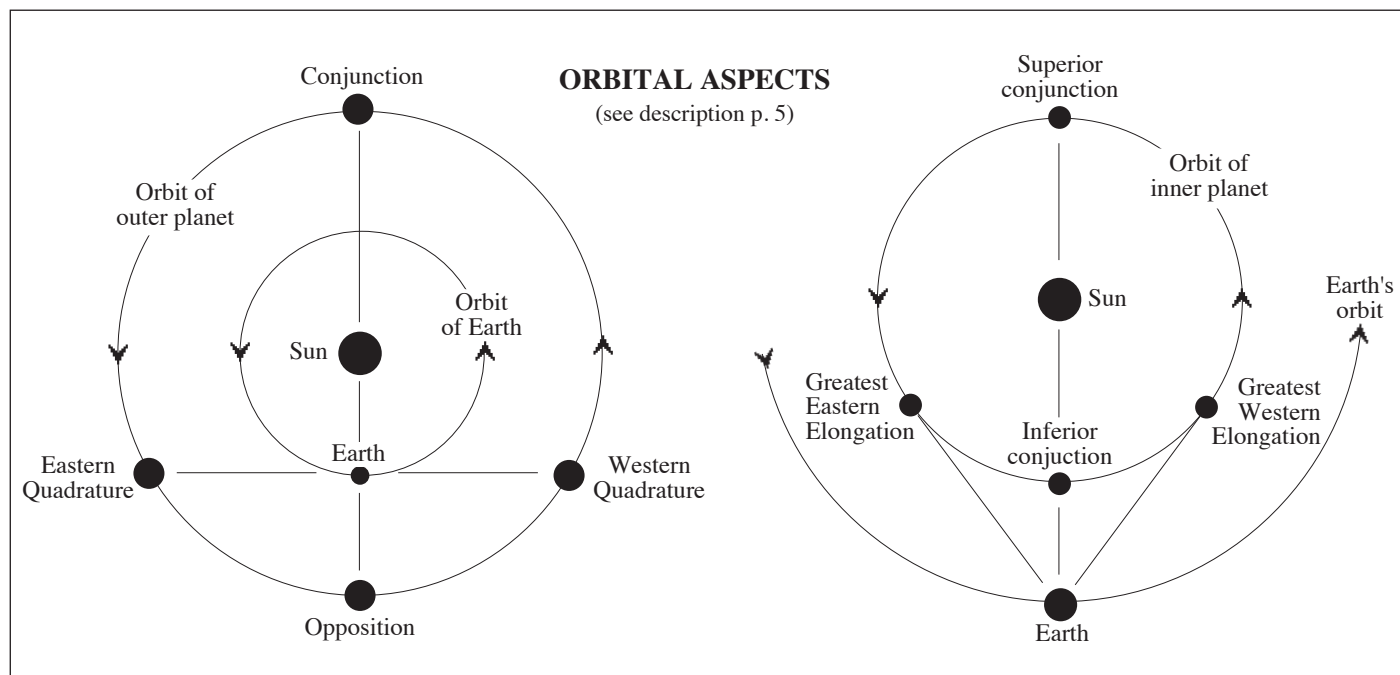
- 1) Work out how long since the satellite’s most recent greatest northern elongation.
- 2) Express this as a fraction of the sidereal orbital period. Satellites II, III, and IV have periods of 4.14, 8.71 and 13.46 days respectively.
- 3) Multiply the result by 360° and add 10° .

SATELLITES OF NEPTUNE (see p.99)

With typical amateur telescopes, Triton (I) is the only observable moon. To find Triton, the same approach as described above for the satellites of Uranus is used. Except in this case, the apparent major axis is in the east/west direction. The greatest eastern elongation is actually 13° towards the south, from east, at position angle 103° . Like Uranus, the orbits of the Neptunian satellites are currently, relatively open or “face-on”. In 1993, Triton’s apparent orbit as seen from Earth is a pronounced ellipse (not as circular as Uranus’ satellites) with the minor axis being 74% of the major axis. Therefore Triton, at opposition, varies from $17''$ (see p. 67) 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 in step 3 add 103° (not 10°).

PLUTO (see p. 100)

The finder chart shows stars down to magnitude 14.5. This is necessary to pick out the faint star-like image of Pluto (magnitude 13.7) from the other numerous faint stars in the field. The commonly available star atlases do not include stars down to anywhere near this magnitude limit (or faintness). To create the



main finder chart, the authors “constructed” this field from data in the “Hubble (space telescope) Guide Star Catalogue”. This is the most complete catalogue of stars available. It covers some 19 million stars and deep sky objects!

MINOR PLANETS (see pp. 102 and 103)

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 4600 such bodies catalogued! Their sizes vary from around a thousand kilometres down to a few hundred metres. Most of these orbit 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 them, at least twice, over a number of days and detecting them as they move against the distant star field. Only about 60 of these bodies can be considered to be bright (by amateur standards) and only then around their time of opposition. The ephemerides are for 20 of the minor planets, returning to opposition during 1993, that are expected to reach magnitude 10 or brighter.

CONJUNCTIONS, OPPOSITIONS AND ELONGATIONS.

A conjunction of two objects is when they make their closest approach to each other as seen from Earth ie minimum angular separation. It is common to hear this word in reference to a planet and the Sun (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. Inferior planets (ie. the inner planets, Mercury and Venus, can never reach opposition).

Elongation is often used in reference to the inner planets and their greatest angular distance from the Sun ie. greatest western elongation (visible in the eastern morning sky just before sunrise) and eastern elongation (a western evening sky object just after sunset).

See orbital aspects diagrams to the left.

RETROGRADE MOTION

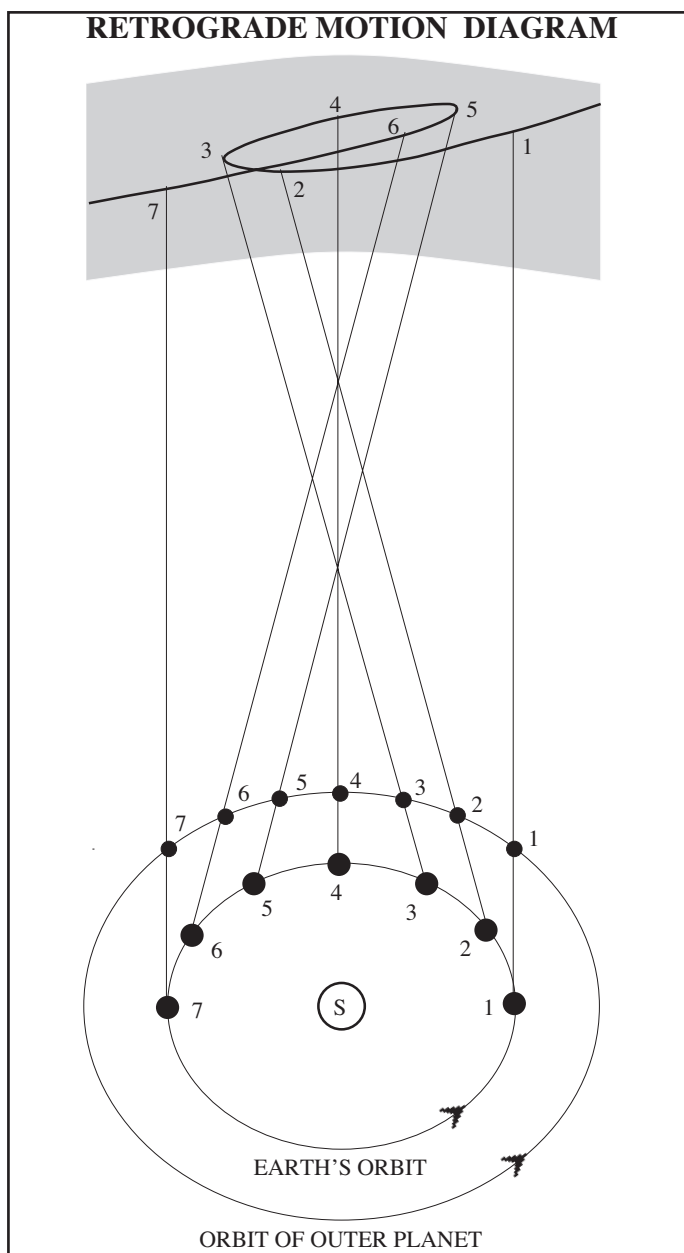
The finder charts, for the outer planets, have one thing in common - an apparent motion with a “loop” shape. This puzzled astronomers for centuries until it was finally recognised the Earth orbited the Sun just like any of the other “wanderers” (planets). Unfortunately the Earth was no longer the centre of the Universe. The following illustrates the combined effects of the orbital motions of Earth and Mars to explain this “loop”. In the diagram (below) the shaded area represents the path of Mars against the celestial sphere. For clarity the orbits of both planets are exaggerated and are not to scale.

As the Earth moves around the Sun faster than Mars and the other outer planets it overtakes them; the effect is this loop or 'S-bend' in the apparent path against the celestial sphere. This reversal in the planets motion is known as retrograde motion, and at this time the planet moves from east to west instead of from west to east.

The diagram shows the approximate positions of Mars and Earth at monthly intervals from October 1992 (1) through to April 1993 (7). At position 1 and 2, Mars continues on its west to east path and begins to slow at 3 as the Earth catches up. Between 3 and 5 Mars is in retrograde motion, moving east to west and is at opposition (in line with the Earth and the Sun) at 4. After 5, as the Earth passes the slower planet it rapidly continues on its west to east direction.

Because of the inclination of the Martian orbit to the Earth's ($1^{\circ}51'$), the apparent path of Mars can never be a straight line; the

planet's motion will appear as an 'S-bend' if it is near one of its nodes (the points where a planet crosses the plane of the Earth's orbit), or a loop (as in the January 1993 opposition) when distant from the nodes.



SOLAR SYSTEM DATA — THE PLANETS

NAME	MEAN DISTANCE FROM SUN (x 10 ³ km) (Earth = 1)		MAG at OPP	EQUATORIAL DIAMETER (km).	FLATTENING ¹	No of MOONS	MASS (x10 ²⁴ kg) (Earth = 1)	
Sun	-		-26.8	1392530	0	-	1989085	332946
Moon	-		-12.74 ¹¹	3475	0	-	0.073483	0.0123
Mercury	57856	0.387	0.16 ¹²	4879	0	0	0.33022	0.055
Venus	108132	0.723	-4.07 ¹²	12104	0	0	4.8690	0.816
Earth	149492	1.000	-3.5 ¹³	12756	0.00335364	1	5.9742	1.000
Mars	227780	1.524	-2.01	6794	0.006476	2	0.64191	0.107
Jupiter	777776	5.203	-2.70	142984	0.064874	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.

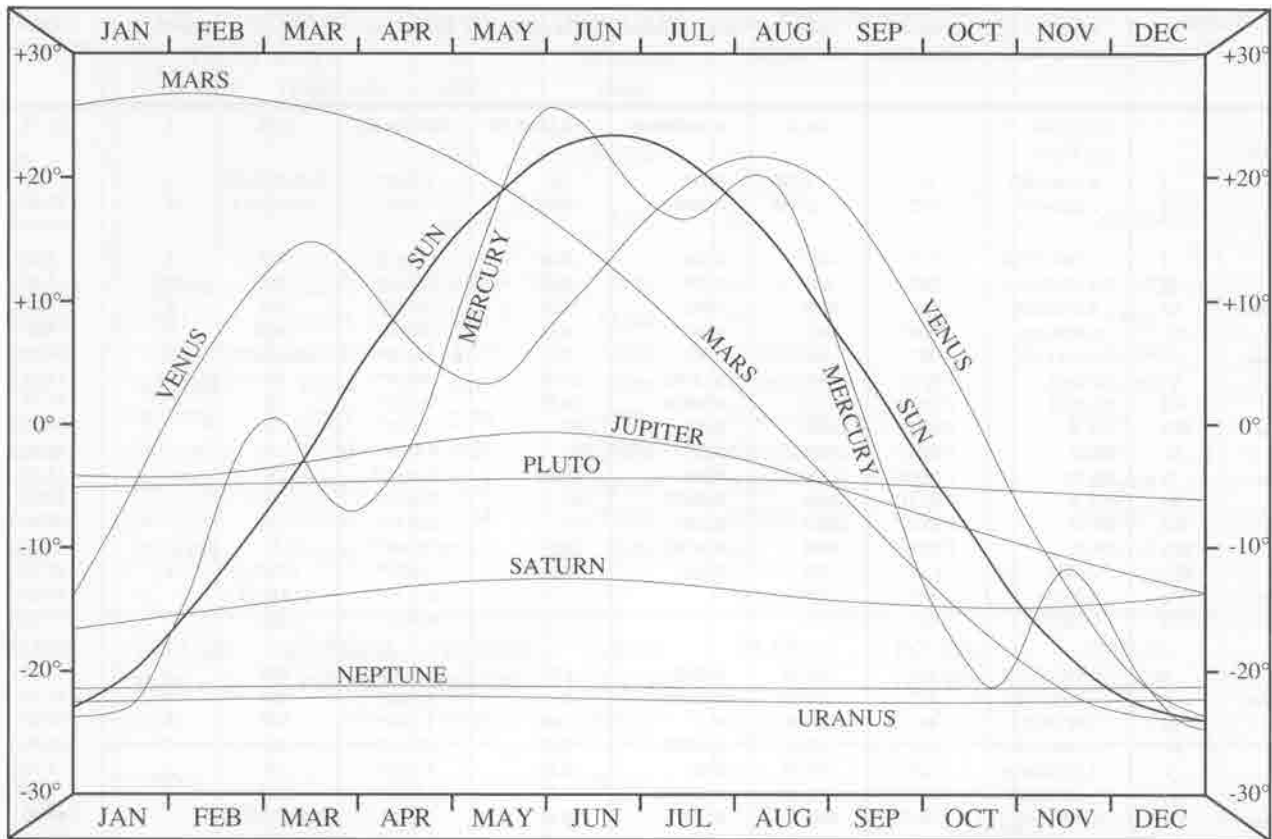
SOLAR SYSTEM DATA — SATELLITES

PLANET	SATELLITE	ORBITAL PERIOD (days) (R=retrograde)	MAX. ELONG AT MEAN OPPOSITION	SEMI-MAJOR 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										
	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
	Amalthea	V 0.49817905	0' 59"	181	0.003	0.40	38x10 ⁻¹⁰	131x73x67	S	14.1
	Himalia	VI 250.5662	1° 02' 46"	11480	0.15798	27.63	50x10 ⁻¹⁰	85	0.4	14.84
	Elara VII	259.6528 1° 04' 10"	11737	0.20719	24.77	4x10 ⁻¹⁰	40		16.77	
	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
	Lysithea	X 259.22	1° 04' 04"	11720	0.107	29.02	0.4x10 ⁻¹⁰	12	0.533	18.4
	Carme	XI 692. R	2° 03' 31"	22600	0.20678	164	0.5x10 ⁻¹⁰	15	0.433	18.0
	Ananke	XII 631. R	1° 55' 52"	21200	0.16870	147	0.2x10 ⁻¹⁰	10	0.35	18.9
	Leda XIII	238.72 1° 00' 39"	11094	0.14762	26.07	0.03x10 ⁻¹⁰	5		20.2	
	Thebe	XIV 0.6745	1' 13"	222	0.015	0.8	4x10 ⁻¹⁰	55x45	S	15.7
	Adrastea	XV 0.29826	0' 42"	129			0.1x10 ⁻¹⁰	13x10x8	S	19.1
	Metis	XVI 0.294780	0' 42"	128			0.5x10 ⁻¹⁰	20	S	17.5
Saturn										
	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
	Tethys	III 1.887802160	0' 48"	294.66	0.00000	1.86	1.10x10 ⁻⁶	536x528x526	S	10.2
	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
	Janus	X 0.6945	0' 24"	151.472	0.007	0.14	3.38x10 ⁻⁹	97x95x77	S	14
	Epimetheus	XI 0.6942	0' 24"	151.422	0.009	0.34	9.5x10 ⁻¹⁰	69x55x55	S	15
	Helene	XII 2.7369	1' 01"	377.40	0.005	0.0		18x16x15		18
	Telesto	XIII 1.8878	0' 48"	294.66				15x12.5x7.5		18.5
	Calypso	XIV 1.8878	0' 48"	294.66				15x8x8		18.7
	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
	Pan XVIII	0.5750 0' 21"	133.583				10			Uranus
	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
	Miranda	V 1.41347925	0' 10"	129.39	0.0027	4.2	0.08x10 ⁻⁵	240x234x233	S	16.3
	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	
	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										
	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
	Naiaid	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
Pluto										
	Charon	I 6.38725	<1"	19.6	<0.001	99 ³	0.125	593	S	16.8

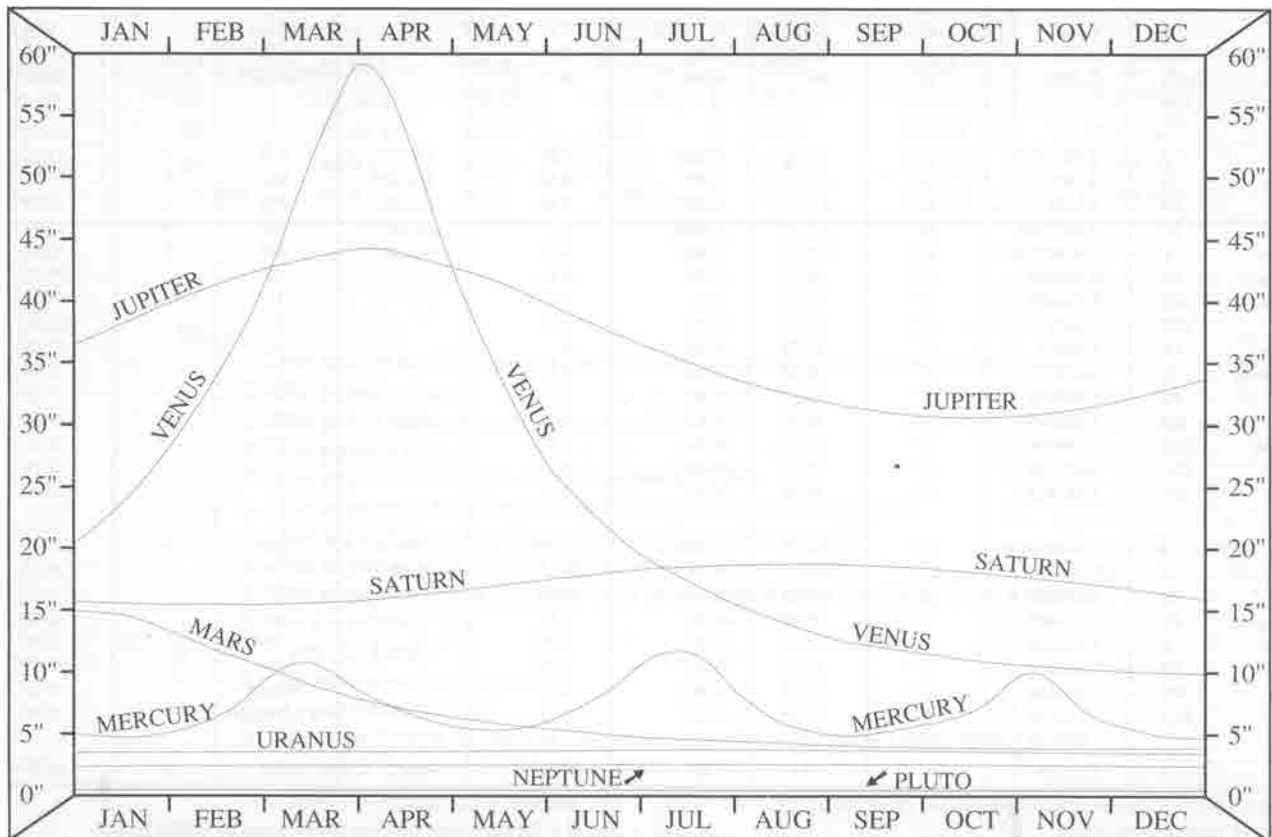
Notes: 1 - Sidereal periods, except tropical periods are given for Saturn. 2 - Relative to the ecliptic plane. 3 - Referred to the equator of 1950.0

4 - S = Synchronous, rotation period same as orbital period. i.e., keeps the same section of its surface facing its planet.

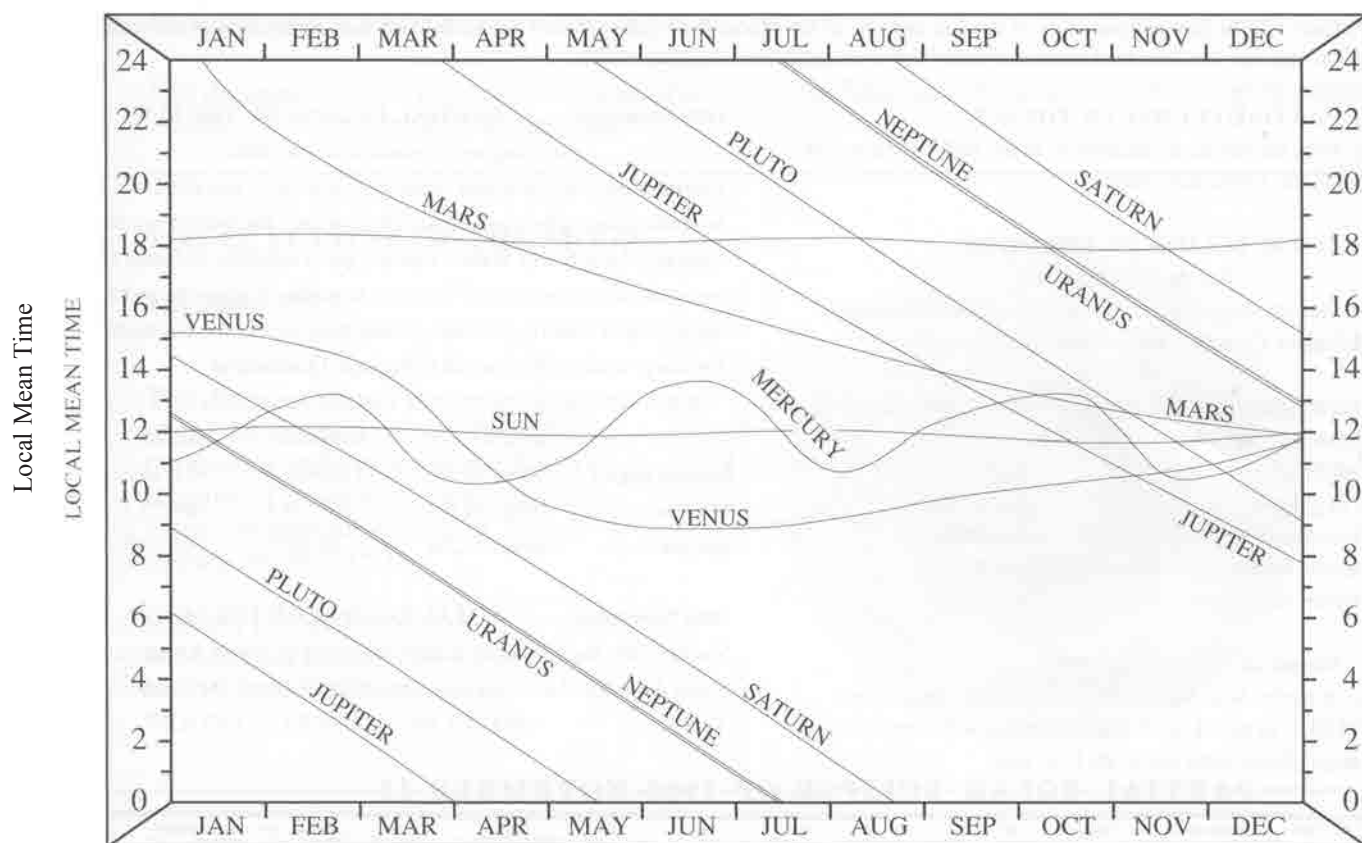
DECLINATIONS of the SUN and PLANETS



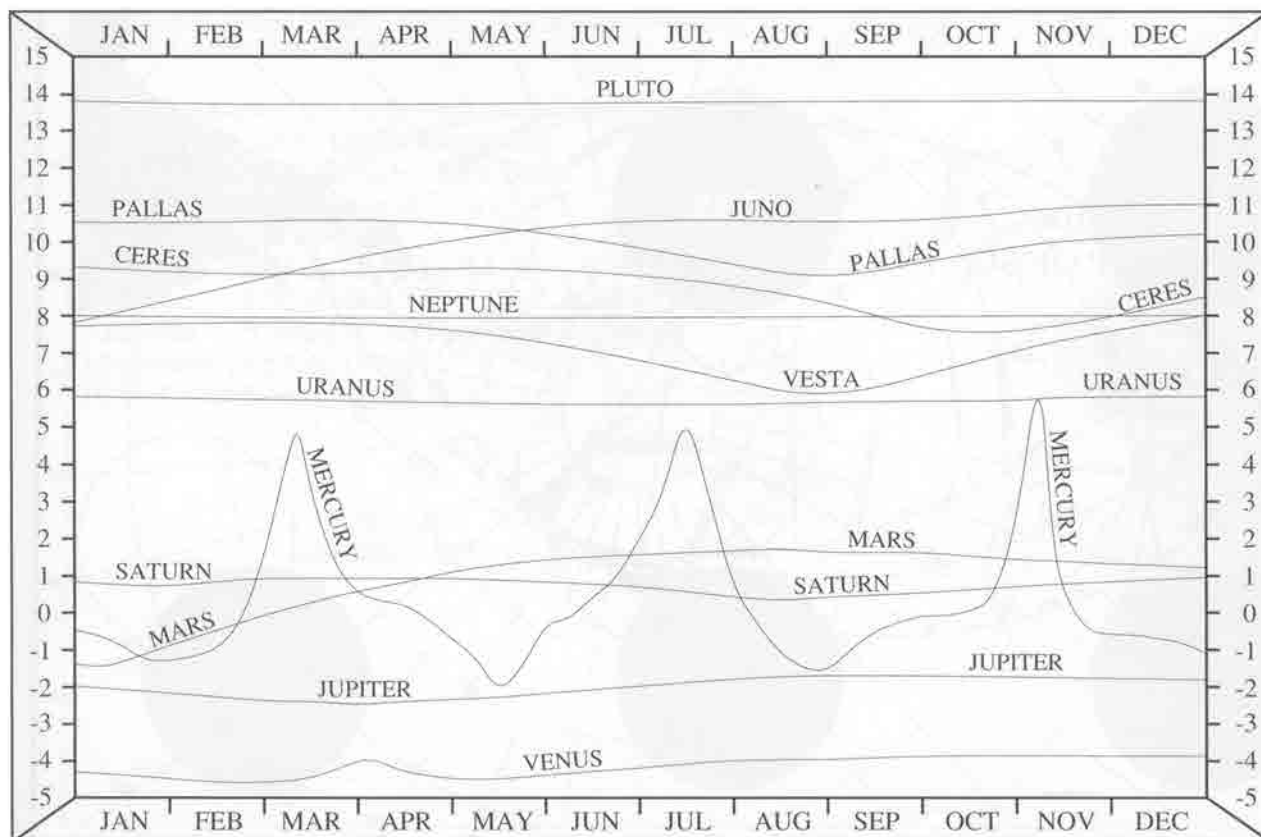
PLANETARY ANGULAR SIZE



MERIDIAN PASSAGE of the SUN and PLANETS



MAGNITUDES of the PLANETS and MAJOR ASTEROIDS



ECLIPSES

During 1993 there will be four eclipses, two of the Sun and two of the Moon. Both solar eclipses are partial, and both lunar eclipses are total. From Australia, only the 4th June total lunar and the 14th November partial solar are visible.

21st May PARTIAL ECLIPSE OF THE SUN

Visible only from the northern hemisphere as the path travels across North America, the Arctic and Europe.

4th June TOTAL ECLIPSE OF THE MOON

(See diagram opposite)

Visible from eastern Asia, Australia, Antarctica, Hawaiian Islands and parts of Alaska, Canada, United States and Mexico.

Moon enters penumbra	June 4	20hrs 10.8m	E.A.S.T.
Moon enters umbra		21hrs 11.2m	
Moon enters totality		22hrs 12.2m	
Middle of eclipse		23hrs 00.5m	
Moon leaves totality		23hrs 48.7m	
Moon leaves umbra	June 5	00hrs 49.7m	
Moon leaves penumbra		01hrs 50.2m	

Magnitude of eclipse = 1.567

First contact of umbra with limb of Moon in position angle (from north point) 100.5° to east. Last contact of umbra with limb of Moon in position angle (from north point) 98.1° to west.

14th November PARTIAL ECLIPSE OF THE SUN

(See diagram opposite and map below)

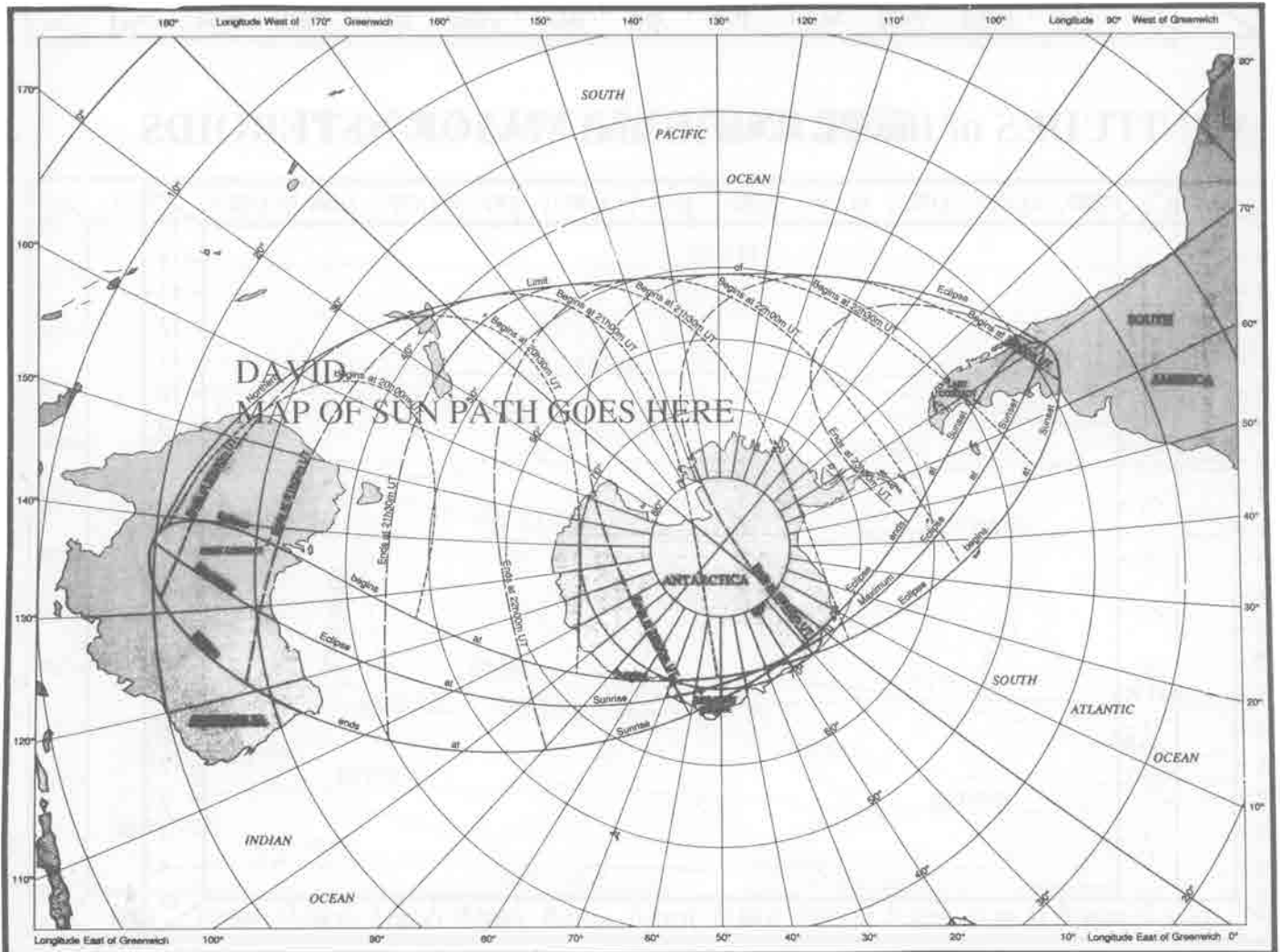
Visible from south of South America, Antarctica, and parts of Australia. The eclipse will be visible from any location in South Australia, New South Wales, Victoria and Tasmania, and only from the south eastern portion of Western Australia (Kalgoorlie and the south Gibson Desert), latitudes greater than 20°s in the Northern Territory, south of Mt Isa and Gympie in Queensland.

	E.A.S.T.	longitude	latitude
Eclipse begins	05hrs 46.4m	+138°01.5'	-31°16.5'
Greatest eclipse	07hrs 44.9m	+58°10.1'	-69°35.2'
Eclipse ends	09hrs 43.2m	-67°45.2'	-48°43.9'

29th November TOTAL ECLIPSE OF THE MOON

Visible from the Hawaiian Islands, North and Central America, South America, Arctic regions, Greenland, Europe and western Africa.

PARTIAL SOLAR ECLIPSE OF 1993 NOVEMBER 13



ECLIPSES

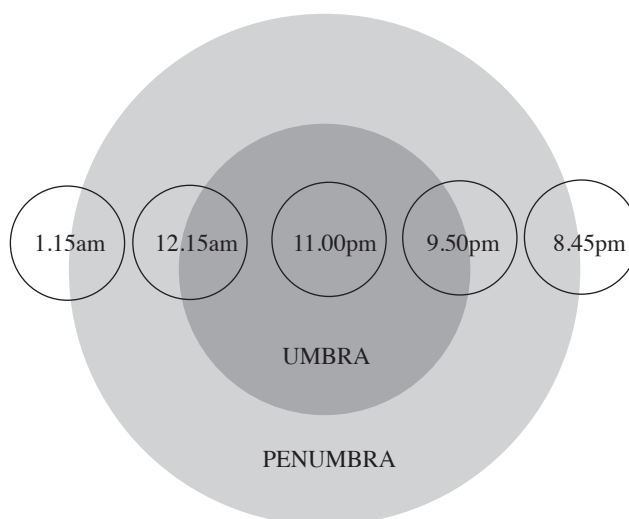
The diagrams below represent the appearances of the June total lunar and the November partial eclipses, for the locations as detailed.

TOTAL ECLIPSE OF THE MOON

4th June 1993

The diagram shows the general appearance of the Moon as it passes through the penumbra and umbra of the Earth's shadow. The view is essentially the same throughout Australia. Times shown are in EAST.

UMBRA DIAMETER = $1^{\circ}26'$
 PENUMBRA DIAMETER = $2^{\circ}30'$
 MOON DIAMETER = $0^{\circ}32'$
 MOON DISTANCE = 364,100 kms



PARTIAL ECLIPSE OF THE SUN

14th November 1993

The diagrams illustrate the views at greatest (mid) eclipse from various Australian capital cities.

At each location the following approximate times for the beginning of the eclipse and altitude of the Sun above the horizon are as follows;

Brisbane	6.03am (EAST)	$14^{\circ}50'$
Sydney	5.52am (EAST)	$12^{\circ}30'$
Adelaide	5.20am (CAST)	$2^{\circ}30'$
Melbourne	5.51am (EAST)	$8^{\circ}30'$
Hobart	5.55am (EAST)	$12^{\circ}20'$



SUN

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	18 46 29		- 23 00 36	20 58 49		- 17 07 40	22 48 03		- 07 37 31	00 41 50		+ 04 29 58	02 33 14		+ 15 02 38	04 36 04		+ 22 02 20
2	18 50 54		- 22 55 29	21 02 53		- 16 50 28	22 51 48		- 07 14 41	00 45 28		+ 04 53 05	02 37 04		+ 15 20 41	04 40 10		+ 22 10 20
3	18 55 18		- 22 49 53	21 06 56		- 16 33 00	22 55 32		- 06 51 45	00 49 07		+ 05 16 06	02 40 54		+ 15 38 29	04 44 16		+ 22 17 57
4	18 59 42		- 22 43 51	21 10 59		- 16 15 14	22 59 16		- 06 28 43	00 52 46		+ 05 39 02	02 44 44		+ 15 56 01	04 48 23		+ 22 25 10
5	19 04 06		- 22 37 22	21 15 01		- 15 57 11	23 02 59		- 06 05 35	00 56 25		+ 06 01 52	02 48 35		+ 16 13 18	04 52 29		+ 22 32 00
6	19 08 29		- 22 30 26	21 19 02		- 15 38 52	23 06 42		- 05 42 23	01 00 04		+ 06 24 36	02 52 27		+ 16 30 18	04 56 37		+ 22 38 26
7	1/1/1904	1/1/1904		21 23 02		- 15 20 17	23 10 24		- 05 19 06	01 03 44		+ 06 47 13	02 56 19		+ 16 47 01	05 00 44		+ 22 44 28
8	1/1/1904	1/1/1904		21 27 01		- 15 01 26	23 14 06		- 04 55 45	01 07 23		+ 07 09 44	03 00 12		+ 17 03 28	05 04 52		+ 22 50 07
9	19 21 35		- 22 06 59	21 31 00		- 14 42 20	23 17 48		- 04 32 20	01 11 03		+ 07 32 07	03 04 05		+ 17 19 38	05 09 00		+ 22 55 21
10	19 25 56		- 21 58 18	21 34 57		- 14 22 59	23 21 29		- 04 08 52	01 14 43		+ 07 54 22	03 07 59		+ 17 35 31	05 13 08		+ 23 00 11
11	19 30 17		- 21 49 11	21 38 55		- 14 03 24	23 25 10		- 03 45 20	01 18 24		+ 08 16 30	03 11 53		+ 17 51 06	05 17 17		+ 23 04 37
12	19 34 37		- 21 39 38	21 42 51		- 13 43 35	23 28 51		- 03 21 46	01 22 05		+ 08 38 29	03 15 48		+ 18 06 23	05 21 25		+ 23 08 38
13	19 38 56		- 21 29 41	21 46 46		- 13 23 31	23 32 31		- 02 58 09	01 25 46		+ 09 00 20	03 19 44		+ 18 21 22	05 25 34		+ 23 12 15
14	19 43 15		- 21 19 18	21 50 41		- 13 03 15	23 36 11		- 02 34 30	01 29 27		+ 09 22 02	03 23 40		+ 18 36 03	05 29 43		+ 23 15 28
15	19 47 33		- 21 08 31	21 54 35		- 12 42 46	23 39 51		- 02 10 49	01 33 09		+ 09 43 35	03 27 37		+ 18 50 24	05 33 53		+ 23 18 16
16	19 51 50		- 20 57 19	21 58 29		- 12 22 04	23 43 31		- 01 47 07	01 36 51		+ 10 04 58	03 31 34		+ 19 04 27	05 38 02		+ 23 20 39
17	19 56 07		- 20 45 43	22 02 21		- 12 01 11	23 47 10		- 01 23 24	01 40 33		+ 10 26 11	03 35 32		+ 19 18 10	05 42 12		+ 23 22 37
18	20 00 23		- 20 33 43	22 06 13		- 11 40 06	23 50 49		- 00 59 40	01 44 16		+ 10 47 14	03 39 31		+ 19 31 34	05 46 21		+ 23 24 11
19	20 04 39		- 20 21 20	22 10 05		- 11 18 50	23 54 28		- 00 35 56	01 48 00		+ 11 08 06	03 43 30		+ 19 44 37	05 50 31		+ 23 25 20
20	20 08 53		- 20 08 34	22 13 55		- 10 57 23	23 58 07		- 00 12 13	01 51 43		+ 11 28 47	03 47 29		+ 19 57 21	05 54 41		+ 23 26 04
21	20 13 07		- 19 55 26	22 17 45		- 10 35 46	00 01 46		+ 00 11 30	01 55 27		+ 11 49 17	03 51 30		+ 20 09 44	05 58 51		+ 23 26 23
22	20 17 21		- 19 41 54	22 21 35		- 10 13 59	00 05 25		+ 00 35 12	01 59 12		+ 12 09 36	03 55 30		+ 20 21 46	06 03 00		+ 23 26 17
23	20 21 33		- 19 28 01	22 25 23		- 09 52 02	00 09 03		+ 00 58 53	02 02 57		+ 12 29 42	03 59 32		+ 20 33 28	06 07 10		+ 23 25 47
24	20 25 45		- 19 13 47	22 29 12		- 09 29 57	00 12 42		+ 01 22 32	02 06 43		+ 12 49 36	04 03 33		+ 20 44 48	06 11 19		+ 23 24 52
25	20 29 55		- 18 59 11	22 32 59		- 09 07 43	00 16 20		+ 01 46 09	02 10 28		+ 13 09 17	04 07 36		+ 20 55 47	06 15 29		+ 23 23 32
26	20 34 06		- 18 44 14	22 36 46		- 08 45 22	00 19 59		+ 02 09 43	02 14 15		+ 13 28 45	04 11 38		+ 21 06 24	06 19 38		+ 23 21 47
27	20 38 15		- 18 28 57	22 40 32		- 08 22 52	00 23 37		+ 02 33 15	02 18 02		+ 13 48 00	04 15 42		+ 21 16 39	06 23 47		+ 23 19 38
28	20 42 23		- 18 13 20	22 44 18		- 08 00 15	00 27 16		+ 02 56 43	02 21 49		+ 14 07 01	04 19 45		+ 21 26 32	06 27 56		+ 23 17 04
29	20 46 31		- 17 57 23				00 30 54		+ 03 20 08	02 25 37		+ 14 25 48	04 23 49		+ 21 36 03	06 32 05		+ 23 14 06
30	20 50 38		- 17 41 07				00 34 33		+ 03 43 29	02 29 25		+ 14 44 20	04 27 54		+ 21 45 12	06 36 13		+ 23 10 44
31	20 54 44		- 17 24 33				00 38 11		+ 04 06 46				04 31 59		+ 21 53 57			
	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
1	06 40 22		+ 23 06 57	08 45 09		+ 18 02 43	10 41 08		+ 08 19 17	12 29 06		- 03 08 30	14 25 09		- 14 23 29	16 28 44		- 21 47 01
2	06 44 30		+ 23 02 46	08 49 01		+ 17 47 30	10 44 46		+ 07 57 29	12 32 43		- 03 31 46	14 29 04		- 14 42 37	16 33 03		- 21 56 11
3	06 48 37		+ 22 58 11	08 52 53		+ 17 32 01	10 48 23		+ 07 35 33	12 36 20		- 03 54 58	14 33 00		- 15 01 30	16 37 22		- 22 04 56
4	06 52 45		+ 22 53 11	08 56 45		+ 17 16 14	10 52 00		+ 07 13 30	12 39 58		- 04 18 09	14 36 57		- 15 20 09	16 41 43		- 22 13 15
5	06 56 52		+ 22 47 48	09 00 36		+ 17 00 10	10 55 36		+ 06 51 20	12 43 36		- 04 41 16	14 40 54		- 15 38 33	16 46 04		- 22 21 09
6	07 00 59		+ 22 42 01	09 04 26		+ 16 43 50	10 59 13		+ 06 29 03	12 47 15		- 05 04 20	14 44 53		- 15 56 41	16 50 25		- 22 28 37
7	07 05 05		+ 22 35 51	09 08 16		+ 16 27 14	11 02 49		+ 06 06 40	12 50 54		- 05 27 20	14 48 52		- 16 14 33	16 54 47		- 22 35 38
8	07 09 11		+ 22 29 17	09 12 05		+ 16 10 21	11 06 25		+ 05 44 10	12 54 33		- 05 50 16	14 52 52		- 16 32 09	16 59 10		- 22 42 13
9	07 13 17		+ 22 22 19	09 15 53		+ 15 53 13	11 10 01		+ 05 21 35	12 58 13		- 06 13 07	14 56 53		- 16 49 29	17 03 33		- 22 48 21
10	07 17 22		+ 22 14 59	09 19 41		+ 15 35 50	11 13 37		+ 04 58 54	13 01 54		- 06 35 54	15 00 55		- 17 06 31	17 07 56		- 22 54 02
11	07 21 27		+ 22 07 15	09 23 28		+ 15 18 11	11 17 12		+ 04 36 07	13 05 34		- 06 58 36	15 04 58		- 17 23 16	17 12 20		- 22 59 16
12	07 25 31		+ 21 59 08	09 27 15		+ 15 00 18	11 20 48		+ 04 13 16	13 09 16		- 07 21 12	15 09 01		- 17 39 43	17 16 44		- 23 04 03
13	07 29 35		+ 21 50 39	09 31 01		+ 14 42 10	11 24 23		+ 03 50 21	13 12 58		- 07 43 42	15 13 06		- 17 55 52	17 21 09		- 23 08 23
14	07 33 39		+ 21 41 47	09 34 47		+ 14 23 48	11 27 58		+ 03 27 21	13 16 40		- 08 06 05	15 17 11		- 18 11 42	17 25 34		- 23 12 14
15	07 37 42		+ 21 32 33	09 38 32		+ 14 05 13	11 31 34		+ 03 04 17	13 20 23		- 08 28 22	15 21 17		- 18 27 13	17 30 00		- 23 15 38
16	07 41 44		+ 21 22 57	09 42 17		+ 13 46 24	11 35 09		+ 02 41 10	13 24 06		- 08 50 32	15 25 24		- 18 42 24	17 34 25		- 23 18 35
17	07 45 46		+ 21 12 59	09 46 01		+ 13 27 21	11 38 44		+ 02 18 00	13 27 50		- 09 12 34	15 29 32		- 18 57 15	17 38 51		- 23 21 03
18	07 49 48		+ 21 02 40	09 49 45		+ 13 08 06	11 42 19		+ 01 54 47	13 31 35		- 09 34 28	15 33 41		- 19 11 47	17 43 17		- 23 23 03
19	07 53 49		+ 20 51 59	09 53 28		+ 12 48 39	11 45 55		+ 01 31 32	13 35 20		- 09 56 14	15 37 50		- 19 25 57	17 47 43		- 23 24 35
20	07 57 49		+ 20 40 57	09 57 11		+ 12 28 59	11 49 30		+ 01 08 15	13 39 06		- 10 17 51	15 42 01		- 19td			

SUN — RISE, SET (for Sydney, E.A.S.T.)and ORIENTATION

DATE		SUN SET h m	TWILIGHT ENDS h m	TWILIGHT BEGINS h m	SUN RISE h m	P°	B ₀ °	L ₀ °
Jan	2	19:10	20:53	03:05	04:48	+ 1.54	- 3.16	250.98
	9	19:10	20:52	03:12	04:54	- 1.84	- 3.95	158.79
	16	19:09	20:48	03:20	05:00	- 5.16	- 4.67	066.62
	23	19:06	20:43	03:29	05:07	- 8.35	- 5.32	334.45
	30	19:02	20:37	03:39	05:14	- 11.37	- 5.89	242.29
Feb	6	18:57	20:29	03:48	05:21	- 14.18	- 6.37	150.12
	13	18:50	20:20	03:57	05:28	- 16.74	- 6.75	057.95
	20	18:43	20:11	04:06	05:35	- 19.03	- 7.03	325.77
	27	18:34	20:01	04:14	05:41	- 21.03	- 7.19	233.58
Mar	6	18:25	19:51	04:21	05:47	- 22.73	- 7.25	141.36
	13	18:16	19:40	04:28	05:52	- 24.11	- 7.20	049.12
	20	18:07	19:30	04:34	05:58	- 25.17	- 7.04	316.85
	27	17:57	19:20	04:40	06:03	- 25.88	- 6.78	224.55
Apr	3	17:48	19:11	04:45	06:08	- 26.25	- 6.42	132.21
	10	17:39	19:02	04:51	06:14	- 26.27	- 5.97	039.83
	17	17:30	18:53	04:55	06:19	- 25.92	- 5.44	307.41
	24	17:22	18:46	05:00	06:24	- 25.22	- 4.83	214.96
May	1	17:14	18:39	05:05	06:29	- 24.16	- 4.16	122.46
	8	17:08	18:34	05:09	06:35	- 22.74	- 3.43	029.93
	15	17:02	18:29	05:13	06:40	- 20.99	- 2.65	297.36
	22	16:58	18:25	05:17	06:45	- 18.91	- 1.84	204.77
Jun	5	16:55	18:23	05:21	06:49	- 16.54	- 1.01	112.16
	12	16:53	18:22	05:25	06:54	- 13.92	- 0.17	019.52
	19	16:52	18:22	05:28	06:57	- 11.08	+ 0.68	286.87
	26	16:53	18:23	05:30	06:59	- 8.08	+ 1.51	194.21
Jul	3	16:55	18:24	05:31	07:01	- 4.96	+ 2.32	101.56
	10	16:58	18:27	05:32	07:01	- 1.79	+ 3.10	008.90
	17	17:01	18:30	05:31	07:00	+ 1.38	+ 3.84	276.25
	24	17:05	18:33	05:29	06:57	+ 4.50	+ 4.53	183.62
Aug	31	17:10	18:37	05:26	06:54	+ 7.53	+ 5.16	091.01
	7	17:14	18:41	05:22	06:49	+ 10.42	+ 5.72	358.41
	14	17:19	18:45	05:17	06:43	+ 13.14	+ 6.20	265.84
	21	17:24	18:49	05:11	06:36	+ 15.66	+ 6.60	173.30
Sep	28	17:29	18:53	05:04	06:28	+ 17.96	+ 6.91	080.78
	4	17:34	18:57	04:56	06:19	+ 20.02	+ 7.12	348.29
	11	17:39	19:02	04:47	06:10	+ 21.81	+ 7.23	255.82
	18	17:44	19:06	04:38	06:00	+ 23.33	+ 7.24	163.38
Oct	25	17:48	19:11	04:28	05:51	+ 24.55	+ 7.15	070.96
	2	17:53	19:17	04:18	05:41	+ 25.47	+ 6.96	338.57
	9	17:58	19:23	04:07	05:31	+ 26.05	+ 6.67	246.19
	16	18:03	19:29	03:57	05:22	+ 26.30	+ 6.27	153.83
Nov	23	18:09	19:36	03:46	05:13	+ 26.18	+ 5.79	061.49
	30	18:15	19:44	03:36	05:05	+ 25.70	+ 5.22	329.16
	6	18:21	19:52	03:26	04:57	+ 24.83	+ 4.57	236.85
	13	18:27	20:01	03:18	04:50	+ 23.59	+ 3.85	144.55
Dec	20	18:34	20:10	03:10	04:45	+ 21.95	+ 3.07	052.26
	27	18:41	20:19	03:03	04:41	+ 19.95	+ 2.24	319.98
	4	18:47	20:28	02:58	04:38	+ 17.60	+ 1.37	227.72
	11	18:54	20:36	02:55	04:37	+ 14.93	+ 0.48	135.46
Jan	18	18:59	20:43	02:54	04:37	+ 11.99	- 0.41	043.23
	25	19:04	20:48	02:55	04:39	+ 8.83	- 1.30	311.00
	1	19:07	20:52	02:58	04:43	+ 5.53	- 2.18	218.79

VARIATION OF L ₀	
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		
1865	Jan	21.06
1866	Feb	17.40
1867	Mar	16.73
1868	Apr	13.02
1869	May	10.27
1870	Jun	6.48
1871	Jul	3.67
1872	Jul	30.88
1873	Aug	27.12
1874	Sep	23.38
1875	Oct	20.66
1876	Nov	16.97
1877	Dec	14.28
1878	Jan '94	10.61

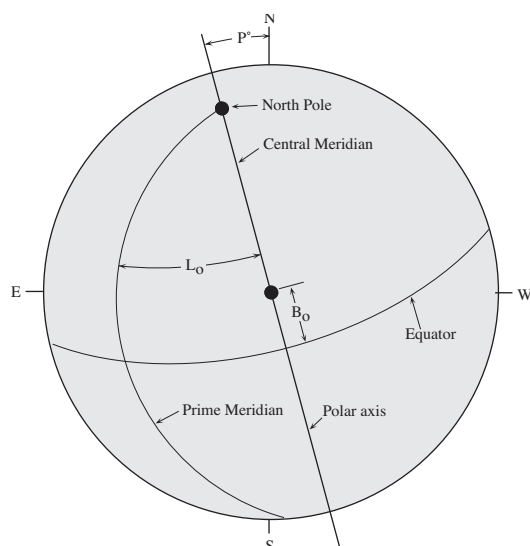
At the date of commencement of each synodic rotation period the value of L₀ is zero; that is, the prime meridian passes through the central point of the disk.

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

B₀° Heliocentric Latitude of centre of Sun

L₀° Heliocentric Longitude of centre of Sun

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.



MOON

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	00 25 09	+ 08	10 35	03 24 28	+ 20	59 00	04 01 51	+ 21	58 06	07 32 04	+ 18	37 40	10 01 30	+ 06	40 51	13 22 26	- 12	56 13
2	01 11 02	+ 12	28 17	04 19 53	+ 22	38 07	04 57 23	+ 22	49 15	08 28 28	+ 14	58 50	10 55 08	+ 01	16 25	14 19 23	- 17	02 56
3	01 59 24	+ 16	20 32	05 18 06	+ 23	04 29	05 54 53	+ 22	26 11	09 24 19	+ 10	21 53	11 49 21	- 04	16 58	15 18 11	- 20	07 01
4	02 50 54	+ 19	34 31	06 18 10	+ 22	07 59	06 53 28	+ 20	43 24	10 19 48	+ 05	02 05	12 44 51	- 09	38 34	16 18 05	- 21	55 03
5	03 45 52	+ 21	55 12	07 18 52	+ 19	45 10	07 52 13	+ 17	41 34	11 15 22	- 00	41 05	13 42 06	- 14	26 18	17 17 50	- 22	20 52
6	04 44 05	+ 23	06 53	08 18 58	+ 16	01 45	08 50 29	+ 13	28 32	12 11 37	- 06	24 46	14 41 12	- 18	18 47	18 16 04	- 21	27 00
7	1/1/1904	1/1/1904		09 17 44	+ 11	12 28	09 47 57	+ 08	19 21	13 09 00	- 11	44 29	15 41 34	- 20	58 37	19 11 41	- 19	23 16
8	1/1/1904	1/1/1904		10 14 57	+ 05	38 53	10 44 46	+ 02	34 54	14 07 44	- 16	16 39	16 42 07	- 22	15 46	20 04 13	- 16	23 44
9	07 46 44	+ 18	12 57	11 10 56	- 00	14 08	11 41 18	- 03	20 13	15 07 33	- 19	41 47	17 41 27	- 22	09 29	20 53 42	- 12	43 15
10	08 45 43	+ 13	56 38	12 06 15	- 06	01 40	12 38 05	- 09	00 20	16 07 38	- 21	47 28	18 38 21	- 20	47 20	21 40 38	- 08	35 22
11	09 42 33	+ 08	48 25	13 01 29	- 11	21 13	13 35 28	- 14	01 33	17 06 52	- 22	30 01	19 32 08	- 18	22 13	22 25 44	- 04	11 32
12	10 37 28	+ 03	11 17	13 57 07	- 15	54 04	14 33 33	- 18	04 12	18 04 07	- 21	53 56	20 22 44	- 15	08 39	23 09 49	+ 00	18 44
13	11 31 05	- 02	32 09	14 53 18	- 19	25 59	15 32 00	- 20	54 45	18 58 37	- 20	09 26	21 10 31	- 11	20 17	23 53 44	+ 04	47 07
14	12 24 12	- 08	01 24	15 49 50	- 21	47 35	16 30 07	- 22	26 43	19 50 06	- 17	29 17	21 56 08	- 07	08 45	00 38 19	+ 09	05 34
15	13 17 34	- 12	58 42	16 46 10	- 22	54 36	17 27 01	- 22	40 33	20 38 47	- 14	06 23	22 40 25	- 02	43 51	01 24 24	+ 13	05 24
16	14 11 44	- 17	08 55	17 41 32	- 22	47 50	18 21 56	- 21	42 20	21 25 08	- 10	12 18	23 24 10	+ 01	45 52	02 12 37	+ 16	36 40
17	15 06 53	- 20	19 39	18 35 14	- 21	32 31	19 14 23	- 19	41 41	22 09 52	- 05	57 13	00 08 13	+ 06	12 15	03 03 27	+ 19	27 52
18	16 02 48	- 22	21 46	19 26 49	- 19	17 13	20 04 15	- 16	49 46	22 53 42	- 01	30 09	00 53 22	+ 10	26 41	03 57 02	+ 21	26 26
19	16 58 50	- 23	10 23	20 16 06	- 16	12 24	20 51 47	- 13	17 50	23 37 25	+ 03	00 20	01 40 18	+ 14	19 27	04 53 01	+ 22	20 22
20	17 54 08	- 22	45 37	21 03 15	- 12	29 08	21 37 25	- 09	16 29	00 21 43	+ 07	25 29	02 29 31	+ 17	39 24	05 50 32	+ 22	00 45
21	18 47 49	- 21	12 35	21 48 39	- 08	18 21	22 21 46	- 04	55 34	01 07 18	+ 11	35 49	03 21 18	+ 20	14 17	06 48 30	+ 20	24 15
22	19 39 20	- 18	40 26	22 32 51	- 03	50 23	23 05 29	- 00	24 24	01 54 43	+ 15	20 49	04 15 30	+ 21	51 52	07 45 49	+ 17	34 38
23	20 28 27	- 15	20 33	23 16 28	+ 00	44 58	23 49 14	+ 04	07 53	02 44 21	+ 18	29 02	05 11 30	+ 22	21 57	08 41 47	+ 13	42 12
24	21 15 22	- 11	24 59	00 00 10	+ 05	18 24	00 33 40	+ 08	31 57	03 36 19	+ 20	48 40	06 08 24	+ 21	38 32	09 36 15	+ 09	01 55
25	22 00 29	- 07	05 15	00 44 38	+ 09	40 39	01 19 24	+ 12	37 57	04 30 22	+ 22	08 49	07 05 08	+ 19	41 30	10 29 30	+ 03	51 03
26	22 44 24	- 02	31 49	01 30 32	+ 13	42 16	02 06 58	+ 16	15 27	05 25 53	+ 22	21 02	08 00 56	+ 16	36 41	11 22 09	- 01	32 22
27	23 27 51	+ 02	05 52	02 18 26	+ 17	13 07	02 56 42	+ 19	13 26	06 22 03	+ 21	21 00	08 55 25	+ 12	34 48	12 14 59	- 06	50 25
28	00 11 35	+ 06	39 02	03 08 49	+ 20	02 15	03 48 45	+ 21	20 48	07 18 04	+ 19	09 22	09 48 42	+ 07	49 35	13 08 46	- 11	45 27
29	00 56 24	+ 10	59 00				04 42 55	+ 22	27 14	08 13 21	+ 15	51 45	10 41 18	+ 02	36 36	14 04 02	- 16	00 20
30	01 43 03	+ 14	56 23				05 38 40	+ 22	24 31	09 07 46	+ 11	37 54	11 33 56	- 02	47 25	15 00 59	- 19	19 08
31	02 32 14	+ 18	20 31				06 35 18	+ 21	07 59				12 27 25	- 08	04 39			
	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
1	15 59 16	- 21	28 42	19 29 59	- 18	29 12	22 29 15	- 04	07 33	00 31 02	+ 07	50 38	03 29 28	+ 19	43 31	05 55 07	+ 21	08 01
2	16 58 00	- 22	20 59	20 21 08	- 15	18 45	23 13 40	+ 00	19 47	01 16 23	+ 11	46 44	04 21 20	+ 21	08 09	06 49 45	+ 19	37 51
3	17 56 02	- 21	54 47	21 09 49	- 11	30 22	23 57 50	+ 04	44 23	02 03 06	+ 15	15 36	05 14 31	+ 21	32 42	07 43 51	+ 17	04 45
4	18 52 13	- 20	15 59	21 56 26	- 07	16 52	00 42 23	+ 08	57 10	02 51 31	+ 18	07 49	06 08 25	+ 20	53 02	08 37 04	+ 13	36 11
5	19 45 47	- 17	35 55	22 41 33	- 02	49 49	01 27 54	+ 12	49 16	03 41 46	+ 20	14 09	07 02 25	+ 19	08 42	09 29 24	+ 09	22 34
6	20 36 31	- 14	08 37	23 25 49	+ 01	40 30	02 14 55	+ 16	11 44	04 33 45	+ 21	26 09	07 56 02	+ 16	23 00	10 21 13	+ 04	36 18
7	21 24 37	- 10	08 10	00 09 57	+ 06	04 56	03 03 50	+ 18	55 24	05 27 09	+ 21	37 00	08 49 09	+ 12	42 35	11 13 10	- 00	28 39
8	22 10 38	- 05	47 23	00 54 40	+ 10	14 58	03 54 51	+ 20	50 53	06 21 27	+ 20	42 21	09 41 55	+ 08	16 57	12 06 00	- 05	36 48
9	22 55 15	- 01	17 11	01 40 40	+ 14	02 04	04 47 55	+ 21	49 10	07 16 09	+ 18	41 10	10 34 48	+ 03	18 15	13 00 30	- 10	30 47
10	23 39 17	+ 03	13 08	02 28 32	+ 17	17 13	05 42 43	+ 21	42 29	08 10 52	+ 15	36 09	11 28 27	- 01	58 29	13 57 15	- 14	51 29
11	00 23 31	+ 07	35 13	03 18 43	+ 19	50 34	06 38 41	+ 20	25 40	09 05 27	+ 11	33 58	12 23 35	- 07	15 02	14 56 23	- 18	19 14
12	01 08 44	+ 11	40 53	04 11 25	+ 21	31 31	07 35 12	+ 17	57 36	10 00 04	+ 06	45 28	13 20 48	- 12	10 10	15 57 24	- 20	36 31
13	01 55 42	+ 15	21 17	05 06 28	+ 22	09 41	08 31 44	+ 14	22 19	10 55 06	+ 01	25 44	14 20 22	- 16	21 03	16 59 10	- 21	31 56
14	02 45 01	+ 18	26 23	06 03 19	+ 21	36 32	09 28 04	+ 09	49 36	11 51 05	- 04	05 49	15 21 54	- 19	26 25	18 00 07	- 21	03 11
15	03 37 01	+ 20	44 49	07 01 09	+ 19	47 37	10 24 14	+ 04	34 50	12 48 34	- 09	26 14	16 24 23	- 21	10 53	18 58 49	- 19	17 39
16	04 31 44	+ 22	04 34	07 59 06	+ 16	44 32	11 20 33	- 01	01 41	13 47 48	- 14	10 57	17 26 15	- 21	28 48	19 54 22	- 16	29 28
17	05 28 38	+ 22	14 49	08 56 30	+ 12	35 54	12 17 27	- 06	36 26	14 48 38	- 17	57 03	18 26 00	- 20	25 00	20 46 33	- 12	55 24
18	06 26 51	+ 21	08 30	09 53 05	+ 07	36 51	13 15 19	- 11	44 56	15 50 21	- 20	27 18	19 22 35	- 18	12 09	21 35 43	- 08	51 31
19	07 25 15	+ 18	44 52	10 48 58	+ 02	07 22	14 14 16	- 16	04 35	16 51 43	- 21	33 20	20 15 39	- 15	06 20	22 22 31	- 04	31 27
20	08 22 54	+ 15	10 39	11 44 34	- 03	29 58	15 14 01	- 19	17 36									

MOON RISE AND SET (for Sydney)

E.A.S.T.

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

MOON PHASES (E.A.S.T.)

Lunation	New Moon		First Quarter		Full Moon		Last Quarter	
	d	h m	d	h m	d	h m	d	h m
866			Jan 01	13:38	Jan 08	22:37	Jan 15	14:01
867	Jan 23	04:27	Jan 31	09:20	Feb 07	09:55	Feb 14	00:57
868	Feb 21	23:05	Mar 02	01:47	Mar 08	19:46	Mar 15	14:17
869	Mar 23	17:14	Mar 31	14:10	Apr 07	04:43	Apr 14	05:39
870	Apr 22	09:49	Apr 29	22:41	May 06	13:34	May 13	22:20
871	May 22	00:07	May 29	04:21	Jun 04	23:02	Jun 12	15:36
872	Jun 20	11:52	Jun 27	08:43	Jul 04	09:45	Jul 12	08:49
873	Jul 19	21:24	Jul 26	13:25	Aug 02	22:10	Aug 11	01:19
874	Aug 18	05:28	Aug 24	19:57	Sep 01	12:33	Sep 09	16:26
875	Sep 16	13:10	Sep 23	05:32	Oct 01	04:54	Oct 09	05:35
876	Oct 15	21:36	Oct 22	18:52	Oct 30	22:38	Nov 07	16:36
877	Nov 14	07:34	Nov 21	12:03	Nov 29	16:31	Dec 07	01:49
878	Dec 13	19:27	Dec 21	08:26	Dec 29	09:05		

LUNAR OCCULTATIONS

INTRODUCTION

An occultation is when a body passes in front of a more distant astronomical object. As viewed from Earth, no solar system body occults more stars, more often, than our own Moon. The reasons for this are -

1. Its large 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 frequently (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, which the Moon occults, are listed in the Zodiacal Catalogue (ZC). There are about 3500 stars in the ZC. They also are listed in the larger "whole" sky SAO (Smithsonian Astrophysical Observatory) catalogue. This covers about 259,000 stars.

The Moon moves from west to east, therefore it sets and rises 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. Without a doubt "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 1993 as predicted for **Sydney, Melbourne, Brisbane and Adelaide**. For any particular star, both events (ie. the disappearance and reappearance) are not necessarily included. An event may not be present because:-

1. The Moon is in daylight
2. The Moon is too close to or below the horizon.
3. For faint stars, events on a bright limb (in particular reappearances) are difficult to observe and have been omitted.

THE TIMING OF OCCULTATIONS.

Besides being a spectacular event, occultations is an area in which the amateur can make a scientific contribution. The exact timing of when a star goes into or out of occultation helps astronomers in refining their knowledge of the Moon's position and the shape of the limb.

TIMING EQUIPMENT. For a single event, such as a normal occultation, a stop-watch and the telephone time signal, as a reference, is all that is required. For multiple events, the amateur may tape record simultaneously a shortwave radio time signal (eg. VNG) with his own voice calling out the events (eg. 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!

If you require further information on timing methods for occultations it would be worthwhile contacting your local astronomical society (see list on page 110).

LUNAR OCCULTATION TABLES

The faintest stars, which have occultation predictions on the following pages, are approximately 8th magnitude. The actual selection criteria was as follows. All events, irrespective of whether it occurs on a bright or dark limb, are given for stars with magnitudes of approx. 5 or brighter. Stars fainter than this have been restricted to dark limb events only. They are nearly all night time events.

EXPLANATION

E.A.S.T.	Is the date and time of the occultation. Hr & min are in E.A.S.T. for the Sydney Melbourne and Brisbane tables. Adelaide is in C.A.S.T.
SAO	The star's number in the SAO (Smithsonian Astrophysical Observatory) catalogue.
Event	Consists of two letters. The first letter is the type of Event ie. "D" = Disappearance, "R" = Reappearance and M = means the star just misses being occulted by the Moon, at the precise latitude and longitude used for the predictions, and there is a "grazing" occultation nearby.. The second letter represents: "D" = Dark limb, "B" = a bright limb event.
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 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" (ie. 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

$$= \text{Time from Table} + (A \times n) + (B \times p)$$

where 'n' and 'p' is the **change** in longitude and latitude respectively (in decimal degrees).

'n' is positive(+) if West, negative(-) if East

'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 geographically.

WORKED EXAMPLE

An observer wishes to calculate a more accurate time for the disappearance of Venus on Feb. 25 for their location in Canberra ($149^\circ 06' \text{ E}$, $-35^\circ 12' \text{ S}$). Sydney is the closest city, therefore we start with the data from its table.

$$\begin{aligned} &\text{-The change in longitude from Sydney (decimal degrees)} \\ &= 150^\circ.25 - 149^\circ.1 = 1^\circ.15 \quad \text{--- 'n' (-)} \end{aligned}$$

$$\begin{aligned} &\text{-The change in latitude from Sydney (decimal degrees)} \\ &= 33^\circ.9 - 35^\circ.2 = -1^\circ.3 \quad \text{--- 'p' (-)} \end{aligned}$$

Note p is negative because the change is in a southerly direction therefore $p = -1^\circ.3$

From the table, the values of A and B are -2.6 and -0.2 respectively. Therefore the equation becomes:-

$$22 + (-0.6 \times 1.15) + (-0.2 \times -1.3) = 19 \text{ minutes (approx.).}$$

The event will be visible from Canberra approx. 3 mins earlier than Sydney, i.e., about 1:19 PM (EAST) on Feb. 25.

LUNAR OCCULTATION TABLE

SYDNEY (33° 54' S, 151° 15' E)

E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	AB	E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B	E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B	
Jan 05 20:30	76499	DD	7.1	140	32	49	-1.9	0.9	May 07 22:08	184240	RD	6.7	162	49	294	-1.1	-1.7	Aug 14 06:10	77710	RD	7.0	52	26	268	-1.8	-0.7
Jan 05 21:58	76512	DD	7.0	141	31	34	-2.3	2.3	May 08 02:20	184331	RD	7.1	160	71	260	-2.1	0.9	Aug 21 16:07	139033	DD	4.7	48	60	43	-4.8	7.6
Jan 06 23:18	77082	DD	6.9	154	30	89	-2.1	0.5	May 09 21:39	186497	DB	3.8	136	20	58	-0.7	-0.1	Aug 21 16:28	139033	RB	4.7	48	57	12	0.9	-8.8
Jan 07 19:37	78098	DD	5.7	166	16	163	-3.0	-5.5	May 09 22:32	186497	RD	3.8	136	31	305	-0.3	-2.3	Aug 24 21:21	183972	DD	5.9	90	40	134	-1.6	-0.9
Jan 08 01:45	78297	DD	2.8	168	22	166	0.2	-2.2	May 10 22:09	162229	RD	5.3	124	15	252	-0.3	-0.5	Aug 25 21:06	184804	DD	6.8	103	55	39	-1.0	3.5
Jan 08 02:21	78297	RB	2.8	168	17	228	-2.4	3.1	May 11 03:44	162413	RD	5.0	122	75	246	-2.3	1.1	Aug 27 20:51	187294	MD	6.8	127	75	164	...	...
Jan 13 02:05	118731	RD	5.4	123	50	278	-2.0	-0.9	May 11 04:11	162432	RD	6.8	122	75	255	-2.3	0.8	Aug 28 02:13	162021	DD	7.0	129	14	55	0.2	1.8
Jan 21 04:15	187071	RD	5.8	22	9	210	-0.8	1.3	May 11 06:37	162521	RD	6.0	121	52	307	-3.1	-1.4	Aug 29 00:41	162980	DD	6.7	140	41	115	-2.0	0.0
Jan 21 04:53	187086	RD	5.9	22	16	299	0.2	-2.0	May 13 06:27	164074	RD	7.1	98	65	242	-2.0	1.6	Aug 29 22:43	163686	DD	6.2	151	67	20	-0.9	3.5
Jan 26 20:21	146443	DD	6.4	40	2	27	0.0	2.5	May 16 04:45	128069	RD	6.8	65	37	273	-1.9	-1.3	Aug 31 00:27	145382	DD	5.8	163	56	92	-2.5	0.7
Jan 31 21:07	75627	DD	7.0	96	21	32	-1.9	3.0	May 22 15:44	Mercury	DD	-1.5	7	16	47	-2.7	3.6	Aug 31 18:03	145836	DD	5.6	171	13	84	-0.4	-1.0
Feb 01 21:32	76242	DD	6.9	107	23	113	-1.5	0.2	May 24 11:38	78135	DD	3.2	30	24	31	-1.0	1.9	Sep 07 04:25	93140	RD	6.6	118	36	290	-2.9	-0.4
Feb 02 20:44	76737	DD	6.2	119	31	129	-2.1	-0.9	May 24 12:17	78135	RB	3.2	30	28	335	-2.5	-3.6	Sep 08 02:16	76045	RD	6.4	108	27	243	-1.5	0.0
Feb 04 00:08	77647	DD	7.0	133	16	94	-1.2	0.9	May 24 18:06	78355	DD	6.6	33	11	118	-0.6	0.2	Sep 10 04:38	77220	RD	6.5	84	30	240	-1.9	0.3
Feb 04 20:43	78742	DD	7.0	145	32	59	-2.3	0.6	May 26 18:24	97725	DD	6.8	58	29	61	-2.8	2.6	Sep 11 03:50	78355	RD	6.6	72	18	289	-1.6	-1.5
Feb 04 23:15	78805	DD	5.2	146	31	96	-2.0	0.4	May 28 19:47	118135	DD	6.8	85	40	134	-1.2	-0.8	Sep 14 04:43	98476	RD	6.3	33	6	273	-0.5	-1.2
Feb 05 01:09	78858	DD	6.8	147	17	76	-1.5	1.5	May 30 20:25	138496	DD	6.9	112	57	123	-1.7	-0.8	Sep 18 19:04	158021	DD	5.8	31	15	147	-0.6	-1.0
Feb 08 20:57	118443	RD	6.6	159	17	274	-0.7	-1.2	Jun 01 18:09	158135	DD	6.9	138	47	130	-0.9	-2.0	Sep 20 17:49	159330	DD	5.5	58	56	66	-1.6	1.9
Feb 09 20:54	138314	RD	6.3	145	10	251	-0.4	-0.6	Jun 04 02:39	183972	DD	5.9	168	41	44	-0.5	3.1	Sep 20 20:40	159402	DD	6.8	59	22	100	-0.5	0.8
Feb 10 22:36	138878	RD	6.9	130	23	291	-0.5	-1.5	Jun 05 19:31	185660	RD	4.9	169	22	276	-0.3	-1.2	Sep 20 21:20	159421	DD	6.9	60	14	67	0.1	1.6
Feb 11 23:06	158021	RD	5.8	116	20	340	0.2	-2.6	Jun 06 23:04	187294	RD	6.8	155	53	247	-1.8	0.1	Sep 20 22:16	159442	DD	5.0	60	4	39	0.8	2.5
Feb 14 00:52	183533	RD	6.1	90	24	245	-0.9	-0.3	Jun 07 00:00	187324	RD	5.4	154	63	220	-2.1	2.1	Sep 21 17:18	184450	DD	4.4	71	73	122	-2.3	-1.3
Feb 14 05:07	183646	RD	5.9	88	73	313	-1.7	-2.4	Jun 07 00:48	187349	RD	6.6	154	71	211	-2.0	3.2	Sep 21 18:30	184450	RB	4.4	71	60	240	-1.6	2.2
Feb 18 04:01	162394	RD	6.7	41	19	320	0.4	-3.5	Jun 07 06:23	162049	RD	6.7	152	29	291	-1.0	0.5	Sep 23 15:06	186794	DD	5.0	96	47	91	-1.4	-1.0
Feb 25 13:22	Venus	DD	-4.3	40	43	81	-2.6	-0.2	Jun 08 02:26	162980	RD	6.7	141	73	288	-3.0	-1.2	Sep 23 16:29	186794	RB	5.0	96	64	262	-2.1	-0.3
Feb 25 14:51	Venus	RB	-4.3	40	45	213	-1.6	2.2	Jun 10 01:28	145382	RD	5.8	118	46	257	-1.8	-0.4	Sep 25 22:05	163471	DD	6.2	121	55	112	-2.8	-0.3
Mar 01 22:03	76613	DD	5.4	88	6	128	-0.3	-0.1	Jun 15 02:39	92310	RD	7.1	63	6	228	-0.1	0.3	Sep 25 22:18	163481	DD	3.2	121	53	121	-3.2	-0.9
Mar 03 21:53	78297	DD	2.8	112	24	89	-1.8	0.9	Jun 22 16:55	97472	DD	5.8	28	23	76	-1.8	1.6	Sep 25 23:01	163481	RB	3.2	121	45	185	0.4	4.3
Mar 03 23:03	78297	RB	2.8	112	15	305	-0.6	0.0	Jun 22 17:47	97472	RB	5.8	28	14	334	0.0	-1.1	Sep 25 23:54	163519	DD	6.7	122	34	65	-0.7	1.8
Mar 05 22:34	97773	DD	6.7	139	37	140	-1.2	-1.0	Jun 24 19:37	117997	DD	6.7	56	20	73	-1.3	2.0	Sep 26 00:26	163532	DD	7.0	122	27	54	-0.3	2.0
Mar 10 05:24	138747	RD	7.1	161	25	302	-0.7	-0.1	Jun 25 17:30	118473	DD	6.6	68	51	176	-0.2	-3.3	Oct 03 23:37	92983	RD	6.4	149	31	283	-2.5	-1.4
Mar 10 21:21	157739	RD	5.3	150	25	337	0.0	-2.5	Jun 26 16:45	138314	DD	6.3	81	58	68	-3.5	1.2	Oct 05 04:53	75940	RD	7.0	137	26	250	-2.0	1.5
Mar 10 23:21	157785	RD	7.0	149	49	340	-0.4	-2.8	Jun 28 16:34	157938	DD	5.6	108	52	110	-1.4	-1.5	Oct 06 04:09	76551	RD	5.4	126	33	213	-2.5	2.7
Mar 12 00:09	158401	RD	4.8	135	50	247	-2.3	0.1	Jun 28 19:50	157978	DD	6.9	109	67	138	-1.6	-1.8	Oct 10 05:03	97472	RD	5.8	78	34	349	-1.4	-3.8
Mar 13 01:34	159090	RD	4.7	121	58	268	-1.9	-0.7	Jun 30 19:59	159263	DD	7.0	136	73	62	-2.9	1.4	Oct 12 03:21	117908	RD	6.7	53	8	234	-0.4	0.1
Mar 13 02:01	159105	RD	6.0	121	63	317	-1.2	-2.4	Jun 30 23:18	159317	DD	6.1	137	55	33	-1.3	5.4	Oct 13 03:33	118443	RD	6.6	39	3	298	-0.2	-1.6
Mar 16 05:48	186509	DB	5.7	82	74	80	-2.4	0.2	Jul 03 02:02	185526	DD	6.6	163	46	122	-1.9	-0.4	Oct 18 16:49	184123	DD	4.1	39	53	100	-1.6	0.5
Mar 16 07:22	186509	RD	5.7	82	74	260	-2.3	0.8	Jul 03 03:49	185584	DD	6.7	164	24	133	-1.2	-0.6	Oct 20 20:44	186544	DD	6.0	66	29	98	-0.8	0.9
Mar 21 05:22	145993	DB	5.8	27	16	109	-0.6	-2.3	Jul 04 20:24	162413	RD	5.0	173	35	248	-1.1	-0.3	Oct 22 23:22	163286	DD	6.8	92	16	80	-0.2	1.3
Mar 29 20:44	76954	DD	6.7	69	7	124	-0.4	0.1	Jul 05 01:18	162588	RD	7.0	172	71	236	-1.8	1.8	Oct 23 18:18	163924	DD	6.0	102	68	117	-3.8	-2.4
Mar 30 19:38	77831	DD	6.9	80	25	65	-2.3	1.7	Jul 05 03:08	162643	RD	6.9	171	52	215	-0.7	2.8	Oct 26 00:19	146136	DD	6.3	126	24	56	-0.7	2.0
Mar 30 20:53	77858	DD	6.3	81	15	176	1.5	-4.2	Jul 06 02:40	163481	DB	3.2	159	64	47	-1.5	2.2	Oct 27 00:06	128069	DD	6.8	137	32	87	-1.5	1.3
Mar 31 23:03	79031	DD	3.6	94	4	79	-0.8	1.5	Jul 06 03:50	163471	RD	6.2	159	51	262	-1.7	1.2	Oct 28 20:33	109369	DD	6.5	158	41	58	-1.7	0.6
Apr 01 22:58	97472	DD	5.8	107	16	121	-0.6	0.1	Jul 06 03:59	163481	RD	3.2	159	49	257	-1.5	1.4	Nov 01 02:57	93328	RD	4.5	167	25	249	-1.9	1.6
Apr 02 20:32	98202	DD	7.0	119	42	82	-2.7	0.5	Jul 07 02:06	164182	MB	4.5	148	68	149	...	...	Nov 01 22:23	76347	RD	7.0	158	22	286	-2.0	-1.6
Apr 03 00:03	98278	DD	6.8	121	17	78	-1.2	1.6	Jul 07 06:13	164240	RD	6.5	147	30	192	0.2	3.2	Nov 05 01:44	78691	RD	7.0	122	28	294	-2.1	-1.4
Apr 03 23:12	117979	DD	7.1	134	38	106	-1.6	0.2	Jul 10 03:18	128184	RD	6.8	114	52	264	-2.7	-0.1	Nov 08 04:43	117751	DB	5.3	83	41	163	-1.0	-2.9
Apr 04 00:25	117997	DD	6.7	134	27	130	-0.7	-0.4	Jul 15 03:25	75915	RD	5.9	58	7	271	-0.8	-1.2	Nov 08 05:41	117751	RD	5.3	83	46	253	-3.0	0.5
Apr 04 18:16	118443	DD	6.6	146	28	111	-1.0	-1.5	Jul 16 06:25	76608	DB	4.3	45	24	58	-1.3	0.1	Nov 12 04:20	157760	RD	6.2	30	14	319	0.0	-1.9
Apr 05 18:26	138314	DD	6.3	160	24	163	-0.2	-2.7	Jul 23 19:29	138216	DD	6.3	53	23	105	-0.8	0.6	Nov 16 19:21	185760	DD	7.1	33	19	107	-0.5	0.6
Apr 07 19:40	158021	RD	5.8	170	23	267	-0.6	-1.0	Jul 24 20:05	138747	DD	7.1	67	30	122	-0.9	-0.1	Nov 17 20:12	161842	DD	7.0	46	20	101	-0.4	0.8
Apr 08 01:16	1																									

LUNAR OCCULTATION TABLE

MELBOURNE (37° 50' S, 145° 00'E)

E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	AB	E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B	E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B	
Jan 05 20:17	76499	DD	7.1	140	26	52	-1.6	0.4	May 07 22:07	184240	RD	6.7	162	43	275	-1.1	-1.2	Aug 08 02:17	109369	RD	6.5	122	38	192	-0.4	2.4
Jan 05 21:38	76512	DD	7.0	141	29	42	-1.9	1.3	May 07 23:28	184285	RD	6.4	161	58	339	-0.4	-4.4	Aug 12 06:12	76430	DB	4.5	76	29	99	-2.4	-0.6
Jan 06 23:04	77082	DD	6.9	154	28	100	-2.1	0.0	May 08 02:02	184331	RD	7.1	160	73	244	-2.2	1.5	Aug 12 07:39	76430	RD	4.5	76	30	241	-2.2	1.0
Jan 07 23:08	78225	DD	7.0	167	29	44	-2.4	1.4	May 09 21:38	186497	DB	3.8	136	16	78	-0.2	-0.8	Aug 14 06:03	77710	RD	7.0	52	19	264	-1.4	-0.8
Jan 13 01:55	118731	RD	5.4	123	42	257	-2.1	-0.5	May 09 22:38	186497	RD	3.8	136	27	285	-0.4	-1.6	Aug 21 15:38	139033	DD	4.7	48	61	80	-2.5	0.7
Jan 21 05:00	187086	RD	5.9	22	13	280	0.1	-1.4	May 10 22:08	162229	RD	5.3	124	11	232	-0.3	-0.1	Aug 21 16:39	139033	RB	4.7	48	56	336	-1.1	-2.2
Jan 26 20:11	146443	DD	6.4	40	9	34	-0.2	2.4	May 10 22:19	162234	RD	6.7	124	12	312	0.4	-2.6	Aug 24 21:15	183972	DD	5.9	90	46	146	-1.9	-1.9
Jan 31 20:46	75627	DD	7.0	96	24	44	-1.9	2.1	May 11 03:26	162413	RD	5.0	122	67	237	-2.0	1.2	Aug 25 01:10	184123	DD	4.1	92	3	72	0.5	1.3
Jan 31 22:58	75662	DD	5.8	96	5	54	-1.1	2.2	May 11 03:54	162432	RD	6.8	122	70	248	-2.1	0.8	Aug 25 20:45	184804	DD	6.8	103	62	50	-1.5	2.7
Feb 01 21:22	76242	DD	6.9	107	23	126	-1.7	-0.2	May 11 06:23	162521	RD	6.0	121	58	304	-3.0	-1.3	Aug 27 02:03	186158	DD	6.8	117	13	36	0.6	2.3
Feb 02 20:35	76737	DD	6.2	119	28	141	-2.2	-1.6	May 13 06:09	164074	RD	7.1	98	64	242	-2.0	1.3	Aug 28 02:07	162021	DD	7.0	129	21	57	0.0	1.9
Feb 03 23:59	77647	DD	7.0	133	18	112	-1.1	0.4	May 16 04:40	128069	RD	6.8	65	29	266	-1.4	-1.1	Aug 28 02:56	162049	DD	6.7	129	12	116	-0.3	0.5
Feb 04 20:30	78742	DD	7.0	145	26	69	-1.8	-0.2	May 22 15:17	Mercury	DD	-1.5	7	20	67	-2.4	2.1	Aug 29 00:27	162980	DD	6.7	140	48	116	-2.2	-0.1
Feb 04 23:03	78805	DD	5.2	146	29	111	-1.8	-0.2	May 24 11:28	78135	DD	3.2	30	16	38	-0.7	0.7	Aug 29 22:23	163686	DD	6.2	151	66	23	-1.2	3.1
Feb 05 00:56	78858	DD	6.8	147	20	97	-1.3	0.8	May 24 12:14	78135	RB	3.2	30	22	326	-2.2	-2.7	Aug 31 00:10	145382	DD	5.8	163	59	91	-2.5	0.5
Feb 09 03:01	118558	RD	7.2	156	47	265	-2.3	0.7	May 24 18:03	78355	DD	6.6	33	13	138	-0.4	-0.3	Sep 05 02:14	92310	RD	7.1	141	40	265	-2.5	0.0
Feb 10 22:39	138878	RD	6.9	130	18	279	-0.4	-1.4	May 26 18:04	97725	DD	6.8	58	31	88	-2.0	0.8	Sep 07 04:09	93140	RD	6.6	118	33	287	-2.8	-0.6
Feb 11 23:16	158021	RD	5.8	116	18	323	0.1	-2.1	May 28 19:45	118135	DD	6.8	85	40	157	-0.7	-1.7	Sep 08 02:08	76045	RD	6.4	108	20	242	-1.1	-0.2
Feb 14 00:44	183533	RD	6.1	90	18	215	-1.7	1.7	May 30 20:21	138496	DD	6.9	112	56	144	-1.3	-1.7	Sep 10 04:27	77220	RD	6.5	84	23	236	-1.4	0.1
Feb 14 05:03	183646	RD	5.9	88	66	293	-1.7	-1.5	May 31 01:23	138579	DD	6.8	114	9	146	-0.3	-0.7	Sep 11 03:48	78355	RD	6.6	72	12	285	-1.2	-1.5
Feb 18 04:13	162394	RD	6.7	41	17	295	0.1	-2.0	Jun 01 18:14	158135	DD	6.9	138	42	149	-0.4	-2.5	Sep 13 04:52	97773	RD	6.7	46	8	355	-1.5	-4.9
Feb 25 13:08	Venus	DD	-4.3	40	36	81	-2.1	-0.5	Jun 02 23:22	158860	DD	6.8	154	67	37	-3.0	6.1	Sep 18 19:05	158021	DD	5.8	31	20	164	-0.8	-2.2
Feb 25 14:33	Venus	RB	-4.3	40	41	215	-1.5	1.7	Jun 04 02:23	183972	DD	5.9	168	49	55	-1.1	2.5	Sep 20 20:34	159402	DD	6.8	59	29	106	-0.7	0.7
Mar 01 22:05	76613	DD	5.4	88	8	153	0.2	-1.3	Jun 05 19:33	185660	RD	4.9	169	18	258	-0.3	-0.8	Sep 20 21:13	159421	DD	6.9	60	21	72	-0.2	1.6
Mar 03 21:40	78297	DD	2.8	112	25	105	-1.7	0.3	Jun 06 22:52	187294	RD	6.8	155	45	228	-1.6	0.7	Sep 20 22:11	159442	DD	5.0	60	11	46	0.5	2.4
Mar 03 22:56	78297	RB	2.8	112	16	286	-1.1	0.6	Jun 06 23:35	187324	RD	5.4	154	52	193	-2.3	6.0	Sep 21 17:11	184450	DD	4.4	71	73	140	-2.1	-2.7
Mar 04 21:29	79328	DD	5.2	125	31	49	-3.3	2.2	Jun 07 06:13	162049	RD	6.7	152	36	289	-1.3	0.6	Sep 21 18:09	184450	RB	4.4	71	66	226	-1.8	3.1
Mar 05 22:34	97773	DD	6.7	139	35	163	-0.7	-1.9	Jun 08 02:13	162980	RD	6.7	141	67	279	-2.4	-0.9	Sep 23 15:04	186794	DD	5.0	96	41	109	-1.0	-1.9
Mar 08 01:07	118271	MD	6.5	168	42	32	...	...	Jun 10 01:20	145382	RD	5.8	118	39	247	-1.3	-0.2	Sep 25 21:49	163471	DD	6.2	121	60	113	-3.0	-0.6
Mar 09 21:08	138617	RD	7.2	164	24	320	-0.4	-2.0	Jun 18 06:58	76275	RD	6.8	26	13	289	-1.5	-1.8	Sep 25 22:02	163481	DD	3.2	121	58	121	-3.3	-1.3
Mar 09 23:19	138664	RD	6.5	163	47	349	-0.3	-3.0	Jun 21 17:25	79031	DD	3.6	15	9	31	-4.2	8.4	Sep 25 22:46	163481	RB	3.2	121	51	185	0.3	4.4
Mar 10 05:18	138747	RD	7.1	161	31	386	-0.9	0.5	Jun 21 17:38	79031	RB	3.6	15	7	8	3.0	-7.2	Sep 25 23:42	163519	DD	6.7	122	41	65	-1.0	1.8
Mar 10 21:30	157739	RD	5.3	150	21	222	-0.1	-2.0	Jun 22 17:48	97472	RB	5.8	28	16	311	-0.5	-0.1	Sep 26 00:16	163532	DD	7.0	122	34	54	-0.6	2.1
Mar 10 23:27	157785	RD	7.0	149	44	320	-0.7	-2.1	Jun 24 18:21	117979	DD	7.1	55	34	64	-2.6	2.7	Oct 03 23:28	92983	RD	6.4	149	24	282	-2.0	-1.6
Mar 11 03:24	157848	RD	7.2	147	61	1	-0.1	-5.2	Jun 24 19:24	117997	DD	6.7	56	25	97	-1.2	0.9	Oct 05 04:34	75940	RD	7.0	137	27	241	-2.1	1.5
Mar 11 05:54	157886	RD	7.1	146	38	305	-1.1	-0.2	Jun 28 16:34	157938	DD	5.6	108	45	128	-0.9	-2.0	Oct 06 03:44	76551	RD	5.4	126	30	201	-1.8	3.0
Mar 13 01:23	159090	RD	4.7	121	50	244	-2.0	0.1	Jun 28 19:51	157978	DD	6.9	109	65	162	-1.0	-3.2	Oct 07 05:28	77057	RD	6.2	114	29	226	-2.6	1.9
Mar 13 02:01	159105	RD	6.0	121	56	296	-1.3	-1.7	Jun 30 19:43	159263	DD	7.0	136	64	85	-2.0	-0.4	Oct 10 05:05	97472	RD	5.8	78	28	332	-1.6	-2.5
Mar 14 23:53	185012	RD	7.2	97	13	297	0.3	-1.7	Jun 30 22:52	159317	DD	6.1	137	63	55	-1.9	2.7	Oct 18 16:37	184123	DD	4.1	39	59	111	-1.8	-0.1
Mar 16 07:04	186509	RD	5.7	82	74	250	-2.2	1.0	Jul 03 01:52	185526	DD	6.6	163	52	129	-2.2	-1.0	Oct 19 22:35	185296	DD	4.5	55	4	124	-0.1	0.2
Mar 21 05:31	145993	DB	5.8	27	13	132	-0.4	-4.8	Jul 03 03:43	185584	DD	6.7	164	31	138	-1.6	-0.9	Oct 20 20:35	186544	DD	6.0	66	36	101	-1.0	0.9
Mar 21 06:00	145993	RD	5.8	27	19	183	-0.4	4.0	Jul 03 05:43	185660	DD	4.9	165	9	131	-0.3	0.0	Oct 22 23:14	163286	DD	6.8	92	23	82	-0.4	1.4
Mar 27 19:35	75810	DD	5.0	45	5	26	-1.7	3.6	Jul 04 20:17	162413	RD	5.0	173	29	229	-1.0	0.3	Oct 23 18:07	163924	DD	6.0	102	62	127	-3.6	-4.0
Mar 29 20:43	76954	DD	6.7	69	9	146	-0.1	-0.7	Jul 05 00:59	162588	RD	7.0	172	71	230	-1.8	1.8	Oct 26 00:06	146136	DD	6.3	126	30	58	-0.9	2.0
Mar 30 19:19	77831	DD	6.9	80	26	83	-2.1	0.8	Jul 05 02:52	162643	RD	6.9	171	58	213	-0.9	2.9	Oct 26 23:50	128069	DD	6.8	137	37	88	-1.8	1.2
Mar 31 22:54	79031	DD	3.6	94	8	100	-0.7	0.9	Jul 06 02:22	163481	DB	3.2	159	66	49	-1.6	1.9	Oct 28 20:22	109369	DD	6.5	158	34	59	-1.4	0.2
Apr 01 22:56	97472	DD	5.8	107	18	142	-0.4	-0.5	Jul 06 03:34	163471	RD	6.2	159	57	262	-1.9	1.1	Nov 01 02:38	93328	RD	4.5	167	27	240	-2.0	1.6
Apr 02 20:17	98202	DD	7.0	119	38	101	-2.1	-0.4	Jul 06 03:43	163481	RD	3.2	159	55	257	-1.7	1.3	Nov 05 01:29	78698	RD	7.1	122	20	339	-2.2	-3.9
Apr 02 23:51	98278	DD	6.8	121	21	101	-1.1	0.7	Jul 06 21:39	164074	RD	7.1	180	22	282	-0.5	-1.8	Nov 05 01:37	78691	RD	7.0	122	22	288	-1.7	-1.4
Apr 03 23:04	117979	DD	7.1	134	39	127	-1.3	-0.5	Jul 07 06:01	164240	RD	6.5	147	36	192	0.0	3.3	Nov 08 04:55	117751	DB	5.3	83	36	192	1.0	-6.5
Apr 04 00:24	117997	DD	6.7	134	29	152	-0.5	-1.1	Jul 10 03:04	128184	RD	6.8	114	45	263	-2.2	-0.5	Nov 08 05:14	117							

LUNAR OCCULTATION TABLE

BRISBANE (27° 30' S, 153° 01'E)

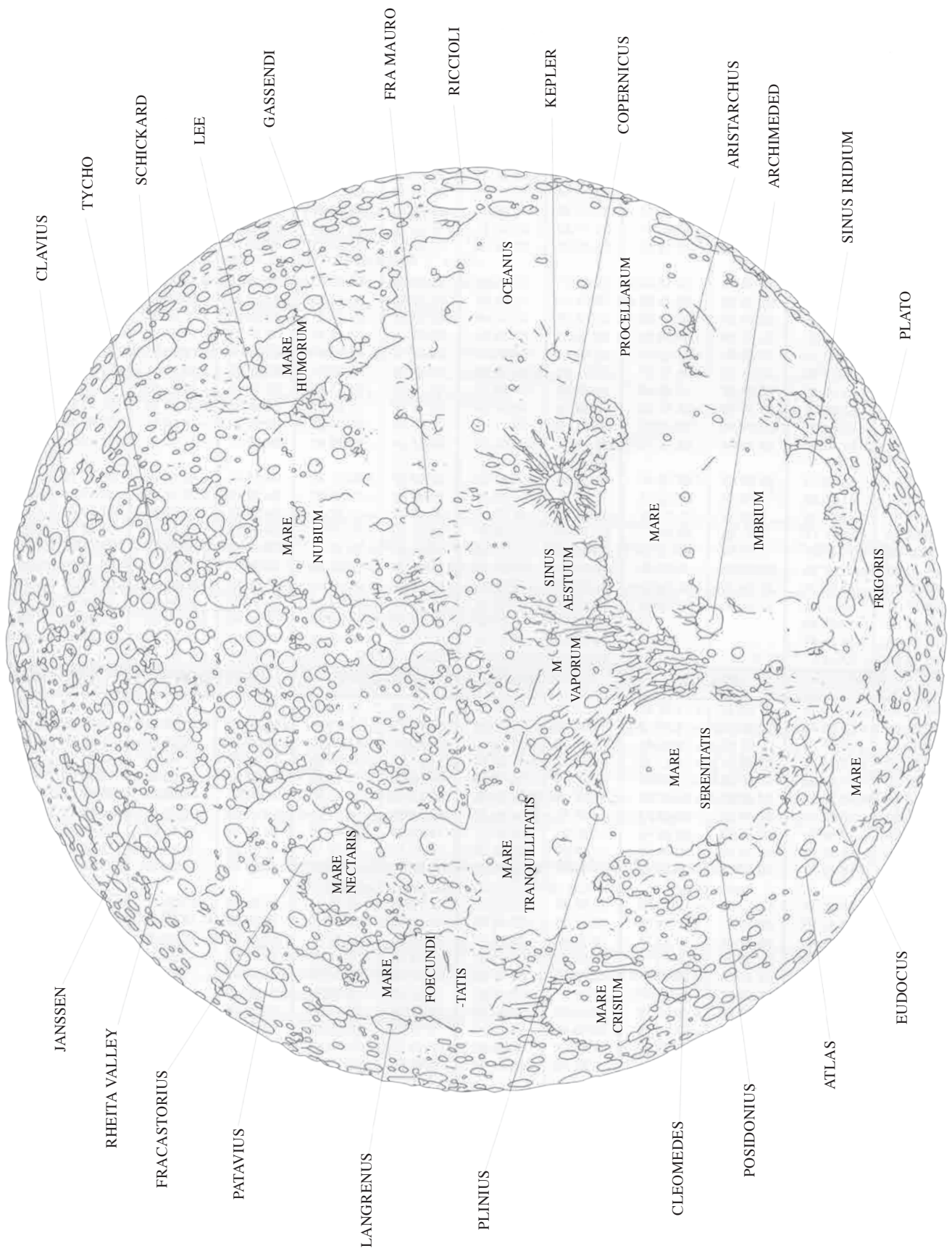
E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	AB	E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B	E.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B	
Jan 05 20:43	76499	DD	7.1	140	39	33	-2.0	2.2	May 07 21:56	184240	RD	6.7	162	48	317	-0.7	-2.5	Aug 31 18:01	145836	DD	5.6	171	14	61	-0.5	0.1
Jan 06 23:27	77082	DD	6.9	154	34	73	-2.5	1.0	May 08 02:27	184331	RD	7.1	160	71	282	-2.4	-0.2	Sep 05 02:37	92310	RD	7.1	141	49	277	-3.4	-0.1
Jan 07 19:19	78098	DD	5.7	166	18	135	-1.9	-2.5	May 09 21:47	186497	DB	3.8	136	21	24	-2.0	3.3	Sep 07 04:24	93140	RD	6.6	118	42	308	-3.7	-2.0
Jan 08 01:37	78297	DD	2.8	168	27	139	-0.8	-0.9	May 09 22:11	186497	RD	3.8	136	27	340	1.0	-5.5	Sep 08 02:19	76045	RD	6.4	108	34	257	-2.0	-0.2
Jan 08 02:38	78297	RB	2.8	168	18	257	-1.4	1.3	May 10 22:04	162229	RD	5.3	124	14	274	-0.1	-1.0	Sep 10 04:44	77220	RD	6.5	84	37	255	-2.4	0.1
Jan 13 02:01	118731	RD	5.4	123	55	296	-1.9	-1.4	May 11 02:37	162394	RD	6.7	122	71	199	-1.9	4.6	Sep 11 03:42	78355	RD	6.6	72	23	305	-1.9	-2.1
Jan 21 04:19	187071	RD	5.8	22	9	240	-0.3	0.0	May 11 03:53	162413	RD	5.0	122	81	266	-2.8	0.2	Sep 13 03:29	97725	RD	6.8	47	3	313	-0.7	-2.1
Jan 21 04:35	187086	RD	5.9	22	12	330	1.0	-3.6	May 11 04:18	162432	RD	6.8	122	79	275	-3.0	-0.1	Sep 14 04:36	98476	RD	6.3	33	8	288	-0.5	-1.3
Jan 31 21:43	75627	MD	7.0	96	18	353	...	...	May 16 04:34	128069	RD	6.8	65	39	302	-3.4	-4.5	Sep 18 19:01	158021	DD	5.8	31	13	122	-0.4	-0.2
Feb 01 21:38	76242	DD	6.9	107	26	97	-1.7	0.6	May 24 18:10	78355	DD	6.6	33	13	96	-0.9	0.7	Sep 20 18:07	159317	GD	6.1	58	52	185	...	...
Feb 02 20:44	76737	DD	6.2	119	37	112	-2.4	-0.4	May 26 18:20	97718	DD	6.6	58	34	158	-0.4	-1.9	Sep 20 18:11	159330	DD	5.5	58	51	34	-1.1	4.9
Feb 04 00:18	77647	DD	7.0	133	18	73	-1.5	1.5	May 28 19:46	118135	DD	6.8	85	43	112	-1.7	-0.2	Sep 20 20:47	159402	DD	6.8	59	18	81	-0.2	1.1
Feb 04 20:59	78742	DD	7.0	145	40	34	-3.5	3.8	May 30 20:26	138496	DD	6.9	112	61	100	-2.4	0.0	Sep 20 21:32	159421	DD	6.9	60	9	45	0.5	2.3
Feb 04 23:24	78805	DD	5.2	146	35	76	-2.5	1.1	May 31 20:55	157550	DD	6.5	126	69	182	0.0	-5.4	Sep 21 17:18	184450	DD	4.4	71	75	98	-2.5	-0.1
Feb 05 01:16	78852	DD	6.7	147	19	151	-0.1	-1.3	Jun 01 18:00	158135	DD	6.9	138	48	112	-1.3	-1.5	Sep 21 18:43	184450	RB	4.4	71	57	262	-1.8	1.1
Feb 05 01:28	78858	DD	6.8	147	17	41	-3.2	4.9	Jun 04 02:36	183969	DD	7.0	168	40	143	-2.0	-1.9	Sep 23 15:06	186794	DD	5.0	96	49	67	-1.9	0.2
Feb 08 20:50	118443	RD	6.6	159	19	288	-0.7	-1.3	Jun 05 19:22	185660	RD	4.9	169	20	297	0.0	-1.6	Sep 23 16:28	186794	RB	5.0	96	67	286	-2.3	-1.4
Feb 09 20:50	138314	RD	6.3	145	11	268	-0.3	-0.9	Jun 06 02:44	185966	RD	6.6	166	63	208	-0.9	3.9	Sep 25 22:11	163471	DD	6.2	121	55	94	-2.3	0.6
Feb 10 22:27	138878	RD	6.9	130	23	306	-0.4	-1.7	Jun 06 23:05	187294	RD	6.8	155	55	271	-1.9	-0.8	Sep 25 22:22	163481	DD	3.2	121	53	101	-2.4	0.3
Feb 11 22:43	158021	RD	5.8	116	17	11	1.7	-5.8	Jun 07 00:13	187324	RD	5.4	154	70	246	-2.4	0.8	Sep 25 23:23	163481	RB	3.2	121	39	204	-0.2	3.0
Feb 14 00:49	183533	RD	6.1	90	24	266	-0.6	-0.8	Jun 07 01:06	187349	RD	6.6	154	80	237	-2.4	1.5	Sep 26 00:07	163519	DD	6.7	122	30	52	-0.4	2.0
Feb 14 04:47	183646	RD	5.9	88	74	345	-0.7	-5.2	Jun 07 06:24	162049	RD	6.7	152	26	312	-1.8	-1.2	Sep 26 00:40	163532	DD	7.0	122	23	41	-0.1	2.2
Feb 25 13:28	Venus	DD	-4.3	40	50	68	-2.6	0.7	Jun 08 02:11	162980	RD	6.7	141	79	326	...	...	Oct 03 23:28	92983	RD	6.4	149	36	305	-4.1	-3.5
Feb 25 15:08	Venus	RB	-4.3	40	50	225	-2.2	2.1	Jun 10 01:26	145382	RD	5.8	118	50	281	-2.3	-1.6	Oct 04 23:10	93394	RD	7.1	139	25	246	-1.2	0.0
Mar 01 22:05	76613	DD	5.4	88	8	107	-0.5	0.4	Jun 15 02:40	92310	RD	7.1	63	10	248	-0.4	-0.2	Oct 05 05:05	75940	RD	7.0	137	28	266	-1.9	1.0
Mar 03 17:17	78135	DD	3.2	111	32	160	-3.0	-4.9	Jun 22 17:24	97472	MD	5.8	28	21	26	...	...	Oct 06 04:28	76551	RD	5.4	126	37	233	-2.8	2.0
Mar 03 17:53	78135	RB	3.2	111	36	208	-2.1	3.6	Jun 25 17:15	118473	DD	6.6	68	57	149	-1.3	-1.9	Oct 12 03:21	117908	RD	6.7	53	11	254	-0.5	-0.5
Mar 03 22:04	78297	DD	2.8	112	27	67	-2.3	1.8	Jun 28 16:30	157938	DD	5.6	108	54	91	-2.0	-0.8	Oct 13 03:23	118443	RD	6.6	39	3	312	-0.2	-1.8
Mar 03 23:00	78297	RB	2.8	112	18	329	-0.1	-1.2	Jun 28 19:45	157978	DD	6.9	109	71	114	-2.2	-0.8	Oct 18 16:57	184123	DD	4.1	39	51	79	-1.5	1.2
Mar 05 22:32	97773	DD	6.7	139	43	121	-1.7	-0.6	Jun 30 22:56	183533	DD	6.1	137	59	162	-2.5	-5.4	Oct 18 18:07	184123	RB	4.1	39	35	280	-1.1	0.5
Mar 10 05:21	138747	RD	7.1	161	25	328	-0.7	-1.3	Jul 01 17:11	184331	DD	7.1	147	31	154	0.3	-3.2	Oct 18 18:19	184133	RB	4.6	39	33	236	-0.4	2.1
Mar 10 21:01	157739	RD	5.3	150	22	4	0.8	-4.2	Jul 03 02:05	185526	DD	6.6	163	43	102	-1.5	0.4	Oct 20 20:52	186544	DD	6.0	66	25	83	-0.5	1.1
Mar 10 22:56	157785	RD	7.0	149	47	13	1.9	-6.3	Jul 03 03:50	185584	DD	6.7	164	21	113	-0.7	0.2	Oct 20 21:52	186575	MD	7.1	67	13	166	...	...
Mar 11 05:45	157886	RD	7.1	146	35	359	-1.1	-5.7	Jul 04 20:22	162413	RD	5.0	173	36	272	-1.1	-1.0	Oct 21 18:22	162204	DD	6.4	78	68	66	-2.0	1.6
Mar 12 00:10	158401	RD	4.8	135	53	271	-1.8	-0.8	Jul 05 01:31	162588	RD	7.0	172	72	253	-2.3	1.2	Oct 22 23:31	163286	DD	6.8	92	11	67	0.0	1.4
Mar 13 01:30	159090	RD	4.7	121	60	289	-1.7	-1.4	Jul 05 03:26	162643	RD	6.9	171	48	230	-0.9	2.1	Oct 23 18:16	163924	DD	6.0	102	75	93	-3.2	0.3
Mar 13 01:42	159105	RD	6.0	121	62	345	-0.2	-4.3	Jul 06 02:59	163481	DB	3.2	159	62	32	-1.0	2.9	Oct 26 00:34	146136	DD	6.3	126	21	44	-0.5	2.2
Mar 16 07:28	186509	RD	5.7	82	75	280	-2.9	-0.2	Jul 06 03:59	163471	RD	6.2	159	49	277	-2.1	0.6	Oct 27 00:17	128069	DD	6.8	137	31	75	-1.3	1.5
Mar 21 05:14	145993	DB	5.8	27	16	83	-0.6	-0.7	Jul 06 04:09	163481	RD	3.2	159	47	271	-1.8	0.9	Oct 28 20:43	109369	DD	6.5	158	49	43	-1.6	1.4
Mar 29 20:47	76954	DD	6.7	69	9	103	-0.6	0.5	Jul 07 01:48	164182	DB	4.5	148	74	107	-3.9	-1.3	Nov 01 03:09	93328	RD	4.5	167	27	264	-1.9	1.1
Mar 30 20:02	77831	DD	6.9	80	26	31	-5.0	6.9	Jul 07 02:49	164182	RD	4.5	148	70	188	-0.4	4.2	Nov 01 22:14	76347	RD	7.0	158	27	307	-3.0	-3.0
Mar 30 20:41	77858	DD	6.3	81	20	141	-0.4	-1.9	Jul 10 03:20	128184	RD	6.8	114	58	282	-3.9	-1.2	Nov 05 01:37	78691	RD	7.0	122	34	309	-2.4	-2.1
Mar 31 23:20	79031	DD	3.6	94	2	44	-1.7	4.2	Jul 14 01:51	92983	RD	6.4	70	5	202	0.5	1.7	Nov 08 04:28	117751	DB	5.3	83	45	144	-1.6	-2.3
Apr 01 23:02	97472	DD	5.8	107	18	98	-0.9	0.6	Jul 15 03:18	75915	RD	5.9	58	10	291	-1.3	-1.9	Nov 08 05:47	117751	RD	5.3	83	52	275	-2.7	-0.4
Apr 02 20:48	98202	DD	7.0	119	47	50	-5.5	4.5	Jul 16 06:31	76608	DB	4.3	45	31	43	-1.3	1.0	Nov 12 04:07	157760	RD	6.2	30	12	337	0.2	-2.4
Apr 03 00:29	98278	MD	6.8	121	14	27	...	...	Jul 21 17:16	117751	RB	5.3	24	22	279	-1.0	0.6	Nov 16 19:26	185760	DD	7.1	33	15	91	-0.2	0.8
Apr 03 23:19	117979	DD	7.1	134	40	81	-2.2	1.2	Jul 23 19:37	138216	DD	6.3	53	22	79	-0.9	1.5	Nov 17 18:27	161777	DD	6.7	45	39	47	-0.5	2.2
Apr 04 00:26	117997	DD	6.7	134	28	107	-1.1	0.2	Jul 24 20:09	138747	DD	7.1	67	28	98	-0.9	0.6	Nov 17 18:40	161754	RB	6.0	45	36	314	-2.3	-1.6
Apr 04 18:09	118443	DD	6.6	146	31	96	-1.3	-1.1	Jul 25 22:15	157886	DD	7.1	81	15	107	-0.4	0.3	Nov 17 20:18	161842	DD	7.0	46	16	87	-0.2	0.9
Apr 05 18:11	138314	DD	6.3	160	23	145	-0.4	-2.1	Jul 26 18:02	158401	DD	4.8	93	78	142	-1.8	-2.4	Nov 17 20:53	161871	DD	6.4	47	8	95	0.0	0.7
Apr 07 19:34	158021	RD	5.8	170	23	284	-0.4	-1.2	Jul 26 19:18	158401	RB	4.8	93	65	262	-2.4	1.0	Nov 20 19:01	145333	DD	6.9	82</				

LUNAR OCCULTATION TABLE

ADELAIDE (34° 58' S, 138° 38'E)

C.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	AB	C.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B	C.A.S.T.	CATALOG	PD	Mag	Elg	Alt	PA	A	B
Jan 05 21:01	76512	DD	7.0	141	31	30	-1.6 1.8	May 11 03:11	162432	RD	6.8	122	68	262	-2.3 -0.1		Aug 24 20:30	183972	DD	5.9	90	55	127	-1.9 -0.9	
Jan 06 22:20	77082	DD	6.9	154	31	96	-2.3 -0.2	May 12 09:32	163481	DB	3.2	107	30	106	-1.1 0.8		Aug 25 00:47	184123	DD	4.1	92	5	57	0.5 1.7	
Jan 13 01:10	118731	RD	5.4	123	37	254	-1.9 -0.5	May 12 10:22	163481	RD	3.2	107	20	206	0.3 2.6		Aug 25 00:58	184135	DD	4.6	92	3	103	0.2 0.7	
Jan 20 04:47	185765	DB	6.2	33	21	85	-0.4 -1.0	May 13 05:27	164074	RD	7.1	98	66	260	-2.5 0.3		Aug 25 20:16	184804	DD	6.8	103	68	30	-1.6 4.8	
Jan 21 04:27	187086	RD	5.9	22	7	281	0.3 -1.3	May 16 03:57	128069	RD	6.8	65	24	264	-1.3 -2.1		Aug 26 01:25	185024	DD	6.3	105	8	96	0.1 0.9	
Jan 26 19:46	146443	DD	6.4	40	13	26	-0.3 2.6	May 22 14:36	Mercury	DD	-1.5	7	26	67	-2.9 1.9		Aug 27 01:45	186158	DD	6.8	117	14	14	1.1 3.6	
Jan 31 20:10	75627	DD	7.0	96	29	37	-2.0 2.3	May 24 11:04	78135	DD	3.2	30	16	8	2.8 9.4		Aug 27 19:39	187294	DD	6.8	127	70	150	-3.0 -7.9	
Jan 31 22:27	75662	DD	5.8	96	11	52	-1.3 2.2	May 24 17:28	78355	DD	6.6	33	20	140	-0.6 -0.6		Aug 28 01:43	162021	DD	7.0	129	24	43	0.1 2.2	
Feb 01 20:39	76242	DD	6.9	107	29	121	-2.2 -0.4	May 28 19:05	118135	DD	6.8	85	46	160	-0.8 -2.0		Aug 28 02:26	162049	DD	6.7	129	16	101	-0.3 0.9	
Feb 02 19:45	76737	DD	6.2	119	31	131	-2.6 -1.6	May 30 19:38	138496	DD	6.9	112	60	146	-1.3 -2.0		Aug 28 23:45	162980	DD	6.7	140	56	95	-2.1 0.7	
Feb 03 23:21	77647	DD	7.0	133	24	113	-1.4 0.2	May 30 23:39	138556	DD	7.2	114	29	103	-1.0 0.6		Aug 30 23:26	145382	DD	5.8	163	64	72	-2.3 1.0	
Feb 04 19:48	78742	DD	7.0	145	24	61	-1.6 0.0	May 31 00:50	138579	DD	6.8	114	15	133	-0.4 -0.3		Sep 04 00:01	109195	RD	7.2	152	40	202	-0.8 2.0	
Feb 04 22:20	78805	DD	5.2	146	33	112	-2.0 -0.5	Jun 01 17:35	158135	DD	6.9	138	36	152	-0.2 -2.5		Sep 05 01:24	92310	RD	7.1	141	40	286	-3.2 -1.4	
Feb 05 00:18	78858	DD	6.8	147	26	99	-1.6 0.5	Jun 04 01:55	183972	DD	5.9	168	54	35	-1.0 4.4		Sep 07 03:15	93140	RD	6.6	118	35	306	-3.9 -2.5	
Feb 10 22:04	138878	RD	6.9	130	12	280	-0.2 -1.3	Jun 04 03:28	184029	DD	7.2	169	36	77	-0.7 1.5		Sep 08 01:30	76045	RD	6.4	108	17	258	-1.2 -0.7	
Feb 11 22:41	158021	RD	5.8	116	11	324	0.2 -2.0	Jun 05 18:59	185660	RD	4.9	169	12	258	-0.1 -0.8		Sep 10 03:48	77220	RD	6.5	84	21	248	-1.4 -0.3	
Feb 14 00:09	183533	RD	6.1	90	11	212	-1.6 2.3	Jun 06 22:14	187294	RD	6.8	155	38	235	-1.4 0.3		Sep 11 03:05	78355	RD	6.6	72	7	299	-1.1 -1.9	
Feb 14 04:18	183646	RD	5.9	88	60	294	-1.5 -1.7	Jun 06 23:02	187324	RD	5.4	154	48	209	-2.0 2.7		Sep 12 06:01	96918	RD	7.2	59	27	252	-1.8 -0.3	
Feb 18 03:38	162394	RD	6.7	41	11	298	0.3 -2.0	Jun 06 23:48	187349	RD	6.6	154	56	206	-2.1 3.4		Sep 18 18:26	158021	DD	5.8	31	27	145	-0.9 -1.0	
Feb 25 12:26	Venus	DD	-4.3	40	33	63	-1.5 0.1	Jun 07 05:31	162049	RD	6.7	152	44	314	-2.8 -1.7		Sep 18 19:12	158021	RB	5.8	31	17	245	-0.2 2.1	
Feb 25 13:57	Venus	RB	-4.3	40	43	232	-1.9 1.0	Jun 08 01:23	162980	RD	6.7	141	62	296	-2.5 -2.4		Sep 20 20:01	159402	DD	6.8	59	34	91	-0.9 1.0	
Mar 01 21:31	76613	DD	5.4	88	14	153	-0.1 -1.6	Jun 10 00:41	145382	RD	5.8	118	33	259	-1.1 -0.8		Sep 20 20:48	159421	DD	6.9	60	25	56	-0.1 2.2	
Mar 03 16:43	78135	MB	3.2	111	18	181	...	Jun 18 06:10	76275	RD	6.8	26	8	314	-2.0 -3.7		Sep 20 21:55	159442	DD	5.0	60	12	18	1.6 5.6	
Mar 03 20:59	78297	DD	2.8	112	30	106	-2.0 0.0	Jun 22 17:13	97472	RB	5.8	28	23	310	-0.8 -0.3		Sep 21 16:22	184450	DD	4.4	71	75	129	-2.0 -2.2	
Mar 03 22:19	78297	RB	2.8	112	23	284	-1.4 0.5	Jun 24 17:40	117979	DD	7.1	55	41	67	-3.0 2.2		Sep 23 14:24	186794	DD	5.0	96	34	105	-0.7 -1.6	
Mar 04 20:44	79328	DD	5.2	125	35	51	-3.2 1.7	Jun 24 18:48	117997	DD	6.7	56	32	96	-1.5 0.7		Sep 24 01:14	161754	DD	6.0	99	6	6	1.4 3.9	
Mar 05 00:58	96945	DD	6.8	127	11	78	-1.1 1.5	Jun 26 19:35	138365	DD	7.2	83	49	174	-0.4 -3.4		Sep 25 21:01	163471	DD	6.2	121	68	91	-2.6 0.3	
Mar 05 21:53	97773	DD	6.7	139	39	167	-0.7 -2.4	Jun 28 15:53	157938	DD	5.6	108	39	131	-0.7 -2.0		Sep 25 21:12	163481	DD	3.2	121	66	97	-2.7 0.1	
Mar 08 00:25	118271	MD	6.5	168	48	33	...	Jun 28 19:05	157978	DD	6.9	109	68	162	-0.9 -3.3		Sep 25 22:24	163481	RB	3.2	121	55	209	-0.8 3.0	
Mar 09 22:39	138664	RD	6.5	163	43	345	-0.3 -2.8	Jun 30 18:59	159263	DD	7.0	136	58	85	-1.9 -0.6		Sep 25 23:12	163519	DD	6.7	122	46	50	-0.9 2.2	
Mar 10 04:42	138747	RD	7.1	161	38	293	-1.2 0.1	Jun 30 22:18	159317	DD	6.1	137	69	40	-2.5 4.7		Sep 25 23:49	163532	DD	7.0	122	39	40	-0.5 2.5	
Mar 10 20:54	157739	RD	5.3	150	15	322	0.0 -2.0	Jul 03 01:07	185526	DD	6.6	163	61	109	-2.1 -0.1		Sep 27 02:27	164275	DD	6.9	135	15	106	-0.5 0.8	
Mar 10 22:47	157785	RD	7.0	149	38	317	-0.6 -2.1	Jul 03 03:03	185584	DD	6.7	164	38	115	-1.4 0.2		Oct 03 22:37	92983	RD	6.4	149	19	308	-2.8 -4.0	
Mar 11 05:15	157886	RD	7.1	146	45	314	-1.3 -0.9	Jul 03 05:12	185660	DD	4.9	165	13	113	-0.3 0.5		Oct 05 03:54	75940	RD	7.0	137	33	248	-2.3 1.1	
Mar 13 00:41	159090	RD	4.7	121	43	241	-1.9 0.1	Jul 01 19:42	162413	RD	5.0	173	23	234	-0.8 0.1		Oct 05 04:32	75946	RD	7.2	137	29	277	-2.2 0.5	
Mar 13 01:18	159105	RD	6.0	121	50	295	-1.1 -1.7	Jul 05 00:21	162588	RD	7.0	172	72	246	-0.2 0.9		Oct 06 03:08	76551	RD	5.4	126	33	216	-1.9 1.7	
Mar 14 06:07	184331	RD	7.1	106	72	339	-2.3 -5.5	Jul 05 02:22	162643	RD	6.9	171	64	232	-1.5 2.1		Oct 07 04:47	77057	RD	6.2	114	33	231	-2.6 1.5	
Mar 16 06:20	186509	RD	5.7	82	75	263	-2.4 0.1	Jul 06 01:49	163481	DB	3.2	159	70	30	-1.4 2.8		Oct 10 04:17	97472	RD	5.8	78	25	339	-1.6 -1.3	
Mar 21 05:34	145993	DD	5.8	27	15	201	-0.4 1.8	Jul 06 02:51	163471	RD	6.2	159	64	282	-2.8 -0.1		Oct 19 22:06	185296	DD	4.5	55	8	109	0.0 0.6	
Mar 27 19:04	75810	DD	5.0	45	11	24	-2.0 3.9	Jul 06 03:03	163481	RD	3.2	159	63	276	-2.5 0.3		Oct 20 20:01	186544	DD	6.0	66	42	84	-1.1 1.2	
Mar 29 20:10	76954	DD	6.7	69	16	146	-0.3 -1.0	Jul 07 00:44	164182	DB	4.5	148	57	114	-2.9 -2.6		Oct 20 21:09	186575	MD	7.1	67	29	165	...	
Mar 30 18:37	77831	DD	6.9	80	31	83	-2.4 0.6	Jul 07 01:39	164182	RD	4.5	148	64	190	-0.8 4.0		Oct 22 19:51	163213	DD	7.2	91	61	33	-1.1 2.9	
Mar 11 22:22	79031	DD	3.6	94	14	101	-0.9 0.8	Jul 07 05:38	164240	RD	6.5	147	41	210	-0.5 2.7		Oct 22 22:46	163286	DD	6.8	92	28	69	-0.5 1.7	
Apr 01 22:20	97472	DD	5.8	107	25	143	-0.6 -0.8	Jul 10 02:15	128184	RD	6.8	114	41	286	-2.7 -2.2		Oct 25 23:36	146136	DD	6.3	126	36	46	-1.0 2.3	
Apr 02 19:32	98202	DD	7.0	119	40	104	-2.1 -0.8	Jul 16 05:43	76608	DB	4.3	45	15	43	-0.5 0.4		Oct 26 23:12	128069	DD	6.8	137	44	74	-2.0 1.4	
Apr 02 23:15	98278	DD	6.8	121	28	102	-1.4 0.5	Jul 16 06:47	76608	RD	4.3	45	24	291	-2.2 -1.6		Oct 28 19:46	109369	DD	6.5	158	31	41	-0.9 0.8	
Apr 03 22:23	117979	DD	7.1	134	45	130	-1.4 -0.9	Jul 16 06:54	76613	MD	5.4	45	24	348	...		Nov 01 01:59	93328	RD	4.5	167	33	247	-2.3 1.2	
Apr 03 23:46	117997	DD	6.7	134	36	152	-0.7 -1.3	Jul 23 18:47	138216	DD	6.3	53	35	118	-1.1 0.0		Nov 05 00:52	78691	RD	7.0	122	18	297	-1.6 -1.8	
Apr 06 19:26	138892	DD	6.8	174	23	35	-1.4 0.4	Jul 24 19:23	138747	DD	7.1	67	42	132	-1.2 -0.7		Nov 08 04:10	117751	DB	5.3	83	33	192	0.7 -7.4	
Apr 08 00:24	158135	RD	6.9	168	68	290	-1.9 -1.0	Jul 25 19:34	157848	DD	7.2	80	52	74	-2.0 1.7		Nov 08 04:28	117751	RD	5.3	83	36	218	-4.3 4.6	
Apr 11 23:40	185660	RD	4.9	116	24	314	0.1 -2.5	Jul 25 21:35	157886	DD	7.1	81	29	130	-0.9 -0.3		Nov 11 04:38	138664	RD	6.5	43	21	258	-0.8 -0.8	
Apr 13 02:49	187233	RD	7.1	102	51	218	-2.0 1.8	Jul 25 23:38	157938	DD	5.6	82	5	92	0.1 1.0		Nov 12 03:54	157760	RD	6.2	30	5	309	0.2 -1.6	
Apr 13 04:49	187294	RD	6.8	102	72	284	-2.5 -1.1	Jul 27 20:06	159105	DD	6.0	107	70	130	-2.0 -1.5		Nov 17 19:33	161842	DD	7.0	46	32	88	-0	

MOON



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

TRANSIT OF MERCURY, 6th November 1993

On the 6th November 1993 the tiny disc of Mercury will be seen silhouetted against the Solar photosphere. This infrequent event (the last on 12th November 1986) only occurs about thirteen times each century, at intervals of about three, seven, ten or thirteen years between successive transits.

A transit of Mercury across the face of the Sun is only possible when the planet is at inferior conjunction and is at one of the nodes of its orbit. As the planet has an orbital tilt of 7° to the ecliptic plane and only crosses the nodes of its orbit in May and November, it generally passes above or below the Sun.

This year's event lasts for about 100 minutes with Mercury barely intruding on the solar disc as shown in figure 1. When a transit happens across the equatorial region the duration can be almost 9 hours.

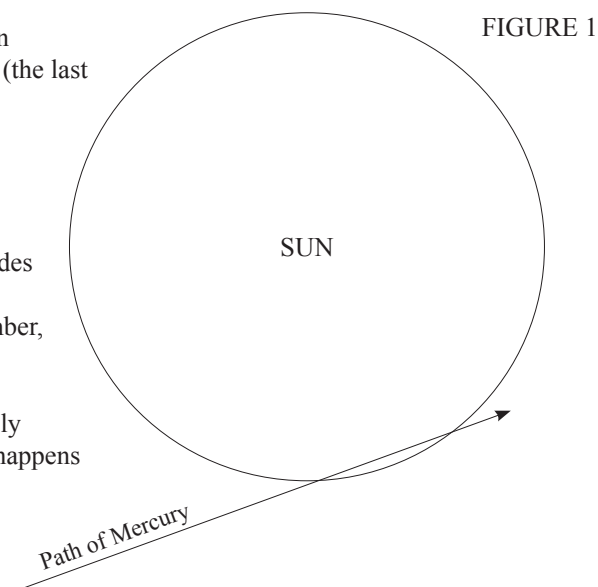


FIGURE 1

The progress of the transit may be monitored with the telescope using normal solar observing techniques; like the projection method or a full aperture solar filter. Mercury's small disc will appear much darker than any nearby sunspots. **WARNING! DO NOT RISK BLINDNESS;** under no circumstances should any other type of device be used, particularly tinted glass eyepiece filters. It is recommended that anyone wishing to see the event, with no previous solar observing experience, join other amateurs familiar with this field.

TRANSIT TIMES	ADELAIDE (CAST)	BRISBANE (EAST)	HOBART (EAST)	MELBOURNE (EAST)	PERTH (WAST)	SYDNEY (EAST)
Ingress, exterior contact	12:35:12 PM	1:05:31 PM	1:04:55 PM	1:05:06 PM	11:05:12 AM	1:05:16 PM
Ingress, interior contact	12:41:02 PM	1:11:24 PM	1:10:43 PM	1:10:56 PM	11:11:00 AM	1:11:07 PM
Mid transit	1:26:08 PM	1:56:05 PM	1:56:06 PM	1:56:06 PM	11:56:19 AM	1:56:05 PM
Egress, interior contact	2:11:15 PM	2:40:44 PM	2:41:28 PM	2:41:17 PM	12:41:36 PM	2:41:02 PM
Egress, exterior contact	2:17:05 PM	2:46:38 PM	2:47:16 PM	2:47:06 PM	12:47:25 PM	2:46:53 PM

**** NB. No allowance has been made for Daylight Savings Time.
If this is in force, add one hour to the times given above.**

FUTURE TRANSITS

16th November 1999	Similar to this year's event, with Mercury just crossing the edge of the photosphere.
7th May 2003	Long duration, partially visible from Australia prior to sunset.
9th November 2006	Long duration.
9th May 2016	Long duration, not visible from Australia.

CONTACT POINTS

Figure 2 details the contact points in the table above

1 = Ingress, exterior contact	2 = Ingress interior contact
3 = Mid transit	4 = Egress, interior contact
5 = Egress, exterior contact	

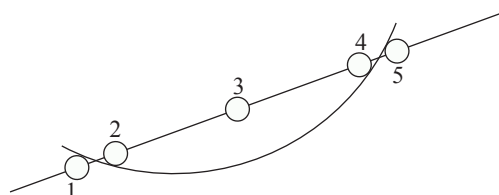


FIGURE 2
(exaggerated for clarity)

MERCURY

RISE AND SET TIMES (for Sydney, E.A.S.T.)

VENUS

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

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

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

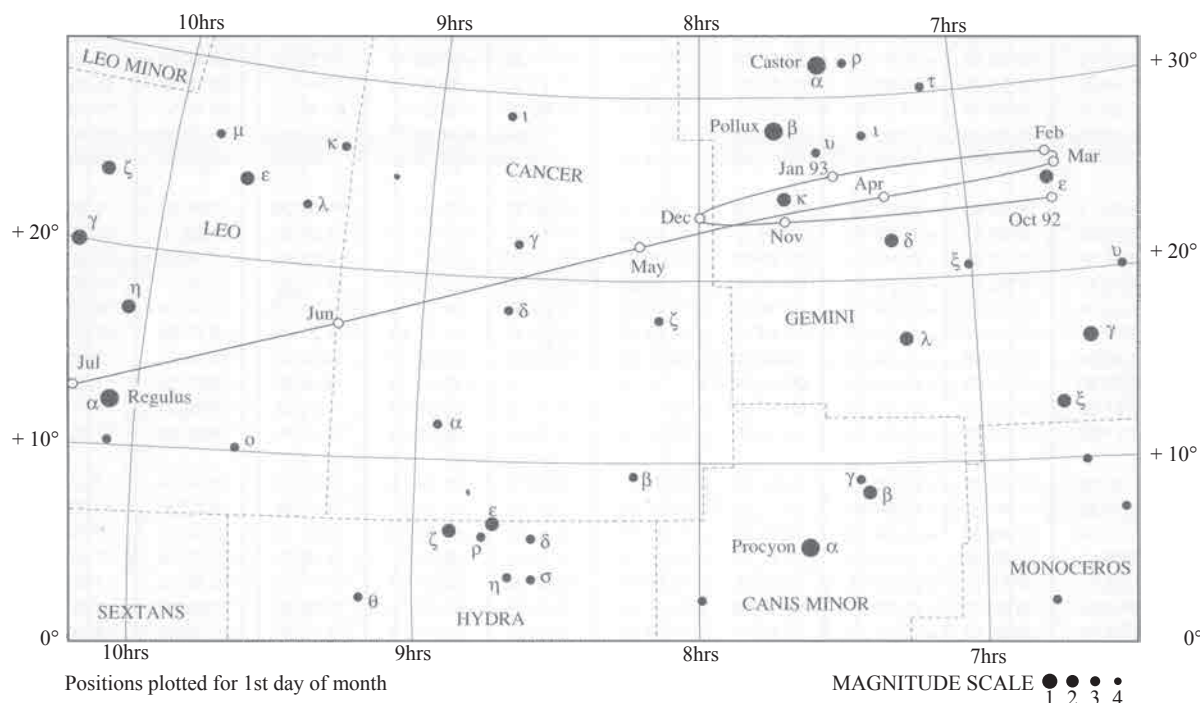
MARS

RISE, SET (for Sydney) (EAST) AND GEOCENTRIC POSITION (0HR UT, Epoch 200.0)

		RA	DEC	RISE	SET
		h m s	° ' "	h mm	h mm
Jan	2	07 29 36	+ 25 47 31	19:48	05:26
	9	07 17 27	+ 26 19 52	19:10	04:45
	16	07 05 36	+ 26 43 10	18:32	04:04
	23	06 55 10	+ 26 56 33	17:55	03:25
	30	06 47 04	+ 27 00 52	17:20	02:49
Feb	6	06 41 47	+ 26 58 09	16:47	02:16
	13	06 39 23	+ 26 50 28	16:17	01:47
	20	06 39 47	+ 26 39 14	15:49	01:20
	27	06 42 43	+ 26 25 12	15:24	00:56
Mar	6	06 47 54	+ 26 08 37	15:01	00:35
	13	06 54 59	+ 25 49 23	14:39	00:15
	20	07 03 40	+ 25 27 04	14:19	23:55
	27	07 13 41	+ 25 01 09	14:00	23:39
Apr	3	07 24 51	+ 24 31 10	13:42	23:25
	10	07 36 54	+ 23 56 43	13:25	23:11
	17	07 49 41	+ 23 17 26	13:08	22:59
	24	08 03 05	+ 22 33 00	12:51	22:47
May	1	08 16 58	+ 21 43 12	12:35	22:36
	8	08 31 13	+ 20 48 02	12:18	22:26
	15	08 45 45	+ 19 47 27	12:02	22:16
	22	09 00 31	+ 18 41 28	11:46	22:06
	29	09 15 28	+ 17 30 12	11:30	21:57
Jun	5	09 30 32	+ 16 13 53	11:14	21:49
	12	09 45 41	+ 14 52 46	10:57	21:40
	19	10 00 56	+ 13 27 02	10:41	21:32
	26	10 16 15	+ 11 57 01	10:24	21:24

		RA	DEC	RISE	SET
		h m s	° ' "	h mm	h mm
Jul	3	10 31 38	+ 10 23 05	10:08	21:16
	10	10 47 04	+ 08 45 36	09:51	21:08
	17	11 02 34	+ 07 04 54	09:34	21:01
	24	11 18 11	+ 05 21 24	09:18	20:54
	31	11 33 53	+ 03 35 33	09:01	20:47
Aug	7	11 49 43	+ 01 47 50	08:45	20:40
	14	12 05 42	- 00 01 19	08:28	20:33
	21	12 21 53	- 01 51 25	08:12	20:26
	28	12 38 17	- 03 41 53	07:56	20:20
Sep	4	12 54 55	- 05 32 07	07:40	20:14
	11	13 11 51	- 07 21 33	07:24	20:09
	18	13 29 07	- 09 09 33	07:09	20:03
	25	13 46 44	- 10 55 22	06:54	19:58
Oct	2	14 04 44	- 12 38 16	06:39	19:54
	9	14 23 10	- 14 17 28	06:25	19:49
	16	14 42 04	- 15 52 09	06:12	19:45
	23	15 01 28	- 17 21 23	05:59	19:42
	30	15 21 20	- 18 44 16	05:47	19:38
Nov	6	15 41 44	- 19 59 51	05:36	19:35
	13	16 02 38	- 21 07 11	05:26	19:32
	20	16 24 01	- 22 05 20	05:16	19:29
	27	16 45 52	- 22 53 22	05:08	19:26
Dec	4	17 08 08	- 23 30 29	05:01	19:22
	11	17 30 46	- 23 55 54	04:54	19:19
	18	17 53 42	- 24 09 03	04:49	19:15
	25	18 16 51	- 24 09 27	04:44	19:10

THE PATH OF MARS FROM OCTOBER 1992 TO JULY 1993



MARS AT OPPOSITION – 1992/1993

On January 8th 1993 Mars comes to opposition (closest approach occurs on 3rd January at a distance of 0.626 A.U. from Earth), providing the best opportunity to observe the red planet since November 1990. The interval between successive oppositions (the synodic period) is 779.8 days, but resulting from the highly elliptical nature of the planet's orbit the Earth/Mars distance at each opposition varies greatly. This apparition is a poor one but shouldn't be ignored by observers as ten years must lapse until the next favourable opposition (See figure 2).

When the Earth passes Mars every 26 months we get a close view of the planet; but when Mars is at perihelion (the point in it's orbit closest to the Sun) we get a particularly good view. The perihelic oppositions happen only every 15 or 17 years, with the next due in the year 2003. Oppositions happening in the early months of the year are always unfavourable because Mars is at aphelion and at close to twice the distance from the Earth than at perihelion. Also the planet's northern declination, at this time, means a low altitude for southern observers.

Perihelic oppositions happen around August, and fortunately for southern hemisphere observers, Mars is at it's greatest southerly declination then. When near conjunction (on the opposite side of the Sun from the Earth) Mars has a disc diameter of only 3.5 seconds of arc, smaller than Uranus, and scarcely worth telescope time; at a poor opposition the diameter is around 14", increasing to 25" at perihelic opposition (see figure 1). During the 1992/3 opposition the disc steadily grows from 3.88" at the beginning of 1992 to 15" on the 4th January 1993.

It's generally recommended that observations begin and end about six weeks either side of opposition; the period where most can be gained from the enlarged disc. Since the Martian day is about 40 minutes longer than that of the Earth, surface features cross the central meridian 40 minutes later each night. As the 40 minute delay equals about 8° of longitude per day, observations made at the same time each night will see all surface features cross the central meridian in a little over six weeks.

EPHEMERIS FOR PHYSICAL OBSERVATIONS (0HR UT)

NOVEMBER '92					DECEMBER '92					JANUARY '93					FEBRUARY '93					MARCH '93					APRIL '93				
Cent Mer °	Tilt °	P.A. °	Phase	Phase Angle	Cent Mer °	Tilt °	P.A. °	Phase	Phase Angle	Cent Mer °	Tilt °	P.A. °	Phase	Phase Angle	Cent Mer °	Tilt °	P.A. °	Phase	Phase Angle	Cent Mer °	Tilt °	P.A. °	Phase	Phase Angle	Cent Mer °	Tilt °	P.A. °	Phase	Phase Angle
1 186.5	12.0	346	0.891	039	268.7	12.6	349	0.941	028	352.8	08.6	345	0.997	007	079.7	04.1	339	0.973	019	184.8	04.6	339	0.926	032	254.3	09.0	344	0.901	037
2 177.1	12.1	346	0.892	038	259.6	12.6	349	0.943	028	344.0	08.4	345	0.998	006	070.8	04.0	339	0.971	020	175.5	04.7	339	0.925	032	244.8	09.2	344	0.901	037
3 167.7	12.2	347	0.893	038	250.6	12.5	349	0.945	027	335.3	08.2	345	0.998	005	061.8	04.0	339	0.970	020	166.2	04.8	339	0.923	032	235.4	09.3	344	0.901	037
4 158.3	12.2	347	0.895	038	241.5	12.5	349	0.947	027	326.5	08.0	344	0.999	004	052.8	03.9	339	0.968	021	157.0	04.9	339	0.922	032	225.9	09.5	344	0.901	037
5 148.9	12.3	347	0.896	038	232.5	12.4	349	0.950	026	317.8	07.8	344	0.999	004	043.8	03.9	339	0.966	021	147.7	05.0	339	0.921	033	216.4	09.7	345	0.900	037
6 139.6	12.4	347	0.897	037	223.4	12.3	349	0.952	025	309.0	07.7	344	0.999	003	034.8	03.9	339	0.964	022	138.4	05.1	339	0.920	033	206.9	09.9	345	0.900	037
7 130.2	12.5	347	0.898	037	214.4	12.2	349	0.954	025	300.3	07.5	344	0.999	003	025.8	03.8	338	0.962	022	129.1	05.2	339	0.919	033	197.4	10.1	345	0.900	037
8 120.9	12.5	347	0.900	037	205.4	12.1	349	0.956	024	291.5	07.3	343	1.000	003	016.8	03.8	338	0.960	023	119.8	05.4	339	0.918	033	187.9	10.3	345	0.900	037
9 111.5	12.6	348	0.901	037	196.4	12.0	349	0.958	024	282.7	07.1	343	0.999	003	007.8	03.8	338	0.959	024	110.5	05.5	340	0.917	034	178.4	10.4	346	0.900	037
10 102.2	12.6	348	0.903	036	187.4	11.9	349	0.960	023	274.0	06.9	343	0.999	003	358.7	03.8	338	0.957	024	101.1	05.6	340	0.916	034	168.9	10.6	346	0.899	037
11 092.9	12.7	348	0.904	036	178.5	11.8	349	0.963	022	265.2	06.8	343	0.999	004	349.7	03.8	338	0.955	025	091.8	05.7	340	0.915	034	159.4	10.8	346	0.899	037
12 083.6	12.7	348	0.906	036	169.5	11.7	349	0.965	022	256.5	06.6	343	0.999	004	340.6	03.8	338	0.953	025	082.5	05.9	340	0.914	034	149.9	11.0	346	0.899	037
13 074.3	12.8	348	0.907	036	160.6	11.6	349	0.967	021	247.7	06.4	342	0.998	005	331.5	03.8	338	0.951	026	073.1	06.0	340	0.913	034	140.4	11.2	347	0.899	037
14 065.0	12.8	348	0.909	035	151.7	11.5	348	0.969	020	238.9	06.3	342	0.997	006	322.4	03.8	338	0.949	026	063.8	06.1	340	0.912	035	130.9	11.4	347	0.899	037
15 055.7	12.8	348	0.910	035	142.7	11.3	348	0.971	020	230.2	06.1	342	0.997	007	313.3	03.8	338	0.948	026	054.4	06.3	340	0.911	035	121.3	11.6	347	0.899	037
16 046.4	12.9	349	0.912	035	133.8	11.2	348	0.973	019	221.4	05.9	342	0.996	007	304.2	03.8	338	0.946	027	045.0	06.4	341	0.910	035	111.8	11.8	347	0.899	037
17 037.2	12.9	349	0.914	034	125.0	11.1	348	0.975	018	212.6	05.8	341	0.995	008	295.1	03.9	338	0.944	027	035.7	06.6	341	0.909	035	102.3	11.9	348	0.899	037
18 027.9	12.9	349	0.915	034	116.1	10.9	348	0.977	018	203.8	05.6	341	0.994	009	286.0	03.9	338	0.943	028	026.3	06.7	341	0.909	035	092.7	12.1	348	0.899	037
19 018.7	12.9	349	0.917	033	107.2	10.8	348	0.979	017	195.0	05.5	341	0.993	010	276.8	03.9	338	0.941	028	016.9	06.9	341	0.908	035	083.2	12.3	348	0.899	037
20 009.5	12.9	349	0.919	033	098.4	10.6	348	0.981	016	186.2	05.3	341	0.992	010	267.7	04.0	338	0.939	029	007.5	07.0	341	0.907	036	073.7	12.5	348	0.899	037
21 000.2	12.9	349	0.921	033	089.5	10.5	347	0.982	015	177.4	05.2	341	0.991	011	258.5	04.0	338	0.938	029	358.1	07.2	341	0.907	036	064.1	12.7	349	0.899	037
22 351.0	12.9	349	0.923	032	080.7	10.3	347	0.984	014	168.6	05.1	340	0.989	012	249.3	04.1	338	0.936	029	348.7	07.3	342	0.906	036	054.6	12.9	349	0.899	037
23 341.8	12.9	349	0.925	032	071.8	10.2	347	0.986	014	159.7	04.9	340	0.988	013	240.1	04.2	338	0.935	030	339.3	07.5	342	0.905	036	045.0	13.1	349	0.900	037
24 332.7	12.9	349	0.927	031	063.0	10.0	347	0.987	013	150.9	04.8	340	0.986	013	230.9	04.2	338	0.933	030	329.9	07.6	342	0.905	036	035.4	13.3	350	0.900	037
25 323.5	12.9	349	0.929	031	054.2	09.8	347	0.989	012	142.0	04.7	340	0.985	014	221.7	04.3	338	0.932	030	320.4	07.8	342	0.904	036	025.9	13.5	350	0.900	037
26 314.3	12.9	349	0.931	031	045.4	09.7	346	0.990	011	133.2	04.6	340	0.983	015	212.5	04.4	339	0.930	031	311.0	08.0	342	0.904	036	016.3	13.7	350	0.900	037
27 305.2	12.8	349	0.933	030	036.6	09.5	346	0.992	011	124.3	04.5	340	0.982	016	203.3	04.5	339	0.929	031	301.6	08.1	343	0.903	036	006.7	13.9	350	0.900	037
28 296.0	12.8	349	0.935	030	027.8	09.3	346	0.993	010	115.4	04.4	339	0.980	016	194.0	04.5	339	0.927	031	292.1	08.3	343	0.903	036	357.2	14.1	351	0.900	037
29 286.9	12.7	349	0.937	029	019.1	09.1	346	0.994	009	106.5	04.3	339	0.978	017						282.7	08.5	343	0.902	036	347.6	14.3	351	0.901	037
30 277.8	12.7	349	0.939	029	010.3	08.9	346	0.995	008	097.6	04.2	339	0.977	018						273.2	08.6	343	0.902	037	338.0	14.5	351	0.901	037
31					001.5	08.8	345	0.996	007	088.6	04.2	339	0.975	018						263.8	08.8	343	0.902	037					

FIGURE 1

COMPARATIVE
SIZES OF MARS AT:

A - Conjunction
B - Poor opposition
C - Perihelic opposition

A
3.5"

B
14"

C
25"

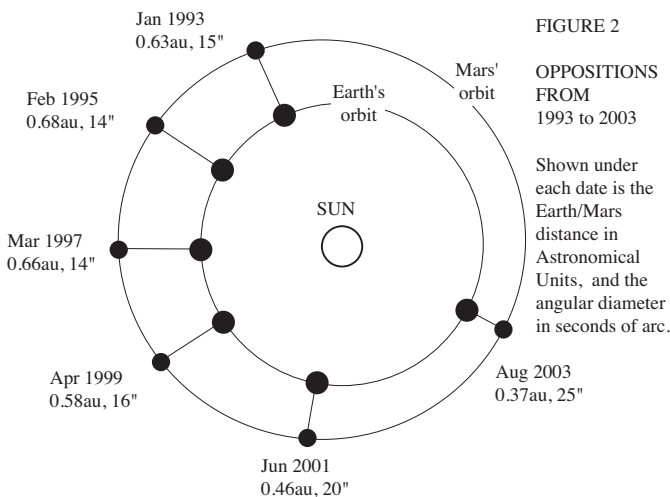


FIGURE 2

OPPOSITIONS
FROM
1993 to 2003

Shown under
each date is the
Earth/Mars
distance in
Astronomical
Units, and the
angular diameter
in seconds of arc.

Central Meridian — Increase in Longitude

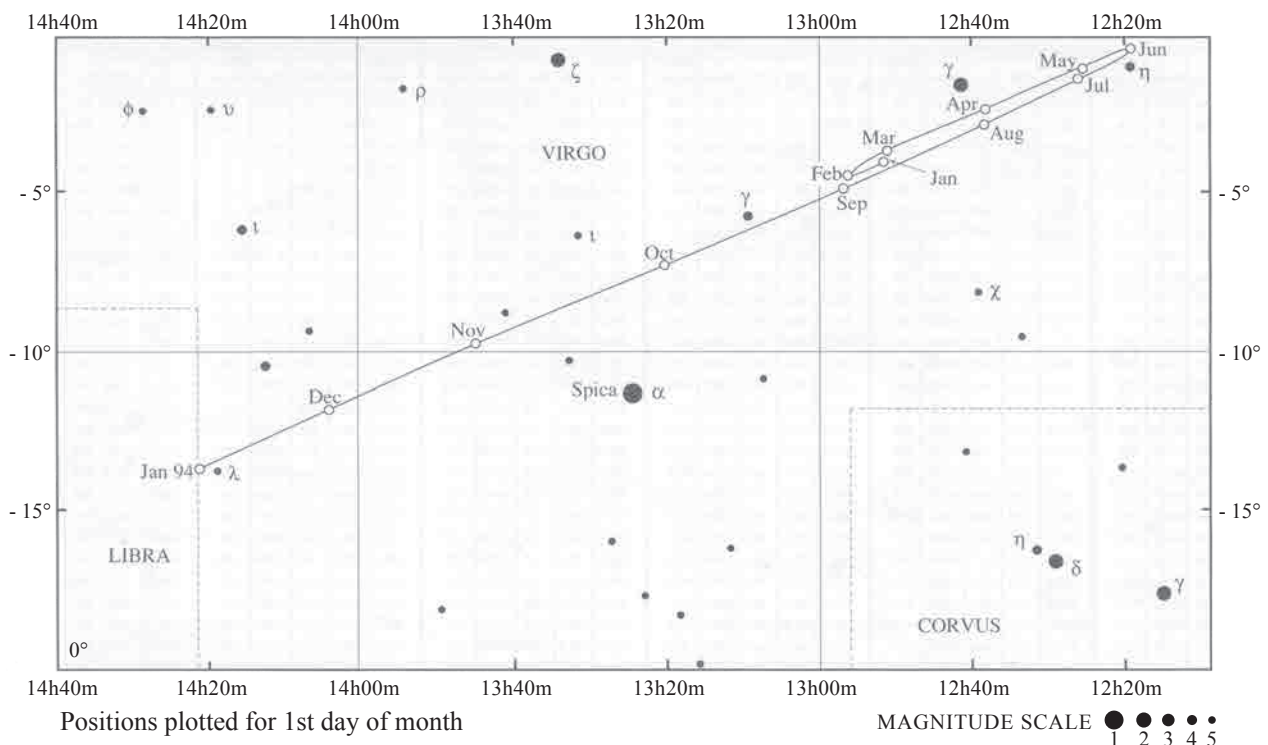
hr	deg°	hr	deg°	hr	deg°	hr	deg°	min	deg°
01	014.6	07	102.3	13	190.1	19	277.8	10	002.4
02	029.2	08	117.0	14	204.7	20	292.4	20	004.9
03	043.9	09	131.6	15	219.3	21	307.0	30	007.3
04	058.5	10	146.2	16	233.9	22	321.7	40	009.7
05	073.1	11	160.8	17	248.6	23	336.3	50	012.2
06	087.7	12	175.5	18	263.2	24	350.9		

JUPITER

RISE, SET (for Sydney) (EAST) AND GEOCENTRIC POSITION (0HR UT, Epoch 200.0)

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

JUPITER FINDER CHART



JUPITER — LONGITUDE OF CENTRAL MERIDIAN

SYSTEM I (0hr UT)														
DATE	JAN ◊	FEB ◊	MAR ◊	APR ◊	MAY ◊	JUN ◊	JUL ◊	AUG ◊	SEP ◊	OCT ◊	NOV ◊	DEC ◊	DATE	
1	273.7	129.8	234.2	093.4	153.1	007.6	061.0	269.8	117.5	167.4	015.6	067.3	1	
2	071.5	287.8	032.2	251.4	311.0	165.4	218.7	067.5	275.2	325.1	173.3	225.1	2	
3	229.5	085.8	190.2	049.4	109.0	323.2	016.4	225.2	072.9	122.8	331.0	022.8	3	
4	027.4	243.8	348.3	207.5	266.9	121.0	174.2	022.9	230.5	280.4	128.7	180.6	4	
5	185.3	041.8	146.3	005.5	064.9	278.9	331.9	180.5	028.2	078.1	286.4	338.3	5	
6	343.2	199.8	304.4	163.5	222.8	076.7	129.6	338.2	185.8	235.8	084.1	136.1	6	
7	141.1	357.7	102.4	321.5	020.7	234.5	287.3	135.9	343.5	033.5	241.8	293.9	7	
8	299.0	155.7	260.4	119.5	178.6	032.3	085.1	293.6	141.2	191.1	039.5	091.6	8	
9	096.9	313.7	058.5	277.5	336.5	190.1	242.8	091.2	298.8	348.8	197.3	249.4	9	
10	254.8	111.7	216.5	075.6	134.5	347.9	040.5	248.9	096.5	146.5	355.0	047.1	10	
11	052.8	269.8	014.6	233.6	292.4	145.7	198.2	046.6	254.1	304.2	152.7	204.9	11	
12	210.7	067.8	172.6	031.6	090.3	303.5	355.9	204.3	051.8	101.8	310.4	002.7	12	
13	008.6	225.8	330.7	189.6	248.2	101.3	153.6	001.9	209.5	259.5	108.1	160.5	13	
14	166.6	023.8	128.7	347.6	046.1	259.0	311.3	159.6	007.1	057.2	265.8	318.2	14	
15	324.5	181.8	286.7	145.6	204.0	056.8	109.1	317.3	164.8	214.9	063.6	116.0	15	
16	122.4	339.8	084.8	303.6	001.8	214.6	266.8	114.9	322.5	012.5	221.3	273.8	16	
17	280.4	137.8	242.8	101.6	159.7	012.4	064.5	272.6	120.1	170.2	019.0	071.6	17	
18	078.3	295.8	040.9	259.5	317.6	170.2	222.2	070.3	277.8	327.9	176.7	229.4	18	
19	236.3	093.9	198.9	057.5	115.5	327.9	019.9	227.9	075.4	125.6	334.5	027.1	19	
20	034.2	251.9	357.0	215.5	273.4	125.7	177.6	025.6	233.1	283.3	132.2	184.9	20	
21	192.2	049.9	155.0	013.5	071.2	283.5	335.3	183.3	030.8	081.0	289.9	342.7	21	
22	350.1	207.9	313.0	171.5	229.1	081.2	133.0	340.9	188.4	238.7	087.6	140.5	22	
23	148.1	006.0	111.1	329.4	027.0	239.0	290.7	138.6	346.1	036.3	245.4	298.3	23	
24	306.0	164.0	269.1	127.4	184.8	036.7	088.3	296.2	143.8	194.0	043.1	096.1	24	
25	104.0	322.0	067.2	285.4	342.7	194.5	246.0	093.9	301.4	351.7	200.9	253.9	25	
26	262.0	120.1	225.2	083.3	140.5	352.2	043.7	251.6	099.1	149.4	358.6	051.7	26	
27	059.9	278.1	023.2	241.3	298.4	150.0	201.4	049.2	256.8	307.1	156.3	209.5	27	
28	217.9	076.1	181.3	039.3	096.2	307.7	359.1	206.9	054.4	104.8	314.1	007.3	28	
29	015.9	339.3	339.3	197.2	254.1	105.5	156.8	004.6	212.1	262.5	111.8	165.1	29	
30	173.8	137.3	355.2	051.9	263.2	314.5	162.2	009.8	060.2	269.6	323.0		30	
31	331.8	295.4			209.7		112.1	319.9		217.9		120.8		31

SYSTEM II (0hr UT)													
DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DATE
1	316.2	295.8	186.5	169.2	360.0	337.9	162.5	134.8	106.0	287.0	258.7	081.5	1
2	106.4	086.1	336.9	319.6	150.3	128.1	312.6	284.9	256.0	077.0	048.7	231.6	2
3	256.7	236.5	127.3	110.0	300.6	278.3	102.7	074.9	046.1	227.1	198.8	021.7	3
4	047.0	026.9	277.7	260.4	090.9	068.5	252.8	225.0	196.1	017.1	348.9	171.8	4
5	197.3	177.2	068.1	050.7	241.2	218.7	042.9	015.0	346.1	167.2	138.9	322.0	5
6	347.5	327.6	218.5	201.1	031.5	008.9	193.0	165.1	136.2	317.2	289.0	112.1	6
7	137.8	117.9	008.9	351.5	181.8	159.1	343.1	315.1	286.2	107.3	079.1	262.2	7
8	288.1	268.3	159.3	141.9	332.1	309.3	133.2	105.2	076.2	257.3	229.2	052.3	8
9	078.4	058.7	309.8	292.3	122.4	099.4	283.2	255.2	226.3	047.3	019.3	202.5	9
10	228.7	209.1	100.2	082.7	272.7	249.6	073.3	045.2	016.3	197.4	169.3	352.6	10
11	019.0	359.4	250.6	233.0	063.0	039.8	223.4	195.3	166.3	347.4	319.4	142.8	11
12	169.3	149.8	041.0	023.4	213.2	189.9	013.5	345.3	316.4	137.5	109.5	292.9	12
13	319.6	300.2	191.4	173.8	003.5	340.1	163.6	135.4	106.4	287.5	259.6	083.0	13
14	109.9	090.6	341.8	324.2	153.8	130.2	313.7	285.4	256.4	077.6	049.7	233.2	14
15	260.2	240.9	132.2	114.5	304.0	280.4	103.7	075.4	046.4	227.6	199.8	023.3	15
16	050.5	031.3	282.6	264.9	094.3	070.5	253.8	225.5	196.5	017.7	349.9	173.5	16
17	200.8	181.7	073.1	055.3	244.6	220.7	043.9	015.5	346.5	167.7	140.0	323.6	17
18	351.1	332.1	223.5	205.6	034.8	010.8	194.0	165.5	136.5	317.8	290.1	113.8	18
19	141.4	122.5	013.9	356.0	185.1	161.0	344.0	315.6	286.6	107.8	080.2	263.9	19
20	291.8	272.9	164.3	146.3	335.3	311.1	134.1	105.6	076.6	257.9	230.3	054.1	20
21	082.1	063.3	314.7	296.7	125.5	101.3	284.2	255.7	226.6	048.0	020.4	204.3	21
22	232.4	213.7	105.1	087.0	275.8	251.4	074.2	045.7	016.7	198.0	170.5	354.4	22
23	022.7	004.1	255.5	237.4	066.0	041.5	224.3	195.7	166.7	348.1	320.6	144.6	23
24	173.1	154.5	045.9	027.7	216.2	191.6	014.4	345.8	316.7	138.1	110.7	294.8	24
25	323.4	304.9	196.3	178.0	006.5	341.8	164.4	135.8	106.8	288.2	260.8	084.9	25
26	113.7	095.3	346.8	328.4	156.7	131.9	314.5	285.8	256.8	078.3	050.9	235.1	26
27	264.1	245.7	137.2	118.7	306.9	282.0	104.5	075.9	046.9	228.3	201.0	025.3	27
28	054.4	036.1	287.6	269.0	097.1	072.1	254.6	225.9	196.9	018.4	351.1	175.5	28
29	204.7	078.0	059.4	247.3	247.3	222.2	044.7	015.9	346.9	168.4	141.2	325.6	29

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

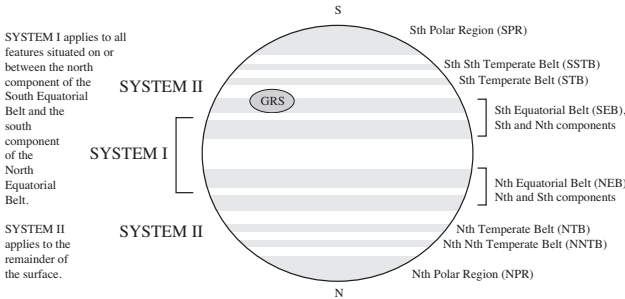
Increase in longitude

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

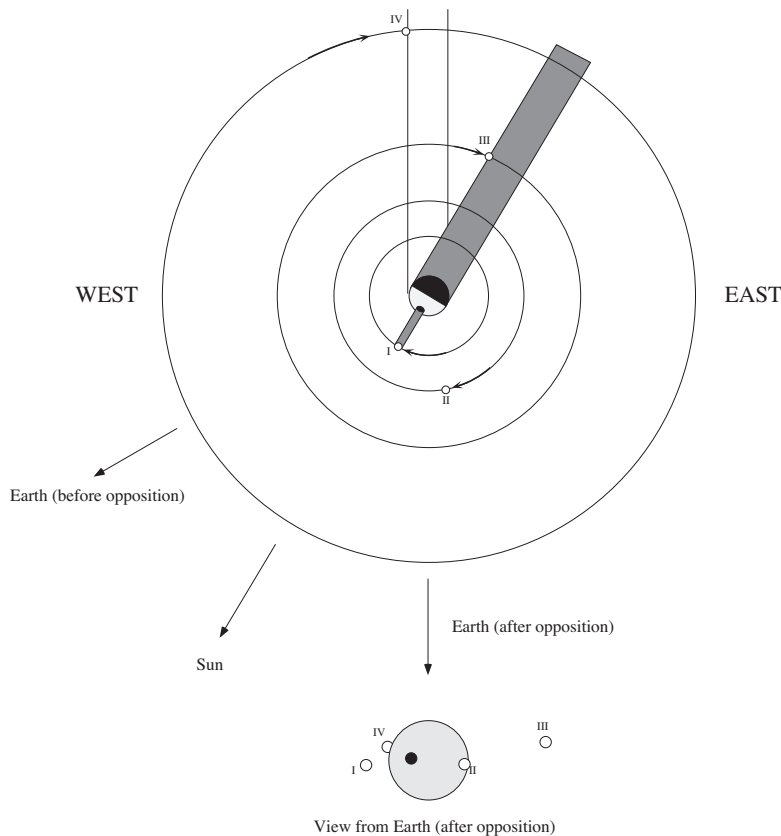


JUPITER SATELLITE EVENTS

EXPLANATION

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 proposed them to be called the ‘Medicean Stars’), are bright enough to be visible to the smallest of 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” in Part 1 of this publication. All the moons orbit in roughly the same plane, which is very close to that of the Earth (plane of the ecliptic). 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 can appear to move across the face of Jupiter as it passes in front of the planet. 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 - 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 1993 is March 30.
- 3 A satellite can go into **occultation** ie. 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 ie. disappearance or reappearance, will be obscured (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. The positions for the disappearance (d) and reappearance (r) for each moon, relative to Jupiter, for each month, is presented diagrammatically in the “Phases of the Eclipses” (under the “Jupiter’s Moons”) in Part 1. The event positions, as measured in Jupiter radii (East-West, North-South) from the planet’s centre, is presented in tabular form on page 93.



The diagram at left 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: There are no events for Callisto (IV) during 1993

JUPITER SATELLITE EVENT TABLES (following 2 pages)

Legend

- Column 1 Date & time (in EAST). 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

JUPITER SATELLITE EVENTS (Times are EAST)

JANUARY				
3 2:34 III Ec R 4:39 III Oc D 4:42 I Sh I	8 1:48 II Oc R	14 1:06 III Tr E 23:23 II Ec D	22 1:59 II Ec D	28 0:26 I Tr I 1:20 III Sh I 1:31 I Sh E 2:37 I Tr E 4:17 III Sh E 23:45 I Oc R
4 1:50 I Ec D	10 3:30 III Ec D	15 4:20 II Oc R	23 22:33 II Tr I 22:42 II Sh E	29 4:34 II Ec D
5 0:24 I Tr I 1:23 I Sh E 2:35 I Tr E 23:44 I Oc R	11 3:43 I Ec D	19 2:57 I Sh I 4:08 I Tr I	24 0:56 II Tr E	30 22:45 II Sh I
6 1:48 II Sh I 4:16 II Tr I 4:19 II Sh E	12 1:03 I Sh I 2:16 I Tr I 3:16 I Sh E 4:27 I Tr E	20 0:04 I Ec D 3:27 I Oc R 22:36 I Tr I 23:37 I Sh E	26 4:50 I Sh I	31 1:00 II Tr I 1:16 II Sh E 3:23 II Tr E 22:33 III Oc R
13 1:36 I Oc R 4:21 II Sh I		21 0:20 III Sh E 0:46 I Tr E 2:19 III Tr I 4:54 III Tr E		
FEBRUARY				
1 22:31 II Oc R	7 1:19 II Sh I 3:25 II Tr I 3:49 II Sh E 22:17 III Ec R 23:38 III Oc D	13 0:41 I Tr E 21:48 I Oc R	19 2:05 I Ec D 5:08 I Oc R 23:26 I Sh I	24 21:18 II Tr I 22:14 II Sh E 23:41 II Tr E
3 3:50 I Ec D	8 2:11 III Oc R	14 3:53 II Sh I 23:17 III Ec D	20 0:17 I Tr I 1:39 I Sh E 2:27 I Tr E 20:33 I Ec D 23:35 I Oc R	25 20:20 III Tr I 22:49 III Tr E
4 1:11 I Sh I 2:15 I Tr I 3:24 I Sh E 4:26 I Tr E 5:18 III Sh I 22:18 I Ec D	9 0:55 II Oc R	15 2:14 III Ec R 3:12 III Oc D 23:01 II Ec D	21 20:54 I Tr E	26 3:58 I Ec D
5 1:34 I Oc R 21:52 I Sh E 22:53 I Tr E	11 3:05 I Sh I 4:03 I Tr I 5:17 I Sh E	16 3:17 II Oc R	22 3:16 III Ec D	27 1:20 I Sh I 2:03 I Tr I 3:32 I Sh E 4:13 I Tr E 22:27 I Ec D
	12 0:12 I Ec D 3:21 I Oc R 21:33 I Sh I 22:30 I Tr I 23:45 I Sh E	17 21:21 II Tr E	23 1:35 II Ec D 5:37 II Oc R	28 1:20 I Oc R 20:29 I Tr I 22:00 I Sh E 22:40 I Tr E
18 4:58 I Sh I				
MARCH				
2 4:10 II Ec D	8 0:25 I Tr E 21:32 I Oc R	15 1:47 I Sh E 2:09 I Tr E 19:18 III Oc R 20:42 I Ec D 23:16 I Oc R	22 1:29 I Sh I 1:42 I Tr I 3:41 I Sh E 3:53 I Tr E 19:07 III Ec D 22:36 III Oc R 22:36 I Ec D	28 6:02 I Ec D 19:22 II Sh I 19:31 II Tr I 21:52 II Sh E 21:55 II Tr E
3 22:19 II Sh I 23:36 II Tr I	11 0:53 II Sh I 1:53 II Tr I 3:24 II Sh E 4:16 II Tr E	16 20:16 I Sh E 20:35 I Tr E	23 1:00 I Oc R 19:57 I Sh I 20:08 I Tr I 22:10 I Sh E 22:19 I Tr E	29 3:22 I Sh I 3:26 I Tr I 5:35 I Sh E 5:36 I Tr E 23:06 III Ec D
4 0:49 II Sh E 1:59 II Tr E 21:08 III Sh I 23:44 III Tr I	12 1:06 III Sh I 3:04 III Tr I 3:58 III Sh E 5:34 III Tr E 20:02 II Ec D 23:20 II Oc R	18 3:29 II Sh I 4:09 II Tr I	24 19:26 I Oc R	30 0:30 I Ec D 1:57 III Ec R 2:44 I Oc R 21:51 I Sh I 21:51 I Tr I
5 0:01 III Sh E 2:13 III Tr E 21:04 II Oc R		19 5:04 III Sh I 22:37 II Ec D	27 1:11 II Ec D 3:49 II Oc R	31 0:02 I Tr E 0:03 I Sh E 18:58 I Oc D 21:12 I Ec R
6 3:13 I Sh I 3:48 I Tr I 5:26 I Sh E	13 5:06 I Sh I 5:32 I Tr I	20 1:35 II Oc R		
7 0:20 I Ec D 3:05 I Oc R 21:41 II Sh I 22:14 I Tr I 23:54 I Sh E	14 2:14 I Ec D 4:50 I Oc R 23:35 I Sh I 23:58 I Tr I	21 4:08 I Ec D 19:16 II Sh E 19:39 II Tr E		

JUPITER SATELLITE EVENTS (Times are EAST)

APRIL				
1 18:28 I Tr E 18:32 I Sh E	7 1:57 I Sh E 20:42 I Oc D 23:06 I Ec R	14 1:19 I Tr I 1:39 I Sh I 3:30 I Tr E 3:51 I Sh E 22:27 I Oc D	20 21:15 II Oc D	24 3:43 III Sh E 18:08 I Tr E 18:42 I Sh E
3 3:39 II Oc D	8 18:01 I Tr I 18:13 I Sh I 20:12 I Tr E 20:26 I Sh E	15 1:01 I Ec R 19:45 I Tr I 20:07 I Sh I 21:56 I Tr E 22:19 I Sh E	21 0:41 II Ec R 3:04 I Tr I 3:33 I Sh I	27 17:48 III Ec R 23:31 II Oc D
4 21:45 II Tr I 21:58 II Sh I	9 18:43 III Tr E 19:47 III Sh E	16 19:24 III Tr I 19:29 I Ec R 20:57 III Sh I 22:02 III Tr E 23:45 III Sh E	22 0:11 I Oc D 2:55 I Ec R 17:52 II Tr E 18:58 II Sh E 21:30 I Tr I 22:02 I Sh I 23:41 I Tr E	28 3:15 II Ec R
5 0:10 II Tr E 0:27 II Sh E 5:09 I Tr I 5:16 I Sh I	12 0:01 II Tr I 0:34 II Sh I 2:26 II Tr E 3:03 II Sh E	19 2:17 II Tr I 3:10 II Sh I 4:43 II Tr E	23 0:13 I Sh E 18:38 I Oc D 21:24 I Ec R 22:44 III Tr I	29 1:57 I Oc D 17:44 II Tr I 19:06 II Sh I 20:11 II Tr E 21:34 II Sh E 23:16 I Tr I 23:56 I Sh I
6 2:16 I Oc D 2:35 III Ec D 4:38 I Ec R 19:32 II Ec R 23:35 I Tr I 23:45 I Sh I	13 4:00 I Oc D 19:00 II Oc D 22:06 II Ec R		24 0:56 III Sh I 1:24 III Tr E	30 1:27 I Tr E 2:07 I Sh E 20:24 I Oc D 23:19 I Ec R
7 1:46 I Tr E				
MAY				
1 2:06 III Tr I 17:42 I Tr I 18:24 I Sh I 19:53 I Tr E 20:36 I Sh E	7 3:13 I Tr E 22:11 I Oc D	14 0:20 II Sh I 0:55 II Tr E 2:48 II Sh E 2:50 I Tr I 23:58 I Oc D	19 1:43 III Oc R	25 18:01 I Ec R
2 17:47 I Ec R	8 1:13 I Ec R 19:06 II Ec R 19:29 I Tr I 20:19 I Sh I 21:40 I Tr E 22:30 I Sh E	15 17:19 II Oc D 21:17 I Tr I 21:40 II Ec R 22:13 I Sh I 23:28 I Tr E	21 0:51 II Tr I	29 19:04 III Tr E 20:50 III Sh I 22:07 II Oc D 23:32 III Sh E
4 18:38 III Oc R 19:00 III Ec D 21:46 III Ec R	9 19:43 I Ec R	16 0:24 I Sh E 18:26 I Oc D 21:37 I Ec R	22 1:47 I Oc D 19:34 III Sh E 19:42 II Oc D 23:06 I Tr I	30 0:55 I Tr I 22:05 I Oc D
5 1:49 II Oc D	11 19:20 III Oc D 22:08 III Oc R 22:59 III Ec D	17 17:55 I Tr E 18:53 I Sh E	23 0:08 I Sh I 0:15 II Ec R 1:17 I Tr E 2:18 I Sh E 20:15 I Oc D 23:32 I Ec R	31 1:27 I Ec R 18:53 II Sh I 19:02 II Tr E 19:23 I Tr I 20:31 I Sh I 21:20 II Sh E 21:34 I Tr E 22:41 I Sh E
6 20:04 II Tr I 21:43 II Sh I 22:32 II Tr E	12 1:44 III Ec R	18 22:53 III Oc D	24 17:33 I Tr I 18:36 I Sh I 18:43 II Sh E 19:44 I Tr E 20:47 I Sh E	
7 0:11 II Sh E 1:02 I Tr I 1:50 I Sh I	13 22:27 II Tr I			
JUNE				
1 19:56 I Ec R	7 22:25 I Sh I 23:26 I Tr E 23:57 II Sh E	14 21:35 II Tr I 23:07 I Tr I	21:38 III Ec R	22:53 I Sh E 22:56 III Ec D 23:49 II Ec R
2 17:10 I Sh E	8 0:36 I Sh E 18:25 I Oc D 21:51 I Ec R	15 0:05 II Tr E 0:08 II Sh I 0:20 I Sh I 20:18 I Oc D 23:46 I Ec R	17 18:15 I Ec R	24 20:10 I Ec R
5 19:56 III Tr I 22:48 III Tr E	9 16:54 I Sh I 17:39 III Ec R 17:54 I Tr E 18:40 II Ec R 19:04 I Sh E	16 17:35 I Tr I 18:49 I Sh I 18:57 III Ec D 19:46 I Tr E 20:59 I Sh E 21:15 II Ec R	22 0:09 II Tr I 22:12 I Oc D	25 17:22 I Sh E 18:31 II Sh E
6 0:34 II Oc D 0:49 III Sh I 23:57 I Oc D	12 23:45 III Tr I		23 17:40 III Oc D 18:51 II Oc D 19:28 I Tr I 20:37 III Oc R 20:43 I Sh I 21:22 II Oc R 21:23 II Ec D 21:40 I Tr E	30 21:23 I Tr I 21:25 II Oc D 21:39 III Oc D 22:38 I Sh I 23:34 I Tr E
7 19:02 II Tr I 21:14 I Tr I 21:30 II Sh I 21:33 II Tr E				

JUPITER SATELLITE EVENTS (Times are EAST)

						JULY								
1 18:36	I	Oc D	8 20:32	I	Oc D	11 18:15	II	Ec R	19:44	III	Tr I	18:38	II	Oc D
22:06	I	Ec R				18:31	III	Tr E	20:49	II	Ec R	19:29	I	Sh E
			9 17:47	I	Tr I	20:46	III	Sh I	22:38	III	Tr E			
2 17:07	I	Sh I	18:45	II	Tr I							27 18:18	II	Sh E
18:03	I	Tr E	19:01	I	Sh I	15 22:29	I	Oc D	22 17:32	III	Ec R	29 18:55	III	Ec D
18:37	II	Tr E	19:56	I	Tr E							21:30	III	Ec R
18:43	II	Sh I	21:11	I	Sh E	16 19:44	I	Tr I	23 21:41	I	Tr I			
19:17	I	Sh E	21:17	II	Tr E	20:56	I	Sh I				31 20:55	I	Oc D
21:08	II	Sh E	21:20	II	Sh I	21:27	II	Tr I	24 18:56	I	Oc D			
						21:55	I	Tr E	22:20	I	Ec R			
4 19:24	III	Sh E	10 18:30	I	Ec R	17 20:25	I	Ec R	25 17:19	I	Sh I			
7 23:18	I	Tr I				18 17:35	I	Sh E	18:22	I	Tr E			
						AUGUST								
1 18:08	I	Tr I	3 20:55	II	Sh E	10 17:47	I	Sh E	17 17:31	I	Sh I	24 18:35	I	Tr I
19:14	I	Sh I				19:01	II	Tr I	18:47	I	Tr E	19:26	I	Sh I
20:20	I	Tr E	5 18:24	III	Oc D	21:08	II	Sh I	19:42	I	Sh E	20:47	I	Tr E
21:20	II	Oc D	21:20	III	Oc R	21:32	II	Tr E						
21:24	I	Sh E							19 20:25	II	Ec R	25 18:57	I	Ec R
2 18:44	I	Ec R	8 20:06	I	Tr I	12 17:50	II	Ec R	23 19:54	III	Tr E	26 18:54	II	Oc D
			21:08	I	Sh I				20:41	III	Sh I			
3 18:31	II	Sh I	9 17:24	I	Oc D	16 19:14	III	Sh E				28 18:04	II	Sh E
18:47	II	Tr E	20:39	I	Ec R	19:24	I	Oc D						
						SEPTEMBER								
1 17:55	I	Oc D	4 18:16	II	Sh I	9 17:43	I	Sh I	16 19:06	I	Tr I	24 18:28	I	Oc D
			19:19	II	Tr E	19:17	I	Tr E	19:38	I	Sh I	25 18:11	I	Sh E
2 17:59	I	Sh E				19:54	I	Sh E				28 19:03	III	Sh E
			8 19:56	I	Oc D				17 19:10	I	Ec R			
						NOVEMBER								
4 4:46	II	Tr I	20 3:38	II	Ec D	23 3:52	I	Sh E	29 3:36	II	Sh E	30 3:35	I	Sh I
						4:27	I	Tr E				4:16	I	Tr I
13 4:18	II	Oc R	22 4:32	I	Ec D									
						DECEMBER								
1 3:46	I	Oc R	8 2:47	I	Ec D	16 2:45	I	Tr I	22 3:18	II	Ec D	31 2:42	III	Tr E
						4:02	I	Sh E				2:48	II	Tr I
2 4:22	III	Sh I	9 2:56	I	Tr E				23 3:45	I	Sh I	2:55	I	Ec D
						17 2:13	I	Oc R				3:04	II	Sh E
6 3:47	II	Sh I	13 4:14	III	Oc R	20 2:26	III	Ec D	24 2:27	II	Tr E			
									4:10	I	Oc R			

JUPITER ECLIPSE CO-ORDINATES

MONTH	1 Ec D	1 Ec R	2 Ec D	2 Ec R	3 EC D	3 Ec R
Jan	2.0W - 0.3S	—	2.5W - 0.5S	—	3.4W - 0.6S	1.8W - 0.6S
Feb	1.7W - 0.3S	—	2.1W - 0.5S	—	2.8W - 0.7S	1.2W - 0.7S
Mar	1.3W - 0.3S	—	1.3W - 0.5S	—	1.6W - 0.7S	—
Apr	—	1.3E - 0.3S	—	1.4E - 0.5S	—	1.5E - 0.6S
May	—	1.8E - 0.2S	—	2.2E - 0.5S	1.5E - 0.6S	3.0E - 0.6S
Jun	—	2.0E - 0.2S	—	2.5E - 0.4S	2.0E - 0.6S	3.5E - 0.5S
Jul	—	2.0E - 0.2S	—	2.5E - 0.4S	2.0E - 0.5S	3.4E - 0.5S
Aug	—	1.8E - 0.2S	—	2.1E - 0.4S	1.5E - 0.6S	2.9E - 0.6S
Sep	—	1.4E - 0.2S	—	1.5E - 0.5S	—	1.8E - 0.6S
Oct	—	1.0E - 0.3S	—	1.0E - 0.5S	—	1.0E - 0.6S
Nov	1.4W - 0.3S	—	1.5W - 0.5S	—	1.6W - 0.7S	—
Dec	1.7W - 0.3S	—	2.0W - 0.5S	—	2.5W - 0.7S	1.3W - 0.7S

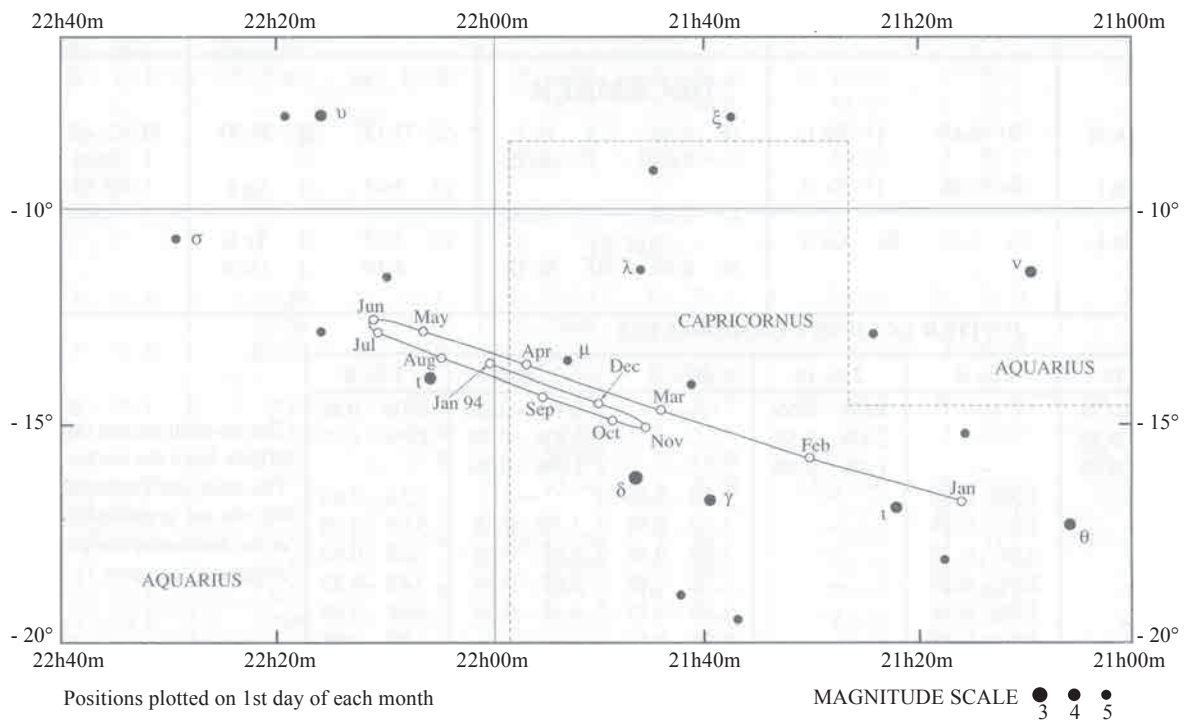
The co-ordinates to the left are offsets from the centre of Jupiter. The units are "Jupiter Radii". These figures are graphically represented at the bottom of the configuration diagrams. (see part 1).

SATURN

RISE, SET (for Sydney) (EAST) AND GEOCENTRIC POSITION (0HR UT, Epoch 200.0)

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

SATURN FINDER CHART



SATURN LONGITUDE OF CENTRAL MERIDIAN (System I)

Date	JAN °	FEB °	MAR °	APR °	MAY °	JUN °
1	271.9	161.0	038.4	289.9	058.7	313.3
2	036.1	285.1	162.6	054.2	183.0	077.7
3	160.2	049.3	286.9	178.4	307.3	202.1
4	284.4	173.5	051.1	302.7	071.7	326.4
5	048.5	297.7	175.3	067.0	196.0	090.8
6	172.7	061.9	299.5	191.3	320.3	215.2
7	296.8	186.0	063.7	315.5	084.6	339.5
8	061.0	310.2	188.0	079.8	209.0	103.9
9	185.2	074.4	312.2	204.1	333.3	228.3
10	309.3	198.6	076.4	328.4	097.6	352.7
11	073.5	322.8	200.7	092.7	222.0	117.0
12	197.6	087.0	324.9	216.9	346.3	241.4
13	321.8	211.2	089.1	341.2	110.6	005.8
14	085.9	335.4	213.4	105.5	235.0	130.2
15	210.1	099.6	337.6	229.8	359.3	254.5
16	334.3	223.8	101.8	354.1	123.7	018.9
17	098.4	348.0	226.1	118.4	248.0	143.3
18	222.6	112.2	350.3	242.7	012.4	267.7
19	346.8	236.3	114.6	007.0	136.7	032.1
20	110.9	000.6	238.8	131.3	261.0	156.5
21	235.1	124.8	003.1	255.6	025.4	280.8
22	359.2	249.0	127.3	019.9	149.7	045.2
23	123.4	013.2	251.6	144.2	274.1	169.6
24	247.6	137.4	015.8	268.5	038.5	294.0
25	011.8	261.6	140.1	032.8	162.8	058.4
26	135.9	025.8	264.3	157.1	287.2	182.8
27	260.1	150.0	028.6	281.4	051.5	307.2
28	024.3	274.2	152.8	045.7	175.9	071.6
29	148.4		277.1	170.1	300.2	195.9
30	272.6		041.4	294.4	064.6	320.3
31	036.8		165.6		189.0	

Date	JUL °	AUG °	SEP °	OCT °	NOV °	DEC °
1	084.7	340.9	236.5	006.0	257.7	023.5
2	209.1	105.3	000.8	130.3	021.9	147.6
3	333.5	229.7	125.1	254.6	146.2	271.8
4	097.9	354.1	249.5	018.8	270.4	036.0
5	222.3	118.5	013.8	143.1	034.6	160.1
6	346.7	242.9	138.2	267.4	158.8	284.3
7	111.1	007.2	262.5	031.7	283.0	048.5
8	235.5	131.6	026.8	155.9	047.2	172.6
9	359.9	256.0	151.2	280.2	171.4	296.8
10	124.3	020.4	275.5	044.5	295.6	061.0
11	248.7	144.8	039.8	168.7	059.8	185.1
12	013.1	269.1	164.2	293.0	184.0	309.3
13	137.5	033.5	288.5	057.2	308.2	073.4
14	261.8	157.9	052.8	181.5	072.4	197.6
15	026.2	282.3	177.1	305.8	196.6	321.8
16	150.6	046.7	301.5	070.0	320.8	085.9
17	275.0	171.0	065.8	194.3	085.0	210.1
18	039.4	295.4	190.1	318.5	209.1	334.2
19	163.8	059.8	314.4	082.7	333.3	098.4
20	288.2	184.1	078.7	207.0	097.5	222.5
21	052.6	308.5	203.0	331.2	221.7	346.7
22	177.0	072.9	327.3	095.5	345.9	110.9
23	301.4	197.2	091.6	219.7	110.1	235.0
24	065.8	321.6	215.9	343.9	234.2	359.2
25	190.2	086.0	340.2	108.2	358.4	123.3
26	314.6	210.3	104.5	232.4	122.6	247.5
27	079.0	334.7	228.8	356.6	246.8	011.6
28	203.4	099.0	353.1	120.9	010.9	135.8
29	327.8	223.4	117.4	245.1	135.1	259.9
30	092.1	347.7	241.7	009.3	259.3	024.1
31	216.5	112.1		133.5		148.3

SATURN'S RINGS

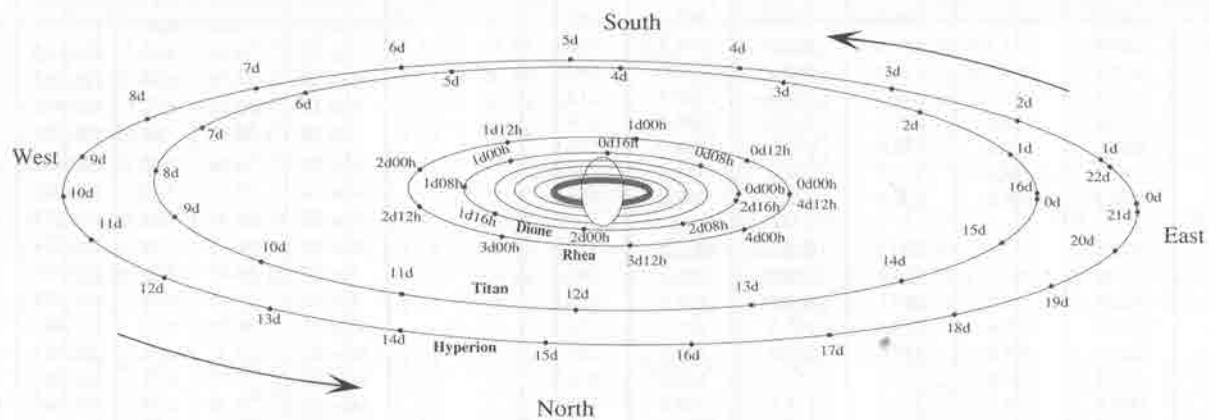
Date	Major "	Minor "	U °	B °
Jan 01	35.43	9.65	190.657	15.806
Jan 09	35.20	9.38	191.475	15.452
Jan 17	35.02	9.11	192.328	15.081
Jan 25	34.89	8.85	193.207	14.695
Feb 02	34.81	8.60	194.102	14.299
Feb 10	34.79	8.36	195.003	13.897
Feb 18	34.82	8.12	195.902	13.494
Feb 26	34.90	7.91	196.790	13.094
Mar 06	35.04	7.70	197.657	12.701
Mar 14	35.22	7.52	198.495	12.320
Mar 22	35.46	7.34	199.297	11.954
Mar 30	35.74	7.19	200.054	11.609
Apr 07	36.07	7.06	200.758	11.289
Apr 15	36.45	6.95	201.402	10.998
Apr 23	36.86	6.87	201.980	10.739
May 01	37.31	6.81	202.483	10.517
May 09	37.79	6.78	202.907	10.335
May 17	38.30	6.78	203.246	10.195
May 25	38.83	6.81	203.496	10.100
Jun 02	39.36	6.87	203.652	10.052
Jun 10	39.90	6.96	203.714	10.052
Jun 18	40.42	7.09	203.681	10.098
Jun 26	40.93	7.24	203.553	10.192
Jul 04	41.40	7.42	203.336	10.328
Jul 12	41.82	7.62	203.035	10.504
Jul 20	42.19	7.84	202.658	10.716
Jul 28	42.48	8.07	202.216	10.956
Aug 05	42.70	8.31	201.724	11.216
Aug 13	42.83	8.53	201.197	11.490
Aug 21	42.86	8.74	200.651	11.768
Aug 29	42.80	8.93	200.105	12.040
Sep 06	42.65	9.09	199.577	12.299
Sep 14	42.42	9.21	199.084	12.536
Sep 22	42.10	9.29	198.644	12.743
Sep 30	41.72	9.32	198.272	12.914
Oct 08	41.28	9.32	197.978	13.045
Oct 16	40.80	9.27	197.774	13.132
Oct 24	40.28	9.18	197.666	13.171
Nov 01	39.75	9.05	197.658	13.162
Nov 09	39.21	8.89	197.752	13.105
Nov 17	38.68	8.70	197.947	13.000
Nov 25	38.16	8.49	198.240	12.848
Dec 03	37.67	8.25	198.626	12.653
Dec 11	37.20	8.00	199.099	12.417
Dec 19	36.78	7.74	199.652	12.142
Dec 27	36.39	7.46	200.278	11.832

See introduction to part 2 (p 63)
for explanation

Increase in Longitude

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

SATELLITES OF SATURN



APPARENT ORBITS OF SATELLITES I - VII AT DATE OF OPPOSITION, AUGUST 19

NAME	MEAN SYNODIC PERIOD	NAME	MEAN SYNODIC PERIOD
	d h		d h
I Mimas	0 22.6	VI Titan	15 23.3
II Enceladus	1 08.9	VII Hyperion	21 07.6
III Tethys	1 21.3	VIII Iapetus	79 22.1
IV Dione	2 17.7	IX Phoebe	523 15.6
V Rhea	4 12.5		

IAPETUS (EAST)

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
Mar 3 02.6	Jan 1 00.8	Jan 22 09.8	Feb 11 19.3
May 22 18.8	Mar 23 10.0	Apr 13 17.2	May 3 18.3
Aug 9 15.9	Jun 11 18.5	Jul 2 13.0	Jul 22 01.7
Oct 27 03.9	Aug 29 05.4	Sep 18 18.7	Oct 8 09.4
	Nov 16 01.0	Dec 7 02.9	Dec 27 05.7

TITAN (EAST)

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
Jan 2 17.1	Jan 6 20.0	Jan 11 00.1	Jan 14 21.3
Jan 18 17.5	Jan 22 20.6	Jan 27 00.7	Jan 30 21.8
Feb 3 18.1	Feb 7 21.4	Feb 12 01.3	Feb 15 22.3
Feb 19 18.7	Feb 23 22.1	Feb 28 01.9	Mar 3 22.8
Mar 7 19.3	Mar 11 22.7	Mar 16 02.4	Mar 19 23.1
Mar 23 19.7	Mar 27 23.1	Apr 1 02.7	Apr 4 23.3
Apr 8 19.9	Apr 12 23.4	Apr 17 02.8	Apr 20 23.2
Apr 24 19.8	Apr 28 23.3	May 3 02.6	May 6 22.9
May 10 19.4	May 14 22.9	May 19 02.0	May 22 22.2
May 26 18.6	May 30 22.0	Jun 4 01.0	Jun 7 21.1
Jun 11 17.5	Jun 15 20.8	Jun 19 23.7	Jun 23 19.7
Jun 27 15.9	Jul 1 19.1	Jul 5 21.9	Jul 9 17.9
Jul 13 14.0	Jul 17 17.1	Jul 21 19.9	Jul 25 15.8
Jul 29 11.8	Aug 2 14.8	Aug 6 17.6	Aug 10 13.5
Aug 14 09.4	Aug 18 12.3	Aug 22 15.1	Aug 26 11.1
Aug 30 07.0	Sep 3 09.7	Sep 7 12.7	Sep 11 08.7
Sep 15 04.6	Sep 19 07.4	Sep 23 10.5	Sep 27 06.6
Oct 1 02.5	Oct 5 05.3	Oct 9 08.5	Oct 13 04.7
Oct 17 00.7	Oct 21 03.6	Oct 25 06.9	Oct 29 03.3
Nov 1 23.3	Nov 6 02.3	Nov 10 05.7	Nov 14 02.2
Nov 17 22.4	Nov 22 01.5	Nov 26 05.0	Nov 30 01.5
Dec 3 21.8	Dec 8 01.1	Dec 12 04.6	Dec 16 01.2
Dec 19 21.6	Dec 24 01.0	Dec 28 04.6	Jan 1 01.2

HYPERION (EAST)

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
Jan 4 06.6	Jan 9 00.2	Jan 13 22.2	Jan 19 23.0
Jan 25 17.5	Jan 30 10.5	Feb 4 09.4	Feb 10 11.4
Feb 16 05.0	Feb 20 21.5	Feb 25 21.4	Mar 4 00.2
Mar 9 16.7	Mar 14 08.6	Mar 19 09.4	Mar 25 13.1
Mar 31 04.4	Apr 4 19.9	Apr 9 21.6	Apr 16 01.6
Apr 21 15.8	Apr 26 06.8	May 1 09.1	May 7 13.5
May 13 02.6	May 17 17.1	May 22 20.1	May 29 00.3
Jun 3 12.6	Jun 8 02.7	Jun 13 05.9	Jun 19 10.0
Jun 24 21.4	Jun 29 11.2	Jul 4 14.5	Jul 10 18.3
Jul 16 05.2	Jul 20 18.9	Jul 25 22.0	Aug 1 01.4
Aug 6 12.2	Aug 11 01.7	Aug 16 04.6	Aug 22 07.7
Aug 27 18.2	Sep 1 07.8	Sep 6 10.5	Sep 12 13.6
Sep 18 00.0	Sep 22 13.7	Sep 27 16.5	Oct 3 19.4
Oct 9 05.9	Oct 13 19.6	Oct 18 22.8	Oct 25 01.7
Oct 30 12.0	Nov 4 01.8	Nov 9 05.5	Nov 15 08.6
Nov 20 18.3	Nov 25 08.3	Nov 30 12.7	Dec 6 16.0
Dec 12 01.0	Dec 16 15.1	Dec 21 20.5	Dec 27 23.8

TIMES OF GREATEST EASTERN ELONGATION (E.A.S.T.)

RHEA

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 22.6	4 14.6	3 18.0	4 09.8	1 12.9	2 04.1	3 18.8	4 09.3	4 23.5	2 01.7	2 16.5	4 07.9
8 11.1	9 03.1	8 06.5	8 22.3	6 01.3	6 16.5	8 07.2	8 21.6	9 11.9	6 14.1	7 05.0	8 20.4
12 23.7	13 15.7	12 19.1	13 10.8	10 13.8	11 04.9	12 19.5	13 09.9	14 00.2	11 02.4	11 17.4	13 08.9
17 12.3	18 04.3	17 07.6	17 23.4	15 02.3	15 17.3	17 07.9	17 22.2	18 12.6	15 14.8	16 05.9	17 21.4
22 00.8	22 16.8	21 20.2	22 11.9	19 14.7	20 05.7	21 20.2	22 10.6	23 00.9	20 03.3	20 18.4	22 10.0
26 13.4	27 05.4	26 08.7	27 00.4	24 03.2	24 18.1	26 08.6	26 22.9	27 13.3	24 15.7	25 06.9	26 22.5
31 02.0		30 21.3		28 15.6	29 06.5	30 20.9	31 11.2		29 04.1	29 19.4	31 11.0

DIONE

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 11.7	1 14.8	1 00.3	2 21.0	2 23.9	2 02.6	2 05.0	1 07.3	3 03.1	3 05.4	2 07.9	2 10.7
5 05.4	4 08.6	3 18.0	5 14.8	5 17.6	4 20.3	4 22.7	4 00.9	5 20.7	5 23.0	5 01.6	5 04.4
7 23.2	7 02.3	6 11.7	8 08.5	8 11.3	7 14.0	7 16.3	6 18.6	8 14.4	8 16.7	7 19.3	7 22.1
10 16.9	9 20.1	9 05.5	11 02.2	11 05.0	10 07.6	10 10.0	9 12.2	11 08.1	11 10.4	10 13.0	10 15.8
13 10.6	12 13.8	11 23.2	13 19.9	13 22.7	13 01.3	13 03.7	12 05.9	14 01.7	14 04.1	13 06.7	13 09.6
16 04.4	15 07.5	14 16.9	16 13.6	16 16.4	15 19.0	15 21.3	14 23.5	16 19.4	16 21.8	16 00.4	16 03.3
18 22.1	18 01.3	17 10.7	19 07.4	19 10.1	18 12.7	18 15.0	17 17.2	19 13.0	19 15.4	18 18.1	18 21.0
21 15.9	20 19.0	20 04.4	22 01.1	22 03.8	21 06.3	21 08.6	20 10.8	22 06.7	22 09.1	21 11.8	21 14.8
24 09.6	23 12.8	22 22.1	24 18.8	24 21.5	24 00.0	24 02.3	23 04.5	25 00.4	25 02.8	24 05.5	24 08.5
27 03.4	26 06.5	25 15.8	27 12.5	27 15.2	26 17.7	26 20.0	25 22.1	27 18.0	27 20.5	26 23.3	27 02.2
29 21.1		28 09.6	30 06.2	30 08.9	29 11.3	29 13.6		30 11.7	30 14.2	29 17.0	29 19.9
		31 03.3					31 09.4				

TETHYS

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 09.3	1 14.6	1 22.6	1 03.9	1 09.0	2 11.3	2 16.1	1 20.8	1 01.5	1 06.2	2 08.4	2 13.6
4 06.6	3 12.0	3 20.0	3 01.2	3 06.3	4 08.6	4 13.4	3 18.1	2 22.8	3 03.5	4 05.8	4 10.9
6 04.0	5 09.3	5 17.3	4 22.5	5 03.7	6 05.9	6 10.7	5 15.4	4 20.1	5 00.8	6 03.1	6 08.2
8 01.3	7 06.6	7 14.6	6 19.9	7 01.0	8 03.2	8 08.0	7 12.7	6 17.4	6 22.1	8 00.4	8 05.5
9 22.6	9 04.0	9 12.0	8 17.2	8 22.3	10 00.5	10 05.3	9 10.0	8 14.7	8 19.4	9 21.7	10 02.9
11 19.9	11 01.3	11 09.3	10 14.5	10 19.6	11 21.8	12 02.6	11 07.3	10 12.0	10 16.7	11 19.0	12 00.2
13 17.3	12 22.6	13 06.6	12 11.8	12 16.9	13 19.1	13 23.9	13 04.6	12 09.3	12 14.0	13 16.3	13 21.5
15 14.6	14 20.0	15 03.9	14 09.2	14 14.2	15 16.4	15 21.2	15 01.9	14 06.5	14 11.4	15 13.7	15 18.8
17 12.0	16 17.3	17 01.3	16 06.5	16 11.5	17 13.7	17 18.5	16 23.2	16 03.8	16 08.7	17 11.0	17 16.2
19 09.3	18 14.6	18 22.6	18 03.8	18 08.9	19 11.0	19 15.8	18 20.5	18 01.1	18 06.0	19 08.3	19 13.5
21 06.6	20 12.0	20 19.9	20 01.1	20 06.2	21 08.3	21 13.1	20 17.7	19 22.4	20 03.3	21 05.6	21 10.8
23 04.0	22 09.3	22 17.3	21 22.4	22 03.5	23 05.6	23 10.4	22 15.0	21 19.7	22 00.6	23 02.9	23 08.2
25 01.3	24 06.6	24 14.6	23 19.8	24 00.8	25 02.9	25 07.7	24 12.3	23 17.0	23 21.9	25 00.3	25 05.5
26 22.6	26 04.0	26 11.9	25 17.1	25 22.1	27 00.2	27 05.0	26 09.6	25 14.3	25 19.2	26 21.6	27 02.8
28 20.0	28 01.3	28 09.2	27 14.4	27 19.4	28 21.5	29 02.3	28 06.9	27 11.6	27 16.5	28 18.9	29 00.1
30 17.3		30 06.6	29 11.7	29 16.7	30 18.8	30 23.5	30 04.2	29 08.9	29 13.8	30 16.2	30 21.5
			31 14.0						31 11.1		

ENCELADUS

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
1 12.6	2 01.3	1 11.2	1 23.8	2 03.5	1 07.0	1 10.4	1 22.6	1 01.8	1 05.2	1 17.6	1 21.2
2 21.5	3 10.2	2 20.1	3 08.7	3 12.4	2 15.9	2 19.2	3 07.4	2 10.7	2 14.1	3 02.5	3 06.1
4 06.4	4 19.1	4 05.0	4 17.6	4 21.2	4 00.7	4 04.1	4 16.3	3 19.6	3 23.0	4 11.4	4 15.0
5 15.3	6 04.0	5 13.9	6 02.5	6 06.1	5 09.6	5 13.0	6 01.2	5 04.5	5 07.8	5 20.2	5 23.9
7 00.2	7 12.9	6 22.8	7 11.4	7 15.0	6 18.5	6 21.9	7 10.1	6 13.4	6 16.7	7 05.1	7 08.8
8 09.1	8 21.8	8 07.7	8 20.3	8 23.9	8 03.4	8 06.8	8 18.9	7 22.2	8 01.6	8 14.0	8 17.7
9 18.0	10 06.7	9 16.6	10 05.2	10 08.8	9 12.3	9 15.6	10 03.8	9 07.1	9 10.5	9 22.9	10 02.6
11 02.9	11 15.6	11 01.5	11 14.1	11 17.7	10 21.2	11 00.5	11 12.7	10 16.0	10 19.4	11 07.8	11 11.5
12 11.8	13 00.5	12 10.4	12 23.0	13 02.6	12 06.0	12 09.4	12 21.6	12 00.9	12 04.3	12 16.7	12 20.4
13 20.7	14 09.4	13 19.3	14 07.9	14 11.5	13 14.9	13 18.3	14 06.4	13 09.7	13 13.2	14 01.6	14 05.3
15 05.6	15 18.3	15 04.2	15 16.8	15 20.3	14 23.8	15 03.2	15 15.3	14 18.6	14 22.0	15 10.5	15 14.2
16 14.5	17 03.1	16 13.1	17 01.7	17 05.2	16 08.7	16 12.0	17 00.2	16 03.5	16 06.9	16 19.4	16 23.1
17 23.4	18 12.1	17 22.0	18 10.6	18 14.1	17 17.6	17 20.9	18 09.1	17 12.4	17 15.8	18 04.3	18 08.0
19 08.3	19 20.9	19 06.9	19 19.5	19 23.0	19 02.4	19 05.8	19 17.9	18 21.3	19 00.7	19 13.2	19 16.9
20 17.2	21 05.9	20 15.8	21 04.3	21 07.9	20 11.3	20 14.7	21 02.8	20 06.1	20 09.6	20 22.0	21 01.8
22 02.1	22 14.7	22 00.7	22 13.2	22 16.8	21 20.2	21 23.5	22 11.7	21 15.0	21 18.5	22 06.9	22 10.7
23 11.0	23 23.6	23 09.6	23 22.1	24 01.7	23 05.1	23 08.4	23 20.6	22 23.9	23 03.4	23 15.8	23 19.5
24 19.9	25 08.5	24 18.5	25 07.0	25 10.5	24 14.0	24 17.3	25 05.4	24 08.8	24 12.2	25 00.7	25 04.4
26 04.8	26 17.4	26 03.4	26 15.9	26 19.4	25 22.8	26 02.2	26 14.3	25 17.7	25 21.1	26 09.6	26 13.3
27 13.7	28 02.3	27 12.3	28 00.8	28 04.3	27 07.7	27 11.0	27 23.2	27 02.6	27 06.0	27 18.5	27 22.2
28 22.6		28 21.2	29 09.7	29 13.2	28 16.6	28 19.9	29 08.1	28 11.4	28 14.9	29 03.4	29 07.1
30 07.5		30 06.1	30 18.6	30 22.1	30 01.5	30 04.8	30 17.0	29 20.3	29 23.8	30 12.3	30 16.0
31 16.4		31 15.0				31 13.7			31 08.7		

URANUS, NEPTUNE & PLUTO

GEOCENTRIC POSITION

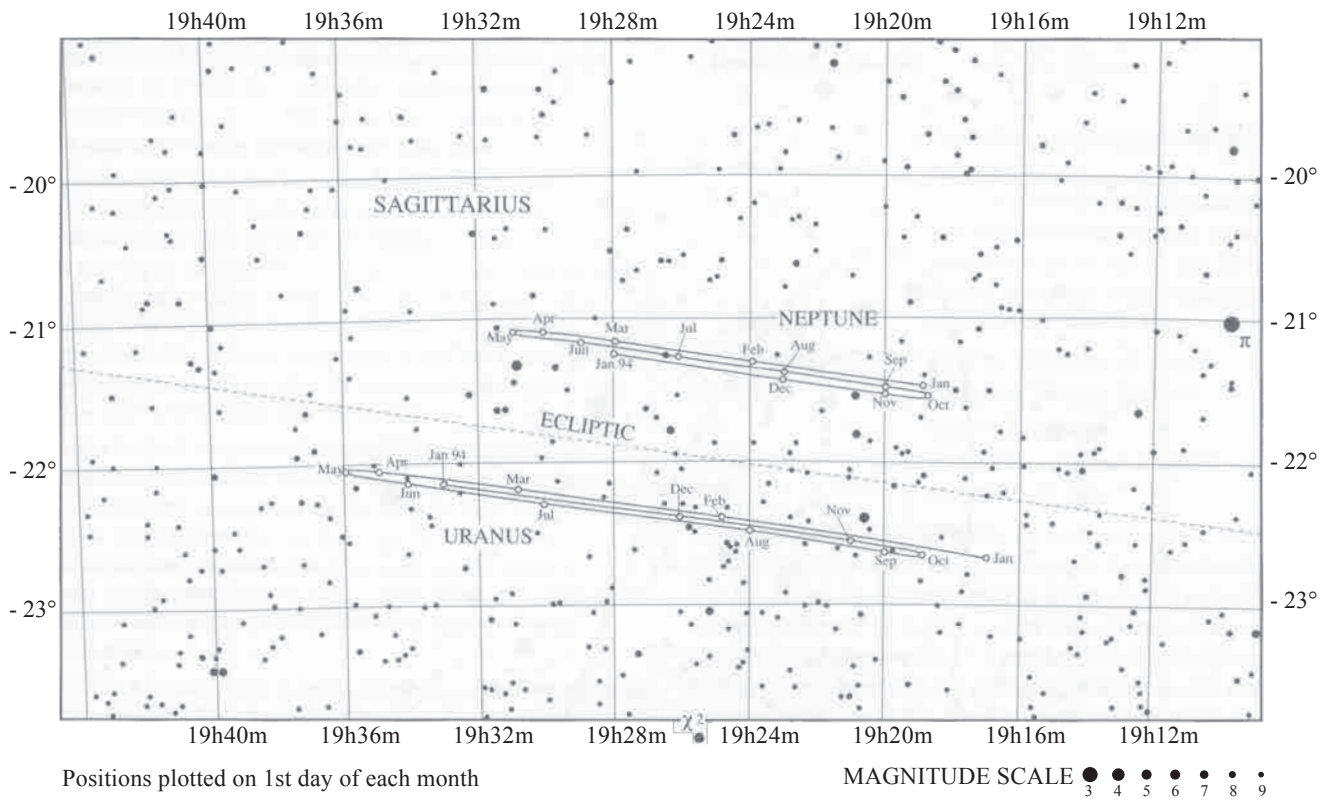
(0 hrs UT Epoch 2000.0)

RISE AND SET TIMES (for Sydney)

E.A.S.T.

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

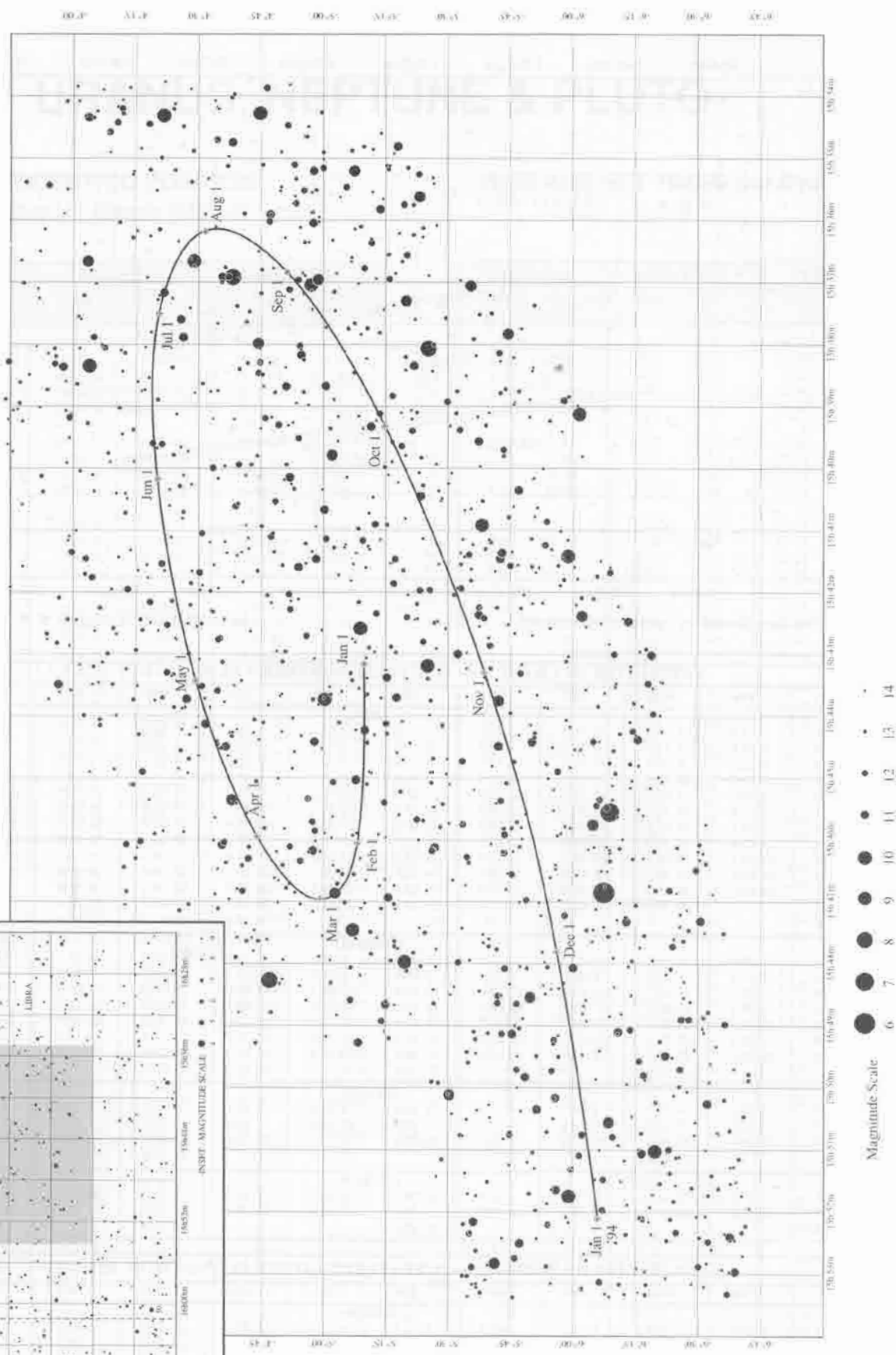
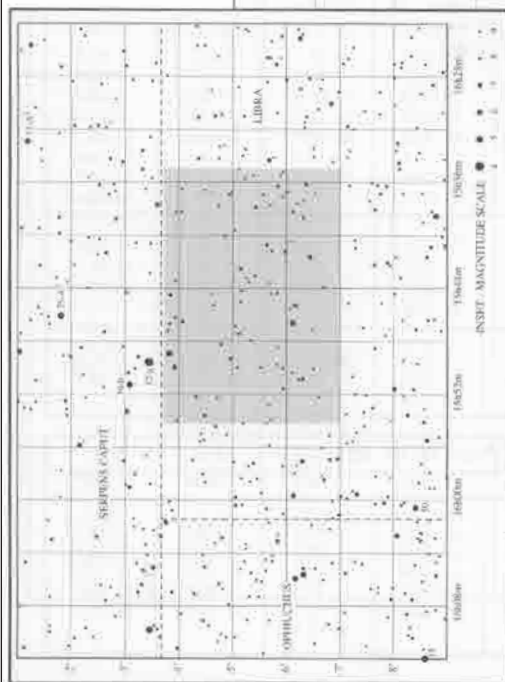
URANUS and NEPTUNE FINDER CHART



SATELLITES OF URANUS — GREATEST NORTHERN ELONGATION (E.A.S.T.)											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ARIEL											
1 17.1	3 11.3	3 04.5	2 10.3	2 16.0	1 21.9	2 03.8	1 09.8	3 04.3	3 10.2	2 16.1	2 21.9
4 05.5	5 23.8	5 17.0	4 22.8	5 04.5	4 10.4	4 16.3	3 22.3	5 16.8	5 22.7	5 04.6	5 10.4
6 18.0	8 12.2	8 05.5	7 11.2	7 17.0	6 22.9	7 04.8	6 10.8	8 05.3	8 11.2	7 17.1	7 22.9
9 06.5	11 00.7	10 17.9	9 23.7	10 05.5	9 11.4	9 17.3	8 23.3	10 17.8	10 23.7	10 05.6	10 11.4
11 19.0	13 13.2	13 06.5	12 12.2	12 18.0	11 23.8	12 05.8	11 11.7	13 06.3	13 12.2	12 18.1	12 23.8
14 07.5	16 01.6	15 18.9	15 00.7	15 06.5	14 12.3	14 18.3	14 00.3	15 18.8	16 00.6	15 06.6	15 12.3
16 19.9	18 14.1	18 07.4	17 13.2	17 19.0	17 00.8	17 06.8	16 12.8	18 07.3	18 13.1	17 19.1	18 00.8
19 08.5	21 02.6	20 19.9	20 01.6	20 07.5	19 13.3	19 19.3	19 01.3	20 19.8	21 01.6	20 07.5	20 13.3
21 20.9	23 15.1	23 08.4	22 14.1	22 20.0	22 01.8	22 07.8	21 13.8	23 08.3	23 14.1	22 20.0	23 01.8
24 09.4	26 03.5	25 20.9	25 02.6	25 08.4	24 14.3	24 20.3	24 02.2	25 20.8	26 02.6	25 08.5	25 14.3
26 21.9	28 16.0	28 09.3	27 15.1	27 20.9	27 02.8	27 08.8	26 14.8	28 09.2	28 15.1	27 21.0	28 02.8
29 10.4		30 21.8	30 03.5	30 09.4	29 15.3	29 21.3	29 03.3	30 21.7	31 03.6	30 09.4	30 15.2
31 22.8							31 15.8				
UMBRIAL											
3 14.1	1 13.9	2 13.8	4 17.5	3 17.7	1 17.7	4 21.5	2 22.0	5 01.9	4 02.1	2 02.3	1 02.5
7 17.5	5 17.3	6 17.3	8 21.0	7 21.1	5 21.2	9 01.0	7 01.5	9 05.4	8 05.6	6 05.7	5 06.0
11 20.9	9 20.7	10 20.7	13 00.4	12 00.5	10 00.6	13 04.5	11 05.0	13 08.8	12 09.0	10 09.2	9 09.4
16 00.2	14 00.1	15 00.2	17 03.9	16 03.9	14 04.1	17 08.0	15 08.5	17 12.2	16 12.5	14 12.7	13 12.9
20 03.6	18 03.5	19 03.7	21 07.3	20 07.3	18 07.6	21 11.6	19 12.0	21 15.8	20 15.9	18 16.0	17 16.3
24 07.0	22 07.0	23 07.2	25 10.7	24 10.8	22 11.1	25 14.9	23 15.5	25 19.3	24 19.3	22 19.5	21 19.8
28 10.4	26 10.5	27 10.6	29 14.2	28 14.3	26 14.5	29 18.4	27 19.0	29 22.7	28 22.8	26 23.0	25 23.2
		31 14.0			30 18.0		31 22.5			26 23.0	30 02.6
TITANIA											
3 00.7	6 20.1	4 22.7	8 18.1	4 20.7	8 16.5	4 19.6	8 15.8	3 19.0	8 14.9	3 17.6	8 12.9
11 17.5	15 12.9	13 15.5	17 11.0	13 13.6	17 09.5	13 12.6	17 09.0	12 12.0	17 07.8	12 10.4	17 05.8
20 10.4	24 05.9	22 08.4	26 03.8	22 06.5	26 02.6	22 05.8	26 02.0	21 05.0	26 00.7	21 03.3	25 22.6
29 03.2		31 01.3		30 23.5		30 22.8		29 22.0		29 20.1	
OBERON											
4 09.1	13 17.0	12 14.4	8 12.6	5 10.8	1 09.5	11 19.3	7 17.7	3 16.4	14 01.9	10 00.2	6 22.0
17 19.8	27 03.6	26 01.5	21 23.7	18 22.1	14 20.8	25 06.4	21 05.2	17 03.7	27 12.9	23 11.1	20 08.7
31 06.3					28 08.0			30 14.8			

SATELLITE OF NEPTUNE — GREATEST EASTERN ELONGATION (E.A.S.T.)											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TRITON											
3 19.1	2 03.8	3 12.4	1 21.3	1 06.4	5 12.8	4 22.4	3 08.1	1 17.7	1 03.1	5 09.3	4 18.1
9 16.1	8 00.7	9 09.4	7 18.3	7 03.4	11 09.9	10 19.6	9 05.2	7 14.8	7 00.2	11 06.3	10 15.1
15 13.0	13 21.6	15 06.3	13 15.3	13 00.5	17 07.0	16 16.7	15 02.3	13 11.9	12 21.2	17 03.2	16 12.0
21 09.9	19 18.5	21 03.3	19 12.3	18 21.5	23 04.2	22 13.8	20 23.5	19 09.0	18 18.2	23 00.2	22 09.0
27 06.8	25 15.5	27 00.3	25 09.3	24 18.6	29 01.3	28 11.0	26 20.6	25 06.0	24 15.3	28 21.2	28 05.9
				30 15.7					30 12.3		

PLUTO FINDER CHART



METEOR SHOWERS

In addition to the meteor showers listed in the accompanying table, an average of about 5 to 10 sporadic meteors (originating from random points in the sky) are visible per hour under moonless dark sky conditions. More meteors are visible in the early morning sky than in the evening, and more during the latter half of the year.

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.

If a very bright fireball is seen or photographed, the information should be reported immediately to your nearest astronomical society. If any sounds are heard accompanying the fireball, there is a possibility that some fragments may have reached the ground. If observers from several locations report accurate details on the fireball's path, astronomers may be able to track down the meteorite by triangulation and information provided by local witnesses in the suspected fall area.

DEFINITIONS: A meteoroid is a small solid particle moving through space in orbit about the Sun. A meteoroid striking the Earth's atmosphere and heated to incandescence is known as a meteor, or a fireball if negative magnitudes are reached. If the meteor is large enough to survive the trip

through the atmosphere and falls to Earth it is known as a meteorite.

NOTES:

MAX ACT	Date when maximum activity can be expected.
MOON PHASE	Phase of Moon on date of maximum activity (this should not rule out any chance of observation as the Moon may be below the horizon when the radiant is at or near culmination).
APPROX DURATION	Approximate dates of activity.
RA & Dec	Position of Shower Radiant.
Dia.	Radiant diameter.
SPEED	Speed of encounter with Earth.
ZHR:	Zenith Hourly Rate.

When two numbers are given for the radiant diameter, the first is the spread in right ascension and the second is the spread in declination. The RA & Dec co-ordinates refer to the maximum period, and allowances should be made for other dates as the radiants drift eastward by approximately 0°.6 per day. The Zenith Hourly Rate is a theoretical rate assuming the radiant to be at the zenith with a sky limiting magnitude of 6.5. Showers marked with an asterisk (*) are periodic and produce listed rates only in certain years. In other years the rate is generally limited to a few meteors per hour.

SHOWER	MAX ACT	MOON PHASE	APPROX DURATION	R. A. hh mm	Dec. °	DIA °	SPEED km/s	ZHR
Quadrantids	3-Jan	FQ	Jan 01 - Jan 05	15 20	+49°	5°	41	100
Delta Cancri	14-Jan	LQ	Jan 05 - Jan 24	08 40	+20°	10°-5°	28	5
Alpha Crucids	19-Jan	NM	Jan 06 - Jan 28	12 48	-63°	10°-5°	50	5
Alpha Carinids	1-Feb	FQ	Jan 24 - Feb 09	06 20	-54°	5°	25	7
Theta Centaurids			Jan 23 - Mar 12	14 00	-40°	6°	60	6
Alpha Centaurids	8-Feb	FM	Jan 28 - Feb 21	14 00	-59°	4°	56	5 to 30
Omicron Centaurids	12-Feb	LQ	Jan 31 - Feb 19	11 48	-56°	6°	51	5
Virginids	several		Feb 01 - May 30	13 00	-04°	15°-10°	30	1 to 5
Gamma Normids	14-Mar	LQ	Feb 25 - Mar 22	16 36	-51°	5°	56	3 to 10
Delta Pavonids	6-Apr	FM	Mar 11 - Apr 16	20 32	-63°	10°-15°	59	13
Lyrids	22-Apr	NM	Apr 16 - Apr 25	18 04	+34°	5°	49	20
Pi Puppids*	23-Apr	NM	Apr 15 - Apr 28	07 20	-45°	5°	18	40
Alpha Bootids	28-Apr	FQ	Apr 14 - May 12	14 32	+19°	8°	20	3
Eta Aquarids	4-May	FM	Apr 19 - May 28	22 24	-02°	4°	66	50
Scorpid/Sagittarids	several		Apr 15 - Jul 25	17 20	-30°	15°-10°	30	10
Lyrids (Jun)	16-Jun	NM	Jun 11 - Jun 21	18 32	+35°	5°	31	5
Bootids (Jun)	28-Jun	FQ	Jun 28 - Jun 28	14 36	+49°	8°	14	2
Pegasids (Jul)	9-Jul	LQ	Jul 07 - Jul 11	22 40	+15°	5°	70	8
Phoenicids (Jul)	11-Jul	LQ	Jun 24 - Jul 18	01 24	-43°	7°	47	5
Piscis Austrinids	28-Jul	FQ	Jul 09 - Aug 17	22 44	-30°	5°	35	8
Alpha Capricornids	30-Jul	FM	Jul 03 - Aug 25	20 32	-10°	8°	23	8
Delta Aquarids S	29-Jul	FQ	Jul 08 - Aug 19	22 44	-16°	5°	41	20
Delta Aquarids N	12-Aug	LQ	Jul 15 - Aug 25	22 48	-04°	5°	42	5
Iota Aquarids S	5-Aug	FM	Jul 15 - Aug 25	22 20	-15°	5°	34	3
Iota Aquarids N	20-Aug	NM	Aug 11 - Sep 20	21 48	-06°	5°	31	3
Perseids	12-Aug	LQ	Jul 17 - Aug 24	03 20	+58°	5°	59	100
Kappa Cygnids	18-Aug	NM	Aug 03 - Aug 31	19 04	+59°	6°	25	5
Pi Eridanids	28-Aug	FM	Aug 20 - Sep 05	03 28	-15°	6°	59	7
Alpha Aurigids	1-Sep	FM	Aug 24 - Sep 05	05 36	+42°	5°	66	15
Piscids	24-Sep	FQ	Aug 15 - Oct 14	00 32	00°	8°	26	3
Kappa Aquarids	20-Sep	NM	Sep 08 - Sep 30	22 36	-02°	5°	16	3
Capricornids (Oct)	3-Oct	FM	Sep 20 - Oct 14	20 12	-10°	5°	15	3
Sigma Orionids	5-Oct	FM	Sep 10 - Oct 26	05 44	-03°	5°	65	3
Draconids*	9-Oct	LQ	Oct 06 - Oct 10	17 28	+54°	5°	20	storm
Epsilon Geminids	19-Oct	NM	Oct 14 - Oct 27	06 56	+27°	5°	71	5
Orionids	22-Oct	FQ	Oct 02 - Nov 07	06 20	+16°	10°	66	30
Taurids S	3-Nov	FM	Sep 15 - Nov 26	03 20	+13°	10°-5°	27	12
Taurids N	13-Nov	NM	Sep 13 - Dec 01	03 52	+22°	10°-5°	29	8
Leonids*	17-Nov	NM	Nov 14 - Nov 21	10 08	+22°	5°	71	storm
Monocerotids (Nov)	20-Nov	FQ	Nov 15 - Nov 25	07 48	-06°	5°	60	5
Phoenicids (Dec)	5-Dec	LQ	Nov 28 - Dec 09	01 12	-53°	5°	18	2-Oct
Puppids/Velids	several		Oct 15 - Jan 22	08 00	-45°	20°-5°	40	15-Oct
Monocerotids	11-Dec	NM	Nov 27 - Dec 17	06 04	+14°	5°	42	5
Chi Orionids N	2-Dec	FM	Nov 16 - Dec 15	05 28	+23°	8°	28	3
Sigma Hydrids	11-Dec	NM	Dec 03 - Dec 15	08 28	+02°	5°	58	5
Geminids	14-Dec	NM	Dec 07 - Dec 17	07 28	+33°	4°	35	100
Coma Berenicids	17-Dec	FQ	Dec 12 - Jan 23	11 40	+25°	5°	65	5

MINOR PLANET POSITIONS (0hr UT, Epoch 2000.0)

		1 CERES				2 PALLAS				3 JUNO				4 VESTA				6 HEBE			
		R. A.		Dec.	Mag.	R. A.		Dec.	Mag.	R. A.		Dec.	Mag.	R. A.		Dec.	Mag.	R. A.		Dec.	Mag.
		hr	min	°	'	hr	min	°	'	hr	min	°	'	hr	min	°	'	hr	min	°	'
Jan	2	21	44.5	-22	17	19	35.3	1	28	06	20.2	0	25	17	51.8	-21	33	10	33.2	8	56
	9	21	54.7	-20	21	19	44.7	1	32	06	14.6	1	11	18	07.9	-21	44	10	32.2	9	37
	16	22	04.9	-20	24	19	54.2	1	40	06	10.0	2	08	18	24.1	-21	48	10	29.9	10	29
	23	22	15.3	-19	25	20	03.5	1	52	06	06.7	3	13	18	40.1	-21	46	10	26.4	11	29
	30	22	25.7	-18	24	20	12.9	2	08	06	04.8	4	23	18	56.0	-21	38	10	21.7	12	37
Feb	6	22	36.1	-17	23	20	22.1	2	28	06	04.5	5	35	19	11.7	-21	26	10	16.1	13	49
	13	22	46.5	-16	20	20	31.1	2	51	06	05.8	6	48	19	27.2	-21	07	10	09.9	15	02
	20	22	56.9	-15	17	20	40.0	3	17	06	08.6	7	58	19	42.5	-20	45	10	03.4	16	14
	27	23	07.3	-14	13	20	48.7	3	47	06	12.8	9	04	19	57.5	-20	18	09	57.1	17	21
Mar	6	23	17.7	-13	09	20	57.2	4	19	06	18.3	10	06	20	12.2	-19	47	09	51.3	18	21
	13	23	28.0	-12	05	21	05.5	4	53	06	24.9	11	02	20	26.5	-19	13	09	46.4	19	12
	20	23	38.3	-11	02	21	13.5	5	29	06	32.5	11	52	20	40.5	-18	37	09	42.5	19	53
	27	23	48.4	-9	59	21	21.2	6	06	06	40.9	12	36	20	54.1	-17	59	09	39.8	20	25
Apr	3	23	58.6	-8	57	21	28.6	6	45	06	50.2	13	13	21	07.2	-17	19	09	38.5	20	46
	10	00	08.6	-7	55	21	35.6	7	24	07	00.0	13	44	21	20.0	-16	39	09	38.4	20	59
	17	00	18.5	-6	55	21	42.3	8	04	07	10.4	14	08	21	32.2	-15	59	09	39.5	21	03
	24	00	28.3	-5	57	21	48.5	8	44	07	21.2	14	26	21	43.9	-15	19	09	41.7	21	00
May	1	00	37.9	-5	01	21	54.2	9	23	07	32.3	14	38	21	55.1	-14	41	09	45.0	20	51
	8	00	47.5	-4	06	21	59.5	10	01	07	43.8	14	43	22	05.8	-14	06	09	49.3	20	35
	15	00	56.8	-3	14	22	04.1	10	38	07	55.5	14	42	22	15.8	-13	34	09	54.3	20	14
	22	01	06.0	-2	25	22	08.2	11	12	08	07.3	14	36	22	25.1	-13	05	10	00.1	19	48
	29	01	15.0	-1	38	22	11.6	11	44	08	19.3	14	25	22	33.7	-12	42	10	06.6	19	18
Jun	5	01	23.7	0	55	22	14.3	12	11	08	31.3	14	08	22	41.4	-12	24	10	13.5	18	44
	12	01	32.2	0	14	22	16.2	12	35	08	43.4	13	47	22	48.2	-12	13	10	21.0	18	06
	19	01	40.3	0	22	22	17.3	12	52	08	55.4	13	21	22	54.1	-12	10	10	28.8	17	26
	26	01	48.2	0	55	22	17.6	13	04	09	07.5	12	50	22	58.8	-12	15	10	37.1	16	42
Jul	3	01	55.6	1	24	22	16.9	13	08	09	19.5	12	17	23	02.3	-12	29	10	45.6	15	56
	10	02	02.5	1	48	22	15.3	13	03	09	31.4	11	39	23	04.5	-12	52	10	54.3	15	07
	17	02	09.0	2	08	22	12.9	12	49	09	43.3	10	59	23	05.4	-13	25	11	03.3	14	16
	24	02	14.9	2	24	22	09.6	12	24	09	55.1	10	15	23	04.7	-14	07	11	12.5	13	24
	31	02	20.1	2	34	22	05.5	11	47	10	06.8	9	29	23	02.6	-14	58	11	21.8	12	30
Aug	7	02	24.5	2	40	22	00.8	11	00	10	18.4	8	42	22	59.1	-15	54	11	31.3	11	35
	14	02	28.1	2	40	21	55.7	10	02	10	29.9	7	52	22	54.3	-16	53	11	40.9	10	39
	21	02	30.8	2	35	21	50.4	8	53	10	41.3	7	00	22	48.7	-17	53	11	50.6	9	42
	28	02	32.5	2	25	21	45.1	7	36	10	52.5	6	08	22	42.4	-18	48	12	00.4	8	45
Sep	4	02	33.1	2	11	21	40.0	6	12	11	03.7	5	15	22	36.0	-19	38	12	10.3	7	47
	11	02	32.5	1	52	21	35.5	4	45	11	14.7	4	21	22	29.9	-20	17	12	20.3	6	50
	18	02	30.8	1	29	21	31.6	3	16	11	25.6	3	27	22	24.5	-20	46	12	30.3	5	53
	25	02	27.9	1	04	21	28.5	1	49	11	36.3	2	33	22	20.2	-21	03	12	40.4	4	56
Oct	2	02	23.9	0	38	21	26.4	0	24	11	47.0	1	40	22	17.2	-21	08	12	50.5	4	00
	9	02	19.0	0	11	21	25.3	0	55	11	57.4	0	47	22	15.6	-21	02	13	00.6	3	06
	16	02	13.3	0	13	21	25.3	-2	07	12	07.7	0	04	22	15.4	-20	46	13	10.8	2	13
	23	02	07.2	0	35	21	26.2	-3	13	12	17.9	0	54	22	16.6	-20	21	13	21.0	1	22
	30	02	01.0	0	50	21	28.1	-4	10	12	27.8	-1	43	22	19.2	-19	49	13	31.2	0	33
Nov	6	01	54.9	-1	00	21	31.0	-5	00	12	37.6	-2	29	22	22.9	-19	10	13	41.4	0	14
	13	01	49.3	-1	01	21	34.7	-5	42	12	47.1	-3	13	22	27.7	-18	24	13	51.5	0	58
	20	01	44.5	0	55	21	39.2	-6	16	12	56.4	-3	53	22	33.5	-17	34	14	01.6	-1	40
	27	01	40.7	0	41	21	44.4	-6	43	13	05.4	-4	31	22	40.1	-16	39	14	11.6	-2	18
Dec	4	01	37.9	0	19	21	50.3	-7	03	13	14.1	-5	06	22	47.5	-15	39	14	21.6	-2	52
	11	01	36.4	0	11	21	56.8	-7	17	13	22.4	-5	36	22	55.4	-14	36	14	31.4	-3	23
	18	01	36.0	0	46	22	03.7	-7	24	13	30.3	-6	02	23	03.9	-13	30	14	41.0	-3	50
	25	01	36.8	1	28	22	11.2	-7	26	13	37.7	-6	24	23	12.9	-12	21	14	50.4	-4	12

		7 IRIS				8 FLORA				09 METIS				10 HYGIEA				11 PARTHENOPE								
Jan	2	12	01.9	-7	04	10.2	15	16.1	-13	07	11.6	19	29.2	-24	44	11.4	07	53.5	20	05	10.2	19	11.1	-21	29	11.1
	9	12	05.0	-7	44	10.1	15	26.7	-13	41	11.6	19	42.7	-24	18	11.3	07	47.7	20	13	10.1	19	26.7	-21	06	11.0
	16	12	06.9	-8	16	10.0	15	37.0	-14	12	11.6	19	56.1	-23	48	11.3	07	41.6	20	22	9.9	19	42.3	-20	38	11.0
	23	12	07.5	-8	41	9.9	15	46.9	-14	39	11.5	20	09.5	-23	15	11.3	07	35.5	20	31	10.1	19	57.9	-20	05	11.1
	30	12	06.8	-8	58	9.8	15	56.4	-15	01	11.5	20	22.8	-22	37	11.4	07	29.8	20	38	10.3	20	13.3	-19	26	11.2
Feb	6	12	04.8	-9	04	9.7	16	05.5	-15	19	11.4	20	36.0	-21	57	11.4	07	24.7	20	44	10.4	20	28.5	-18	42	11.2
	13	12	01.5	-9	01	9.6	16	14.0	-15	34	11.4	20	49.1	-21	13	11.5	07	20.4	20	48	10.5	20	43.6	-17	54	11.3
	20	11	56.9	-8	47	9.5	16	21.8	-15	44	11.3	21	02.0	-20	27	11.5	07	17.1	20	50	10.7	20	58.5	-17	02	11.3
	27	11	51.4	-8	24	9.3	16	28.9	-15	51	11.2	21	14.8	-19	37	11.5	07	14.9	20	51	10.8	21	13.2	-16	06	11.3
Mar	6	11	45.2	-7	51	9.2	16	35.1	-15	54	11.1	21	27.4	-18	46	11.5	07	13.8	20	50	10.9	21	27.7	-15	07	11.4
	13	11	38.6	-7	11	9.1	16	40.4	-15	54	11.0	21	39.9	-17	53	11.5	07	14.0	20	48	11.0	21	42.0	-14	05	11.4
	20	11	31.9	-6	26	9.1	16	44.6	-15	51	10.9	21	52.1	-16	59	11.5	07	15.2	20	44	11.1	21	56.0	-13	01	11.4
	27	11	25.7	-5	38	9.3	16	47.6	-15	46	10.8	22	04.1	-16	03	11.5	07	17.4	20	38	11.2	22	09.8	-11	55	11.4
Apr	3	11	20.1	-4	50	9.4	16	49.3	-15	38	10.6	22	15.9	-15	06	11.5	07	20.7	20	30	11.2	22	23.4	-10	48	11.4
	10	11	15.5	-4	05	9.6	16	49.6	-15	28	10.5	22	27.5	-14	10	11.5	07	24.9	20	20	11.3	22	36.7	-9	40	11.4
	17	11	12.0	-3	25	9.8	16	48.5	-15	16	10.4	22	38.9	-13	13	11.5	07	29.8	20	09	11.4	22	49.7	-8	32	11.4
	24	11	09.7	-2	50	9.9	16	45.8	-15	03	10.2	22	50.0	-12	16	11.4	07	35.6	19	55	11.4	23	02.5	-7	23	11.4
May	1	11	08.6	-2	22	10.1	16	41.7	-14	50	10.1	23	00.8	-11	21	11.4	07	41.9	19	39	11.4	23	15.0	-6	16	11.4
	8	11	08.8	-2	02	10.2	16	36.3	-14	37	9.9	23	11.3	-10	26	11.3	07	48.9	19	20	11.5	23	27.2	-5	10	11.3
	15	11	10.0	-1	49	10.3	16	29.8	-14	24	9.7	23	21.5	-9	34	11.3	07	56.3	18	59	11.5	23	39.1	-4	05	11.3
	22	11	12.3	-1	44	10.5	16	22.5	-14	13	9.6	23	31.4	-8	44	11.2	08	04.2	18	35	11.5	23	50.7	-3	03	11.3
	29	11	15.6	-1	45	10.6	16	14.8	-14	04	9.6	23	40.9	-7	56	11.2	08	12.4	18	08	11.5	00	01.9	-2	03	11.2
Jun	5	11	19.7	-1	54	10.7	16	07.2	-13	58	9.7	23	49.9	-7	12	11.1	08	21.0	17	39	11.5	00	12.7	-1	07	11.2
	12	11	24.6	-2	08	10.8	16	00.1	-13	56	9.8	23	58.5	-6	31	11.0	08	29.9	17	07	11.5	00	23.1	0	14	11.1
	19	11	30.1	-2	27	10.9	15	53.8	-13	58	9.9	00	06.6	-5	54	10.9	08	39.0	16	32	11.5	00	33.1	0	34	11.1
	26	11	36.3	-2	52	11.0	15	48.7	-14	05	10.0	00	14.1	-5	23	10.8	08	48.3	15	54	11.5	00	42.5	1	18	11.0
Jul	3	11	43.0	-3	21	11.0	15	45.0	-14	17	10.2	00	20.9	-4	57	10.7	08	57.8	15	14	11.5	00	51.3	1	56	10.9
	10	11	50.1	-3	55	11.1	15	42.6	-14	35	10.3	00	26.9	-4	37	10.6	09	07.4	14	31	11.4	00	59.4	2	28	10.8
	17	11	57.7	-4	32	11.1	15	41.8	-14	57	10.4	00	32.1	-4	23	10.4	09	17.1	13	45	11.4	01	06.8	2	54	10.7
	24	12	05.6	-5	12	11.2	15	42.4	-15	23	10.5	00	36.2	-4	17	10.3	09	26.9	12	57	11.3	01	13.2	3	13	10.6
	31	12	13.8	-5	55	11.2	15	44.4	-15	52	10.6	00	39.3	-4	18	10.2	09	36.7	12	07	11.3	01	18.7	3	24	10.5
Aug	7	12	22.3	-6	40	11.3	15	47.7	-16	25	10.7	00	41.1	-4	27	10.0	09	46.6	11	14	11.2	01	23.1	3	27	10.4
	14	12	31.1	-7	27	11.3	15	52.2	-16	59	10.8	00	41.7	-4	43	9.8	09	56.5	10	19	11.1	01	26.2	3	22	10.3
	21	12	40.2	-8	16	11.3	15	57.9	-17	36	10.9	00	40.8	-5	08	9.7	10	06.5	9	23	11.0	01	28.0	3	08	10.2
	28	12	49.5	-9	07	11.3	16	04.6	-18	13	11.0	00	38.5	-5	39	9.5	10	16.4	8	24	11.0	01	28.4	2	46	10.0
Sep	4	12	58.9	-9	58	11.3	16	12.3	-18	50	11.1	00	34.8	-6	15	9.3	10	26.3	7	24	11.1	01	27.4	2	15	9.9
	11	13	08.6	-10	50	11.3	16	20.8	-19	27	11.1	00	29.9	-6	54	9.2	10	36.1	6	23	11.2	01	24.9	1	37	9.7
	18	13	18.4	-11	43	11.3	16	30.1	-20	03	11.2	00	24.0	-7	34	9.0	10	45.9	5	20	11.2	01	21.0	0	54	9.6
	25	13	28.4	-12	36	11.3	16	40.2	-20	38	11.2	00	17.5	-8	11	8.9	10	55.7	4	17	11.3	01	16.1	0	07	9.5
Oct	2	13	38.5	-13	28	11.2	16	51.0	-21	10	11.2	00	10.8	-8	42	9.0	11	05.4	3	13	11.3	01	10.4	0	41	9.3
	9	13	48.8	-14	20	11.2	17	02.4	-21	40	11.2	00	04.4	-9	05	9.1	11	15.0	2	08	11.3	01	04.2	-1	26	9.3
	16	13	59.2	-15	12	11.1	17	14.4	-22	07	11.3	23	58.7	-9	19	9.3	11	24.4	1	03	11.3	00	58.1	-2	05	9.4
	23	14	09.7	-16	02	11.1	17	26.9	-22	30	11.3	23	54.1	-9	21	9.4	11	33.8	0	02	11.3	00	52.5	-2	37	9.6
	30	14	20.3	-16	51	11.0	17	40.0	-22	49	11.3	23	50.8	-9	12	9.5	11	43.0	-1	07	11.3	00	47.7	-2	59	9.8
Nov	6	14	31.0	-17	39	11.0	17	53.4	-23	03	11.3	23	49.0	-8	52	9.7	11	52.0	-2	11	11.3	00	44.0	-3	10	9.9
	13	14	41.7	-18	25	11.1	18	07.3	-23	13	11.3	23	48.7	-8	22	9.8	12	00.9	-3	15	11.3	00	41.6	-3	11	10.1
	20	14	52.6	-19	09	11.2	18	21.6	-23	18	11.3	23	49.9	-7	42	9.9	12	09.5	-4	17	11.3	00	40.5	-3	01	10.3
	27	15	03.4	-19	51	11.2	18	36.1	-23	17	11.2	23	52.5	-6	55	10.1	12	17.9	-5	18	11.2	00	40.9	-2	41	10.4
Dec	4	15	14.2	-20	31	11.3	18	50.9	-23	11	11.2	23	56.5	-6	01	10.2	12	25.9	-6	18	11.2	00	42.5	-2	13	10.6
	11	15	25.1	-21	08	11.3	19	06.0	-22	59	11.2	00	01.6	-5	00	10.3	12	33.6	-7	15	11.2	00	45.4	-1	37	10.7
	18	15	35.8	-21	43	11.3	19	21.2	-22	41	11.1	00	07.7	-3	54	10.4	12	40.9	-8	10	11.1	00	49.4	0	54	10.9
	25	15	46.5	-22	15	11.3	19	36.6	-22	17	11.1	00	14.9	-2	43	10.5	12	47.7	-9	02	11.0	00	54.4	0	06	11.0

MINOR PLANET POSITIONS (0hr UT, Epoch 2000.0)

		13 EGERIA				14 IRENE				15 EUNOMIA				18 MELPOMENE				40 HARMONIA								
		R. A.		Dec.	Mag.	R. A.		Dec.	Mag.	R. A.		Dec.	Mag.	R. A.		Dec.	Mag.	R. A.		Dec.	Mag.					
		hr	min	°	'	hr	min	°	'	hr	min	°	'	hr	min	°	'	hr	min	°	'					
Jan	2	14	14.1	-4	27	11.8	17	09.8	-20	51	11.4	17	24.1	-28	46	11.0	7	29.7	9	12	9.1	19	52.0	-21	29	12.4
	9	14	22.8	-5	20	11.8	17	24.0	-21	17	11.4	17	36.3	-28	48	11.0	7	22.1	9	58	9.0	20	04.4	-20	55	12.3
16		14	30.9	-6	11	11.7	17	38.0	-21	39	11.5	17	48.4	-28	47	11.0	7	14.6	10	50	9.1	20	16.9	-20	18	12.2
	23	14	38.4	-6	57	11.7	17	51.8	-21	55	11.5	18	00.4	-28	42	11.0	7	07.8	11	46	9.3	20	29.3	-19	38	12.1
Feb	30	14	45.1	-7	40	11.6	18	05.4	-22	08	11.5	18	12.3	-28	35	11.0	7	02.0	12	44	9.5	20	41.7	-18	54	12.1
	6	14	51.0	-8	18	11.5	18	18.7	-22	16	11.6	18	23.9	-28	24	11.0	6	57.7	13	40	9.7	20	54.0	-18	07	12.2
13		14	55.9	-8	54	11.4	18	31.7	-22	21	11.6	18	35.3	-28	10	11.0	6	54.9	14	34	9.9	21	06.2	-17	18	12.3
	20	14	59.7	-9	26	11.3	18	44.3	-22	23	11.6	18	46.4	-27	54	11.0	6	53.8	15	24	10.1	21	18.3	-16	26	12.3
27		15	02.3	-9	55	11.2	18	56.5	-22	22	11.6	18	57.2	-27	36	10.9	6	54.3	16	09	10.3	21	30.3	-15	31	12.3
	Mar	6	15	03.7	-10	20	11.1	19	08.2	-22	19	11.6	19	07.5	-27	15	10.9	6	56.4	16	50	10.4	21	42.2	-14	35
13		15	03.6	-10	43	11.0	19	19.4	-22	14	11.6	19	17.5	-26	52	10.8	6	59.8	17	25	10.6	21	53.9	-13	37	12.4
	20	15	02.0	-11	04	10.8	19	30.0	-22	09	11.5	19	26.9	-26	28	10.8	7	04.5	17	54	10.8	22	05.5	-12	37	12.4
27		14	59.0	-11	22	10.7	19	40.0	-22	03	11.5	19	35.8	-26	02	10.7	7	10.4	18	19	10.9	22	16.9	-11	36	12.4
	Apr	3	14	54.5	-11	37	10.5	19	49.4	-21	58	11.5	19	44.1	-25	35	10.6	7	17.2	18	38	11.0	22	28.1	-10	34
10		14	48.8	-11	51	10.4	19	57.9	-21	54	11.4	19	51.7	-25	08	10.6	7	24.8	18	51	11.2	22	39.1	-9	32	12.4
	17	14	42.0	-12	04	10.2	20	05.7	-21	52	11.4	19	58.6	-24	41	10.5	7	33.2	18	59	11.3	22	50.0	-8	29	12.3
24		14	34.6	-12	15	10.0	20	12.6	-21	53	11.3	20	04.6	-24	15	10.4	7	42.1	19	02	11.4	23	00.6	-7	26	12.3
	May	1	14	26.8	-12	26	9.9	20	18.5	-21	57	11.2	20	09.7	-23	49	10.3	7	51.6	19	00	11.4	23	11.1	-6	24
8		14	19.1	-12	38	10.1	20	23.4	-22	06	11.1	20	13.9	-23	24	10.1	8	01.5	18	53	11.5	23	21.3	-5	23	12.2
	15	14	12.0	-12	50	10.3	20	27.1	-22	19	11.0	20	16.9	-23	00	10.0	8	11.7	18	41	11.6	23	31.2	-4	23	12.2
22		14	05.8	-13	05	10.5	20	29.6	-22	39	10.9	20	18.8	-22	38	9.9	8	22.3	18	24	11.7	23	40.8	-3	25	12.1
	29	14	00.6	-13	22	10.7	20	30.8	-23	04	10.8	20	19.3	-22	19	9.7	8	33.0	18	03	11.7	23	50.2	-2	28	12.1
Jun	5	13	56.8	-13	43	10.9	20	30.6	-23	34	10.7	20	18.6	-22	01	9.6	8	43.9	17	38	11.8	23	59.2	-1	34	12.0
12		13	54.3	-14	08	11.0	20	29.0	-24	10	10.6	20	16.5	-21	45	9.4	8	55.0	17	09	11.8	00	07.8	0	42	11.9
	19	13	53.2	-14	36	11.2	20	26.0	-24	51	10.4	20	13.0	-21	30	9.2	9	06.1	16	36	11.8	00	16.0	0	06	11.8
26		13	53.4	-15	08	11.3	20	21.7	-25	35	10.3	20	08.2	-21	17	9.1	9	17.4	16	00	11.8	00	23.6	0	50	11.7
	Jul	3	13	54.8	-15	43	11.4	20	16.3	-26	20	10.2	20	02.4	-21	04	8.9	9	28.6	15	20	11.9	00	30.7	1	30
10		13	57.4	-16	22	11.6	20	10.1	-27	04	10.0	19	55.6	-20	51	8.7	9	39.9	14	38	11.9	00	37.1	2	05	11.5
	17	14	01.1	-17	04	11.7	20	03.2	-27	46	9.9	19	48.3	-20	38	8.4	9	51.1	13	53	11.9	00	42.8	2	35	11.4
24		14	05.8	-17	48	11.8	19	56.3	-28	23	10.0	19	40.9	-20	23	8.6	10	02.4	13	05	11.9	00	47.6	2	59	11.2
	31	14	11.3	-18	35	11.9	19	49.5	-28	54	10.1	19	33.8	-20	07	8.7	10	13.6	12	15	11.8	00	51.4	3	16	11.1
Aug	7	14	17.7	-19	23	12.0	19	43.4	-29	18	10.3	19	27.4	-19	49	8.9	10	24.8	11	23	11.8	00	54.2	3	26	10.9
14		14	24.8	-20	13	12.0	19	38.2	-29	35	10.5	19	21.9	-19	31	9.0	10	35.9	10	29	11.8	00	55.7	3	28	10.8
	21	14	32.6	-21	04	12.1	19	34.2	-29	46	10.7	19	17.7	-19	12	9.1	10	47.0	9	34	11.7	00	55.9	3	21	10.6
28		14	41.0	-21	55	12.1	19	31.5	-29	50	10.9	19	15.0	-18	53	9.2	10	58.0	8	38	11.7	00	54.7	3	06	10.4
	Sep	4	14	49.9	-22	47	12.2	19	30.3	-29	50	11.0	19	13.8	-18	33	9.4	11	09.0	7	41	11.6	00	52.2	2	43
11		14	59.5	-23	38	12.2	19	30.4	-29	45	11.2	19	14.0	-18	13	9.5	11	19.9	6	44	11.5	00	48.2	2	12	10.0
	18	15	09.5	-24	29	12.3	19	31.8	-29	36	11.3	19	15.7	-17	52	9.6	11	30.7	5	46	11.6	00	43.1	1	35	9.8
25		15	19.9	-25	18	12.3	19	34.5	-29	24	11.4	19	18.8	-17	31	9.7	11	41.5	4	49	11.7	00	37.1	0	54	9.6
	Oct	2	15	30.8	-26	07	12.3	19	38.3	-29	09	11.5	19	23.1	-17	09	9.8	11	52.2	3	52	11.8	00	30.5	0	11
9		15	42.2	-26	54	12.3	19	43.2	-28	51	11.6	19	28.6	-16	45	9.8	12	02.7	2	55	11.9	00	23.9	0	31	9.6
	16	15	53.9	-27	39	12.3	19	48.9	-28	30	11.7	19	35.1	-16	19	9.9	12	13.2	2	00	11.9	00	17.7	-1	08	9.8
23		16	05.9	-28	22	12.3	19	55.6	-28	06	11.8	19	42.6	-15	50	10.0	12	23.6	1	05	12.0	00	12.3	-1	38	9.9
	30	16	18.3	-29	02	12.3	20	02.9	-27	40	11.9	19	50.9	-15	19	10.0	12	33.9	0	13	12.0	00	08.1	-1	58	10.1
Nov	6	16	31.0	-29	40	12.3	20	10.8	-27	11	12.0	19	59.9	-14	45	10.1	12	44.0	0	38	12.0	00	05.4	-2	08	10.2
13		16	43.9	-30	14	12.3	20	19.3	-26	40	12.0	20	09.6	-14	07	10.1	12	53.9	-1	26	12.1	00	04.1	-2	08	10.3
	20	16	57.1	-30	45	12.2	20	28.2	-26	06	12.1	20	19.9	-13	25	10.1	13	03.7	-2	12	12.1	00	04.4	-1	57	10.5
27		17	10.5	-31	13	12.2	20	37.5	-25	29	12.1	20	30.6	-12	40	10.2	13	13.3	-2	54	12.1	00	06.3	-1	36	10.6
	Dec	4	17	24.1	-31	38	12.2	20	47.2	-24	49	12.1	20	41.8	-11	50	10.2	13	22.7	-3	33	12.1	00	09.6	-1	06
11		17	37.9	-31	58	12.1	20	57.1	-24	08	12.2	20	53.4	-10	57	10.2	13	31.7	-4	09	12.0	00	14.3	0	28	10.8
	18	17	51.7	-32	15	12.1	21	07.1	-23	23	12.2	21	05.2	-9	59	10.2	13	40.5	-4	40	12.0	00	20.2	0	19	10.9
25		18	05.6	-32	29	12.1	21	17.4	-22	36	12.2	21	17.4	-8	56	10.2	13	48.9	-5	07	12.0	00	27.2	1	11	11.0

COMETS FOR 1993

INTRODUCTION

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, of just over 3 years, is "Encke". There are also a number of comets that are not expected to return for hundreds of years. Each year sees the discovery of around 10 to 20 new comets that have not been recorded before. The majority of these have either open ended orbits (ie. 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 the comet draws closer to the Sun, the nucleus, or snowball, heats up and the ice evaporates forming a cloud, called a "Coma", around the core. The coma can be tens of thousands of kilometres in diameter. The solar radiation, 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. The point of closest approach a comet makes to the Sun, is referred to as it's perihelion. Comets are normally named after their discoverers.

It is true that there is no such thing as a "typical comet". Like people, they are all slightly different from each other. The orbits, the overall brightness, the size of the coma and the tail can vary dramatically from comet to comet. To watch a comet 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 reach perihelion during 1993 (or late 1992 in the case of Swift-Tuttle). The table, below, lists these objects. The tables on the opposite page, give "ephemerides" (a list of expected positions in the sky and magnitude estimates for different dates) for some of these brighter comets. Most of the comets expected in 1993 are extremely faint and would require professional size telescopes or long exposure astrophotographs to detect them.

In many cases the positions/ magnitudes are only approximates, for the comet may have not been found yet on this return. Hence the orbital elements and magnitude parameters, used to generate ephemerides, are often based on previous returns. There are non gravitational effects, associated with comets, which can render ephemerides inaccurate.!

NOTES ON SELECTED BRIGHT COMETS FOR 1993

COMET SWIFT-TUTTLE (1992t)

Unfortunately, the return of this brilliant comet, this year is not very favourable; especially when it is compared to its previous apparitions. Swift-Tuttle returns only once every 130 years (approximately). This makes it one of the longer period comets known. In 1737, this visitor was so bright, that it was reported in China to be visible to the unaided eye during a full Moon. Its last return in 1862 was no less spectacular, with Swift-Tuttle reaching 2nd magnitude with a 30 degree naked eye tail! In 2126, the comet is expected to make an extremely

close approach to the Earth. Exactly how close is very difficult to predict. However it is possible that the Earth may pass through the comet's coma. That year, the Perseid meteor shower (long been connected to Swift-Tuttle) may be very impressive.

Our view of Swift-Tuttle, from the southern hemisphere, this time around, is as follows. It is first visible low in the NW early evening sky in the constellation of Hercules in November. It then moves rapidly south in December (ie. around perihelion) passing within 3 degrees of a 2 day old Moon on Dec. 26. On this day, at 8:00pm, the comet will have an altitude of only 4°. It is unfortunate that during its bright period (Dec./Jan.) Swift-Tuttle will not be above the horizon in the "dark sky", ie out of the twilight. In 1993 it continues south, moving into the SE morning sky towards the end of February. By mid March the comet will be circumpolar.

p/ SCHAUMASSE

Up to the time of perihelion (Mar. 4), Schaumasse will be found in the early evening sky. It commences the year in Taurus (altitude is 33°, azimuth is due north, at 9:00pm on Jan. 2). The comet then moves down and towards the NW as Schaumasse moves quickly north. The comet is 1° above Capella on March 4th at 8:30pm with an altitude of only 5°. The best time to observe it from Australia is mid February (around the 13th). Although Schaumasse will not be at its brightest, it is the best chance for observations before the comet gets too low on the horizon or before the rising Moon interferes. The further north, you are - the better.

p/ WEST-KOHOUTEK-IKEMURA

The comet is at opposition during its perihelion period (peri. is Dec. 25). Although the comet will be observable most of the night, it is questionable whether a tail will be visible. If one exists it would tend to point away from the Earth. The comet moves into Orion in late October. It will be approx. 3° east of Rigel on Nov. 8. West-Kohoutek-Ikemura passes into Taurus at the end of November, being 1° from Aldebaran on Dec. 18.

EXPLANATION OF COMET EPHEMERIDES

DATE is for 0 hr UT or 10am E.A.S.T. (9:30am C.A.S.T.) of date.

R. A., DEC Right Ascension and Declination are for equinox 2000

Δ (delta) is the geocentric distance in AU (The distance from the Earth)

R is the heliocentric distance in AU (distance from the Sun).

(1 AU or "Astronomical Unit" is the mean distance between the Sun and the Earth. It is a convenient yard-stick for measuring distances in the Solar System.)

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 its brightness at it's previous return(s).

* The estimate of magnitude is normally calculated using the formula :

$$\text{MAG.} = H1 + 5 \log (\Delta) + 2.5 n \log R.$$

where H is the absolute magnitude of the comet, which is the theoretical brightness the comet would reach if it was one AU from the Sun and the Earth. The value, "n", is a constant for the comet. For many comets it's value is equal to 4. For newly discovered comets the value of "n" is nearly always assumed to be equal to 4 until it's light curve can be studied in detail. The brightness of a comet is often very uncertain; in particular 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 "H" and "n") after perihelion compared to before.

COMETS FOR 1993

NAME	PERIHELION DATE	PERIHELION DISTANCE (AU)	PERIOD (Years)	NAME	PERIHELION DATE	PERIHELION DISTANCE (AU)	PERIOD (Years)
p Swift-Tuttle (1992t)(*)	Dec. 12, 1992	0.959	130	p Wiseman-Skiff	Jun. 4	1.509	6.5
p Ciffreo (1992s)	Jan. 23	1.709	7.2	p Slaughter-Burnham	Jun. 22	2.543	11.6
p Howell (*)	Feb. 26	1.409	5.6	p Urata-Nijima	Jul. 13	1.457	6.6
p Schaumasse (*)	Mar. 4	1.202	8.2	p Ashbrook-Jackson (1992j) (*)	Jul. 14	2.316	7.5
Helin-Lawrence (1992q)	Mar. 11	2.099	-	p Gehrels 3	Jul. 25	3.427	8.1
p Forbes	Mar. 14	1.447	6.1	p Neujmin 3	Nov. 13	2.001	10.6
p Holmes	Apr. 10	2.177	7.1	p Shajn-Schaldach	Nov. 15	2.344	7.5
p Vaisala 1	Apr. 29	1.783	10.8	p West-Kohoutek-Ikemura (*)	Dec. 25	1.577	6.4
p Lovas 2	Jun. 2	1.462	6.8				

(*) Denotes there is an ephemeris for this comet on the following page.

"p" prefix means the comet is known to be periodic.

(1992_ indicates the comet was recovered or discovered in 1992

"-" in "Period" column shows that period is unknown or the orbit is open (comet is making its only visit to the Sun).

p ASHBROOK-JACKSON (1992j)

Date	R. A. h m	Dec ° '	Δ AU	R AU	Mag
1993 Mar 20	22 09.7	-18 51	3.236	2.455	13.6
1993 Mar 27	22 22.8	-17 30	3.177	2.440	13.5
1993 Apr 3	22 35.7	-16 06	3.114	2.425	13.4
1993 Apr 10	22 48.4	-14 41	3.049	2.411	13.3
1993 Apr 17	23 00.8	-13 14	2.981	2.398	13.3
1993 Apr 24	23 13.0	-11 47	2.911	2.386	13.2
1993 May 1	23 24.9	-10 19	2.839	2.375	13.1
1993 May 8	23 36.6	-08 51	2.765	2.364	13.0
1993 May 15	23 48.0	-07 24	2.689	2.355	13.0
1993 May 22	23 59.1	-05 56	2.612	2.347	12.9
1993 May 29	00 09.8	-04 30	2.534	2.339	12.8
1993 Jun 5	00 20.2	-03 04	2.455	2.333	12.7
1993 Jun 12	00 30.2	-01 40	2.375	2.327	12.6
1993 Jun 19	00 39.7	+00 18	2.295	2.323	12.6
1993 Jun 26	00 48.7	+01 02	2.215	2.320	12.5
1993 Jul 3	00 57.2	+02 20	2.135	2.318	12.4
1993 Jul 10	01 05.0	+03 36	2.055	2.317	12.3
1993 Jul 17	01 12.1	+04 49	1.977	2.316	12.2
1993 Jul 24	01 18.3	+05 59	1.900	2.317	12.1
1993 Jul 31	01 23.6	+07 06	1.826	2.319	12.1
1993 Aug 7	01 27.9	+08 09	1.754	2.323	12.0
1993 Aug 14	01 30.9	+09 09	1.686	2.327	11.9
1993 Aug 21	01 32.7	+10 04	1.622	2.332	11.8
1993 Aug 28	01 33.2	+10 55	1.565	2.338	11.8
1993 Sep 4	01 32.2	+11 41	1.514	2.345	11.7
1993 Sep 11	01 29.8	+12 21	1.471	2.354	11.7
1993 Sep 18	01 26.1	+12 55	1.437	2.363	11.6
1993 Sep 25	01 21.3	+13 23	1.414	2.373	11.6
1993 Oct 2	01 15.7	+13 44	1.402	2.384	11.6
1993 Oct 9	01 09.5	+14 00	1.403	2.396	11.6
1993 Oct 16	01 03.3	+14 10	1.417	2.409	11.7
1993 Oct 23	00 57.5	+14 16	1.443	2.423	11.7
1993 Oct 30	00 52.4	+14 20	1.483	2.437	11.8
1993 Nov 6	00 48.4	+14 24	1.534	2.453	11.9
1993 Nov 13	00 45.5	+14 29	1.595	2.469	12.0
1993 Nov 20	00 44.1	+14 36	1.667	2.486	12.2
1993 Nov 27	00 44.0	+14 47	1.748	2.503	12.3
1993 Dec 4	00 45.2	+15 03	1.836	2.521	12.4
1993 Dec 11	00 47.7	+15 23	1.930	2.540	12.6
1993 Dec 18	00 51.4	+15 47	2.030	2.560	12.7
1993 Dec 25	00 56.1	+16 16	2.133	2.580	12.9
1994 Jan 1	01 01.7	+16 49	2.240	2.600	13.0

p HOWELL

Date	R. A. h m	Dec ° '	Δ AU	R AU	Mag
1993 Jan 2	17 37.6	-24 07	2.440	1.526	12.7
1993 Jan 9	18 02.2	-24 25	2.401	1.500	12.5
1993 Jan 16	18 27.3	-24 28	2.364	1.476	12.4
1993 Jan 23	18 52.8	-24 16	2.330	1.456	12.3
1993 Jan 30	19 18.4	-23 49	2.300	1.439	12.2
1993 Feb 6	19 44.0	-23 05	2.274	1.426	12.1
1993 Feb 13	20 09.5	-22 07	2.252	1.416	12.0
1993 Feb 20	20 34.5	-20 55	2.233	1.411	12.0
1993 Feb 27	20 59.1	-19 30	2.219	1.409	12.0
1993 Mar 6	21 23.0	-17 55	2.207	1.412	12.0
1993 Mar 13	21 46.2	-16 10	2.199	1.418	12.0
1993 Mar 20	22 08.7	-14 19	2.194	1.429	12.0
1993 Mar 27	22 30.5	-12 23	2.191	1.443	12.1
1993 Apr 3	22 51.4	-10 25	2.190	1.461	12.2
1993 Apr 10	23 11.6	-08 25	2.191	1.482	12.3
1993 Apr 17	23 31.0	-06 25	2.192	1.506	12.4
1993 Apr 24	23 49.7	-04 27	2.193	1.533	12.5
1993 May 1	00 07.7	-02 33	2.193	1.563	12.6
1993 May 8	00 25.0	+00 42	2.193	1.595	12.7
1993 May 15	00 41.7	+01 04	2.191	1.630	12.9
1993 May 22	00 57.7	+02 45	2.187	1.666	13.0
1993 May 29	01 13.0	+04 20	2.181	1.704	13.2
1993 Jun 5	01 27.7	+05 49	2.172	1.743	13.3
1993 Jun 12	01 41.8	+07 12	2.160	1.783	13.4
1993 Jun 19	01 55.2	+08 28	2.145	1.825	13.6
1993 Jun 26	02 07.9	+09 38	2.126	1.867	13.7
1993 Jul 3	02 19.8	+10 41	2.103	1.910	13.8
1993 Jul 10	02 31.0	+11 38	2.077	1.954	14.0
1993 Jul 17	02 41.3	+12 29	2.048	1.998	14.1
1993 Jul 24	02 50.8	+13 14	2.015	2.042	14.2

p SCHAUMASSE

Date	R. A. h m	Dec ° '	Δ AU	R AU	Mag
1993 Jan 2	03 35.6	+21 52	0.561	1.436	10.5
1993 Jan 9	03 31.6	+24 13	0.553	1.391	10.0
1993 Jan 16	03 31.0	+26 46	0.548	1.349	09.6
1993 Jan 23	03 33.9	+29 28	0.547	1.311	09.2
1993 Jan 30	03 40.9	+32 18	0.546	1.278	08.9
1993 Feb 6	03 52.3	+35 12	0.547	1.250	08.6
1993 Feb 13	04 08.2	+38 07	0.549	1.228	08.4
1993 Feb 20	04 29.1	+40 55	0.551	1.213	08.2
1993 Feb 27	04 55.4	+43 27	0.555	1.204	08.1
1993 Mar 6	05 27.1	+45 32	0.560	1.202	08.1
1993 Mar 13	06 03.8	+46 56	0.569	1.208	08.2
1993 Mar 20	06 44.2	+47 27	0.581	1.220	08.4
1993 Mar 27	07 26.4	+46 56	0.599	1.239	08.7
1993 Apr 3	08 07.8	+45 23	0.622	1.264	09.0
1993 Apr 10	08 46.4	+42 55	0.653	1.295	09.4
1993 Apr 17	09 21.3	+39 47	0.691	1.331	09.9
1993 Apr 24	09 52.0	+36 12	0.738	1.371	10.5
1993 May 1	10 19.1	+32 24	0.793	1.415	11.0
1993 May 8	10 42.8	+28 34	0.856	1.462	11.6
1993 May 15	11 03.9	+24 48	0.928	1.512	12.2
1993 May 22	11 22.9	+21 12	1.008	1.565	12.8
1993 May 29	11 40.3	+17 47	1.095	1.619	13.5
1993 Jun 5	11 56.3	+14 35	1.189	1.674	14.1
1993 Jun 12	12 11.3	+11 36	1.290	1.731	14.7
1993 Jun 19	12 25.4	+08 49	1.396	1.789	15.3

p SWIFT-TUTTLE (1992t)

Date	R. A. h m	Dec ° '	Δ AU	R AU	Mag
1992 Nov 7	17 16.9	+35 46	1.167	1.132	06.9
1992 Nov 14	17 55.6	+25 54	1.184	1.074	06.7
1992 Nov 21	18 26.6	+16 14	1.244	1.027	06.6
1992 Nov 28	18 51.6	+07 30	1.334	0.990	06.6
1992 Dec 5	19 12.4	+00 05	1.445	0.967	06.7
1992 Dec 12	19 29.9	-06 33	1.565	0.959	06.8
1992 Dec 19	19 45.3	-12 04	1.685	0.966	07.0
1992 Dec 26	19 59.0	-16 50	1.799	0.987	07.2
1993 Jan 2	20 11.8	-21 00	1.902	1.022	07.5
1993 Jan 9	20 24.1	-24 43	1.991	1.068	07.8
1993 Jan 16	20 36.1	-28 05	2.066	1.125	08.1
1993 Jan 23	20 48.2	-31 11	2.126	1.189	08.4
1993 Jan 30	21 00.5	-34 06	2.171	1.259	08.7
1993 Feb 6	21 13.3	-36 53	2.203	1.333	09.0
1993 Feb 13	21 26.7	-39 37	2.223	1.411	09.2
1993 Feb 20	21 40.9	-42 18	2.232	1.492	09.5
1993 Feb 27	21 56.0	-45 01	2.233	1.574	09.7
1993 Mar 6	22 12.4	-47 46	2.227	1.657	09.9
1993 Mar 13	22 30.3	-50 34	2.216	1.741	10.1
1993 Mar 20	22 50.3	-53 25	2.203	1.825	10.3
1993 Mar 27	23 12.7	-56 19	2.190	1.910	10.5
1993 Apr 3	23 38.3	-59 14	2.179	1.994	10.7
1993 Apr 10	00 08.1	-62 06	2.173	2.079	10.9
1993 Apr 17	00 43.1	-64 48	2.174	2.163	11.0
1993 Apr 24	01 24.3	-67 12	2.183	2.246	11.2
1993 May 1	02 12.4	-69 08	2.204	2.329	11.4
1993 May 8	03 06.3	-70 24	2.236	2.412	11.6
1993 May 15	04 03.3	-70 55	2.281	2.494	11.8
1993 May 22	04 59.0	-70 39	2.339	2.576	12.0

p WEST-KOHOUTEK-IKEMURA

Date	R. A. h m	Dec ° '	Δ AU	R AU	Mag
1993 Aug 21	04 06.1	-13 02	1.693	1.995	14.1
1993 Aug 28	04 17.7	-12 56	1.602	1.957	13.9
1993 Sep 4	04 28.8	-12 52	1.512	1.920	13.7
1993 Sep 11	04 39.3	-12 49	1.423	1.884	13.5
1993 Sep 18	04 49.1	-12 45	1.337	1.849	13.3
1993 Sep 25	04 58.0	-12 38	1.252	1.816	13.1
1993 Oct 2	05 05.9	-12 26	1.169	1.784	12.9
1993 Oct 9	05 12.6	-12 07	1.089	1.753	12.6
1993 Oct 16	05 17.9	-11 37	1.011	1.725	12.4
1993 Oct 23	05 21.5	-10 50	0.937	1.699	12.2
1993 Oct 30	05 23.2	-09 41	0.867	1.674	11.9
1993 Nov 6	05 22.9	-08 03	0.801	1.652	11.7
1993 Nov 13	05 20.4	-05 48	0.743	1.633	11.5
1993 Nov 20	05 15.5	-02 50	0.692	1.616	11.3
1993 Nov 27	05 08.4	+00 56	0.651	1.602	11.1
1993 Dec 4	04 59.7	+05 29	0.623	1.591	11.0
1993 Dec 11	04 49.8	+10 39	0.609	1.583	10.9
1993 Dec 18	04 39.7	+16 07	0.610	1.579	10.9
1993 Dec 25	04 30.5	+21 34	0.627	1.577	11.0
1994 Jan 1	04 23.1	+26 39	0.657	1.578	11.1
1994 Jan 8	04 18.2	+31 13	0.700	1.583	11.2
1994 Jan 15	04 16.3	+35 10	0.753	1.591	11.4

APPENDIX A

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 1, are calculated for Sydney. Likewise, tables for Brisbane, Melbourne, Adelaide and Hobart are presented in Appendix H (pages 112 to 117). 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:-

$$\cos A = -\tan B \cdot \tan C$$

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; if you are using table 2.

Example of rise/set time corrections.

Calculate the rise/set times for the Sun on Jan 23 for Cairns (16° 55'S, 145° 49'E)

	Rise	Set
From p. 73 the rise/set values for Sydney are:-	5:07	19:06
Adjust for longitude (151.25-145.82)*4 (table 1)	+ :22	+ :22
(value is positive due to Albury being west of Syd.)		
Adjust for latitude & Declination of Sun from table 2 (Dec. = -19°31' p. 72)	- :05	+ :05
Rise/Set times for Cairns are :-	5:59	18:58

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

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
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
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
SOUTH AUSTRALIA				
Port Lincoln	34 42	135 59	15.3	61
Mount Gambier	37 41	140 49	10.4	42

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

Declination

	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

APPENDIX B

JULIAN DATE — 1993

To calculate Julian Date (JD), first convert local time to Universal Time (UT); subtract 10 hrs from E.A.S.T., 9.5 hrs from C.A.S.T. 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 Sydney time on July 17th. Subtract 10 hours to get UT.

$$23 - 10 = 13:00 \text{ hrs UT}$$

From the table the JD for July is 2449168.5 Add the day of month, 17 gives us 2449185.5

Now add the hours as a fraction of a day from the 2nd table. 13 hr is 0.542. Thus JD at 23:00hr 17 Jul 1993 at Sydney is 2449186.042

JULIAN DATE at 0hrs UT		Hours as decimal of a day.			
Month	Julian Date				
Jan 0	244 8987.5	01	0.042	13	0.542
Feb 0	244 9018.5	02	0.083	14	0.583
Mar 0	244 9046.5	03	0.125	15	0.625
Apr 0	244 9077.5	04	0.167	16	0.667
May 0	244 9107.5	05	0.208	17	0.708
Jun 0	244 9138.5	06	0.250	18	0.750
Jul 0	244 9168.5	07	0.292	19	0.792
Aug 0	244 9199.5	08	0.333	20	0.833
Sep 0	244 9230.5	09	0.375	21	0.875
Oct 0	244 9260.5	10	0.417	22	0.917
Nov 0	244 9291.5	11	0.458	23	0.958
Dec 0	244 9321.5	12	0.500	24	1.000

APPENDIX C

SIDEREAL TIME — 1993

Greenwich mean sidereal time at 0hrs UT

Jan 0	06.6448	Jul 0	18.5383
Feb 0	08.6818	Aug 0	20.5753
Mar 0	10.5217	Sep 0	22.6123
Apr 0	12.5587	Oct 0	00.5835
May 0	14.5299	Nov 0	02.6205
Jun 0	16.5669	Dec 0	04.5918

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.

$$= \text{GMST at 0h UT (from table above)} + 0.06571 d + 1.00274 t$$

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

$$\text{LMST} = \text{GMST} + \text{east longitude (or - west longitude)}$$

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 on 17th July 1993.

$$23:00 \text{ local time} = 13:00 \text{ UT. GMST for July 0 is 18.5383 hrs.}$$

$$\text{GMST} = 18.5383 + (0.06571 \times 17) + (1.00274 \times 13) = 32.6910$$

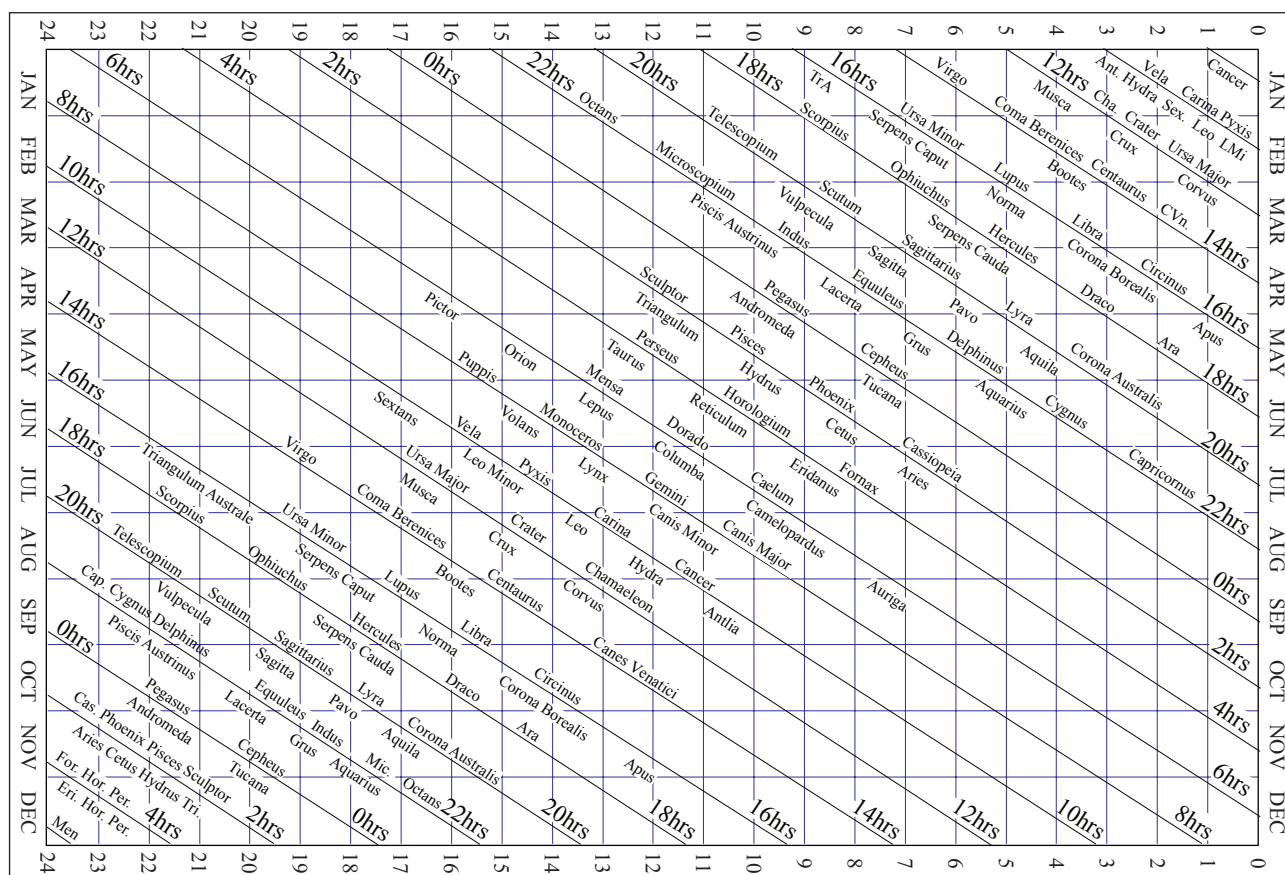
Sydney's longitude is 151.25° which is 10.0833 hrs so

$$\text{LMST} = 32.6910 + 10.0833 = 42.7743$$

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

$$42.7743 - 24 = 18.7743 \text{ hrs or } 18\text{h } 46\text{m } 27.4\text{s}$$

APPENDIX D — HOURS of RIGHT ASCENSION / CONSTELLATIONS on the MERIDIAN



APPENDIX E

PLACES OF ASTRONOMICAL INTEREST

The following is a list of places of astronomical interest. All the locations, below, cater to the public in regards to tours and/or displays.

NEW SOUTH WALES

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 setup 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.

Hours: 2pm to 5pm, Monday to Friday; 10am to 5pm, Saturday and Sunday and night sessions are 8:30-10:30pm. Bookings are required for evening tours.

Cost: There is a charge for evening sessions - \$5:00 Adults, \$2:00 Students or concession and \$12:00 for Families.

Contact: (02) 241-2478.

PARKES RADIO TELESCOPE

The observatory is located on the western plains of NSW, a few kilometres north of Parkes (just off the Newell Highway). The Parkes Telescope was indeed a pioneer in Radio Astronomy. It is still a "work horse" and will soon be able to function as part of the Australia Telescope. At the observatory, public education has a high priority, hence their impressive visitors complex. As well as having a great view of the telescope, the centre offers a superbly-crafted audio/ visual presentation on Astronomy and the Universe. The displays are interactive and well supported by the very knowledgeable staff.

Hours: 8:30am to 4:15pm - every day of the year, except for Christmas Day, and Boxing Day.

Cost: A charge is made for the Audio/Visual presentation: \$3:00 Adults, \$2:50 Students, \$2:00 Pensioners and up to \$10 for families.

Contact: (068) 62-3677

SIDING SPRING OBSERVATORY

The Warrumbungle National Park indeed makes a magnificent setting for, this, one of the few world class observatories 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 newer 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 consists of the "Exploring the Universe" exhibition. This provides an introduction to the science and technology of modern astronomical research. This exhibit was recently expanded.

Hours: 9:00am to 4:00pm every day. (it is only closed on Christmas Day).

Cost: \$5:00 Adults, \$3:00 Children/Pensioners and \$12:00 Family.

Contact - phone (068) 42-6211.

MT. STROMLO OBSERVATORY

For many years, Mt Stromlo was greatly responsible for the excellent worldwide reputation of Australian optical astronomical research. Since the establishment of Siding Spring Mountain Observatory much of the Astronomical breakthroughs are now being made in the dark, clear skies over the Warrumbungles. The 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. None of the domes are open to the public for inspection. However, the visitors gallery, which is built onto the side of the 1.9m telescope building, gives a view of this instrument through a window. The 1.9m was the largest (most light gathering power) optical telescope in Australia before the AAT and the ATT. The visitors centre is a static display of posters and photographs which illustrates the history and work at the observatory.

Hours: 9:30am to 4:00pm - 7 days per week.

Cost: There is no charge.

Contact: (06) 249-5111

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. Another 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 visitors centre, at Narrabri, is well located. Being adjacent to the array's track, excellent 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: 8:30am to 4:00pm every day (it is normally not staffed on weekends).

Cost: There is no charge to visit the centre. There is a cost of \$40 to \$60 (depending on the number of people) for bus tours; refreshments also available if booked in advance. There is no charge for school groups.

Contact: (067) 95-9205.

TIDBINBILLA TRACKING STATION

The station is located 40km southwest of Canberra, further along the same road you would take to visit Mt. Stromlo. 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 tracking network. It has played a large role in nearly all of NASA's lunar and planetary probes. The Tracking Station, in the past, has also teamed up with the Parkes Radio Telescope to jointly monitor the faint signals from the distant Voyager spacecrafts as they made their historic flybys of the outer planets.

As one would expect, the visitors centre concentrates on both NASA's manned and unmanned probes. The centre incorporates audio and visual displays as well as a multi-slide production. In December 1990, an additional visitors building was opened which has more spectacular displays and a new theatre. The visitors area offers an excellent view of the main antenna (dish). There is also a well equipped souvenir and sandwich/ hot food shop.

Hours: 9:00am to 5:00pm, 7 days per week.

Cost: There is no charge for the visitor's centre.

Contact: (062) 49-0811 or (06) 249-0825 (visitor's centre)

JOHN TEBBUTT OBSERVATORIES

Today, John Tebbutt is best known as the man on the \$100 note. As well as being a gentleman farmer, he was also a remarkably successful amateur astronomer. He built his observatory at Windsor, NSW, in the mid 19th century. For some 60 years he conducted an incredible career which continually outstripped all the professional astronomers in Australia at that time. His crowning achievement was his discovery of the great comet of 1861. This was by far the brightest comet of the 19th century with it being clearly visible in bright daylight ! In recorded history, perhaps, only "Halley" in 1910 had a tail that came as close to Earth and as spectacular as "1861".

In recent years the observatory has been expertly restored and has had reinstalled (and overhauled) Tebbutt's original 9 inch refractor. The observatory has on display some excellent and rare memorabilia on Tebbutt's life and his work.

Tours are organised as required. Cost approx. \$10 per adult.

Contact: George Smith (018) 61-1232

GILGANDRA OBSERVATORY

This is a privately run amateur observatory in Gilgandra, NSW. The owner, Jack Estens, has spent many years, as an amateur astronomer, educating and imparting his love for the stars onto hundreds of visitors. During the day, visitors are shown the Sun (weather permitting) and there are limited night time observing sessions.

Contact: John. L. Estens c/o PO Box 81, Gilgandra.

KOOLANG ASTRONOMY AND SCIENCE CENTRE.

This centre, located near Gosford, on the Central Coast, is due to open in January 1993. The observatory will open with an operating 0.5 metre telescope housed in a two-story building. The ground floor will feature a number of displays. In the longer term, the centre will consist of a number of large buildings which will house various astronomy and space science displays.

Contact: (043) 41-5853

PORT MACQUARIE OBSERVATORY

Regular public observing nights are held. Contact the Port Macquarie Astronomical Society for more information.

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 by a full-time curator in the Planetarium's "Cosmic Skydome". The programmes are based on specific astronomical themes and are changed regularly. The "Cosmic Skydome" consists of an artificial sky which is projected onto the interior surface of a 12.5 metre dome. This is certainly a "world class" planetarium and well worth the visit! There is also a Gallery, which surrounds the theatre, which houses an interesting collection of artefacts related to astronomy. A special feature of the Planetarium is the 15cm refractor and 44cm "deep sky" reflector. If sky conditions are suitable, on nights of operation, viewing sessions can be organised for a limited number of visitors.

Theatre Times:

General: 3:30pm and 7:30pm - Wednesday to Friday (also 1:30pm during Queensland school holidays). 1:30pm, 3:30pm and 7:30pm on Saturday. 1:30pm and 3:30pm on Sunday. Visitors are requested to arrive 10 mins. before the starting time.

Cost: \$6:50 Adults, \$3:00 Children (under 15 years) and \$5:00 Students / Pensioners.

Bookings and Enquiries - (07) 377-8896 - Wednesday to Sunday ONLY.

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.

Contact: (08) 223-1272 for details of show times and cost.

TASMANIA

LAUNCESTON PLANETARIUM

Show Times: Tues. to Sat., 2:00pm and 3:00pm. Also Mondays and Saturdays during school holidays. Group bookings by arrangement.

Cost: \$2:00 Children (under 15), \$3:00 Adults and \$7:00 family

Contact: (003) 31-6777

VICTORIA

MELBOURNE OBSERVATORY

The historic Old Melbourne Observatory is located in the Botanic Gardens at South Yarra. The observatory is very popular and it is important to make bookings. For 1993, bookings open on January 15 and the year is expected to be booked out by mid March. The dates vary and are usually set around first quarter moon. Times are 8:00pm to 10:00pm and occasionally day time demonstrations are organised.

Contact Richard Allen (03) 669-9942 or (03) 669-9973 (at Museum of Victoria) for bookings and cost.

H.V. MCKAY MELBOURNE PLANETARIUM

Current session times (Nov/Dec 1992) are: Sat. and Sun. 1,2,3 and 4:00pm; Mon. to Thurs. 2:00pm; Fri. 2 and 8:00pm and public and school holidays 11 am, 1,2,3 and 4:00pm.

Contact: as for Melbourne Observatory (see above), for costs and programme/ timetable details.

WESTERN AUSTRALIA

PERTH OBSERVATORY

Situated in the Darling Ranges, 40km inland from the West coast, Perth Observatory is well located to conduct astronomical research as well as educational activities for the public of WA. Telescopes are used as part of the Observatory public education program, where visitors can come to the grounds on specific nights for viewing evenings. A substantial museum, showing instruments from the old Observatory as well as meteorites, paintings and photographs has been established to inform and educate the constant stream of tourists.

Hours: each week, a Sunday afternoon tour is provided at 3pm. Night tours and week day tours are available by appointment.

Cost: Day Tours, \$7 Adults and \$4 Concessions. Night Tours, \$4 Adults and \$2 Concessions.

Contact: (09) 293-8255. There is also a recorded Information Line (09) 293-8109.

APPENDIX F

ASTRONOMICAL COURSES, SOURCES OF INFORMATION IN 1993

The following lists astronomy courses, a magazine and a radio programme, known to the authors, for 1993. 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. These types of programmes have been specifically designed for the lay person and are not tertiary programmes. Enquiries from the general public are most welcome. It will be necessary to make contact through the relevant phone number to ascertain course details or timetable information.

A number of the amateur astronomical societies also provide an invaluable service to public education by their public lectures and public observing nights. You will need to contact the societies for further details.

SKY AND SPACE MAGAZINE (formerly SOUTHERN ASTRONOMY)

This is the only astronomy and space exploration magazine produced specifically for enthusiasts in Australia and New Zealand. It covers a wide range of topics, from asteroids to galaxies, telescopes to space probes, the Big Bang to black holes. It caters to both the very experienced and the novice. The magazine comes out every two months, and is widely available through newsagencies or by subscription. Telephone (02) 387-6666, Fax (02) 369-3366.

NEW SOUTH WALES

(all Sydney Metropolitan area)

ASTRONOMY COURSE

Conducted by Paul Payne. This is an 8 to 10 week course. Timetable for 1993 was unknown at time of printing.

Cost: \$80

Venue: Sydney Observatory ph (02) 241-2478.

W.E.A. COURSE

To be run at Sydney Observatory, 3 or 4 times during 1993.

Contact (02) 264-2781 for cost, timetable details.

PRACTICAL ASTRONOMY

An 8 week W.E.A. course conducted by Sutherland Astronomical Society.

Contact: Jon Little, ph (02) 542-1148.

Cost: \$55

Venue: Green Point Observatory (Sutherland).

ASTRONOMY

Conducted by Ben Pawlutschenko. This general astronomy course is conducted 4 times per year (once per term).

Contact ph. (045) 72-5499

Cost: \$50, 8 weeks (16 hours).

Venue: Liverpool Girls High.

INTRODUCTION TO ASTRONOMY COURSE

Conducted by A. James. 8 weeks (16 hrs) each.

Cost: \$64 per course. Venue: Strathfield Evening College (02) 764-1499

THE SKY THIS WEEK

Radio show, conducted by Geoff McNamara, describing the events in the night sky over the coming week. "The Sky this Week" also looks at the nature of the objects visible in the night sky as well as other related topics.

Time: Thursday 10pm on 2NBC-FM 90.1 MHz (Southern Sydney)

SOUTH AUSTRALIA

W.E.A. COURSES

Beginners and advanced courses are run each semester. Contact the W.E.A. for costs and dates. Phone (08) 223-1272

TASMANIA

The "Adult Education Department" (Hobart) occasionally run Astronomy courses. Phone (003) 44-7100.

VICTORIA

The ASTRONOMICAL SOCIETY OF VICTORIA runs a prerecorded information service "SKYLINE" which is designed to cover the latest astronomical discoveries. The cost is only for the telephone call.

Phone (03) 888-7130.

APPENDIX G

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. Enquiries from anyone, with an interest in astronomy, are most welcome. Where given, annual fees are correct as of printing (Oct 1992).

NEW SOUTH WALES

ASTRONOMICAL SOCIETY OF NSW

The society holds meetings twice per month at the "Catholic College of Education", 179 Albert St, Strathfield. 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 and the other is their "dark sky" property "Wiruna" near Ilford. A monthly magazine "Universe" is published for members. The Society also runs an information service called "Astrocards". This service alerts subscribers quickly to any new discoveries such as Novae and Comets.

Fees: \$34 Full, \$29 Associate, \$10 Student (under 18) and \$26 Student (over 18). There is no joining fee.
Address: PO Box 208, Eastwood NSW 2122
Contact: Tony Buckley (President) ph (02) 874-2070.

SUTHERLAND ASTRONOMICAL SOCIETY

The society operates from Green Point Observatory in Sutherland. This houses a 40cm reflecting telescope. The Society also has a number of other telescopes available for use by members. The SAS regularly conducts open nights for the public at "Green Point" as well as running Workers Education courses on astronomy. The Society also publishes a regular newsletter.

Fees: \$25 Full, \$15 Student/Associate, \$10 Junior/ Pensioners and \$35 for families plus joining fee - Full/Family \$15, others \$5.
Address: PO Box 31, Sutherland NSW 2232.
Contact: Lawrie Purcell (02) 543-4261

BRITISH ASTRONOMICAL ASSOCIATION - NSW BRANCH

The BAA meets at Sydney Observatory. The Association meets on the third Wednesday of each month (except for January), commencing at 7:45pm. 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 Bulletin".

Fees: \$30 Full, \$15 Junior (no joining fee) and there are family concessions available. There is a \$12:50 Joining Fee.
Contact: Michael Chapman (02) 949-1058

WESTERN SYDNEY AMATEUR ASTRONOMICAL SOCIETY

The society holds monthly meetings at the Uni. of Western Sydney, Nepean. There are also regular observing nights and a monthly newsletter.

Fees: \$15
Address: PO Box 400, Kingswood NSW 2747
Contact: John Jarman (047) 30-1588

ILLAWARRA ASTRONOMICAL SOCIETY

Meetings are held at the Uni. of Wollongong Science Centre, Fairy Meadow, on the second Tuesday of each month @ 7:30pm. There are monthly observing nights held at a "deep sky" site west of Wollongong.

Fees: \$15 adult, \$10 junior.
Address: PO Box 1814, Wollongong NSW 2500
Contact: Peter MacKinnon (042) 29-6696

HAWKESBURY ASTRONOMICAL ASSOCIATION

Meetings are held at Windsor library. Time/dates vary

Fees: \$30 adult and \$10 student.
Address: c/o John Tebbutt Observatories, Palmer St., Windsor NSW 2756
Contact: ph (045) 72-1568

NORTHERN DISTRICTS SOCIETY OF AMATEUR ASTRONOMERS

Meetings are held at Riverview Observatory (St. Ignatius College), Lane Cove on the 3rd Tuesday of each month @ 7:30pm. The society has a quarterly journal. It is currently restoring the college's historic observatory.

Fees: \$30 adult
Contact: Gordon Stott (02) 871-7838

PORT MACQUARIE ASTRONOMICAL ASSOCIATION

The Society meets at the Port Macquarie Observatory, twice monthly.

Fees: \$5
Address: PO Box 1453, Port Macquarie NSW 2444

Contact: Jim Daniel (065) 83-1933

TAREE ASTRONOMICAL SOCIETY

The society meets at the Community Centre, Mabiack on the second Thursday of each month @ 7:30pm. There is also a bi-monthly newsletter and regular Friday night observing sessions.

Fees: \$20 adult, \$10 student and \$30 family.
Address: PO Box 111, Taree NSW 2430
Contact: Mr. Jim Ross (065) 50-2213

THE ASTRONOMICAL SOCIETY OF THE HUNTER

Meetings are held at the Kurri TAFE College on the fourth Friday of each month @ 7:30pm.

Fees: \$20 adult
Address: c/o Newcastle Technical College, Tighes Hill NSW 2297
Contact: Colin Maybury (049) 56-5093

SHOALHAVEN ASTRONOMERS

Meet at the library, Falls Creek Public School on the third Friday of each month @ 7:30pm. They also have a monthly journal:

Fees: \$20 adult and \$10 junior.
Address: PO Box 255, Nowra NSW 2541
Contact: David Hawsworth (044) 41-5866

PARKES ASTRONOMY CLUB

The club has infrequent meetings but holds regular observing nights. There is also a monthly newsletter.

Fees: NONE
Address: Australia Telescope, PO Box 276, Parkes NSW 2870
Contact: Ian McGovern (068) 62-3677

ASTRONOMICAL ASSOCIATION OF THE CENTRAL COAST

The Association holds monthly meetings at Gosford Hospital. They also have a monthly newsletter and an observing site at Mt. White.

Fees: \$15 adult, \$20 family and \$10 student.
Address: PO Box 229, Toukley NSW
Contact: Bruce Jessup (043) 43-4735 or Derik Bott (043) 69-3087

ASTRONOMICAL SOCIETY OF COONABARABRAN

Meets on the third Thursday of each month at the Tourist Information Centre. They also publish an occasional newsletter.

Fees: \$10
Address: C/- AAO Private Bag, Coonabarabran NSW 2357
Contact: Paul Cass (068) 42-1639

(ACT) CANBERRA ASTRONOMICAL SOCIETY

Hold meetings at the ANU Jaeger Building on the 3rd Thursday of each month (except Dec/Jan) @ 8:00pm. They also publish a monthly newsletter.

Fees: \$25 adult, \$15 student/ pensioner and \$20 country.
Address: PO Box 1338, Woden ACT 2606
Contact: Clare Williams (06) 231-9484

QUEENSLAND

ASTRONOMICAL ASSOCIATION OF QUEENSLAND (AAQ)

Meetings are held on the Saturday nearest to full moon @ 7:30pm. The venue is Brisbane State High, South Brisbane. They hold regular Astroamps, public field nights and publish a monthly journal and Annual Proceedings.

Fees: \$35 adult, \$23 student and pensioner.
Address: PO Box 101, St. Lucia QLD 4067
Contact: Steven Hutcheon (07) 206-4338

SOUTHERN ASTRONOMICAL SOCIETY

Meetings are held at their observing site/ clubhouse at Pimpama on the second Saturday of each month @ 7:30pm. The society holds regular public field nights and produces a monthly newsletter.

Fees: \$28 adult and \$21 student.
Address: PO Box 685, Springwood QLD 4127
Contact: Ray Suckling (075) 78-3795

BRISBANE ASTRONOMICAL SOCIETY

Meet on the second Friday of each month @ 7:30pm. Venue is Kelvin Grove State High. There is a bi-monthly newsletter.

Fees: \$20 adult, \$25 family and \$10 student and pensioner.
Address: PO Box 204, Morningside QLD 4170
Contact: Darryl Mitchell (07) 349-8393

SOUTH EAST QUEENSLAND ASTRONOMICAL SOCIETY

The society meets at the Teachers Training College, Kedron High on the th Monday of each month. They publish a quarterly newsletter.

Address: 17 Enchelmaier St., Dayboro QLD 4521
Contact: John Stewart (07) 425-1640

TOWNSVILLE ASTRONOMY GROUP

Meet on the last Wednesday of each month @ 7pm at Kiwan State High.
Meetings are followed by observing sessions. There is a monthly newsletter.

Fees: \$15
Address: 21 Gladys St., Kelso QLD 4815.
Contact: Richard Free (077) 89-2214

BUNDABERG ASTRONOMICAL SOCIETY

Meetings are held at Alloway Observatory on the first Friday of each month @ 7:30pm. The society publishes a bi-monthly newsletter and ephemeris.

Fees: \$20 adult and \$15 junior.
Address: PO Box 586, Bundaberg QLD 4670
Contact: Greg Fielding (071) 59-7232

SUN COAST ASTRONOMICAL SOCIETY

Meetings are held at Caloundra State High on the third Saturday of each month (except Dec/Jan.) @ 7:30pm. There is a bi-monthly newsletter.

Address: PO Box 25, Moffat Beach QLD 4551
Contact: Lyn Barclay (07) 396-1391

CAIRNS ASTRONOMY GROUP

Hold monthly meeting at Bob's place (see below)

Fees: \$12
Address: 18 Yurongi St., Caravonica QLD 4878
Contact: Bob Dollery (070) 58-1180

SOUTH AUSTRALIA

ASTRONOMICAL SOCIETY OF SOUTH AUSTRALIA

Meetings are held on the 1st Wednesday of each month (except Jan.) at the Uni. 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.

Fees: \$32 adult (metropolitan), \$10 spouse and \$26 concession (student, country, pensioner)
Address: GPO Box 199, Adelaide SA 5001
Contact: Dr. Tony Beresford (Sec.) (08) 338-1231

BOWMAN PARK ASTRONOMICAL SOCIETY

The society meets twice monthly.

Fees: \$20 adult, \$30 family and \$10 student
Address: PO Box 109, Crystal Brook SA 5523
Contact: Jan Hollick (086) 36-2132

TASMANIA

ASTRONOMICAL SOCIETY OF TASMANIA (AST)

Meetings are held at the Hutchins School, Sandy Bay, on the last Tuesday of each month.

Address: c/o Norwood Ave. PO, Launceston
Contact: Martin George (003) 44-7100

VICTORIA

ASTRONOMICAL SOCIETY OF VICTORIA (ASV)

Meetings are held on the 2nd Wednesday of each month (except Jan.) at the Herbarium, Botanic Gardens in Melbourne. The ASV is probably the largest society in Australia with numerous specialist sections catering to a wide range of astronomical tastes. They offer: monthly members' nights on the telescopes at the Old Melbourne Observatory, an extensive library, a bi-monthly newsletter, a yearly ephemeris, the society observatory and club rooms at Burwood and a dark sky site near Heathcote (1 hour drive Nth of Melbourne).

Fees: \$50 ordinary members, \$55 family, \$44 junior (under 18) or senior (65+) and various other rates.
Address: GPO Box 1059J, Melbourne VIC 3001
Contact: (03) 877-3181 or (03) 850-8309

ASTRONOMICAL SOCIETY OF FRANKSTON

Meets at the Peninsula Church of England School, Mt Eliza, on the 3rd Wednesday of each month @ 8pm. They have a bi-monthly newsletter.

Fees: \$20 adult, \$15 concession/ junior and \$30 family.
Address: PO Box 596, Frankston VIC 3199
Contact: Don Leggett (059) 85-4927

ASTRONOMICAL SOCIETY OF GEELONG

Holds a general meeting the last Friday of each month, plus meetings every other Friday. The venue is the Belmont Common Hall. The society publishes a quarterly newsletter and holds regular viewing nights for schools and community groups.

Fees: \$30 adult, \$45 family and \$15 junior and concession.
Address: PO Box 1799, Geelong VIC 3220
Contact: Miles Charlesworth (Pres.) (052) 21-7484 or Robert Cowdell (Sec.) (052) 55-2702.

ALBURY WODONGA ASTRONOMICAL SOCIETY

The society has occasional meetings at Wodonga High and holds regular viewing nights at the observatory at the school.

Fees: \$12 adult, \$15 family
Address: 1 Poplar St., Wodonga VIC 3690
Contact: (060) 24-5535 or (060) 24-4540

BALLARAT ASTRONOMICAL SOCIETY

The society meets at the Ballarat Municipal Observatory on the second Friday of each month @ 8pm. They publish a quarter journal and yearbook and hold regular public viewing nights.

Fees: \$18 adult and \$12 junior.
Address: PO Box 284, Ballarat VIC 3353
Contact: Ian Thompson (053) 39-6698

LATROBE VALLEY ASTRONOMICAL SOCIETY

Meets at Monash Uni. College, Churchill, on the 2nd Tuesday of each month @ 7:30pm. They publish a bi-monthly newsletter and are active in public education, conducting demonstrations for schools, church and youth groups.

Fees: \$25 adult and \$13 associate
Address: PO Box 144, Churchill VIC 3842
Contact: Geoff Thomas (051) 92-4347

THE BENDIGO DISTRICT ASTRONOMICAL SOCIETY

Bendigo Contact: (054) 74-8220

WESTERN AUSTRALIA

ASTRONOMICAL SOCIETY OF WA

The Society meets at 8 pm on the second Monday of every month at the gymnasium of WESLEY COLLEGE, South Perth. The Society Conducts regular "astrocamps" at remote locations with good accommodation and very dark skies. It also promotes public awareness of astronomy by holding regular viewing nights for the public, and by providing speakers to schools, clubs and community groups. The Society owns a wealth of astronomical apparatus for use by Members. The society also publishes a bi-monthly journal "The Sidereal Times"

Fees: Ordinary Member, \$10 Nom \$30 Sub; Associate Member, \$6 Nom \$15 Sub; Junior Member (under 18), \$6 Nom \$15 Sub.
Address: P.O. Box 421 Subiaco WA 6008
Contact: (09) 458-8462.

MURDOCH ASTRONOMICAL SOCIETY

The Murdoch Astronomical Society is a very active body based at Murdoch University. Membership is open to the general public and no extensive knowledge of astronomy is required, only an interest in astronomy. Meetings are conducted each month at the University.

Fees: Murdoch Students \$ 6, Non Students \$12 (No Joining Fee)
Address: c/- Murdoch University, School of Mathematical and Physical Sciences, Murdoch WA 6150
Contact: T. Belcher (09) 332-661

ASTRONOMICAL SOCIETY OF THE SOUTH WEST

Conducts monthly meetings. The main aim of the ASSW is to increase public awareness in astronomy.

Address: P.O. Box 1100 Bunbury WA 6230
Contact: (09) 95-8516

GOLDFIELDS ASTRONOMICAL SOCIETY

Kalgoorlie Contact: (090) 21-5805

NEWMAN ASTRONOMICAL SOCIETY

Newman Contact: (091) 75-2660

PILBARA ASTRONOMICAL SOCIETY

Sth Hedland Contact: (091) 40-1512

NORTHERN TERRITORY

ASTRONOMICAL SOCIETY OF ALICE SPRINGS

Alice Springs Contact: (089) 52-6426

MELBOURNE (E.A.S.T.)

(37° 50' S, 145° 00' E)

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

SUN AND PLANET RISE AND SET TIMES

BRISBANE (E.A.S.T.)

(27° 30' S, 153° 01' E)

		MERCURY		VENUS		MARS		JUPITER		SATURN		URANUS		NEPTUNE		PLUTO		SUN		TWILIGHT	
		Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	AM	PM
Jan	2	04:00	17:55	08:32	21:35	19:24	05:36	23:40	12:04	07:40	20:56	05:26	19:10	05:31	19:09	02:32	14:57	04:57	18:47	03:25	20:19
	9	04:19	18:15	08:40	21:29	18:46	04:55	23:14	11:39	07:16	20:31	05:00	18:44	05:05	18:43	02:05	14:30	05:02	18:48	03:31	20:19
	16	04:42	18:34	08:46	21:21	18:07	04:15	22:48	11:13	06:52	20:06	04:35	18:18	04:39	18:16	01:39	14:03	05:07	18:48	03:38	20:17
	23	05:09	18:51	08:51	21:11	17:30	03:36	22:21	10:46	06:28	19:41	04:09	17:52	04:12	17:50	01:12	13:36	05:13	18:46	03:45	20:14
	30	05:38	19:05	08:54	21:00	16:55	03:00	21:53	10:19	06:04	19:16	03:44	17:26	03:46	17:23	00:45	13:09	05:19	18:43	03:52	20:09
Feb	6	06:09	19:15	08:55	20:47	16:22	02:28	21:26	09:51	05:41	18:51	03:18	17:00	03:20	16:57	00:18	12:42	05:24	18:39	04:00	20:04
	13	06:39	19:21	08:53	20:32	15:52	01:58	20:58	09:23	05:17	18:26	02:52	16:34	02:53	16:30	23:47	12:15	05:30	18:34	04:07	19:57
	20	06:58	19:17	08:48	20:14	15:24	01:31	20:29	08:53	04:53	18:02	02:26	16:08	02:27	16:04	23:19	11:47	05:35	18:28	04:13	19:50
	27	06:53	18:56	08:38	19:53	14:59	01:07	20:00	08:23	04:30	17:37	02:00	15:42	02:00	15:37	22:52	11:20	05:39	18:22	04:19	19:42
Mar	6	06:15	18:16	08:21	19:28	14:36	00:45	19:31	07:53	04:06	17:12	01:34	15:16	01:33	15:10	22:25	10:52	05:43	18:15	04:24	19:34
	13	05:17	17:32	07:57	18:58	14:15	00:26	19:01	07:22	03:42	16:47	01:08	14:49	01:07	14:43	21:57	10:24	05:47	18:07	04:29	19:25
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SUN AND PLANET RISE AND SET TIMES

ADELAIDE (C.A.S.T.)

(34° 58' S, 138° 38' E)

		MERCURY		VENUS		MARS		JUPITER		SATURN		URANUS		NEPTUNE		PLUTO		SUN		TWILIGHT	
		Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	AM	PM
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SUN AND PLANET RISE AND SET TIMES

HOBART (E.A.S.T.)

(42° 48' S, 147° 13' E)

		MERCURY		VENUS		MARS		JUPITER		SATURN		URANUS		NEPTUNE		PLUTO		SUN		TWILIGHT	
		Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	AM	PM
Jan	2	03:39	19:03	08:31	22:21	20:34	05:12	23:56	12:35	07:33	21:48	05:08	20:15	05:15	20:11	02:46	15:29	04:37	19:53	02:22	22:07
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Feb	6	06:08	20:02	09:23	21:05	17:35	02:01	21:41	10:22	05:37	19:41	03:00	18:04	03:04	17:58	00:32	13:14	05:20	19:30	03:28	21:21
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Nov	6	04:51	18:58	04:14	17:26	05:30	20:14	04:19	17:40	11:55	01:59	08:58	00:08	09:02	23:58	06:30	19:17	04:49	19:01	02:57	20:54
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Dec	4	03:41	18:08	03:56	18:39	04:49	20:06	02:44	16:20	10:11	00:11	07:14	22:18	07:15	22:11	04:43	17:32	04:27	19:36	02:16	21:48
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	18	03:50	19:05	04:01	19:12	04:36	20:00	01:55	15:38	09:21	23:15	06:23	21:26	06:23	21:17	03:50	16:39	04:28	19:48	02:11	22:05
	25	04:02	19:31	04:08	19:26	04:32	19:55	01:31	15:17	08:57	22:48	05:57	21:00	05:56	20:51	03:23	16:13	04:31	19:51	02:14	22:08

MOON RISE AND SET

MELBOURNE (E.A.S.T.)

(E.A.S.T.)

BRISBANE

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

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

MOON RISE AND SET

ADELAIDE

(C.A.S.T.)

(E.A.S.T.)

HOBART

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

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

GLOSSARY

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.

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.

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*

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.

C.A.S.T. Central Australian Standard Time.

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.

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.

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.

E.A.S.T. Eastern Australian Standard Time.

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.

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.

Geocentric As viewed or measured from the centre of the Earth.

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).

118**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.

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.

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.

Opposition When a celestial body is opposite the Sun in the sky.

Orbit The path followed by one body as it moves around another.

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*.

Quadrature A configuration that two celestial bodies have apparent longitudes that differ by 90° as viewed from a third body.

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°).

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.

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 Eastern Australian Standard Time.

Zenith The point directly overhead (90° in altitude).

Zenith Hourly Rate A general guide to the expected intensity of any given meteor shower. It is a theoretical rate, assuming a radiant at the *zenith* with a sky limiting magnitude of 6.5.

INDEX

Entries which refer to diagrams or tables are in **bold** type.

Entries which refer to diagrams or tables are in bold type.

Angles, scale **rear cover**; estimating 6

Angular measurement 6

Angular size of planets **68**

Asteroids - see minor planets

Astronomy clubs 110

Astronomy courses 109

Atlas, star - use of 63

Celestial pole 63

Central meridian, jupiter 63,**89**; Mars 63,**63**,87; Saturn 63,**95**

Comets 104, **105**

Conjunction **64**,65

Constellations on the meridian **107**

Co-ordinates astronomical 6

Courses 109

Declination 6; of sun and planets **68**

Eclipses, lunar and solar 70, **70**, **71**

Elongation **64**,65

Epoch 63

Field of view 63

Finder chart, Mars **86**; Jupiter **88**; Neptune **99**; Saturn **94**;
Uranus **99**; Pluto **100**

Geocentric 6

Hubble guide star catalogue **64**

Jovian satellite phenomena 90, **90-93**; eclipses 90; occultations
90; shadow transits 90; transits 90

Julian date 107

Jupiter 63; belts **89**; Eta Virginis conjunction with **34**;
finder chart **88**; longitude of central meridian,
system I & II **89**; position **88**; rise/set (Sydney) **88**;
rotation period 63; satellite configuration **monthly**
section; satellite events 90, **90-93**

Latitude 6

Light pollution 5

Longitude 6

Lunar occultations 76; events, bright & dark limb 76; for
Sydney **77**; for Melbourne **78**; for Brisbane **79**; for
Adelaide **80**; timing 76; timing equipment 76

Magnitudes of planets and asteroids **69**

Mars 63; finder chart **86**; longitude of central meridian 63, **87**;
observing 63, 87; opposition 87;
oppositions 1993 to 2003 **87**; perihelion 87; position **86**;
retrograde motion 65, **65**; rise/set (Sydney) **86**;
angular size **87**

Mercury, position 82; rise/set (Sydney) **84**; transit 83, **83**;
transits, future 83

Meridian passage of sun and planets **69**

Meteor 101

Meteor showers 101, **101**, **monthly section**

Meteoroid 101

Meteorite 101

Minor planets 65, positions **102-103**

Moon, lunation number **75**; map **81**; phases **75**; position **74**;
rise/set (Sydney) **75**;

Neptune, finder chart **99**; position **98**; rise/set (Sydney) **98**;
satellites 64, **99**

Occultations - lunar 76, events, bright & dark limb 76; for
Sydney **77**; for Melbourne **78**; for Brisbane **79**;
for Adelaide **80**; timing 76; timing equipment 76

Opposition **64**, 65; of mars 87,**87**; of minor planets 65

Places of astronomical interest 108

Planetary data **66**; rise & set times (see Rise/set entry)

Planets, movement diagram - evening **44**; - morning **58**

Pluto 64, finder chart **100**; position **98**; rise/set (Sydney) **98**

Precession 63

Retrograde motion 65, **65**

Right ascension 6, on the meridian **107**

Rise/set times of the moon for, Adelaide **117**; Brisbane **116**;
Hobart **117**; Melbourne **116**; Sydney **75**

Rise/set times of the Sun and planets for, Adelaide **114**; Brisbane
113; Hobart **115**; Melbourne **112**; Sydney **part 2**

Satellites, data **67**; of jupiter **90-93**

Saturn 63; finder chart **94**; longitude of central meridian **95**;
rings 64, **95**; rise/set (Sydney) **94**; position **94**;
rotation period 63; satellites **96-97**

Sidereal time 107

Solar system data **66**

Sun, orientation **73**; position **72**; rise/set (Sydney) **73**;
synodic rotation number **73**; twilight (Sydney) **73**

Time 6; daylight saving 6; eastern standard 6; greenwich mean 6;
solar 6; universal 6

Transit of Mercury 83, **83**

Twilight, astronomical 6; civil 6;

Uranus, finder chart **99**; position **98**; rise/set (Sydney) **98**;
satellites 64, **99**

Venus, occultation by the Moon 13, **77-80**; position **85**;
rise/set (Sydney) **84**



There is no one in the world who has not looked up at the starry heavens, at some time, and wondered. What is that bright star ? Why do some of them seem to move from night to night, disturbing the otherwise constant star patterns ? What planet is that? This "guide to the night sky" is designed with you in mind. A telescope is not necessary. All you need to use this book is the same scientific instrument that was available to scientists and others up to the time of Galileo, the human eye!

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