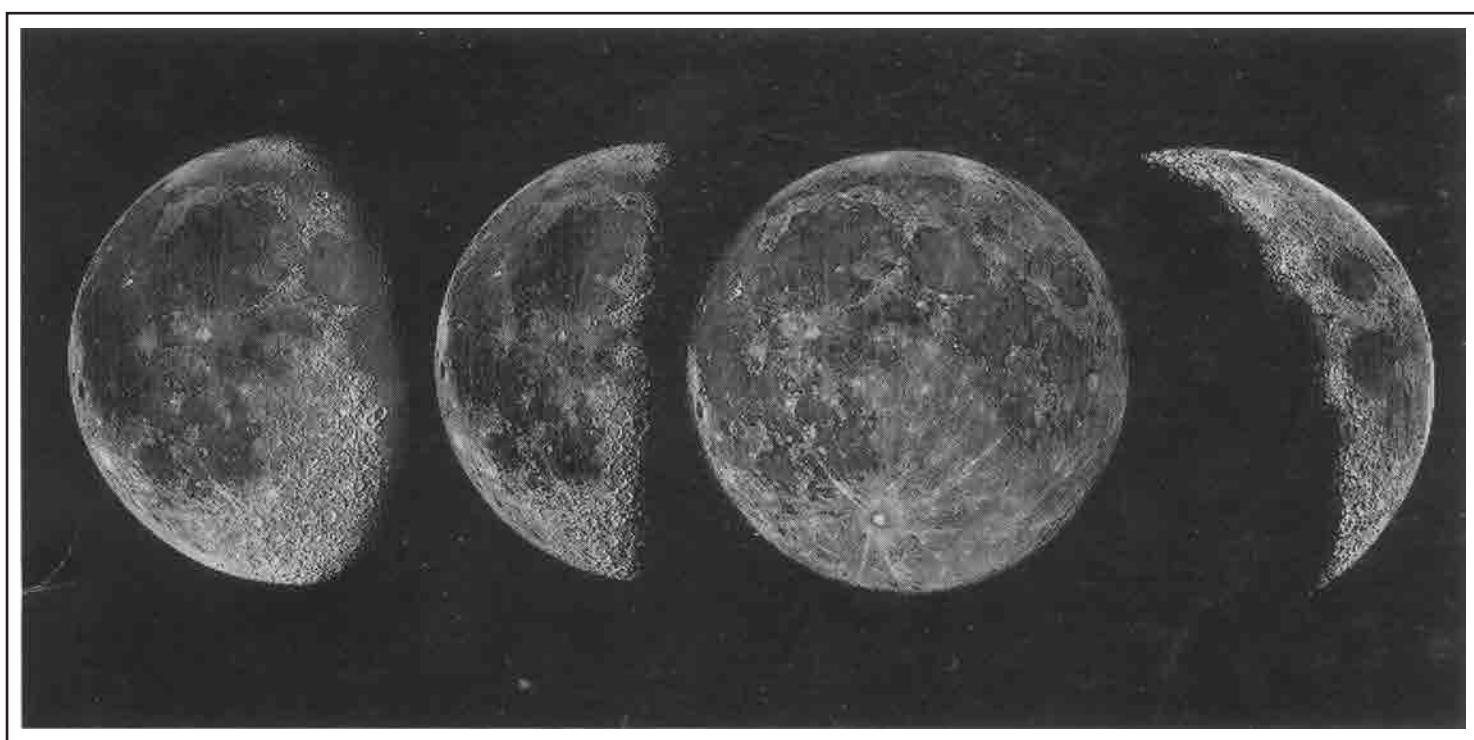

ASTRONOMY

1992



A PRACTICAL GUIDE TO ASTRONOMICAL EVENTS DURING 1992

G. DAWES

P. NORTHFIELD

K. WALLACE

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Ken Wallace

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- Interactive Computing Ephemeris (US Naval Observatory)
- Astronomical Almanac for the Year 1992. (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)

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

THE AGE OF DISCOVERY

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

(November 1991)

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.

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 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.

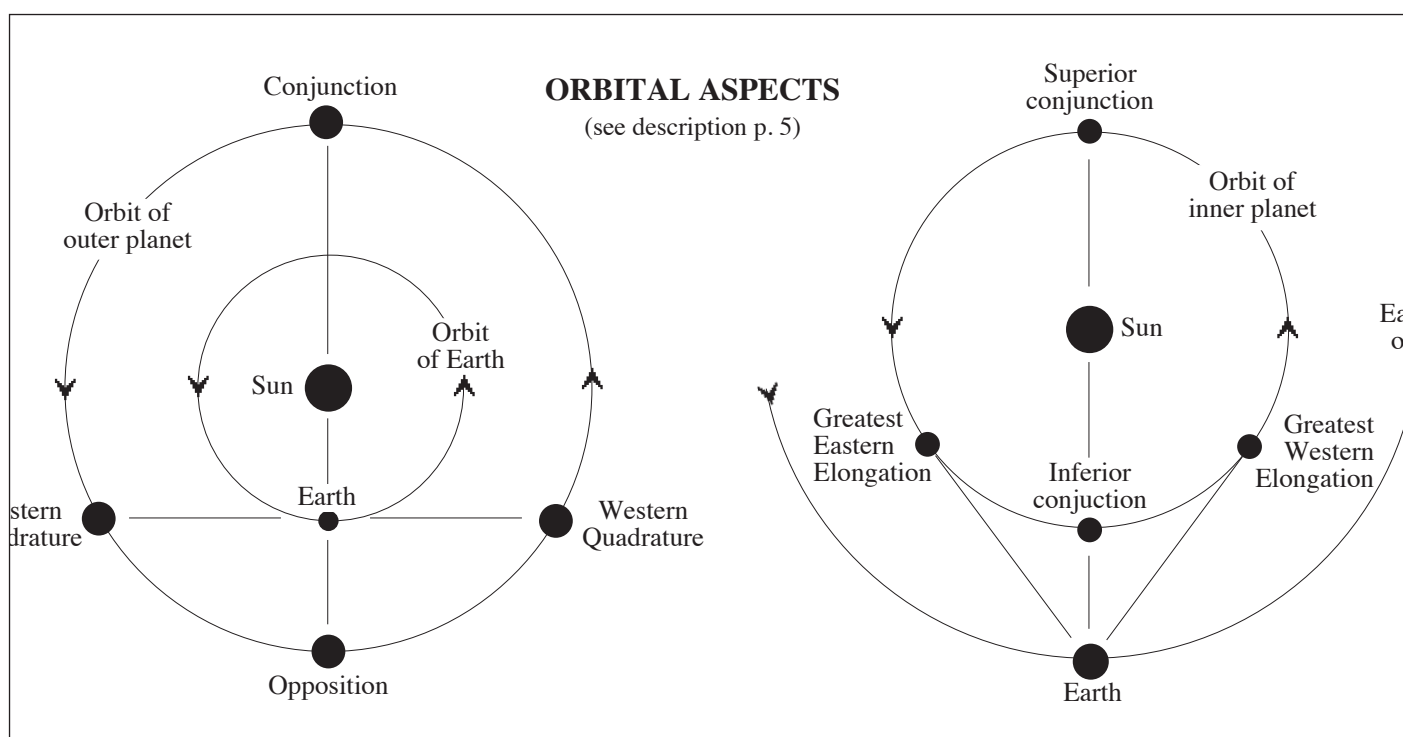
Although the sky is presented as a “negative”, ie black stars with a white (grey) sky, the phase of the Moon is presented as it appears in the sky. That is, the Sun lit portion is white.

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.

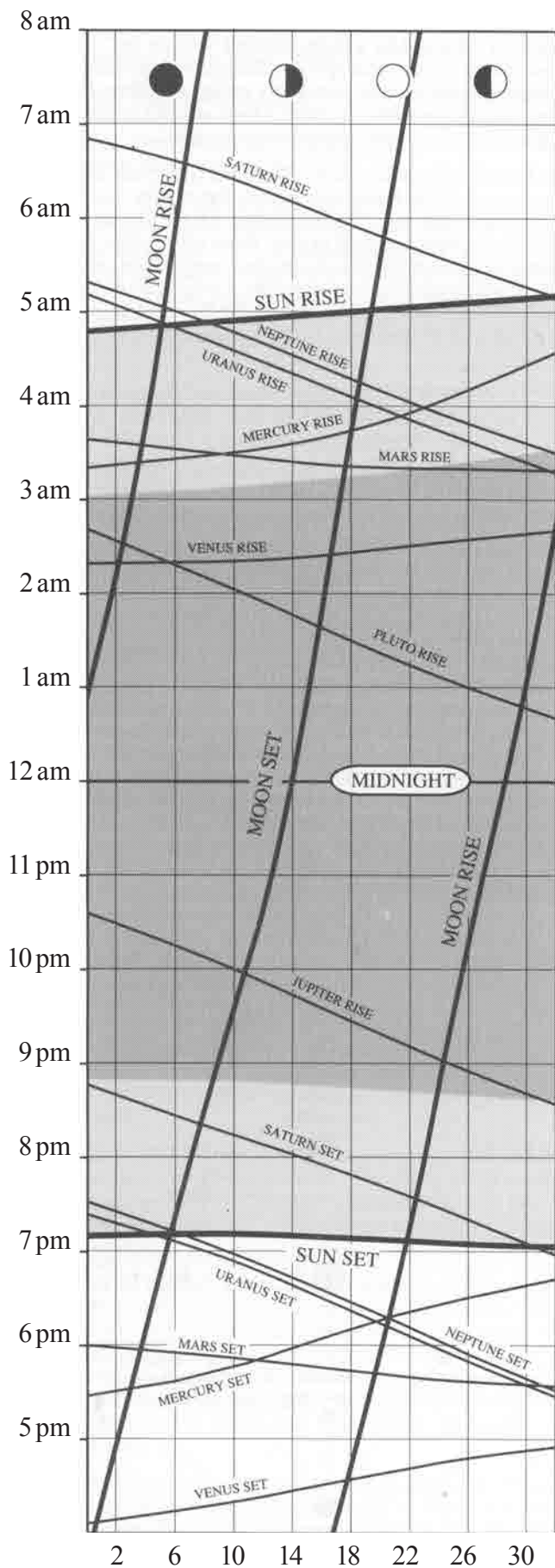
To determine an approximate time in Adelaide (Central Australian Standard Time) corresponding to these “sky views”, add approx. 20mins to the times given. This roughly allows for the change in time zone and longitude differences (at this scale, the latitude shift has little effect).

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



THE MOON

- 3rd Occultation of Mars by the Moon, 8:00pm visible only from extreme south of South America and Antarctica.
- 5th New Moon, 9:10am. Annular eclipse of the Sun, not visible from Australia except partial phase seen from northern region of the continent. (Lunation number 854).
- 6th Moon at apogee (most distant from Earth).
- 13th First Quarter, 12:32pm.
- 19th Moon at perigee (closest to Earth).
- 20th Full Moon, 07:28am.
- 27th Last Quarter, 1:27am.

THE PLANETS

MERCURY is visible in the morning sky during twilight throughout the entire month. On the 3rd at 4am Mercury (magnitude -0.4, altitude 7°) will appear 3.3° directly below the 28 day old Moon (a thin crescent just 5% illuminated) (see sky view diagram). Venus and Mars will also be in the same vicinity at this time. Mercury and Mars can be seen 39' apart on the 10th at 3:30am, but only 5° above the eastern horizon. Binoculars may be helpful in locating Mercury and Mars as twilight begins around 3am.

VENUS, at magnitude -4 is a brilliant object in the eastern morning sky, best seen from about 3am until the sky

MARS rises early in the month after the beginning of twilight and towards month's end just prior to the onset of twilight.

Mars will be a difficult object during this period being close to the horizon as the sky brightens. Mars and Mercury will be 39' apart on the 10th at 3:30am, a good eastern horizon is essential as the planets will only be at an altitude of 5°. With an angular diameter at the beginning of the month of less than 4", Mars is only marginally larger than Uranus and therefore a very poor telescopic object. Observers would be best waiting until later in the year when the disc enlarges as Mars approaches opposition (early January 1993).

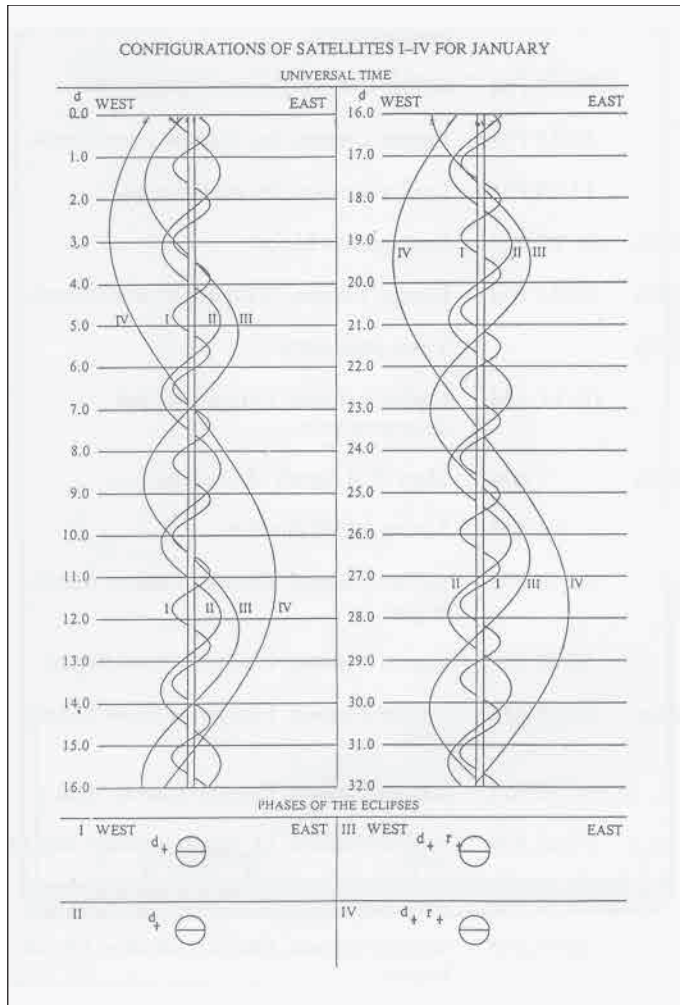
JUPITER, at magnitude -2.5 situated in the constellation of Leo, rises late evening during early January, and at the end of evening twilight late in the month. On the 22nd Jupiter rises 7° below an 18 day old Moon, as both objects transit the meridian around 3am at an altitude of 50° the separation decreases to 6°

SATURN, in the constellation of Capricornus at magnitude 0.6, can only be seen in the western evening sky during twilight early in the month. Thereafter it moves too close to the Sun for observation and on the 30th it will be in conjunction (behind the Sun).

URANUS, in the constellation of Sagittarius, is in conjunction (behind the Sun) on the 5th and is too close to the Sun for observation until late January when it appears in the east during morning twilight.

NEPTUNE is in conjunction with the Sun 1.5 days later than Uranus and is also not observable until late in the month when it appears in the east during morning twilight.

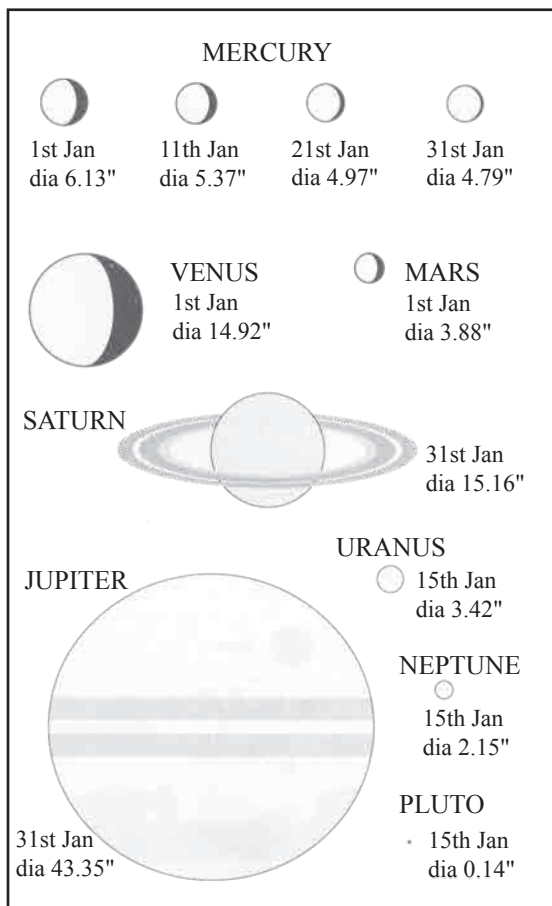
PLUTO is available only for a short period prior to beginning of morning twilight early in the month and for about 2.5 hours at the end of January. Pluto is situated throughout the year in Libra, near the Serpens Caput border, with no bright reference stars in the region; the chart on page 86 will assist in finding the planet.



DAILY EVENTS

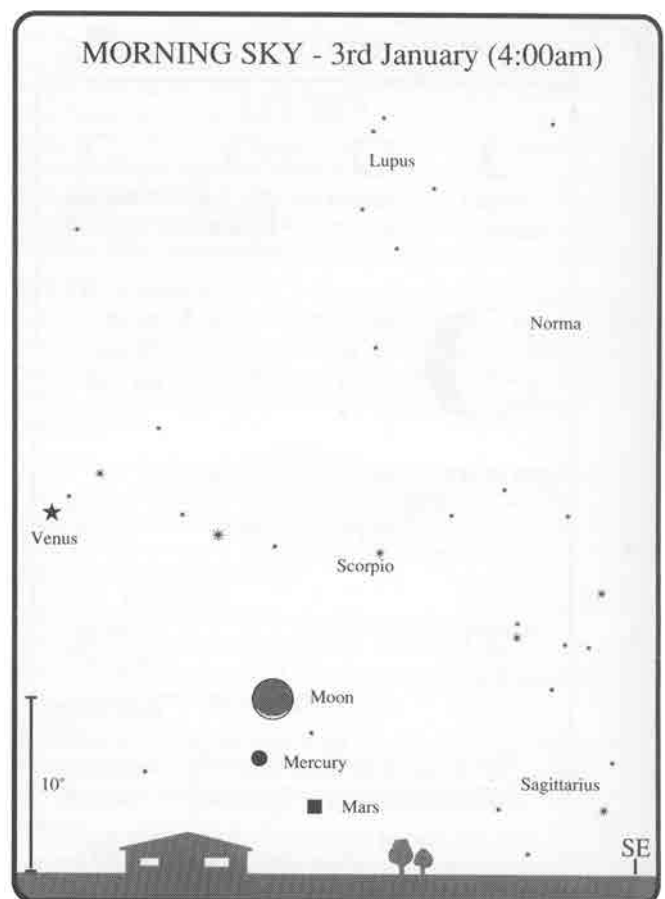
- 1st 01:46 AM Jupiter's moon, Io, shadow transit begins.
 02:52 AM Jupiter's moon, Io, transit begins.
 04:02 AM Jupiter's moon, Io, shadow transit ends.
 10 PM Venus 5° North of Moon.
 10:52 PM Jupiter's moon, Io, eclipse disappearance.
- 2nd 02:16 AM Jupiter's moon, Io, occultation
 reappearance.
 11:34 PM Jupiter's moon, Io, transit ends.
- 3rd 11 AM Mercury 3° North of Moon.
 8 PM Mars 0° 8 North of Moon
- 4th 01:00 AM Sun at perigee.
- 5th 09:10 AM New Moon.
 11 AM Uranus in conjunction.
- 6th 12:25 AM Jupiter's moon, Europa, shadow transit
 begins.
 02:37 AM Jupiter's moon, Europa, transit begins.
 03:13 AM Jupiter's moon, Europa, shadow transit
 ends.
 10 PM Moon at apogee.
 11:48 PM Jupiter's moon, Callisto, eclipse
 reappearance.
- 7th 02:38 AM Jupiter's moon, Ganymede, shadow
 transit begins.
 9 AM Saturn 3° South of Moon.
 11 PM Neptune in conjunction.
- 8th 12:23 AM Jupiter's moon, Europa, occultation
 reappearance.
 03:39 AM Jupiter's moon, Io, shadow transit begins.
 04:41 AM Jupiter's moon, Io, transit begins.
- 9th 12:46 AM Jupiter's moon, Io, eclipse disappearance.
 04:05 AM Jupiter's moon, Io, occultation
 reappearance.
 10:07 PM Jupiter's moon, Io, shadow transit begins.
 11:08 PM Jupiter's moon, Io, transit begins.
- 10th 12:23 AM Jupiter's moon, Io, shadow transit ends.
 01:23 AM Jupiter's moon, Io, transit ends.
- 11th 10:32 PM Jupiter's moon, Io, occultation
 reappearance.
 Mercury at descending node.
 12:16 AM Jupiter's moon, Ganymede, occultation
 reappearance.
- 13th 6 AM Mercury 0° 6 north of Mars
 03:00 AM Jupiter's moon, Europa, shadow transit
 begins.

APPEARANCE OF THE PLANETS

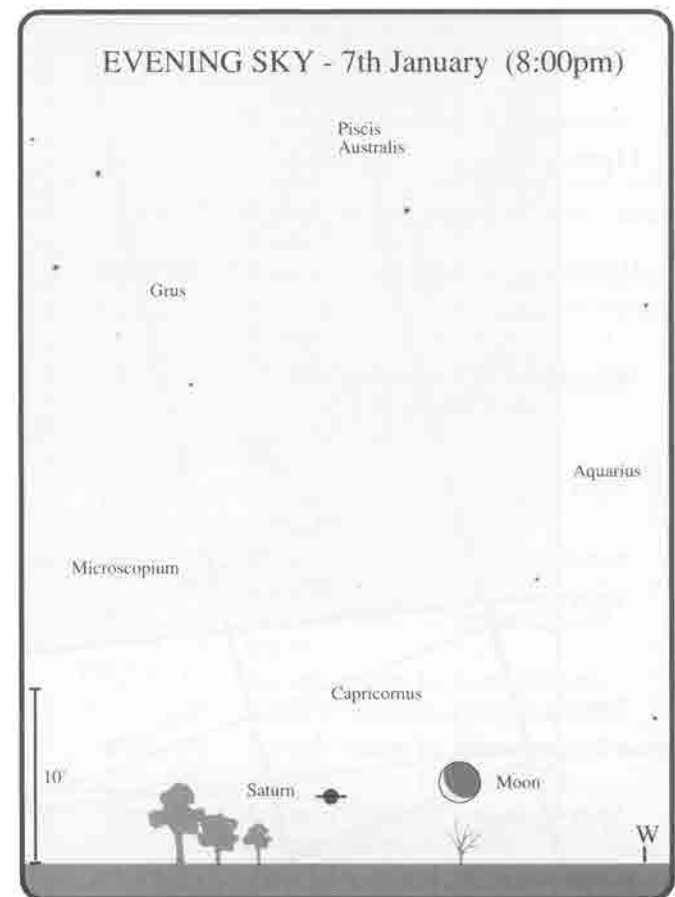
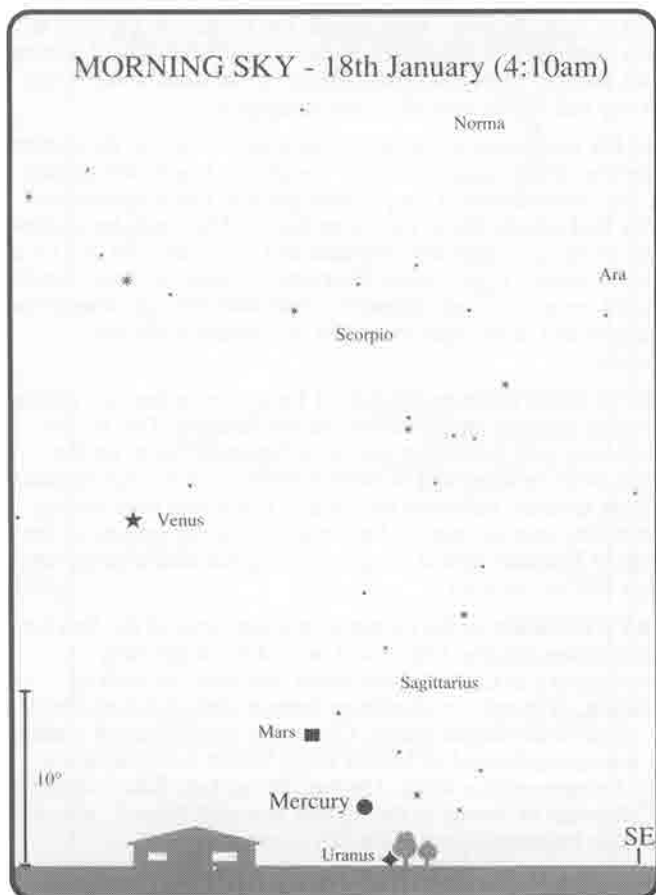
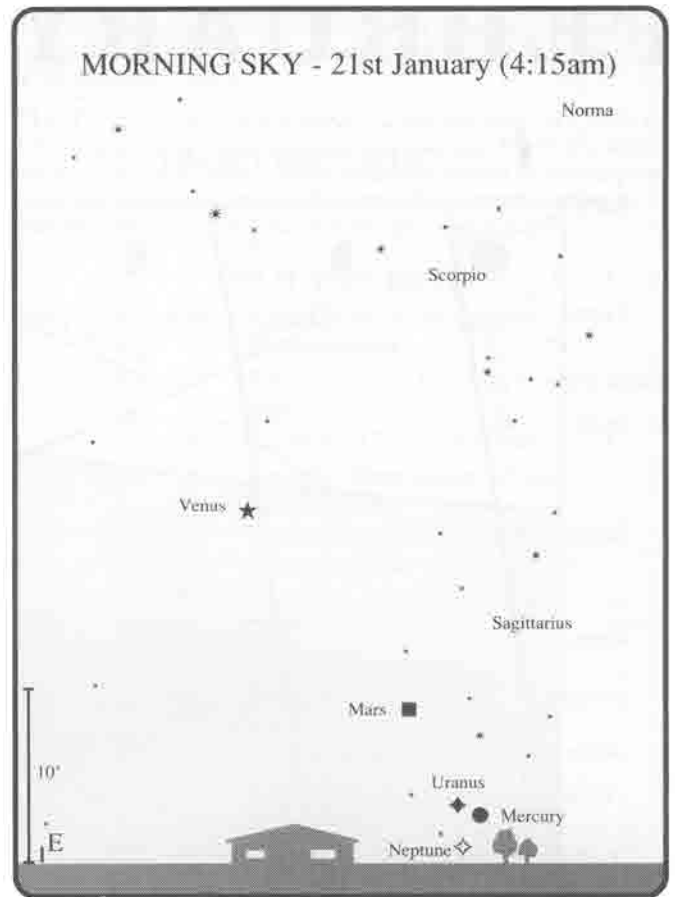
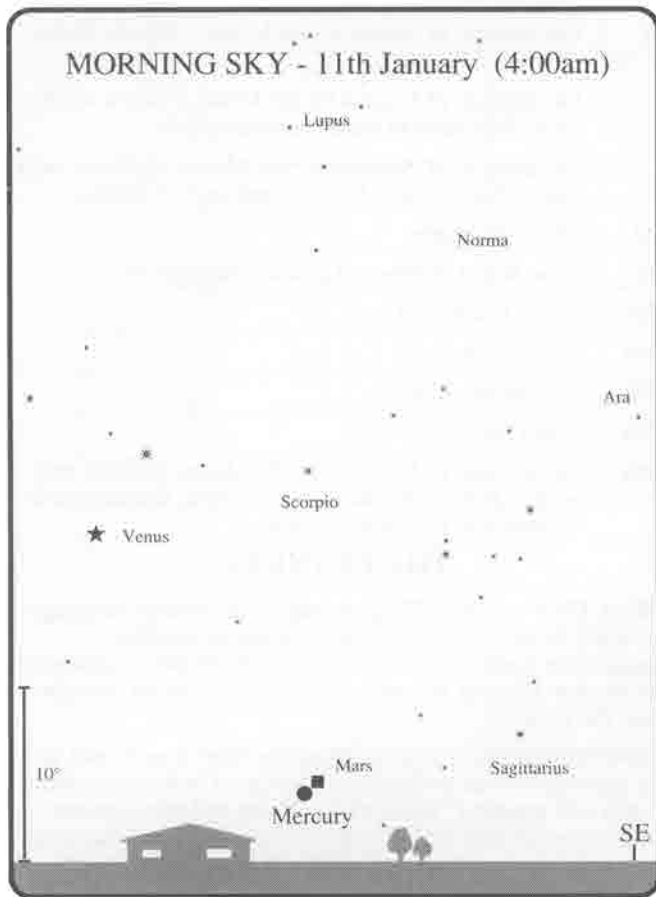


JANUARY

13th	12:32 PM	First quarter Moon.	25th	02:06 AM	Jupiter's moon, Io, occultation reappears.
14th	09:57 PM	Lunar occultation of ZC 223, disappearance.		09:08 PM	Jupiter's moon, Io, transit begins.
	10:06 PM	Jupiter's moon, Europa, eclipse disappearance.		10:38 PM	Jupiter's moon, Io, shadow transit ends.
15th	10:29 PM	Lunar occultation of ZC 356, disappearance.		11:23 PM	Jupiter's moon, Io, transit ends.
	02:45 AM	Jupiter's moon, Europa, occultation reappears.	27th	01:27 AM	Last quarter Moon.
16th	04:55 AM	Jupiter's moon, Callisto, shadow transit begins.	28th	08:52 PM	Jupiter's moon, Ganymede, transit ends.
	02:39 AM	Jupiter's moon, Io, eclipse disappearance.	29th		Vesta stationary.
17th	12:00 AM	Jupiter's moon, Io, shadow transit begins.		03:14 AM	Jupiter's moon, Europa, eclipse disappearance.
	12:55 AM	Jupiter's moon, Io, transit begins.	30th	7 AM	Mars 0°.4 South of Uranus.
	02:16 AM	Jupiter's moon, Io, shadow transit ends.		8 AM	Saturn in conjunction.
	03:10 AM	Jupiter's moon, Io, transit ends.		09:28 PM	Jupiter's moon, Europa, shadow transit begins.
18th	12:12 AM	Jupiter's moon, Ganymede, eclipse reappears.		10:53 PM	Jupiter's moon, Europa, transit begins.
	12:19 AM	Jupiter's moon, Io, occultation reappears.	31st	12:17 AM	Jupiter's moon, Europa, shadow transit ends.
	12:24 AM	Jupiter's moon, Ganymede, occultation disappearance.		01:36 AM	Jupiter's moon, Europa, transit ends.
	03:48 AM	Jupiter's moon, Ganymede, occultation reappears.		03:46 AM	Jupiter's moon, Io, shadow transit begins.
	09:37 PM	Jupiter's moon, Io, transit ends.		04:27 AM	Jupiter's moon, Io, transit begins.
20th	07:28 AM	Full Moon.		10:53 PM	Jupiter's moon, Callisto, shadow transit begins.
	8 AM	Moon at perigee.			
	11 PM	Mercury 0°.6 south of Uranus.			
21st		Mercury at aphelion.			
22nd	9 PM	Mercury 1°.9 south of Neptune.			
	12:40 AM	Jupiter's moon, Europa, eclipse disappearance.			
23rd	04:33 AM	Jupiter's moon, Io, eclipse disappearance.			
	11 AM	Jupiter 7° North of Moon.			
	09:41 PM	Jupiter's moon, Europa, shadow transit ends.			
	09:42 PM	Jupiter's moon, Callisto, occultation disappearance.			
	11:17 PM	Jupiter's moon, Europa, transit ends.			
24th	01:04 AM	Jupiter's moon, Callisto, occultation reappears.			
	01:53 AM	Jupiter's moon, Io, shadow transit begins.			
	02:41 AM	Jupiter's moon, Io, transit begins.			
	03:17 AM	Lunar occultation of 431B Leo, reappears.			
	04:09 AM	Jupiter's moon, Io, shadow transit ends.			
	04:56 AM	Jupiter's moon, Io, transit ends.			
	11:01 PM	Jupiter's moon, Io, eclipse disappearance.			
25th	12:36 AM	Jupiter's moon, Ganymede, eclipse disappearance.			

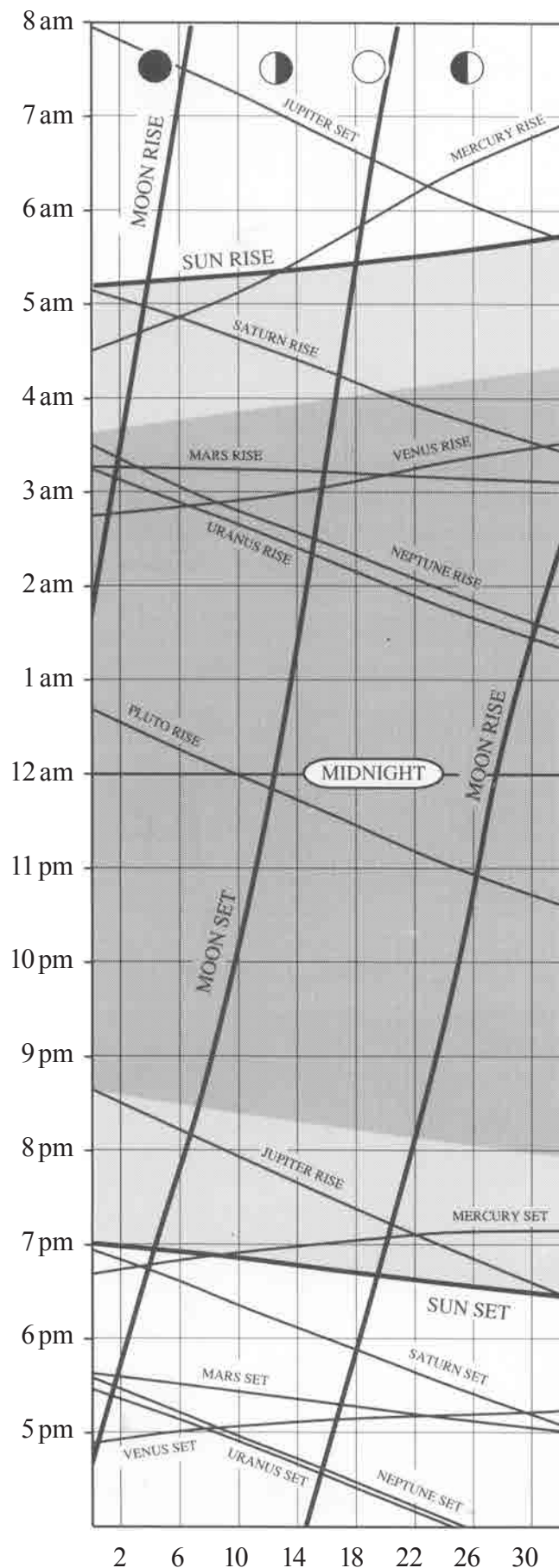


JANUARY



FEBRUARY

RISE/SET CHART



THE MOON

- 1st Occultation of Venus by the Moon, 3:00 am, visible only from Antarctica.
Occultation of Uranus by the Moon, 7:00 pm visible only from parts of northern hemisphere.
Occultation of Neptune by the Moon, 10:00 pm, only visible from South America and central Africa.
- 2nd Moon at apogee.
- 4th New Moon, 5:00 am. (Lunation number 855).
- 12th First Quarter, 2:15 am,
- 17th Moon at perigee.
- 18th Full Moon, 6:04 pm.
- 25th Last Quarter, 5:56 pm.
- 29th Occultation of Neptune by the Moon, 7:00 am, only visible from northern Australia, Java, Borneo, New Guinea and Hawaiian Islands.

THE PLANETS

MERCURY will be difficult to see in the eastern morning sky early in the month, as it moves towards superior conjunction (behind the Sun) on the 12th. It then reappears in the western evening sky and will be visible during twilight

VENUS maintains its -4 magnitude brilliance as it rises in the morning sky an hour prior to twilight. On the 1st at 4 am Venus will appear 1° north of the 27 day old thin crescent Moon at an altitude of 14°, with Uranus, Mars and Neptune below and clustered about 2° south of 3rd magnitude Pi Sagittarii (see sky view diagram). On the 7th around 3:45 am Venus (10° above the eastern horizon) will be 1° north of Uranus, with Neptune 2° below the pair and Mars (5° above the horizon) 6° below and to the south of Venus. On the 9th at 3:45 am Venus will be just 0°20' south of Neptune. Venus (8° above the horizon) can be seen 0°50' north of Mars on the 20th at 4 am. To end a busy month for Venus, on the 29th at 4 am (altitude 5°), it will be seen a close 0°20' north of Saturn with Mars 4° above the pair. Higher in the eastern sky is the 25 day old Moon (see sky view diagram).

MARS rises early in the month around 3:15 am, in the eastern morning sky at magnitude 1.3. The planet begins the month in the constellation of Sagittarius, passing into Capricornus after mid month. From the 1st to the 3rd Mars will be in close proximity to Uranus and Neptune and from the 19th to 21st it will be within 1° of Venus. Best time to observe these planets would be around 4 am. However, with them being close to the horizon and in twilight, they will make poor telescopic objects.

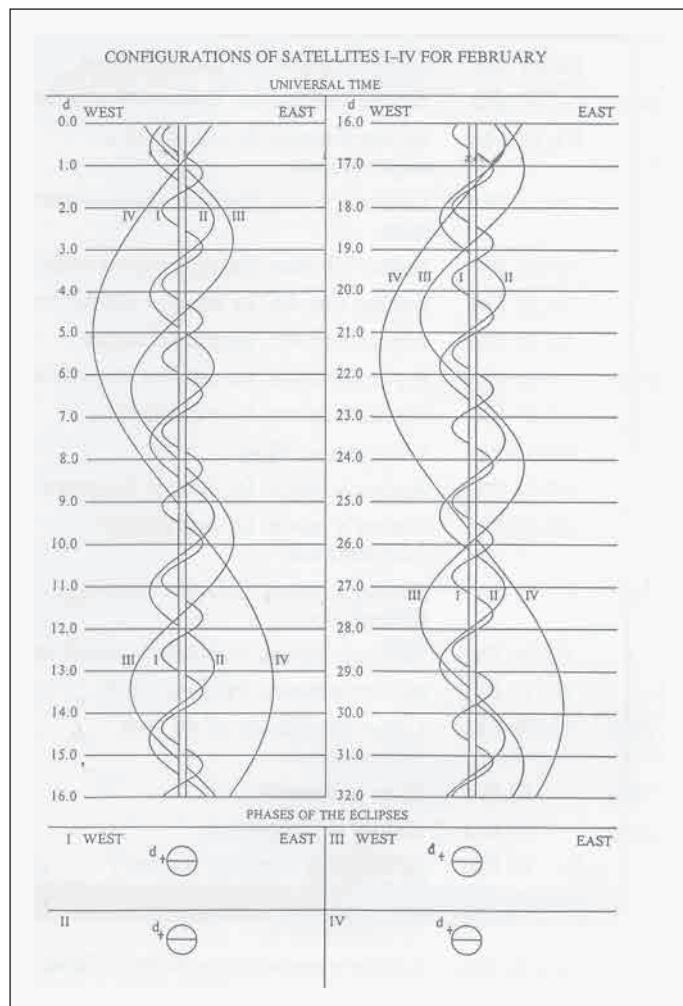
JUPITER in the constellation of Leo, rises in the east during evening twilight and is visible the entire night. The 16 day old Moon will rise in the east with Jupiter 7° away on the 19th. Best viewing will be after 8:30 pm as both objects attain a little altitude. February and March is the best time during the entire year to observe Jupiter as it is at opposition on the 29th of February and at its greatest angular diameter for the year (45").

SATURN, early in the month is still too close to the Sun for observation. By the 15th it will be visible in the early morning sky in Capricornus, rising just after the start of twilight, at month's end only an hour of dark sky is available to observe the ringed planet. Observers would be best waiting at least until the end of March when Saturn is higher in the sky for any serious work. On the 29th at 4 am Saturn appears 0°20' south of Venus in the eastern sky with Mars 4° above the two brighter planets. (see sky view diagram)

URANUS rises early in the month just prior to the start of twilight and by the end of the month around 1:20 am. On the 7th at 3:45 am Uranus (10° above the eastern horizon) will be 1° south of Venus.

FEBRUARY

JUPITER



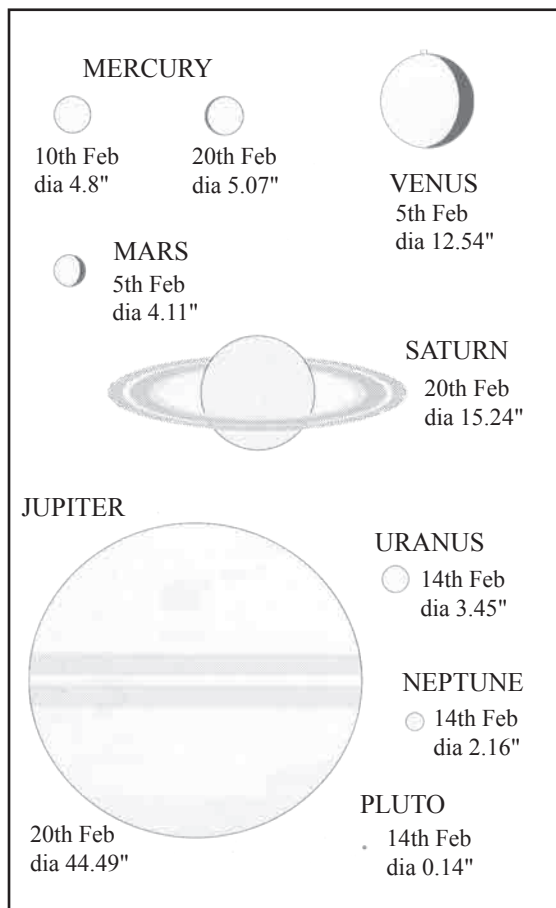
NEPTUNE rises below (and after) Uranus in the early morning sky, and remains within 2° of the planet throughout the month. On the 9th at 3:45am Neptune will be a close $0^\circ 20'$ north of Venus.

PLUTO rises early in the month in the morning sky prior to lam and after the 10th rises in the evening. Observers with instruments of at least 250mm aperture would be best trying to locate the planet towards the end of the month between 2 and 3am when it's altitude will be approaching 60° .

DAILY EVENTS

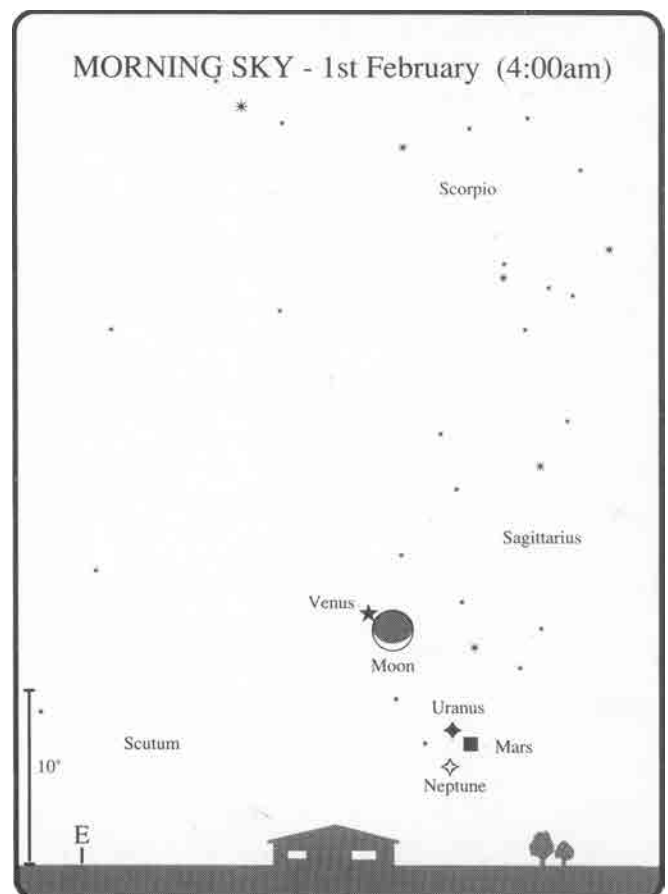
1st	12:55 AM	Jupiter's moon, Io, eclipse disappearance.
	02:58 AM	Jupiter's moon, Callisto, shadow transit ends.
	3 AM	Venus $1^\circ 0$ North of Moon.
	03:51 AM	Jupiter's moon, Io, occultation reappearance.
	04:34 AM	Jupiter's moon, Ganymede, eclipse disappearance.
	4 PM	Mars $1^\circ 5$ south of Neptune
	5 PM	Uranus $0^\circ 9$ south of Moon
	8 PM	Neptune $0^\circ 03$ north of Moon
	08:32 PM	Jupiter's moon, Europa, occultation reappearance.
	9 PM	Mars $1^\circ 5$ South of Moon
	10:15 PM	Jupiter's moon, Io, shadow transit begins.
	10:53 PM	Jupiter's moon, Io, transit begins.
2nd	12:31 AM	Jupiter's moon, Io, shadow transit ends.
	01:08 AM	Jupiter's moon, Io, transit ends.
	10 PM	Moon at apogee.
	10:18 PM	Jupiter's moon, Io, occultation reappearance.
4th	05:00 AM	New Moon.
	08:51 PM	Jupiter's moon, Ganymede, transit begins.
	10:00 PM	Jupiter's moon, Ganymede, shadow transit ends.
5th	12:14 AM	Jupiter's moon, Ganymede, transit ends.
7th	12:04 AM	Jupiter's moon, Europa, shadow transit begins.
	01:10 AM	Jupiter's moon, Europa, transit begins.
	02:52 AM	Jupiter's moon, Europa, shadow transit ends.
	03:54 AM	Jupiter's moon, Europa, transit ends.
	3 PM	Venus $0^\circ 9$ North of Uranus.
8th	02:49 AM	Jupiter's moon, Io, eclipse disappearance.
	07:28 PM	Lunar occultation of ZC 56, disappearance.
	10:47 PM	Jupiter's moon, Europa, occultation reappearance.
9th	12:08 AM	Jupiter's moon, Io, shadow transit begins.
	12:37 AM	Jupiter's moon, Io, transit begins.
	1 AM	Venus $0^\circ 3$ South of Neptune.
	02:24 AM	Jupiter's moon, Io, shadow transit ends.
	02:53 AM	Jupiter's moon, Io, transit ends.
	09:17 PM	Jupiter's moon, Io, eclipse disappearance.
10th	12:02 AM	Jupiter's moon, Io, occultation reappearance.
	08:53 PM	Jupiter's moon, Io, shadow transit ends.
	09:19 PM	Jupiter's moon, Io, transit ends.

APPEARANCE OF THE PLANETS



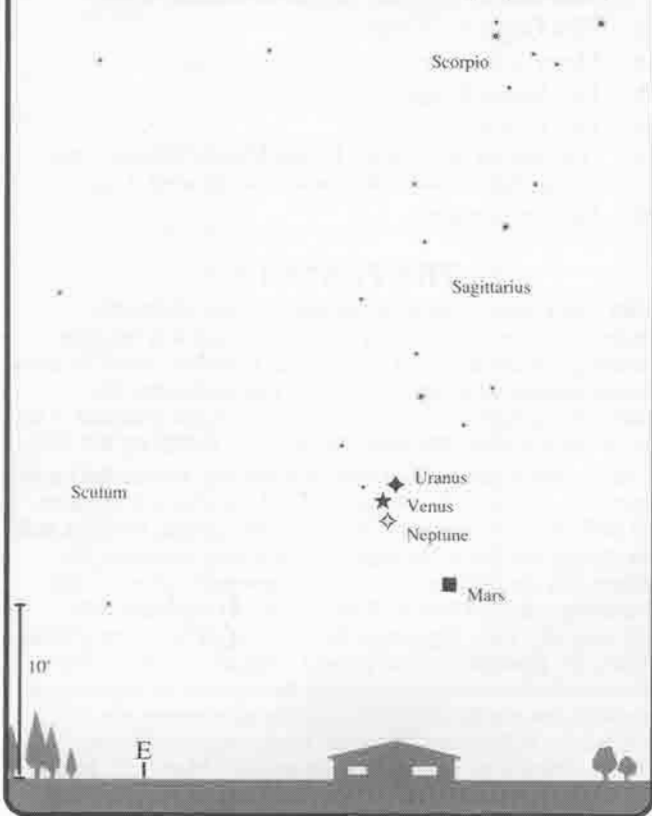
FEBRUARY

11 th	Mercury at greatest latitude South.	23rd	03:55 AM	Jupiter's moon, Io, shadow transit begins.
	10:26 PM		04:05 AM	Jupiter's moon, Io, transit begins.
12 th	12:11 AM	24th	01:06 AM	Jupiter's moon, Io, eclipse disappearance.
	01:58 AM		03:30 AM	Jupiter's moon, Io, occultation reappearance.
	02:15 AM		09:23 PM	Jupiter's moon, Europa, shadow transit ends.
	03:34 AM		09:35 PM	Jupiter's moon, Europa, transit ends.
	02:16 PM		10:24 PM	Jupiter's moon, Io, shadow transit begins.
	02:52 PM		10:31 PM	Jupiter's moon, Io, transit begins.
	7 PM	25th	12:40 AM	Jupiter's moon, Io, shadow transit ends.
	07:40 PM		12:46 AM	Jupiter's moon, Io, transit ends.
14 th	02:40 AM		05:56 PM	Last quarter Moon.
	03:27 AM		07:34 PM	Jupiter's moon, Io, eclipse disappearance.
15 th	12:35 AM		09:56 PM	Jupiter's moon, Io, occultation reappearance.
	04:43 AM	26th	01:33 AM	Jupiter's moon, Callisto, eclipse disappearance.
	09:38 PM		07:08 PM	Jupiter's moon, Io, shadow transit ends.
16 th	01:02 AM		07:12 PM	Jupiter's moon, Io, transit ends.
	02:02 AM	27th	12:59 AM	Lunar occultation of 44 Oph, reappearance.
	02:21 AM	28th	12 PM	Pluto stationary.
	04:18 AM	29th	11 AM	Jupiter at opposition.
	04:36 AM		12 PM	Venus 0°.1 North of Saturn.
	11:11 PM		08:27 PM	Jupiter's moon, Ganymede, occultation disappearance.
17 th	Venus at descending node.		11:59 PM	Jupiter's moon, Ganymede, eclipse reappearance.
	01:46 AM			
	07:48 PM			
	08:30 PM			
	08:47 PM			
	08:51 PM			
	9 PM			
	10:46 PM			
	11:02 PM			
	11:08 PM			
18 th	06:04 PM			
	08:13 PM			
19 th	02:24 AM			
	03:28 AM			
20 th	04:19 AM			
	8 AM			
21 st	05:16 AM			
22 nd	08:37 PM			
23 rd	12:12 AM			
	03:15 AM			

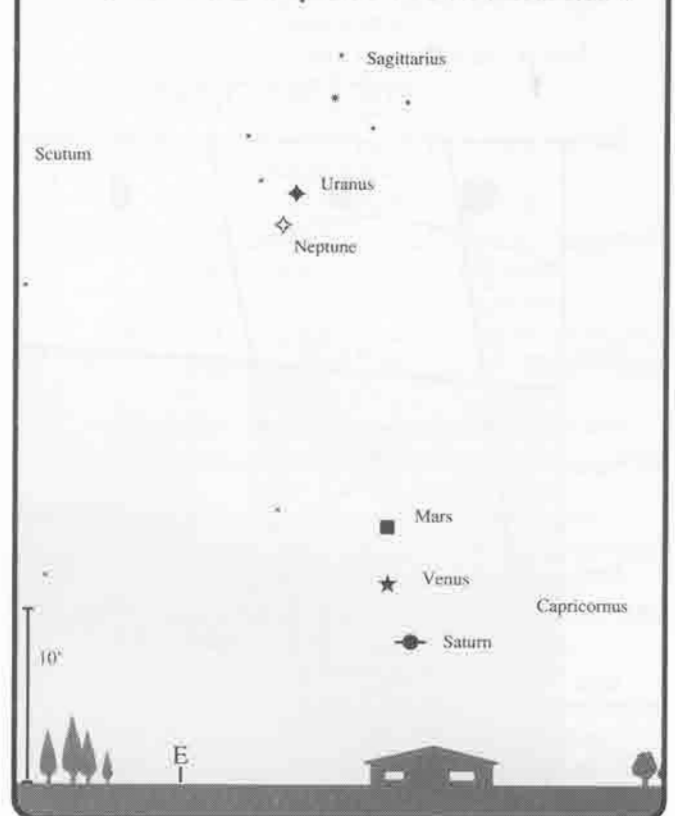


FEBRUARY

MORNING SKY - 8th February (4:20am)



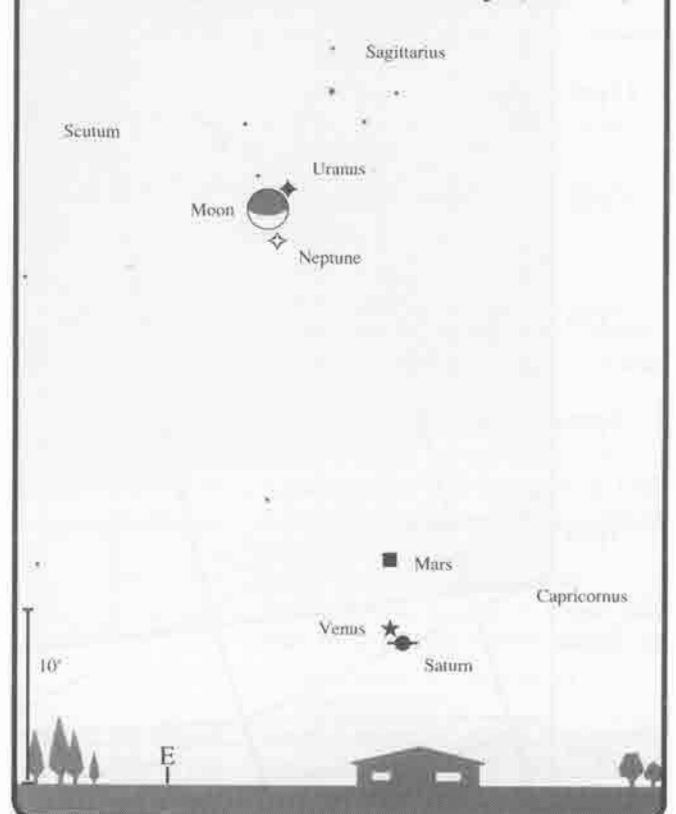
MORNING SKY - 26th February (4:30am)



MORNING SKY - 19th February (4:00am)

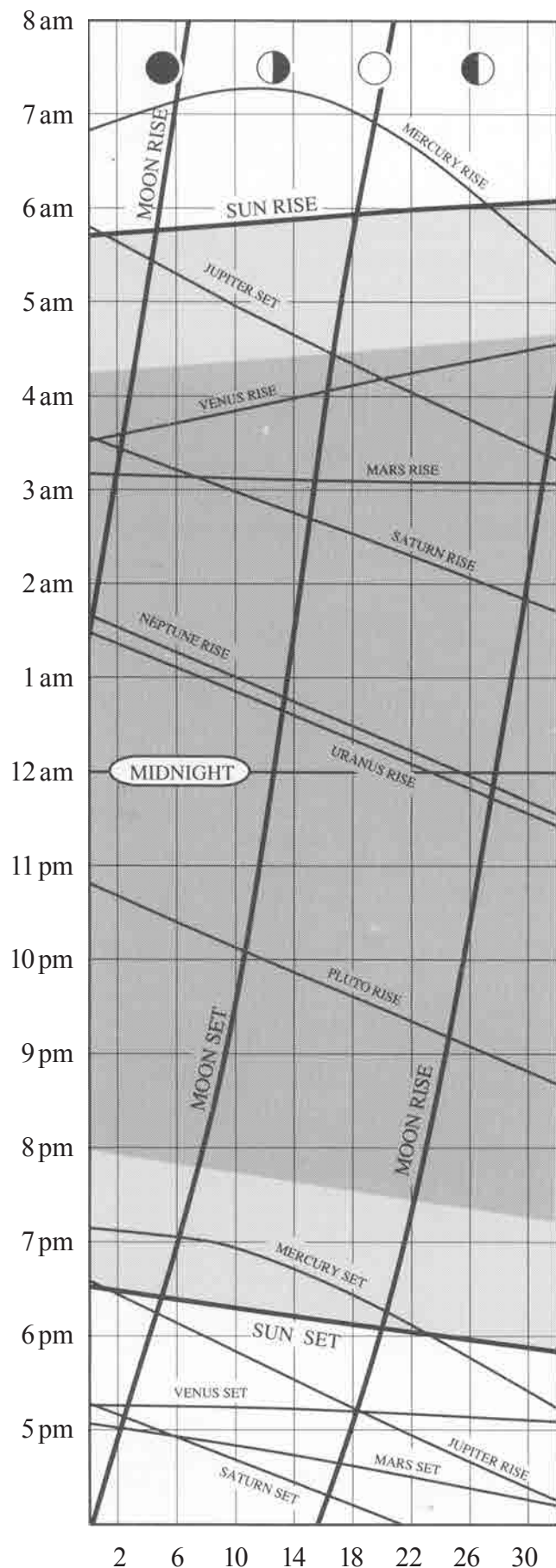


MORNING SKY - 29th February (4:20am)



MARCH

RISE/SET CHART



THE MOON

- 1st Moon at apogee
- 4th New Moon, 11:22pm. (Lunation number 856)
- 12th First Quarter, 12:36pm.
- 16th Moon at perigee
- 19th Full Moon, 4:18am.
- 26th Last Quarter, 12:30pm.
- 27th Occultation of Neptune by the Moon, 3:00pm, only visible from central Africa and south west Asia
- 28th Moon at apogee.

THE PLANETS

MERCURY sets in the western evening sky about 40 minutes after the Sun early in the month, and will become increasingly more difficult to detect as it moves closer to the Sun mid month. The rapidly moving planet reaches it's greatest elongation east of the Sun (18°) on the 10th and is in inferior conjunction (between the Sun and Earth) on the 27th.

VENUS rises in the eastern morning sky just before the onset of morning twilight. At magnitude -3.9 (at which it remains until mid October) it can be observed throughout twilight and even during the day if the observer carefully monitors it's position. On the 2nd an interesting alignment of the 27 day old waning crescent Moon, Venus, Saturn and Mars will occur (see sky view diagram). Best observed between 4:00 to 4:30am, the planets form an almost vertical line above the horizon with the Moon completing the apex of an equilateral triangle to the north. The following measurements are provided for 4:30am just after the beginning of morning twilight; altitude of Venus 10° , Saturn 12° , Mars 15° , Moon 12° . Separation from Moon; Venus 5° , Saturn 4° , Mars 4.5° . Between Saturn and Venus lies the 4th magnitude star Theta

MARS is a morning object until November. It rises just after 3am early in the month and is located in the constellation of Capricornus. The planet crosses over into Aquarius on the 25th. It is 4° south of the Moon on the 2nd, joining with Venus and Saturn to form an interesting planet/moon configuration (see Venus for detail). On the 7th at 4am Mars will be a close $0^\circ 25'$ south of Saturn at an altitude of 10° above the eastern horizon, with 4th magnitude Theta Capricorni just $0^\circ 16'$ east of Saturn, also in the picture is Venus 2° above the horizon (see sky view diagram). Mars has another near approach to the Moon on the 31st at 4:30am, at this time the Moon is 26 days old and the separation of the pair is 5° . Both are about 10° above the horizon.

JUPITER, just past opposition, can be seen throughout most of the night in Leo. It's large angular diameter ($44''$ of arc) lends itself to some serious observation with large apertures and makes it a good object for small instruments. Jupiter rises in the east prior to sunset and sets just on sunrise early in the month and at about 3:30am towards month's end. On the 17th at 10pm in the northern sky, at an altitude of 44° , Jupiter lies 5° below the 13 day old Moon. To the west of the planet (8° away) is 1.35 magnitude Alpha Leonis (Regulus).

SATURN is now at a respectable altitude in the morning sky prior to the onset of twilight permitting some good observing time. It rises at 3:30am at the start of the month and at 2:00am towards the end. Early in the month, Saturn forms part of the configuration outlined in the Venus section. On the 30th at 3am the planet, at an altitude of 13° , will be 6° south of the 25 day old Moon.

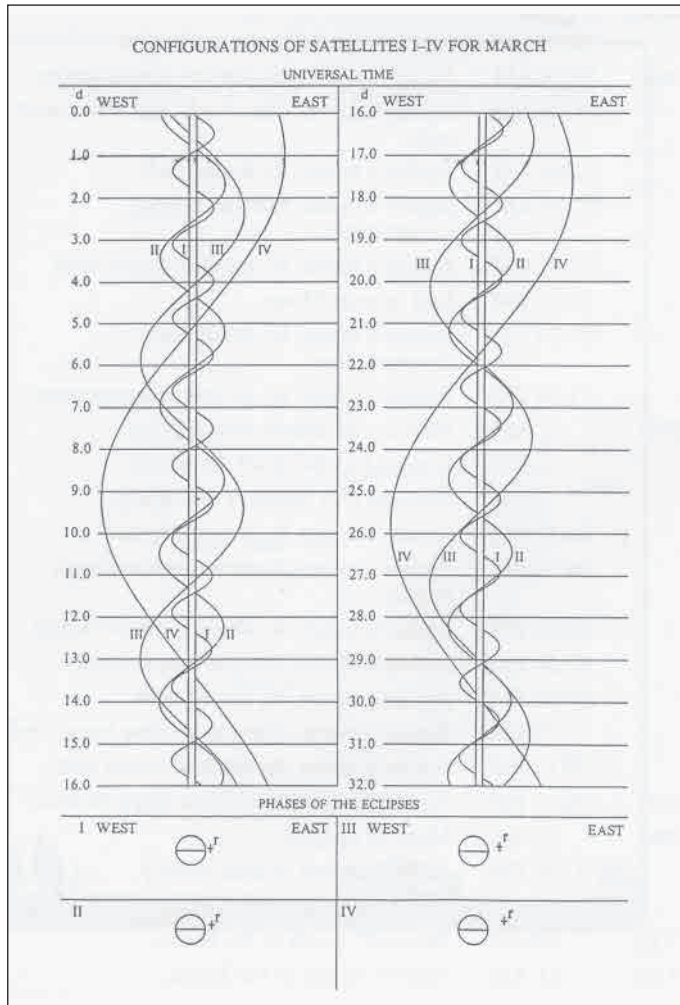
URANUS at magnitude 5.8 rises in the morning sky at 1:30am early in the month and before midnight from the 23rd. On the 27th Uranus rises 6° below a 23 day old Moon and by morning twilight it will close to within 4°

NEPTUNE rises 8 minutes after Uranus and both planets remain within about 2° of 3rd magnitude Pi Sagittarii (Albaldah) throughout the month. Following Uranus, Neptune will also appear near the Moon on the 27th.

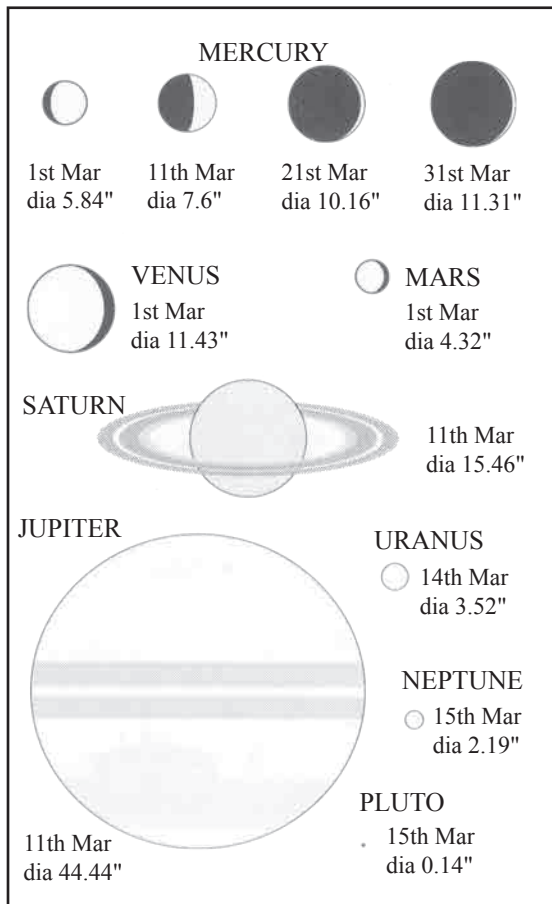
PLUTO rises late in the evening sky early in the month, and by month's end will rise by 9pm.

MARCH

JUPITER



APPEARANCE OF THE PLANETS

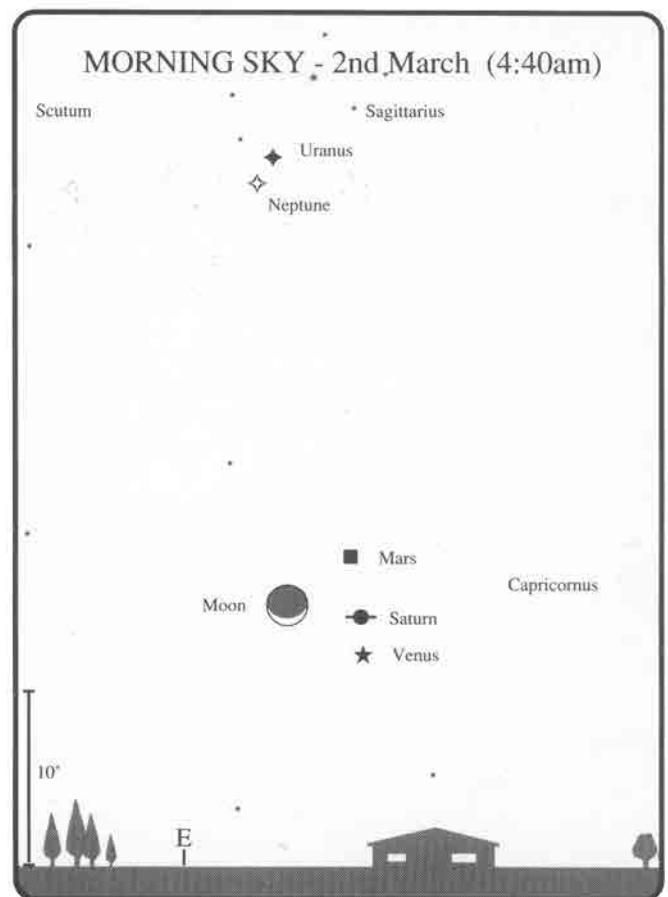


DAILY EVENTS

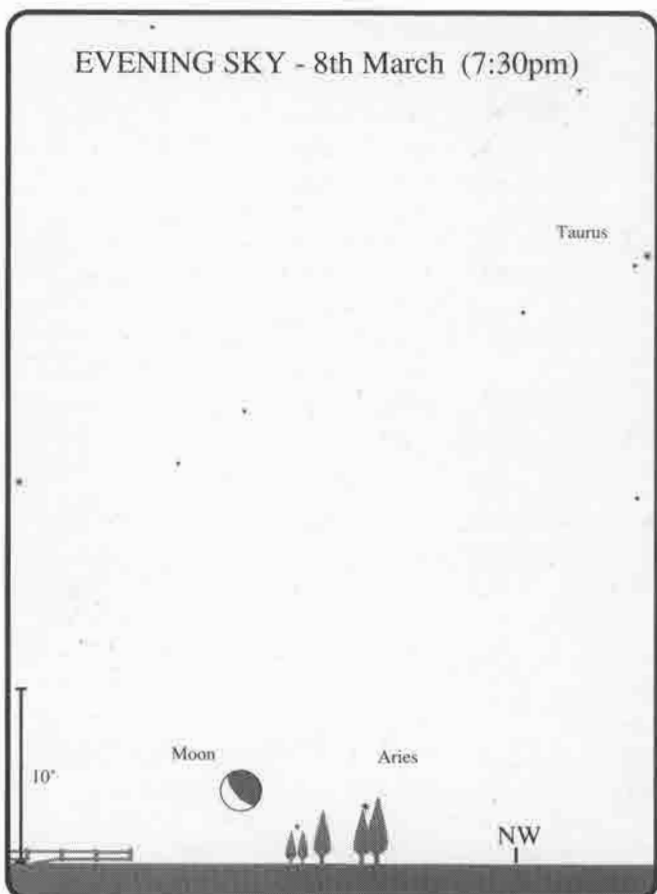
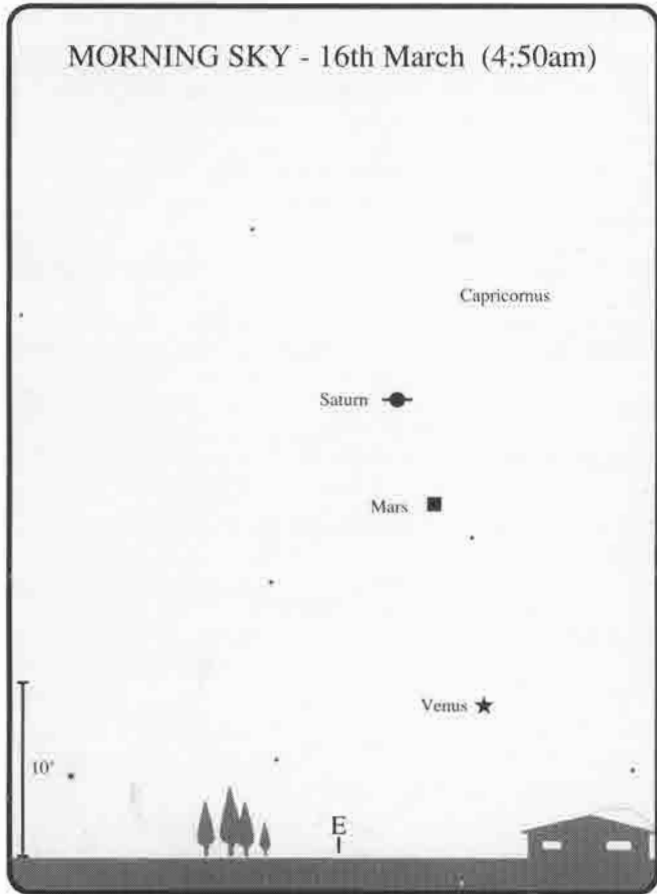
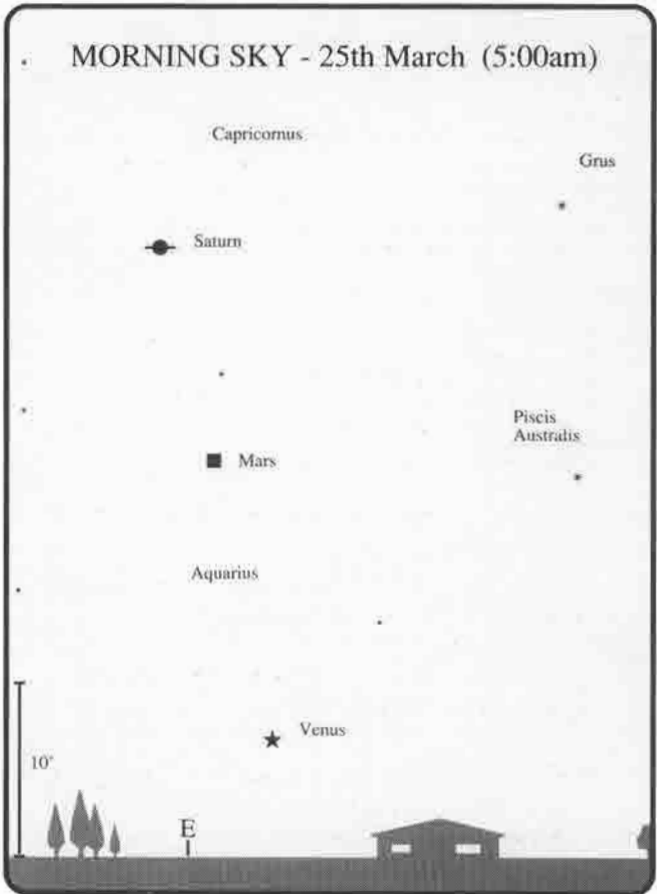
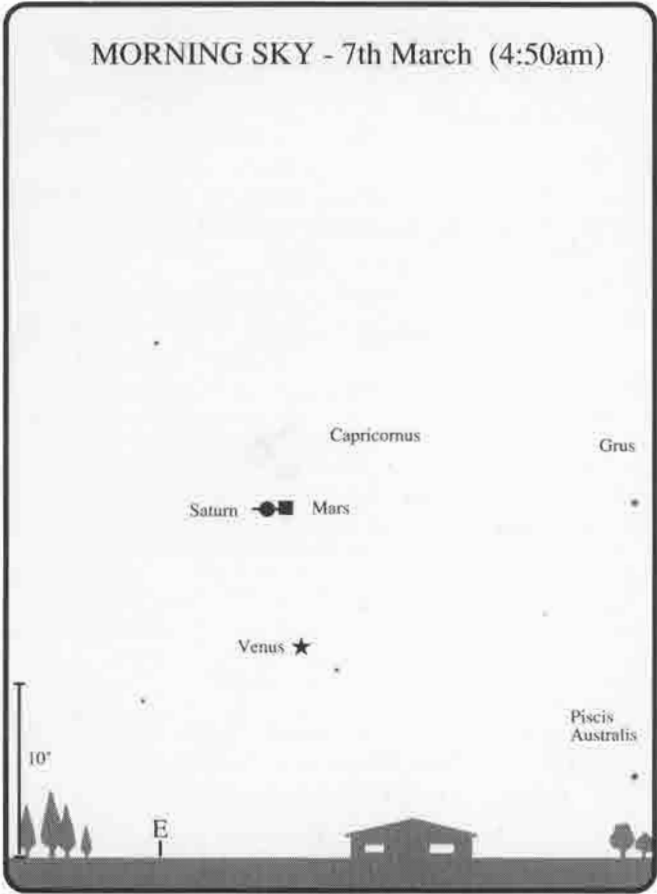
1st	02:45 AM	Mercury at ascending node.
	05:32 AM	Jupiter's moon, Europa, occultation disappearance.
	7 AM	Jupiter's moon, Europa, eclipse reappearance.
	7 AM	Moon at apogee.
2nd	02:58 AM	Jupiter's moon, Io, occultation disappearance.
	4 AM	Mars 4° South of the Moon.
	05:17 AM	Jupiter's moon, Io, eclipse reappearance.
	11 AM	Saturn 4° South of the Moon.
	4 PM	Venus 4° South of the Moon.
	09:05 PM	Jupiter's moon, Europa, transit begins.
	09:11 PM	Jupiter's moon, Europa, shadow transit begins.
	11:50 PM	Jupiter's moon, Europa, transit ends.
	11:59 PM	Jupiter's moon, Europa, shadow transit ends.
3rd	12:14 AM	Jupiter's moon, Io, transit begins.
	12:17 AM	Jupiter's moon, Io, shadow transit begins.
	02:29 AM	Jupiter's moon, Io, transit ends.
	02:34 AM	Jupiter's moon, Io, shadow transit ends.
	09:24 PM	Jupiter's moon, Io, occultation disappearance.
	11:46 PM	Jupiter's moon, Io, eclipse reappearance.
4th	06:40 PM	Jupiter's moon, Io, transit begins.
	06:46 PM	Jupiter's moon, Io, shadow transit begins.
	06:49 PM	Jupiter's moon, Europa, eclipse reappearance.
	08:55 PM	Jupiter's moon, Io, transit ends.
	09:02 PM	Jupiter's moon, Io, shadow transit ends.
	11:22 PM	New Moon.
5th		Mercury at perihelion.
6th	4 PM	Mercury 4° South of the Moon.
	11 PM	Mars 0° 4 South of Saturn.
7th	11:44 PM	Jupiter's moon, Ganymede, occultation disappearance.
8th		Juno in conjunction.
	03:58 AM	Jupiter's moon, Ganymede, eclipse reappearance.
	04:59 AM	Jupiter's moon, Europa, occultation disappearance.
9th		Vesta at opposition.
	04:42 AM	Jupiter's moon, Io, occultation disappearance.
	11:21 PM	Jupiter's moon, Europa, transit begins.
	11:48 PM	Jupiter's moon, Europa, shadow transit begins.
10th	01:58 AM	Jupiter's moon, Io, transit begins.
	02:06 AM	Jupiter's moon, Europa, transit ends.
	02:11 AM	Jupiter's moon, Io, shadow transit begins.
	02:36 AM	Jupiter's moon, Europa, shadow transit ends.
	04:13 AM	Jupiter's moon, Io, transit ends.
	04:27 AM	Jupiter's moon, Io, shadow transit ends.
	7 AM	Mercury at greatest elongation East (18°).
	11:08 PM	Jupiter's moon, Io, occultation disappearance.
11th	01:40 AM	Jupiter's moon, Io, eclipse reappearance.
	06:50 PM	Lunar occultation of ZC 703, disappearance.
	08:24 PM	Jupiter's moon, Io, transit begins.
	08:40 PM	Jupiter's moon, Io, shadow transit begins.
	09:23 PM	Jupiter's moon, Europa, eclipse reappearance.

MARCH

11th	10:39 PM	Jupiter's moon, Io, transit ends.	25th	11:20 PM	Jupiter's moon, Ganymede, transit ends.
	10:56 PM	Jupiter's moon, Io, shadow transit ends.		11:53 PM	Jupiter's moon, Io, transit begins.
12th	12:36 PM	First quarter Moon.	26th	12:28 AM	Jupiter's moon, Io, shadow transit begins.
	08:09 PM	Jupiter's moon, Io, eclipse reappearance.		01:44 AM	Jupiter's moon, Ganymede, shadow transit ends.
13th	08:59 PM	Lunar occultation of ZC 1036, disappearance.		02:08 AM	Jupiter's moon, Io, transit ends.
	11:31 PM	Jupiter's moon, Callisto, eclipse reappearance.		02:30 AM	Jupiter's moon, Europa, eclipse reappearance.
14th	07:55 PM	Lunar occultation of 79 Gem, disappearance.		02:44 AM	Jupiter's moon, Io, shadow transit ends.
15th	03:01 AM	Jupiter's moon, Ganymede, occultation disappearance.		12:30 PM	Last quarter Moon.
	06:43 PM	Lunar occultation of ZC 1306, disappearance.		09:04 PM	Jupiter's moon, Io, occultation disappearance.
	08:53 PM	Lunar occultation of ZC 1316, disappearance.		11:59 PM	Jupiter's moon, Io, eclipse reappearance.
	11:52 PM	Lunar occultation of 54 Cnc, disappearance.	27th	1 AM	Mercury in inferior conjunction.
16th		Mercury at greatest latitude North.		1 PM	Uranus 1°.5 South of the Moon.
17th	1 AM	Mercury stationary.		3 PM	Neptune 0°.5 South of the Moon.
	01:37 AM	Jupiter's moon, Europa, transit begins.		06:19 PM	Jupiter's moon, Io, transit begins.
	02:25 AM	Jupiter's moon, Europa, shadow transit begins.		06:21 PM	Jupiter's moon, Europa, shadow transit begins.
	03:42 AM	Jupiter's moon, Io, transit begins.		06:57 PM	Jupiter's moon, Io, shadow transit begins.
	4 AM	Moon at perigee.		07:50 PM	Jupiter's moon, Europa, transit ends.
	04:05 AM	Jupiter's moon, Io, shadow transit begins.		08:35 PM	Jupiter's moon, Io, transit ends.
	04:23 AM	Jupiter's moon, Europa, transit ends.		09:07 PM	Jupiter's moon, Europa, shadow transit ends.
	10 PM	Jupiter 6° North of the Moon.		09:12 PM	Jupiter's moon, Io, shadow transit ends.
18th	12:52 AM	Jupiter's moon, Io, occultation disappearance.	28th	06:27 PM	Jupiter's moon, Io, eclipse reappearance.
	03:35 AM	Jupiter's moon, Io, eclipse reappearance.	29th	12 AM	Moon at apogee.
	06:17 PM	Jupiter's moon, Ganymede, shadow transit begins.		07:26 PM	Jupiter's moon mutual event:-Europa occults Ganymede.
	07:59 PM	Jupiter's moon, Ganymede, transit ends.	30th	12 AM	Saturn 4° South of the Moon.
	08:20 PM	Jupiter's moon, Europa, occultation disappearance.	31st	11 AM	Mars 6° South of the Moon.
	09:46 PM	Jupiter's moon, Ganymede, shadow transit ends.			
	10:08 PM	Jupiter's moon, Io, transit begins.			
	10:34 PM	Jupiter's moon, Io, shadow transit begins.			
	11:56 PM	Jupiter's moon, Europa, eclipse reappearance			
19th	12:23 AM	Jupiter's moon, Io, transit ends.			
	12:50 AM	Jupiter's moon, Io, shadow transit ends.			
	04:18 AM	Full Moon.			
	07:19 PM	Jupiter's moon, Io, occultation disappearance.			
	10:04 PM	Jupiter's moon, Io, eclipse reappearance.			
20th	06:31 PM	Jupiter's moon, Europa, shadow transit ends.			
	06:48 PM	Solar equinox.			
	06:49 PM	Jupiter's moon, Io, transit ends.			
	07:18 PM	Jupiter's moon, Io, shadow transit ends.			
22nd	12:10 AM	Jupiter's moon, Callisto, transit begins.			
	03:47 AM	Jupiter's moon, Callisto, transit ends.			
	06:08 PM	Jupiter's moon mutual event:-Europa eclipses Ganymede.			
23rd		Venus at aphelion.			
24th	03:54 AM	Jupiter's moon, Europa, transit begins.			
25th	02:38 AM	Jupiter's moon, Io, occultation disappearance.			
	07:53 PM	Jupiter's moon, Ganymede, transit begins.			
	10:16 PM	Jupiter's moon, Ganymede, shadow transit begins.			
	10:35 PM	Jupiter's moon, Europa, occultation disappearance.			

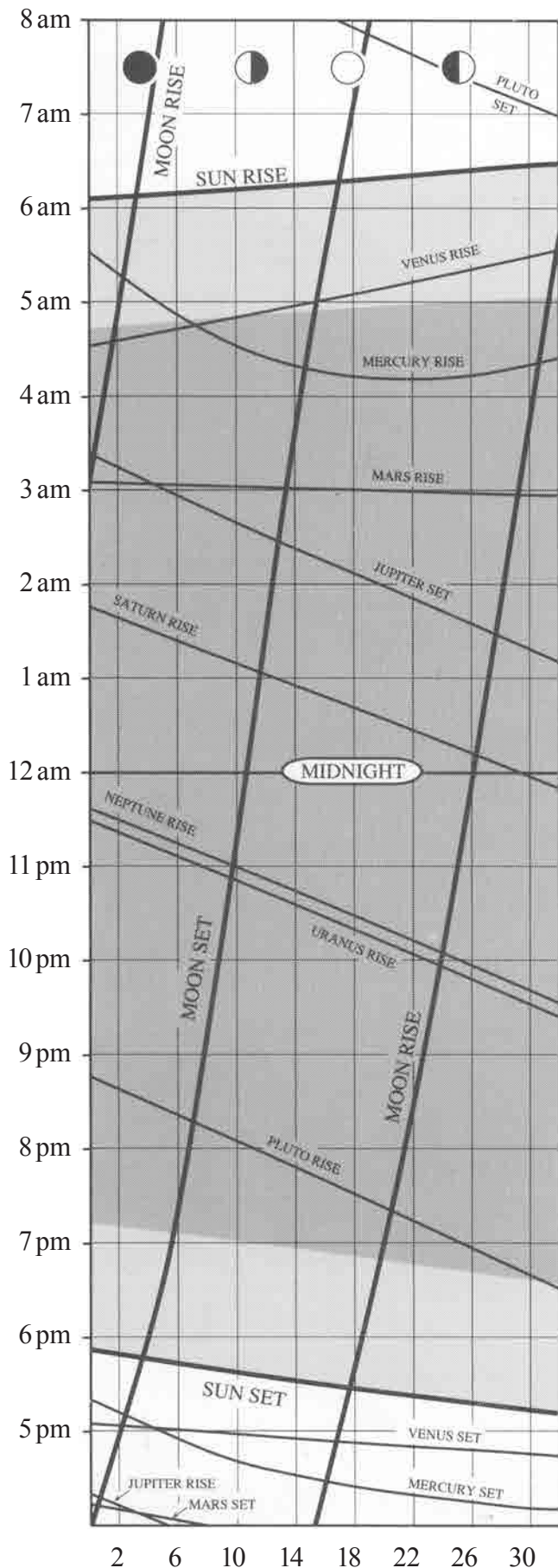


MARCH



APRIL

RISE/SET CHART



THE MOON

- 3rd New Moon, 3:01 pm. (Lunation number 857)
- 10th First Quarter, 8:06 pm.
- 13th Moon at perigee
- 17th Full Moon, 2:42 pm.
- 24th Occultation of Neptune by the Moon, 12:00 am, only visible from North America and north east Pacific Ocean.
- 25th Last Quarter, 7:40 am. Moon at apogee.

THE PLANETS

MERCURY returns to the morning sky this month. Generally the planet is rather difficult to locate because of its close proximity to the Sun, but on the 24th Mercury reaches its greatest elongation west of the Sun (27°), this large angular separation provides the observer with the best opportunity to see the elusive planet in the morning sky this year. The period from April 6th to May 18th sees Mercury rising in a dark sky prior to the onset of morning twilight, on the 24th at 5 am the planet will be at an altitude of 9° with the Sun 18° below the horizon. The magnitude, size and phase of Mercury vary greatly during this short period and make interesting comparisons over a few nights. During April, Mercury's brightness increases from 3.4 to 0.2 magnitude, while its angular size decreases from $11''$ to $7''$. On the 6th, Mercury will be $2^\circ 30'$ north of Venus. The pair rise around the beginning of morning twilight with Venus above the horizon seven minutes before Mercury. On the 7th both planets rise at the same time (4:47 am) only 2° apart (see Sky View diagram).

VENUS rises early in the month in the eastern morning sky prior to 5 am. By mid month it will rise after the commencement of morning twilight. At -3.9 magnitude the planet will be easily visible even as the sky brightens. On the 6th and 7th Venus appears near Mercury (see Mercury for

MARS remains in Aquarius most of the month crossing over into Pisces on the 29th. At the beginning of the month Mars shines at 1.2 magnitude and has an angular diameter of $5''$, not the best size for observation, but this gradually increases throughout the year as the planet nears opposition early in 1993. On the 29th at 3 am Mars rises 7° south of the 26 day old Moon.

JUPITER rises almost two hours before sunset and remains visible in the night sky until early morning. On the 13th at 7 pm (end of evening twilight) Jupiter (altitude 37°) will be visible 5° below the 11 day old Moon with the 1st magnitude star Alpha Leonis (Regulus), 5° to the north, forming a triangle with both bodies (see sky view diagram). Jupiter and Regulus begin the month a little over 6° apart and by month's end are separated by 5° . Jupiter's brightness, throughout April, is above -2 magnitude and its diameter is over $40''$.

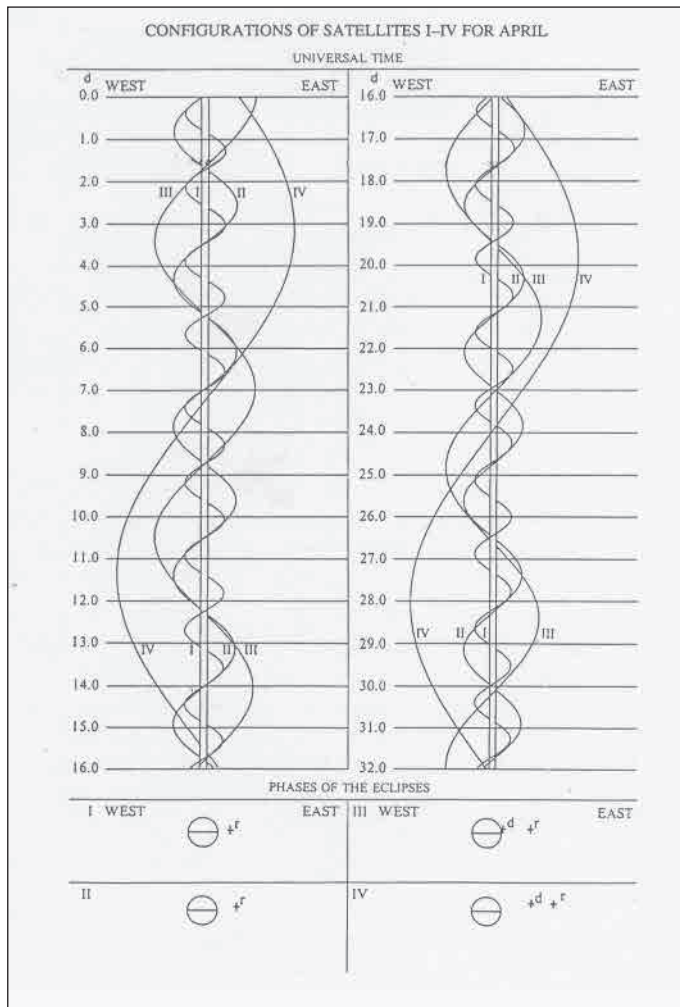
SATURN, at magnitude 0.8, rises in Capricornus (the constellation in which it remains for the entire year) in the early morning sky. Just prior to 2 am early in the month and around midnight towards the end. On the 26th at 12:13 am Saturn rises 6° south of the 23 day old Moon and by the beginning of morning twilight will be 5° from our nearest neighbour.

URANUS rises at 11:30 pm early in the month and at 9:30 pm by the end. On the 23rd at 10 pm Uranus rises $2^\circ 30'$ south of the 21 day old Moon with Neptune between the two.

NEPTUNE rises 8 minutes behind Uranus during the month and will be 1° south of the Moon on the 23rd with Uranus above.

PLUTO at 13.7 magnitude rises just prior to the end of evening twilight throughout the month.

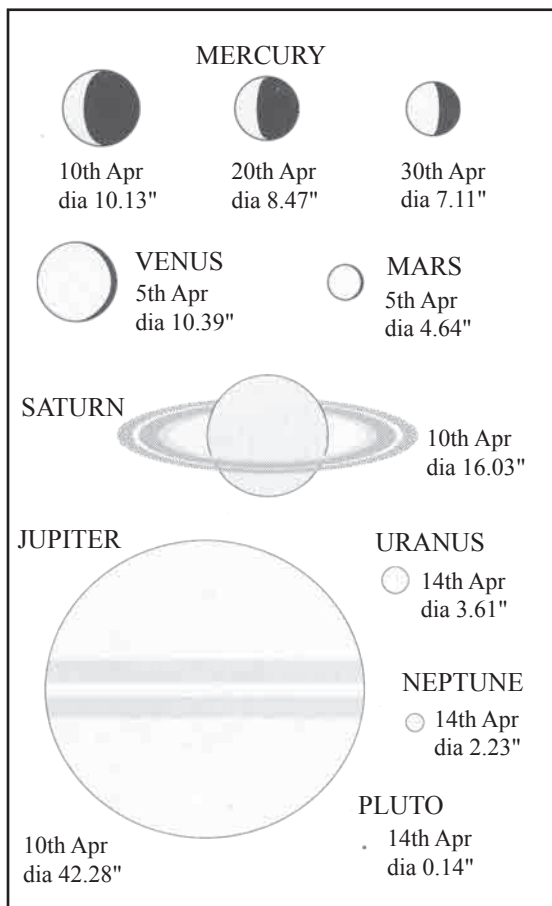
JUPITER



DAILY EVENTS

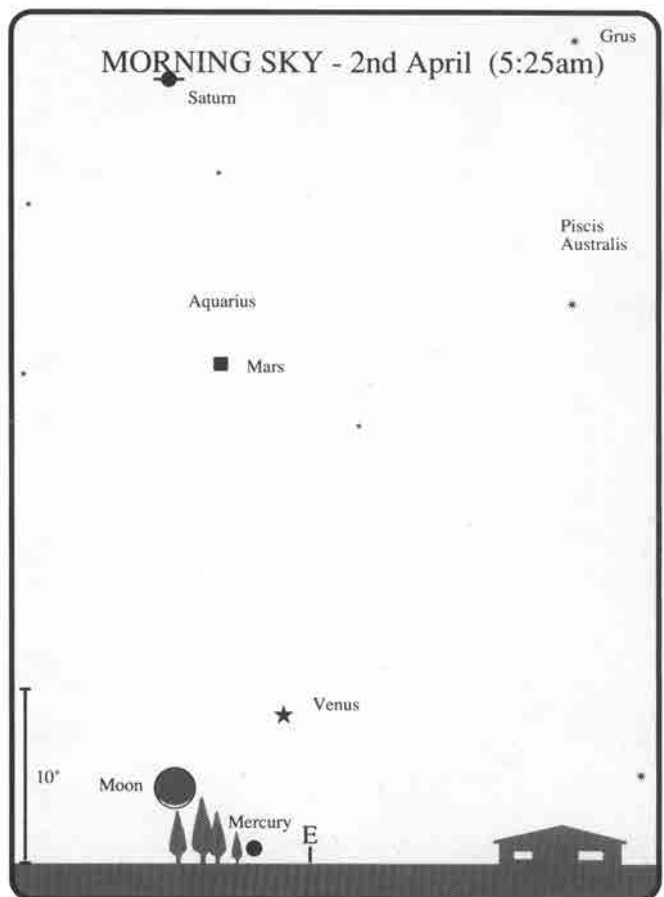
1 st	11:17 PM	Jupiter's moon, Ganymede, transit begins.
2 nd	12:52 AM	Jupiter's moon, Europa, occultation disappearance.
	01:39 AM	Jupiter's moon, Io, transit begins.
	02:16 AM	Jupiter's moon, Ganymede, shadow transit begins.
	02:22 AM	Jupiter's moon, Io, shadow transit begins.
	02:44 AM	Jupiter's moon, Ganymede, transit ends.
	5 AM	Venus 7° South of the Moon.
	6 PM	Mercury 4° South of the Moon.
	10:51 PM	Jupiter's moon, Io, occultation disappearance.
3 rd	01:53 AM	Jupiter's moon, Io, eclipse reappearance.
	03:01 PM	New Moon.
	07:23 PM	Jupiter's moon, Europa, transit begins.
	08:05 PM	Jupiter's moon, Io, transit begins.
	08:51 PM	Jupiter's moon, Io, shadow transit begins.
	08:58 PM	Jupiter's moon, Europa, shadow transit begins.
	10:10 PM	Jupiter's moon, Europa, transit ends.
	10:21 PM	Jupiter's moon, Io, transit ends.
	11:06 PM	Jupiter's moon, Io, shadow transit ends.
	11:44 PM	Jupiter's moon, Europa, shadow transit ends.
4 th	08:22 PM	Jupiter's moon, Io, eclipse reappearance.
5 th	06:21 PM	Jupiter's moon, Europa, eclipse reappearance.
	07:51 PM	Jupiter's moon, Ganymede, eclipse reappearance.
6 th	9 AM	Mercury 2° North of Venus
7 th	06:13 PM	Lunar occultation of ZC 649, disappearance.
	06:45 PM	Jupiter's moon, Callisto, transit ends.
	06:48 PM	Lunar occultation of 62 Tau, disappearance.
	10:52 PM	Jupiter's moon, Callisto, shadow transit begins.
8 th		Mercury at descending node.
	02:33 AM	Jupiter's moon, Callisto, shadow transit ends.
	11 AM	Mercury stationary.
9 th	07:41 PM	Lunar occultation of ZC 990, disappearance.
10 th	12:38 AM	Jupiter's moon, Io, occultation disappearance.
	08:06 PM	First quarter Moon.
	09:45 PM	Jupiter's moon, Europa, transit begins.
	09:52 PM	Jupiter's moon, Io, transit begins.
	10:45 PM	Jupiter's moon, Io, shadow transit begins.
	11:35 PM	Jupiter's moon, Europa, shadow transit begins.
11 th	12:08 AM	Jupiter's moon, Io, transit ends.
	12:32 AM	Jupiter's moon, Europa, transit ends.
	01:00 AM	Jupiter's moon, Io, shadow transit ends.
	02:21 AM	Jupiter's moon, Europa, shadow transit ends.
	06:59 PM	Lunar occultation of ZC 1260, disappearance.

APPEARANCE OF THE PLANETS

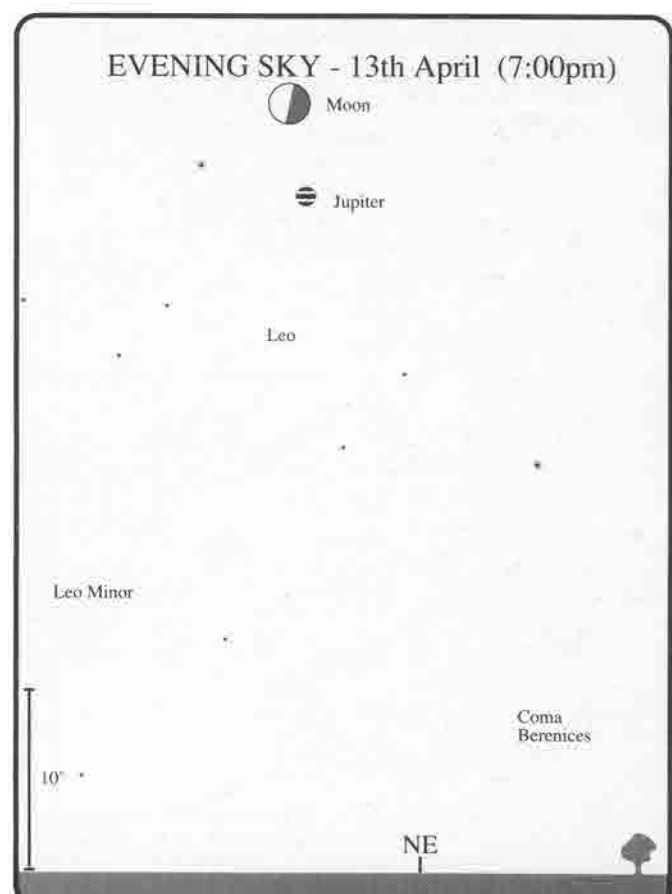
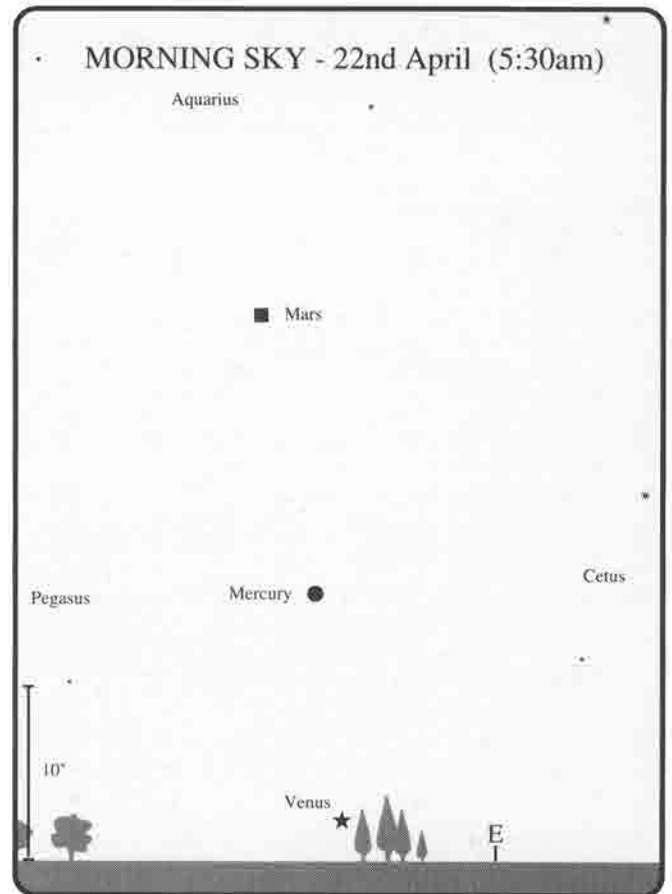
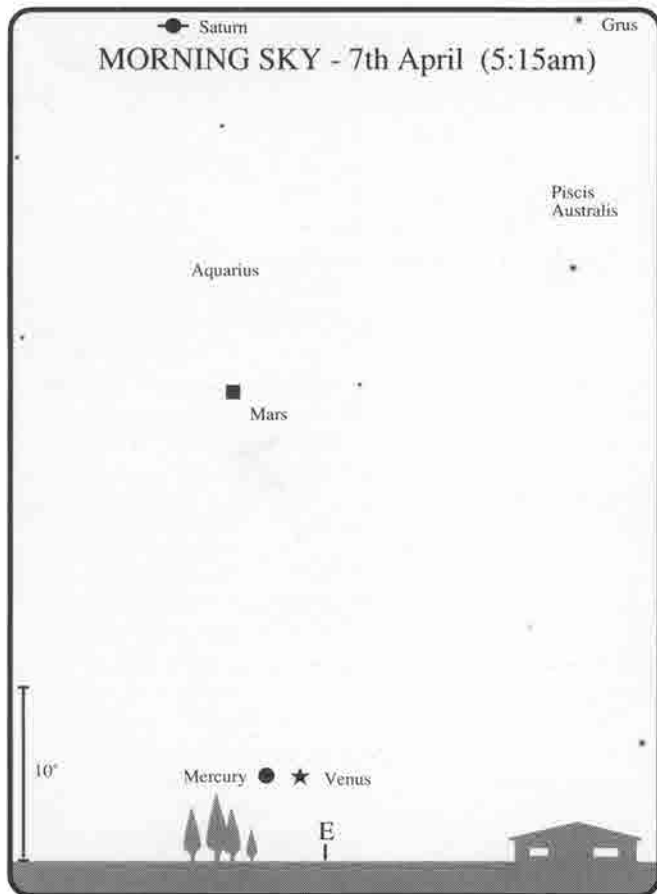


APRIL

11 th	07:05 PM	Jupiter's moon, Io, occultation disappearance.	24th		Pallas stationary.
	07:42 PM	Lunar occultation of 25 Cnc, disappearance.		12 AM	Neptune 0°.7 South of the Moon.
	10:17 PM	Jupiter's moon, Io, eclipse reappearance.		1 AM	Mercury at greatest elongation West (27°)
12 th	06:35 PM	Jupiter's moon, Io, transit ends.	08:28 PM		Jupiter's moon, Callisto, shadow transit ends.
	07:29 PM	Jupiter's moon, Io, shadow transit ends.	25th	01:30 AM	Jupiter's moon, Io, transit begins.
	08:06 PM	Jupiter's moon, Ganymede, occultation reappearance.		07:40 AM	Last quarter Moon.
	08:22 PM	Jupiter's moon, Ganymede, eclipse disappearance.		8 PM	Moon at apogee.
	08:55 PM	Jupiter's moon, Europa, eclipse reappearance.		10:44 PM	Jupiter's moon, Io, occultation disappearance.
	11:51 PM	Jupiter's moon, Ganymede, eclipse reappearance.	26th	07:57 PM	Jupiter's moon, Io, transit begins.
13 th	5 PM	Moon at perigee.		09:03 PM	Jupiter's moon, Io, shadow transit begins.
	06:48 PM	Lunar occultation of ZC 1502, disappearance.		09:08 PM	Jupiter's moon, Europa, occultation disappearance.
14 th		Venus at greatest latitude South.		10:13 PM	Jupiter's moon, Io, transit ends.
	12:02 AM	Lunar occultation of 155B Leo, disappearance.		11:18 PM	Jupiter's moon, Io, shadow transit ends.
	01:25 AM	Lunar occultation of ZC 1526, disappearance.		11:49 PM	Jupiter's moon, Ganymede, occultation disappearance.
	2 AM	Jupiter 6° North of the Moon.		12 PM	Saturn 5° South of the Moon.
	10:37 PM	Lunar occultation of 69 Leo, disappearance.	27th		Vesta stationary.
15 th	10:15 PM	Jupiter's moon, Callisto, occultation disappearance.		08:36 PM	Jupiter's moon, Io, eclipse reappearance.
16 th	02:09 AM	Jupiter's moon, Callisto, occultation reappearance.	28th	5:46 PM	Jupiter's moon, Io, shadow transit ends.
17 th	02:42 PM	Full Moon.		06:10 PM	Jupiter's moon, Europa, shadow transit begins.
	11:41 PM	Jupiter's moon, Io, transit begins.		06:38 PM	Jupiter's moon, Europa, transit ends.
18 th		Mercury at aphelion.		08:54 PM	Jupiter's moon, Europa, shadow transit ends.
	12:10 AM	Jupiter's moon, Europa, transit begins.	29th	5 PM	Mars 7° South of the Moon.
	12:40 AM	Jupiter's moon, Io, shadow transit begins.	30th	06:11 PM	Jupiter's moon, Ganymede, shadow transit begins.
	01:56 AM	Jupiter's moon, Io, transit ends.		09:35 PM	Jupiter's moon, Ganymede, shadow transit ends.
	08:54 PM	Jupiter's moon, Io, occultation disappearance.			
19 th	12:12 AM	Jupiter's moon, Io, eclipse reappearance.			
	06:08 PM	Jupiter's moon, Io, transit begins.			
	06:43 PM	Jupiter's moon, Europa, occultation disappearance.			
	07:08 PM	Jupiter's moon, Io, shadow transit begins.			
	08:10 PM	Jupiter's moon, Ganymede, occultation disappearance.			
	08:23 PM	Jupiter's moon, Io, transit ends.			
	09:23 PM	Jupiter's moon, Io, shadow transit ends.			
	11:30 PM	Jupiter's moon, Europa, eclipse reappearance.			
	11:40 PM	Jupiter's moon, Ganymede, occultation reappearance.			
20 th	12:22 AM	Jupiter's moon, Ganymede, eclipse disappearance.			
	06:41 PM	Jupiter's moon, Io, eclipse reappearance.			
	9 PM	Neptune stationary.			
21 st		Mars at greatest latitude South.			
	06:17 PM	Jupiter's moon, Europa, shadow transit ends.			
22nd	11 AM	Uranus stationary.			
23rd	05:37 PM	Jupiter's moon, Ganymede, shadow transit ends.			
	10 PM	Uranus 1°.8 South of the Moon.			

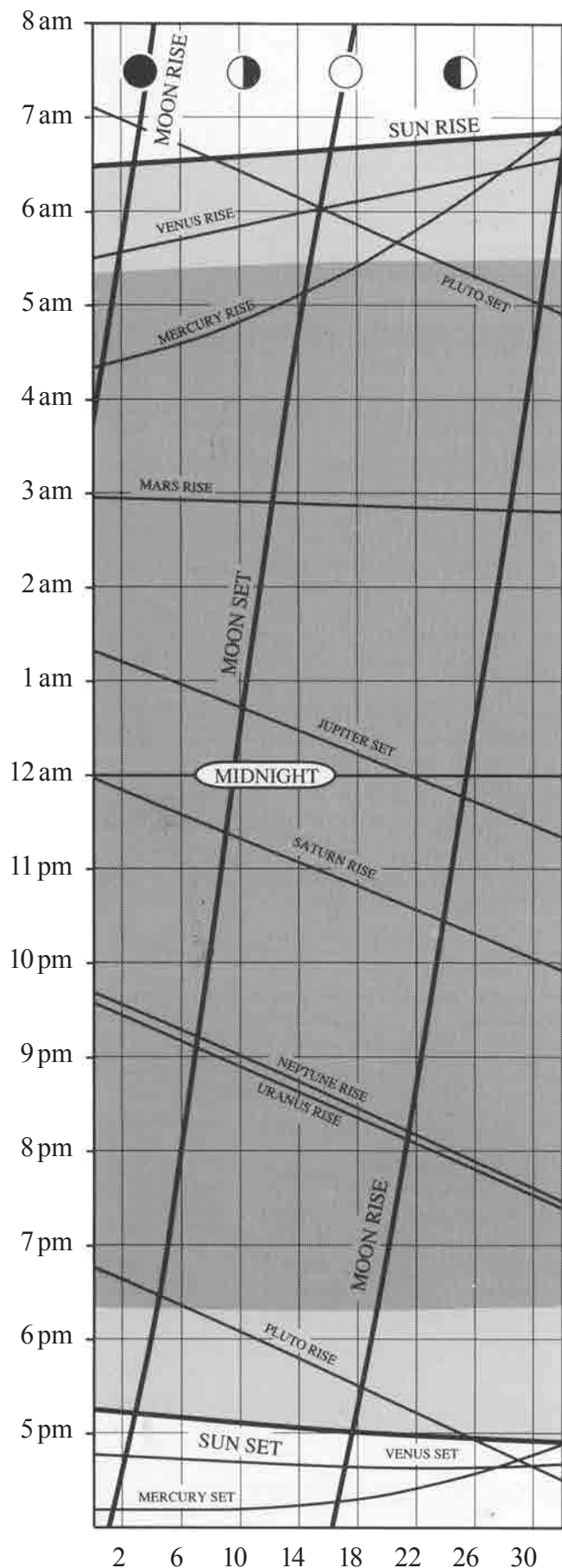


APRIL



MAY

RISE/SET CHART



THE MOON

- 3rd New Moon, 3:44am. (Lunation number 858)
- 8th Moon at perigee.
- 10th First Quarter, 1:43am.
- 17th Full Moon, 2:03am.
- 21st Occultation of Neptune by the Moon, 7:00am, only visible from central Asia.
- 23rd Moon at apogee.
- 25th Last Quarter, 1:53am.

THE PLANETS

MERCURY rises at 4:23am on the 1st. It provides its most favourable observing opportunity, in the morning sky, this year (see sky view diagram). This good viewing period continues until the 18th (when it rises at the beginning of twilight) as it moves towards superior conjunction (behind the Sun) on June 1st. Mercury's brightness continues to increase; 0.2 on the 1st, -0.8 on the 18th and up to -2.0 magnitude at month's end when it gets too close to the Sun for observation. The angular diameter on the 1st is 7" which decreases to 5.5" on the 18th and finally to 5" on the 31st.

VENUS at a brilliant -3.9 magnitude, rises early in the month in the morning sky after the beginning of twilight. After the 14th, the planet moves too close to the Sun for observation.

MARS at just over 5" in size, remains a poor object for the telescope. Located in Pisces for the first two weeks of the month, it crosses into Cetus for a brief five days before returning back into Pisces. At 1st magnitude and rising around 3am, Mars dominates the early morning eastern sky.

JUPITER at the beginning of the month, can be seen in the northern sky as it transits the meridian at 7:45pm, at an altitude of 45°, then setting after lam. By month's end the transits occurs around 6:00pm with the planet setting before midnight. Jupiter and Regulus remain within 6° of each other during the month. On the 10th the 8 day old Moon, Regulus and Jupiter can be seen forming a triangle in the northern sky after dark (see sky view diagram). The separations are Moon/Regulus 4°, Moon/Jupiter 7°30' and Jupiter/Regulus 5°. Jupiter's magnitude for the month remains above -2, and it's disk diameter decreases by month's end to 35"

SATURN, at the beginning of the month rises at midnight and by month's end at 10pm. Saturn transits the meridian mid-month during morning twilight. However, there is no need to wait until transit for observations as it's declination of -16° is well suited to southern observers. On the 23rd Saturn rises 6° above and to the south of a 21 day old Moon, it would be best to wait until around midnight as both objects gain altitude.

URANUS at magnitude 5.7 rises before 10pm early in the month and around 8pm towards the end. Uranus transits the meridian at 3:40am mid month, with Neptune (1°30' away) following 4 minutes later. On the 21st, in the early morning sky (around 3am), both Uranus and Neptune will be just over 2° from the 19 day old Moon.

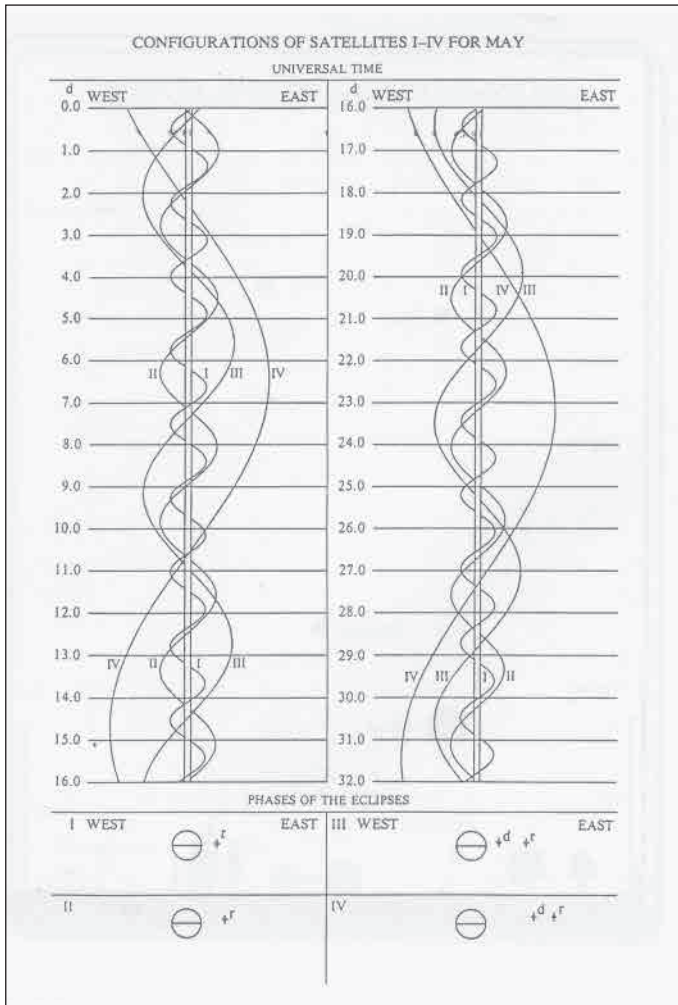
NEPTUNE at magnitude 7.9 follows closely in Uranus' footsteps. From Australian latitudes, the closest approach Neptune makes to the Moon, during the occultation of the 21st, is about 2° at the beginning of morning twilight.

PLUTO at magnitude 13.7 is at opposition on the 12th and is visible throughout the night.

DAILY EVENTS

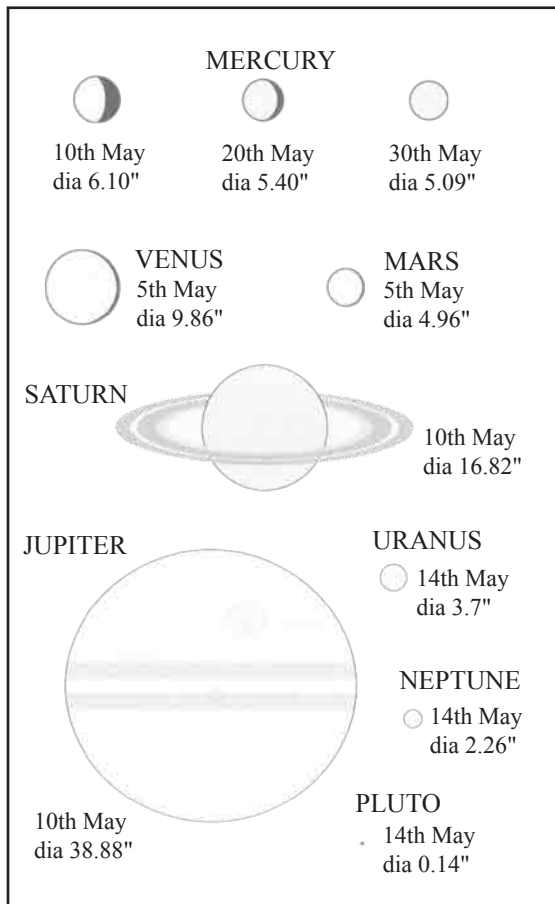
- 1st 7 AM Mercury 8° South of the Moon.
- 3 PM Jupiter stationary.
- 2nd 06:23 PM Jupiter's moon, Callisto, occultation reappearance.

JUPITER



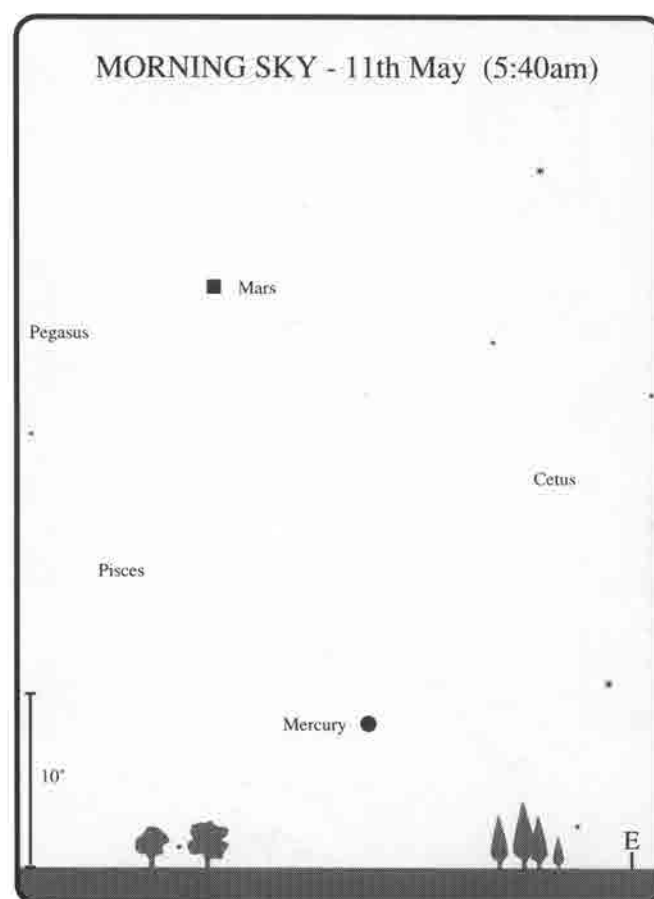
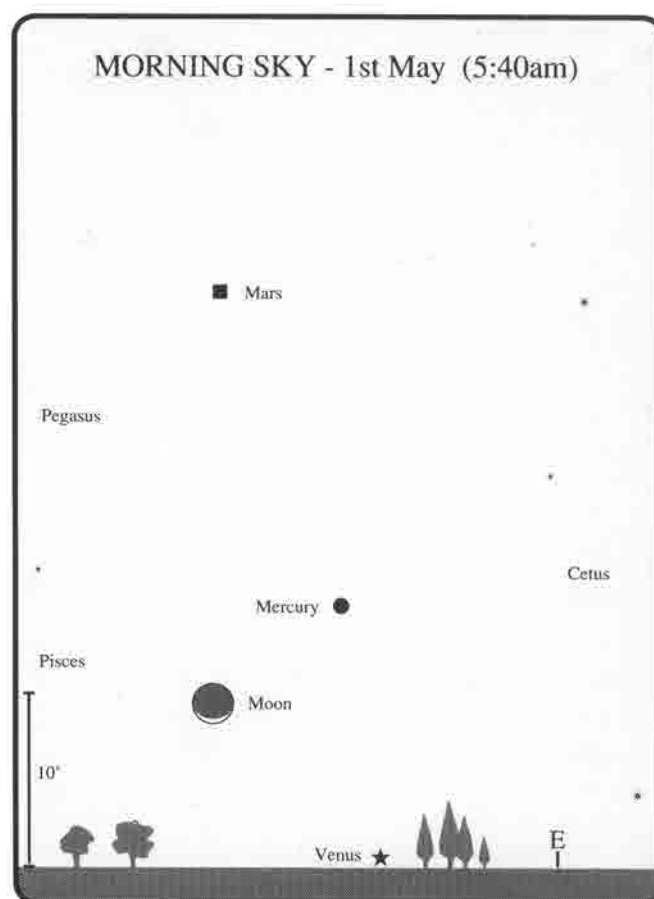
3rd	12:35 AM	Jupiter's moon, Io, occultation disappearance.
	03:44 AM	New Moon.
	09:48 PM	Jupiter's moon, Io, transit begins.
	10:58 PM	Jupiter's moon, Io, shadow transit begins.
	11:34 PM	Jupiter's moon, Europa, occultation disappearance.
4th	12:03 AM	Jupiter's moon, Io, transit ends.
	07:03 PM	Jupiter's moon, Io, occultation disappearance.
	10:31 PM	Jupiter's moon, Io, eclipse reappearance.
5th	05:26 PM	Jupiter's moon, Io, shadow transit begins.
	06:21 PM	Jupiter's moon, Europa, transit begins.
	06:31 PM	Jupiter's moon, Io, transit ends.
	07:41 PM	Jupiter's moon, Io, shadow transit ends.
	08:47 PM	Jupiter's moon, Europa, shadow transit begins.
	09:08 PM	Jupiter's moon, Europa, transit ends.
	11:31 PM	Jupiter's moon, Europa, shadow transit ends.
7th	05:17 PM	Jupiter's moon, Ganymede, transit begins.
	05:56 PM	Jupiter's moon, Europa, eclipse reappearance.
	08:46 PM	Jupiter's moon, Ganymede, transit ends.
	10:10 PM	Jupiter's moon, Ganymede, shadow transit begins.
8th	08:09 PM	Lunar occultation of α Cnc, disappearance.
	08:55 PM	Lunar occultation of ZC 1241, disappearance.
	10 PM	Moon at perigee.
9th		Mercury at greatest latitude South.
	09:40 PM	Lunar occultation of ZC 1367, disappearance.
10th	01:43 AM	First quarter Moon.
	06:34 PM	Lunar occultation of π Leo, disappearance.
	11:17 PM	Jupiter's moon, Callisto, transit begins.
	11:40 PM	Jupiter's moon, Io, transit begins.
11th	8 AM	Jupiter 6° North of the Moon.
	08:55 PM	Jupiter's moon, Io, occultation disappearance.
12th	12:27 AM	Jupiter's moon, Io, eclipse reappearance.
	11 AM	Pluto at opposition.
	06:08 PM	Jupiter's moon, Io, transit begins.
	07:21 PM	Jupiter's moon, Io, shadow transit begins.
	08:00 PM	Lunar occultation of ZC 1705, disappearance.
	08:23 PM	Jupiter's moon, Io, transit ends.
	08:53 PM	Jupiter's moon, Europa, transit begins.
	09:35 PM	Jupiter's moon, Io, shadow transit ends.
	11:25 PM	Jupiter's moon, Europa, shadow transit begins.
	11:40 PM	Jupiter's moon, Europa, transit ends.
13th	06:55 PM	Jupiter's moon, Io, eclipse reappearance.

APPEARANCE OF THE PLANETS

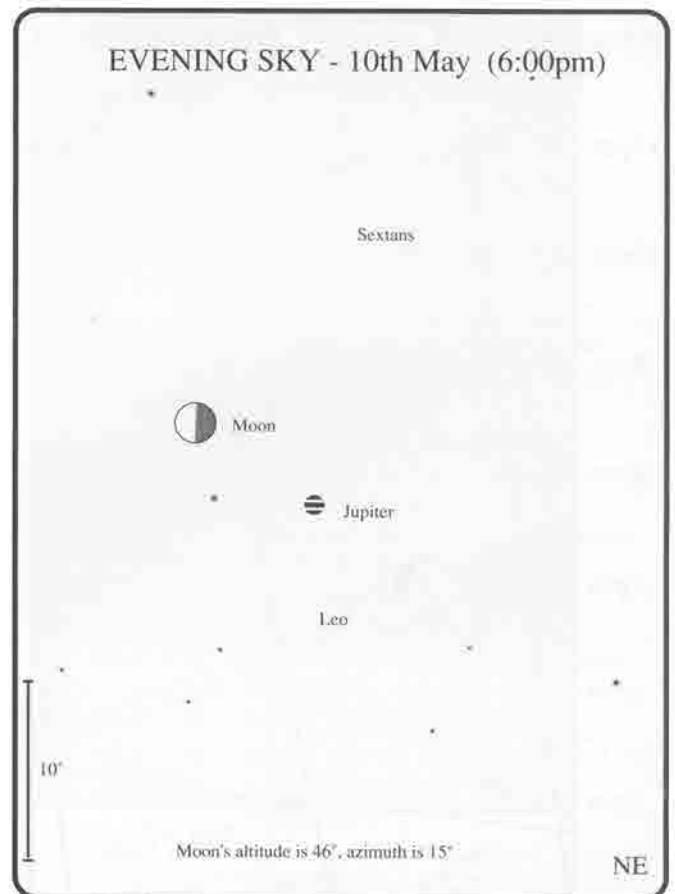
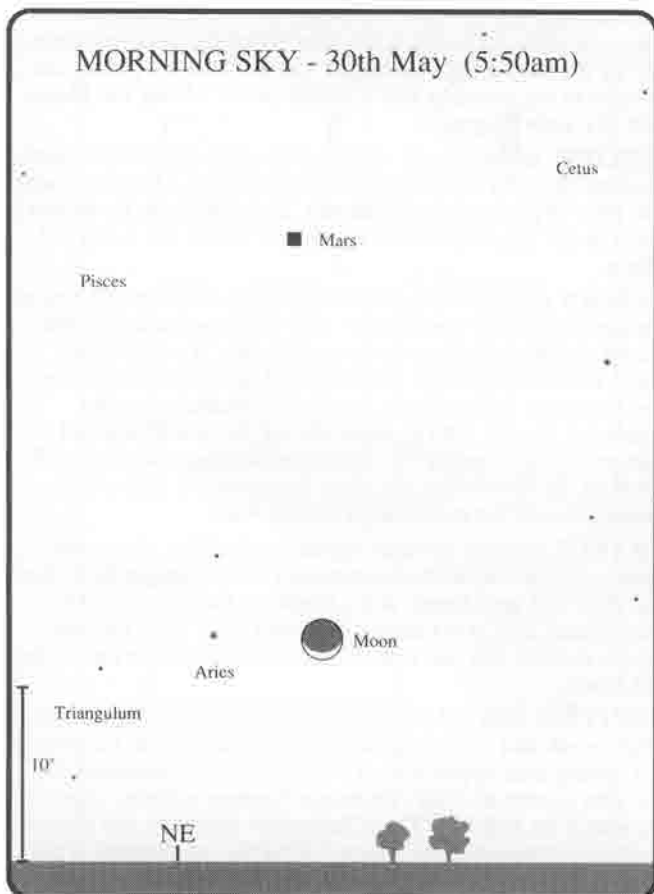
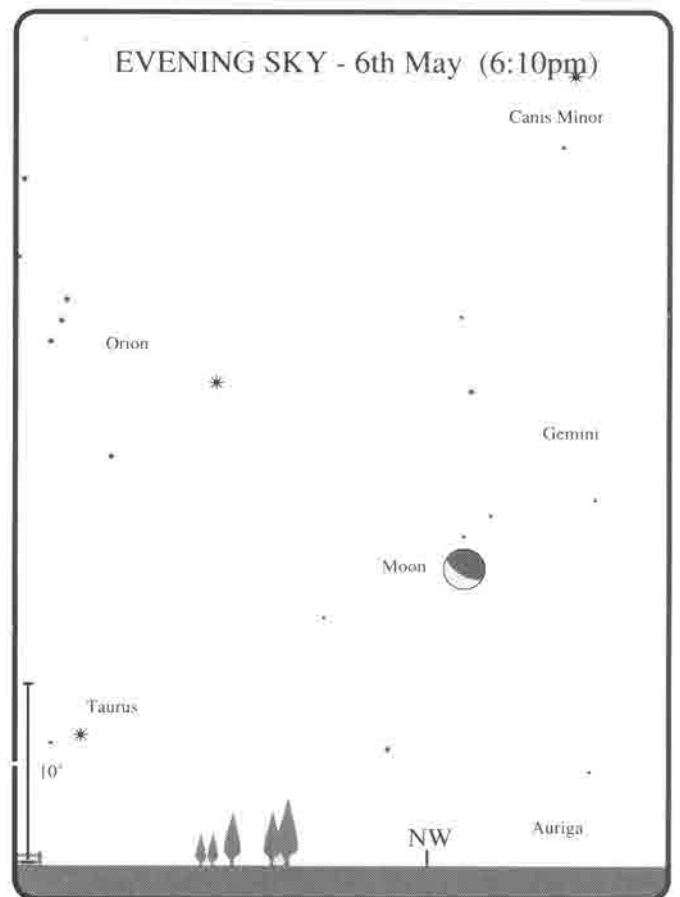
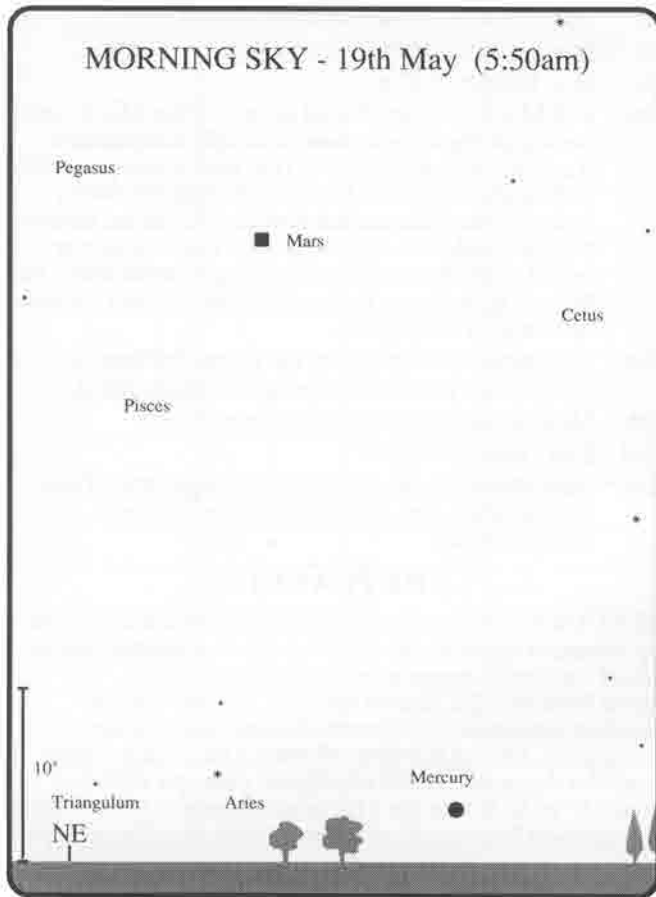


MAY

14th	08:30 PM	Jupiter's moon, Europa, eclipse reappearance.
	09:06 PM	Jupiter's moon, Ganymede, transit begins.
17th	02:03 AM	Full Moon.
18th	07:45 PM	Jupiter's moon, Ganymede, eclipse reappearance.
	10:49 PM	Jupiter's moon, Io, occultation disappearance.
19th	07:54 PM	Jupiter's moon, Callisto, eclipse disappearance.
	08:01 PM	Jupiter's moon, Io, transit begins.
	09:16 PM	Jupiter's moon, Io, shadow transit begins.
	10:16 PM	Jupiter's moon, Io, transit ends.
	11:19 PM	Jupiter's moon, Callisto, eclipse reappearance.
	11:27 PM	Jupiter's moon, Europa, transit begins.
	11:30 PM	Jupiter's moon, Io, shadow transit ends.
20th	05:17 PM	Jupiter's moon, Io, occultation disappearance.
	08:51 PM	Jupiter's moon, Io, eclipse reappearance.
21st	01:52 AM	Lunar occultation of p Sgr, reappearance.
	6 AM	Uranus 2° South of the Moon.
	7 AM	Neptune 0° 9 South of the Moon.
	05:50 PM	Jupiter's moon, Europa, occultation disappearance.
	05:59 PM	Jupiter's moon, Io, shadow transit ends.
	11:05 PM	Jupiter's moon, Europa, eclipse reappearance.
23rd	3 PM	Moon at apogee.
	06:03 PM	Jupiter's moon, Europa, shadow transit ends.
24th	10 PM	Saturn 5° South of the Moon.
25th	01:27 AM	Lunar occultation of 44 Aqr, reappearance.
	01:53 AM	Last quarter Moon.
	06:39 PM	Jupiter's moon, Ganymede, occultation reappearance.
	08:19 PM	Jupiter's moon, Ganymede, eclipse disappearance.
	11:44 PM	Jupiter's moon, Ganymede, eclipse reappearance.
26th	09:56 PM	Jupiter's moon, Io, transit begins.
	11:11 PM	Jupiter's moon, Io, shadow transit begins.
27th	07:12 PM	Jupiter's moon, Io, occultation disappearance.
	08:48 PM	Jupiter's moon, Callisto, transit ends.
	10:46 PM	Jupiter's moon, Io, eclipse reappearance.
28th		Mercury at ascending node.
	7 AM	Mars 7° South of the Moon.
	05:39 PM	Jupiter's moon, Io, shadow transit begins.
	06:39 PM	Jupiter's moon, Io, transit ends.
	07:53 PM	Jupiter's moon, Io, shadow transit ends.
	08:24 PM	Jupiter's moon, Europa, occultation disappearance.
29th	1 PM	Saturn stationary.
	05:15 PM	Jupiter's moon, Io, eclipse reappearance.
30th	05:58 PM	Jupiter's moon, Europa, shadow transit begins.
	06:09 PM	Jupiter's moon, Europa, transit ends.
	08:40 PM	Jupiter's moon, Europa, shadow transit ends.

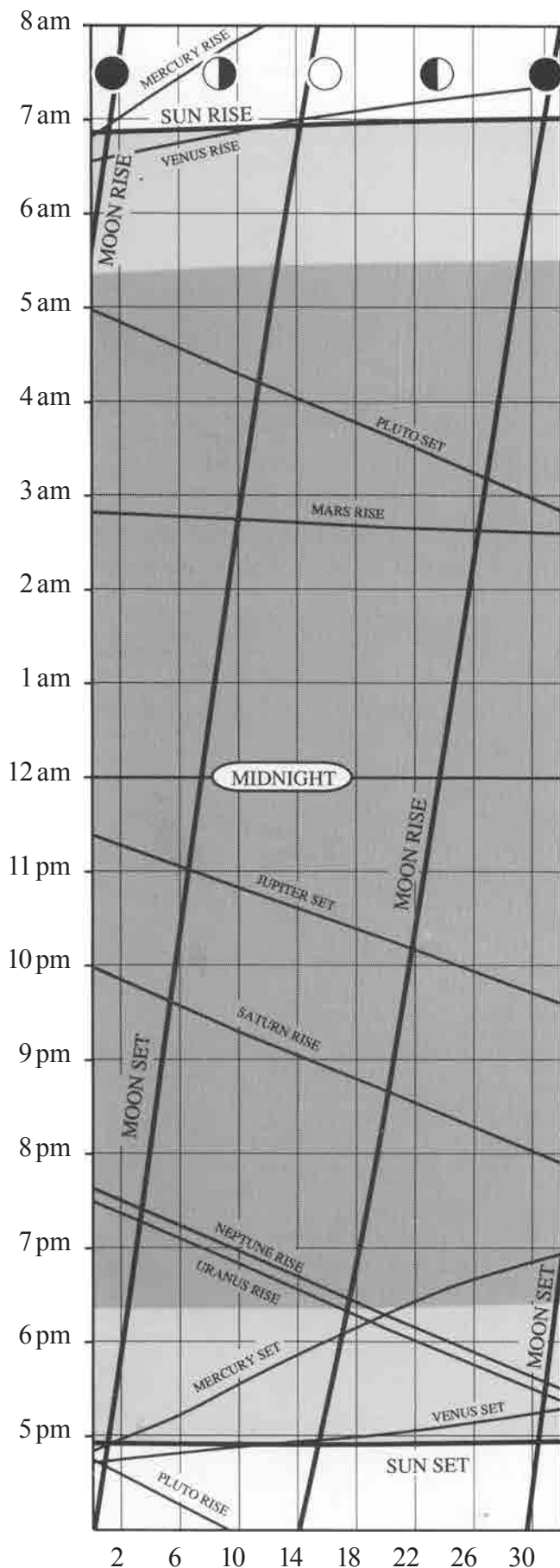


MAY



JUNE

RISE/SET CHART



THE MOON

- 1st New Moon, 1:57pm (Lunation number 859).
- 4th Moon at perigee (closest to Earth).
- 8th First Quarter, 6:47 am.
- 15th Full Moon, 2:50pm. Partial eclipse of the Moon, only the last of the penumbral phase is visible from eastern Australia. Moon rises at 4:51 pm half immersed in the penumbral shadow of the Earth, by 5:45 pm the Moon (only 9° above the eastern horizon) leaves the penumbra. Not an impressive eclipse, and the casual observer would probably not notice anything unusual about the Moon's appearance. Refer section on eclipses for more information see page 57.
- 17th Occultation of Neptune by the Moon, 2:00pm, only visible from parts of Europe and North America.
- 20th Moon at apogee (most distant from Earth).
- 23rd Last Quarter, 6:11 pm.
- 30th New Moon, 10:18pm (Lunation number 860). Total eclipse of the Sun, visible only from the South Atlantic ocean.

THE PLANETS

MERCURY is at superior conjunction (behind the Sun) on the 1st and is lost from the morning sky as it rapidly moves east of the Sun to reappear in the early evening sky. The period from the 20th June to the 22nd July provides an excellent opportunity to observe this tiny world in the evening sky. During this time Mercury's magnitude ranges from -0.4 down to 1.9, and it's angular diameter increases from 6.0" to 10.9". On the 21st, at an altitude of 9° at 5:30pm Mercury will be 5° south of 1st magnitude Beta Geminorum (Pollux).

VENUS is at superior conjunction on the 14th and is too close to the Sun for viewing in both the morning and evening skies throughout June.

MARS remains in Pisces until the 15th when it moves into Aries for the rest of the month. The planet's disc is steadily growing but still under 6" by month's end, and hardly worth telescope time. Rising around 3am, Mars attains an altitude of 30° by the beginning of twilight. On the 26th the planet can be seen in the morning sky 7° south of the 24 day old Moon (see sky view diagram).

JUPITER, at magnitude -1.9, can be easily seen in the north western sky after the end of evening twilight. The planet sets just after 11 pm early in the month and at 9:45pm by month's end. On the 7th, Jupiter can be seen 6° below the 7 day old Moon.

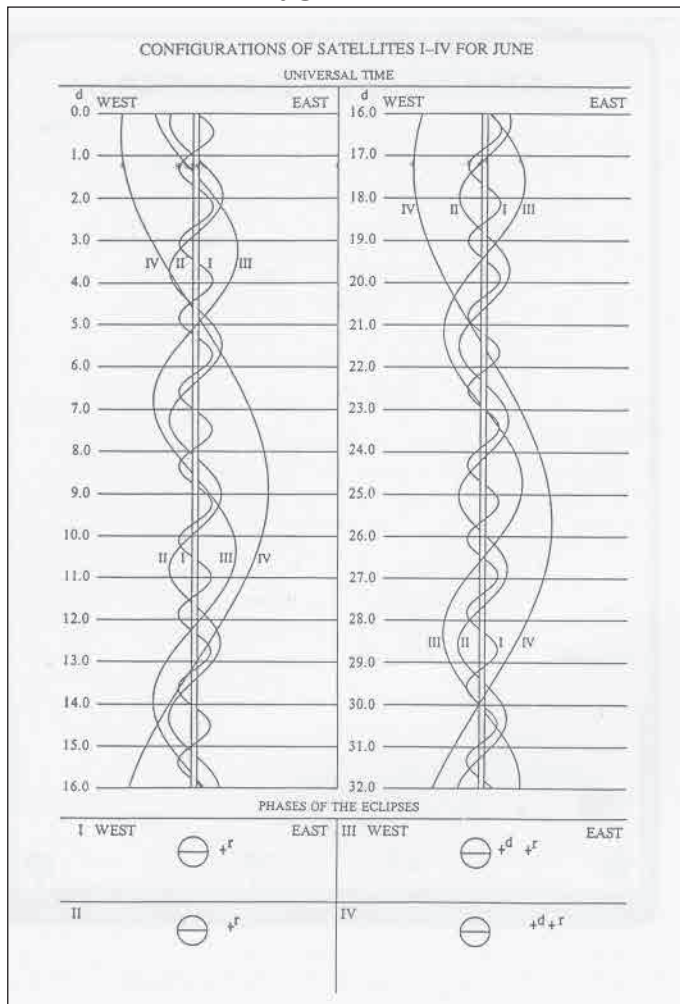
SATURN rises at 10pm at the beginning of the month and at a more convenient 8pm by the 30th. At magnitude 0.5, the planet stands prominent in the eastern sky, it's only rivals being the 1st magnitude stars Alpha Aquilae (Altair) to the northeast and Alpha Piscis Austrini (Fomalhaut) to the southeast. On the 19th at 10pm the 19 day old Moon and Saturn will be situated 15° above the horizon with Saturn 5° south of the Moon (see sky view diagram). At mid month Saturn transits the meridian at around 4am.

URANUS, moving towards opposition in July, rises soon after sunset and transits the meridian mid month at 2am. June and July will see Uranus at it's brightest for the year (5.6 magnitude), and at it's largest diameter (3.7" over this two month period). On the 17th, Uranus rises 6° above the 17 day old Moon.

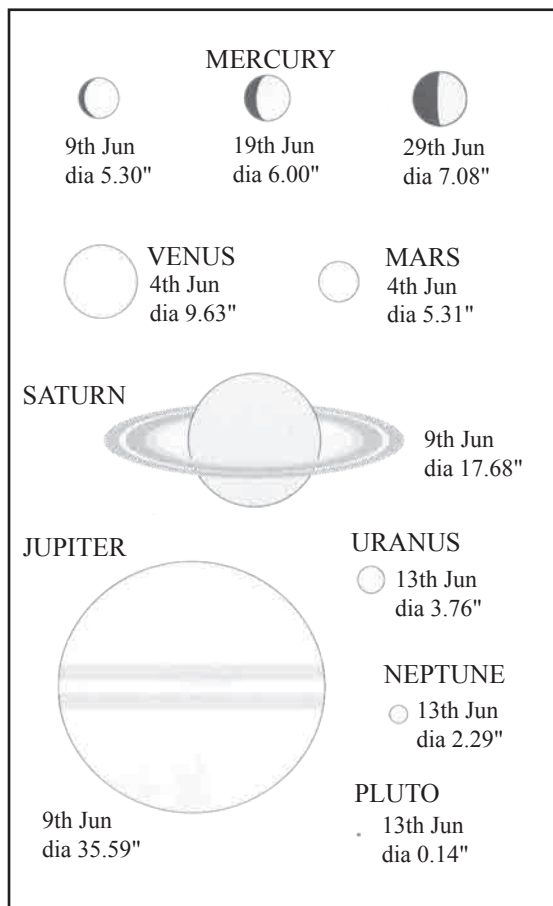
NEPTUNE, akin to Uranus, is moving towards opposition next month and at it's brightest during June/July at magnitude 7.9. Being near opposition, it's largest angular diameter for the year is seen at 2"30'. To locate Neptune a finder chart is presented on page 85. From Australian latitudes, the closest Neptune approaches the Moon during the occultation of the 17th is 4° as the Moon rises at 7pm.

PLUTO is in the sky during most of the night, setting in the early morning.

JUPITER



APPEARANCE OF THE PLANETS

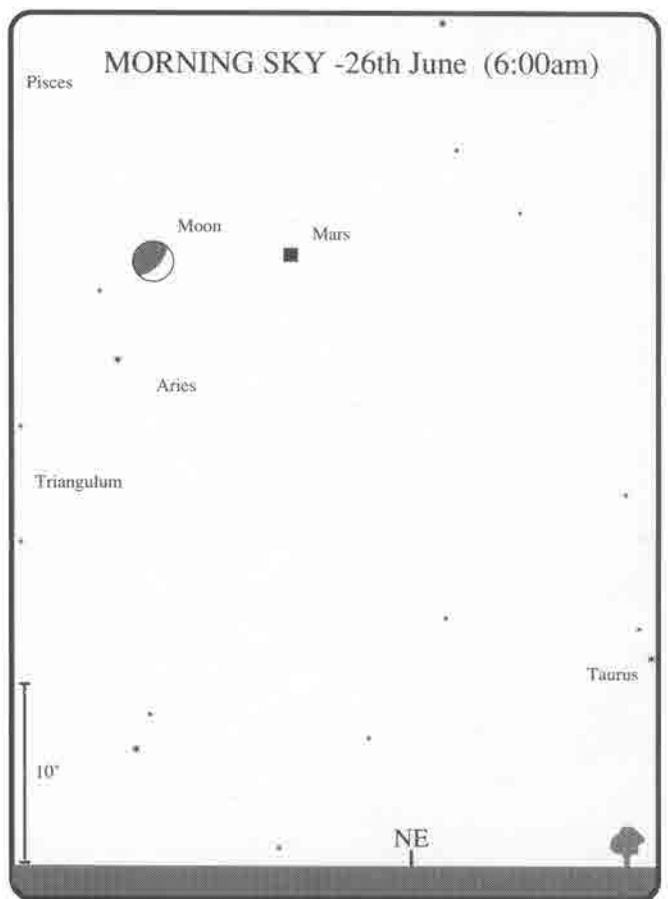
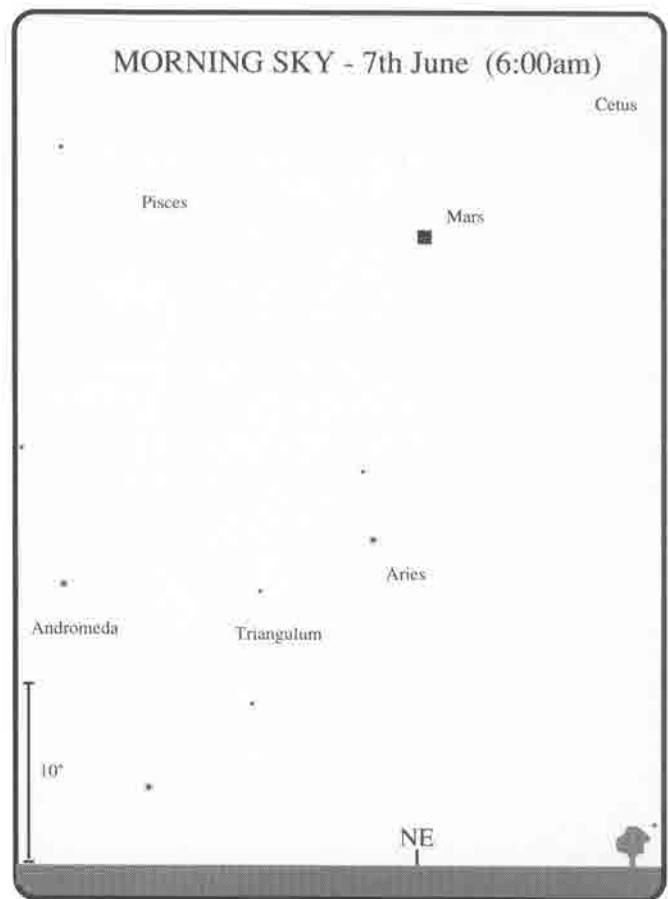


DAILY EVENTS

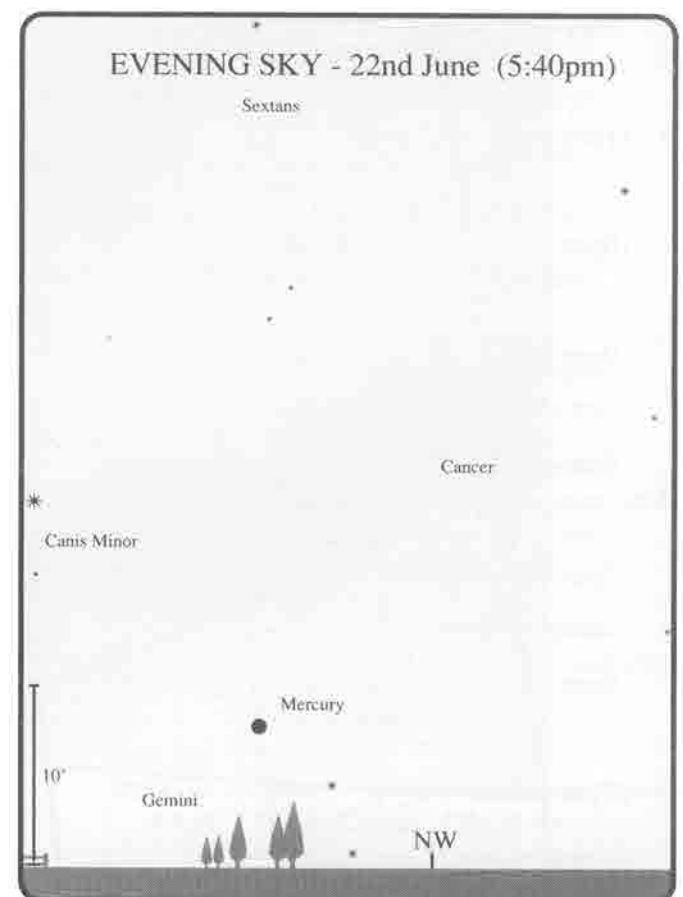
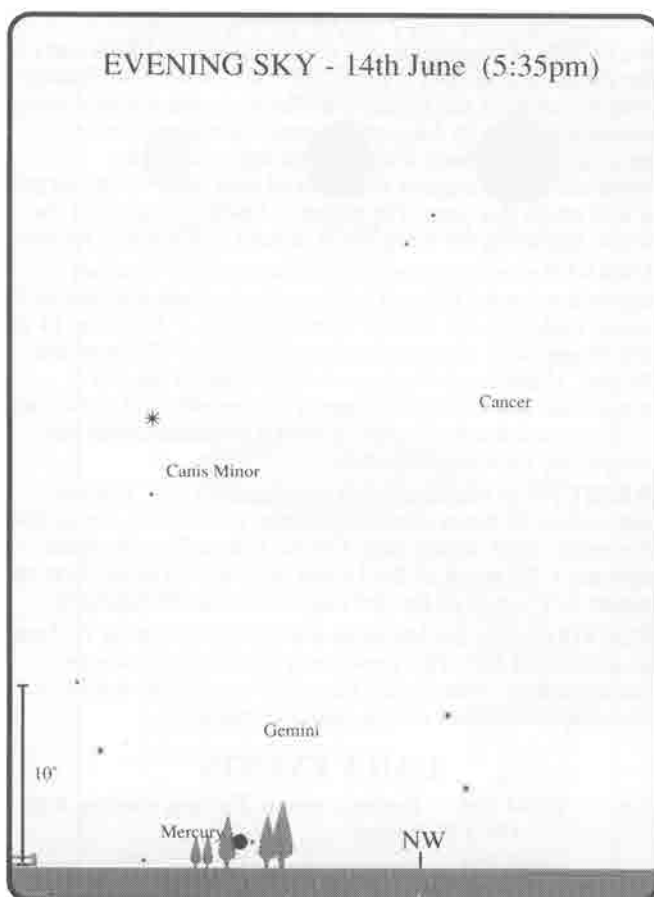
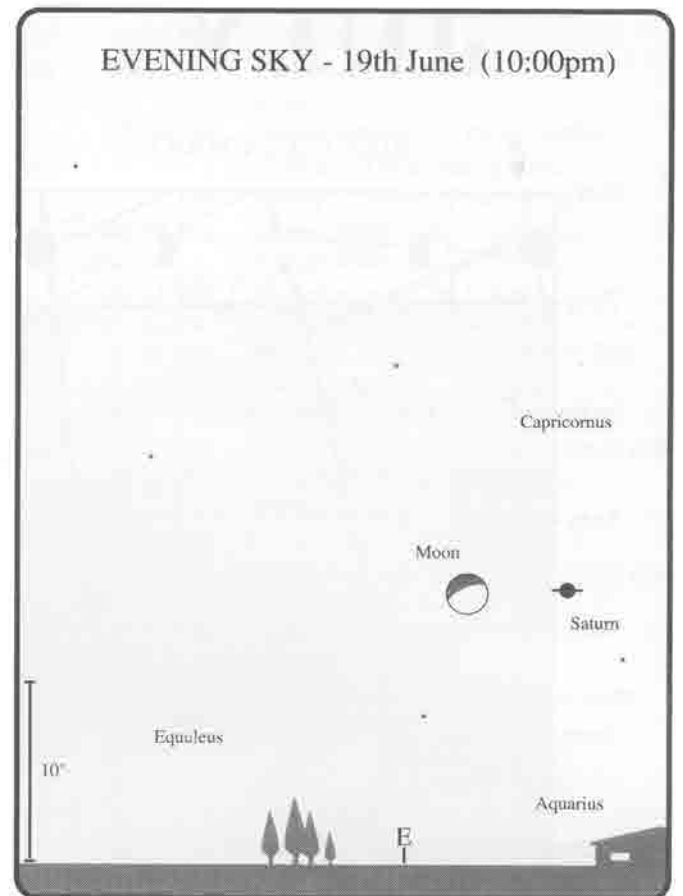
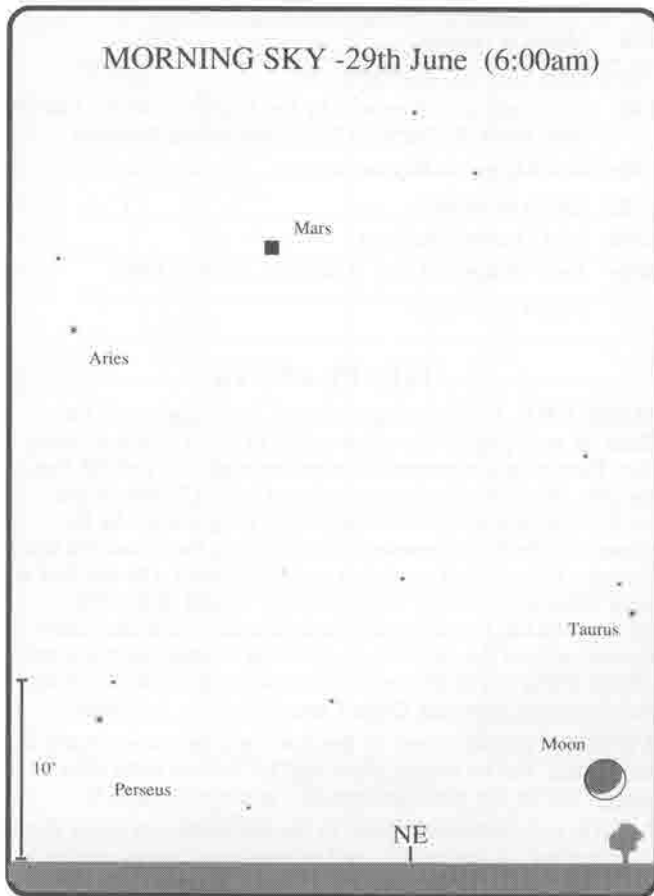
1 st	2 AM	Mercury at perihelion.
	01:57 PM	Mercury in superior conjunction.
	07:07 PM	New Moon.
	10:40 PM	Jupiter's moon, Ganymede, occultation disappearance.
		Jupiter's moon, Ganymede, occultation reappearance.
3 rd	09:08 PM	Jupiter's moon, Io, occultation disappearance.
4 th	12 PM	Moon at perigee.
	06:07 PM	Lunar occultation of 209B Gem, disappearance.
	06:19 PM	Jupiter's moon, Io, transit begins.
	07:34 PM	Jupiter's moon, Io, shadow transit begins.
	08:35 PM	Jupiter's moon, Io, transit ends.
	09:48 PM	Jupiter's moon, Io, shadow transit ends.
	11:00 PM	Jupiter's moon, Europa, occultation disappearance.
5 th	05:15 PM	Jupiter's moon, Callisto, eclipse reappearance.
	05:29 PM	Jupiter's moon, Ganymede, shadow transit ends.
	07:10 PM	Jupiter's moon, Io, eclipse reappearance.
6 th	06:01 PM	Jupiter's moon, Europa, transit begins.
	08:35 PM	Jupiter's moon, Europa, shadow transit begins.
	08:48 PM	Jupiter's moon, Europa, transit ends.
7 th		Ceres stationary.
	5 AM	Jupiter 7° North of the Moon.
	10:33 PM	Lunar occultation of 36 Sex, disappearance.
8 th	06:47 AM	First quarter Moon.
	05:32 PM	Jupiter's moon, Europa, eclipse reappearance.
9 th		Venus at ascending node.
	10:28 PM	Lunar occultation of 163B Vir, disappearance.
10 th	08:04 PM	Lunar occultation of ZC 1906, disappearance.
11 th		Mercury at greatest latitude North.
	08:16 PM	Jupiter's moon, Io, transit begins.
	09:29 PM	Jupiter's moon, Io, shadow transit begins.
	10:31 PM	Jupiter's moon, Io, transit ends.
12 th	05:34 PM	Jupiter's moon, Io, occultation disappearance.
	06:07 PM	Jupiter's moon, Ganymede, shadow transit begins.
	09:05 PM	Jupiter's moon, Io, eclipse reappearance.
	09:28 PM	Jupiter's moon, Ganymede, shadow transit ends.
13 th	05:00 PM	Jupiter's moon, Io, transit ends.
	06:12 PM	Jupiter's moon, Io, shadow transit ends.
	08:19 PM	Lunar occultation of o Sco, disappearance.
	08:34 PM	Lunar occultation of & Sco, reappearance.
	08:41 PM	Jupiter's moon, Europa, transit begins.
14 th	2 AM	Venus in superior conjunction.

JUNE

15th	02:50 PM	Full Moon.
	08:08 PM	Jupiter's moon, Europa, eclipse reappearance.
17th	05:54 AM	Lunar occultation of 2 x Sgr, reappearance.
	11 AM	Uranus 1°.9 South of the Moon.
	2 PM	Neptune 0°.9 South of the Moon.
18th		Pallas at opposition.
	10:12 PM	Jupiter's moon, Io, transit begins.
	11:49 PM	Lunar occultation of 31B Cap, reappearance.
19th	05:13 PM	Jupiter's moon, Ganymede, transit begins.
	07:31 PM	Jupiter's moon, Io, occultation disappearance.
	08:43 PM	Jupiter's moon, Ganymede, transit ends.
	10:06 PM	Jupiter's moon, Ganymede, shadow transit begins.
20th	5 AM	Saturn 5° South of the Moon.
	8 AM	Moon at apogee.
	05:52 PM	Jupiter's moon, Io, shadow transit begins.
	06:57 PM	Jupiter's moon, Io, transit ends.
	08:07 PM	Jupiter's moon, Io, shadow transit ends.
21st	01:14 PM	Solar solstice.
	05:29 PM	Jupiter's moon, Io, eclipse reappearance.
	08:16 PM	Jupiter's moon, Callisto, occultation disappearance.
22nd	05:38 PM	Jupiter's moon, Europa, occultation disappearance.
23rd	06:11 PM	Last quarter Moon.
	12 PM	Mercury 5° South of Pollux.
24th	04:41 AM	Lunar occultation of 41 Psc, reappearance.
	05:49 PM	Jupiter's moon, Europa, shadow transit ends.
25th	04:14 AM	Lunar occultation of 75 Psc, reappearance.
26th	6 AM	Mars 6° South of the Moon.
	09:25 PM	Jupiter's moon, Ganymede, transit begins.
	09:30 PM	Jupiter's moon, Io, occultation disappearance.
27th	06:40 PM	Jupiter's moon, Io, transit begins.
	07:47 PM	Jupiter's moon, Io, shadow transit begins.
	08:55 PM	Jupiter's moon, Io, transit ends.
28th	07:24 PM	Jupiter's moon, Io, eclipse reappearance.
29th	08:20 PM	Jupiter's moon, Europa, occultation disappearance.
30th	05:06 PM	Jupiter's moon, Callisto, shadow transit begins.
	07:39 PM	Jupiter's moon, Ganymede, eclipse reappearance.
	08:05 PM	Jupiter's moon, Callisto, shadow transit ends.
	10:18 PM	New Moon.

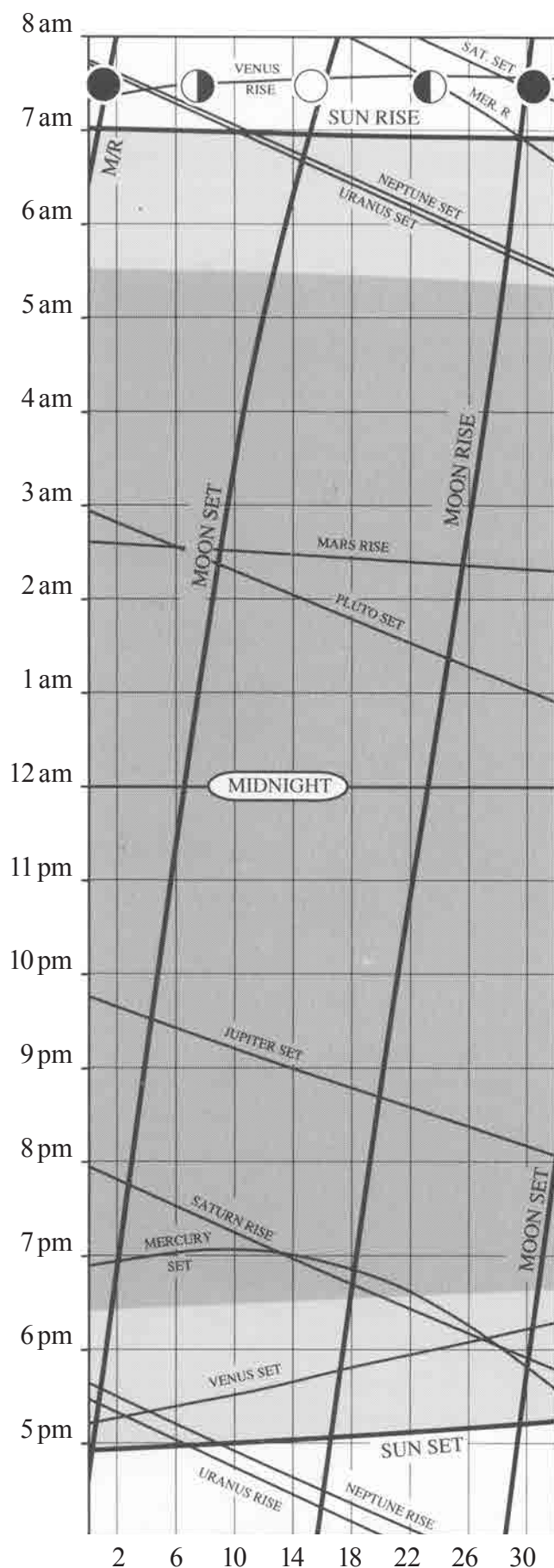


JUNE



JULY

RISE/SET CHART



THE MOON

- 2nd Moon at perigee.
- 7th First Quarter, 12:43pm.
- 14th Occultation of Neptune by the Moon, 7:00pm, visible only from the Pacific Ocean and North America.
- 15th Full Moon, 5:06am.
- 17th Moon at apogee.
- 23rd Last Quarter, 8:12am.
- 30th New Moon, 5:35am (Lunation number 861)
Moon at perigee.

THE PLANETS

MERCURY, from the beginning of the month until the 22nd, is well placed for observation in the western evening sky. Reaching it's greatest elongation east (26°) of the Sun on the 6th, Mercury can be seen around 6pm 12° above the northwestern horizon shinning at 0.5 magnitude. As the planet's diameter increases up to $10.5''$ on the 22nd, it's shape changes from a half moon to a slim crescent. On the 2nd at 6pm Mercury (altitude 10°) will be 3° north of the thin crescent of the two day old Moon (see sky view diagram). On the 4th at 6pm the planet will make an interesting telescopic object when it will be seen very close (approx. $0^\circ 30'$) north of the 4th magnitude star Delta Cancr (Asellus Australis).

VENUS is still too close to the Sun for observation early in the month, but by month's end will be visible soon after sunset low in the northwestern sky at magnitude -3.9.

MARS, rises around 2:30am in the constellation Aries during the first half of the month, and moves into Taurus on the 17th. On the 25th Mars makes a fine sight as it forms a triangle with the 24 day old Moon and the open cluster M45 (Pleiades). At 5am the separation of the bodies are as follows; Moon/Mars 6° , Moon/Pleiades 4° , Mars/Pleiades 5° .

JUPITER can only be observed at a reasonable altitude (35°), at end of twilight, early in the month in the western evening sky. By month's end the altitude decreases to 19° .

SATURN, at magnitude 0.3, rises in the east at 8pm early in the month and at 6pm towards the end. On the 16th Saturn rises 6° south of the 16 day old Moon. As the planet reaches opposition early in August, the next eight weeks or so provides the observer with the best opportunity for observation. It's angular diameter of over $18.5''$ is the largest it will attain this year. The planet is visible throughout the night, transiting the meridian at around 2:00am mid month.

URANUS at magnitude 5.6 and diameter $3.8''$ reaches opposition on the 8th and is above the horizon throughout the entire night. On the 14th at 7pm Uranus is 3° from the 14 day old Moon, with Neptune between the two ($1^\circ 20'$ from the Moon). Uranus and Neptune remain close to the 3rd magnitude star Pi Sagittarii again this month, and at the end of the month the three objects form a trapezium with 4th magnitude Omicron Sagittarii.

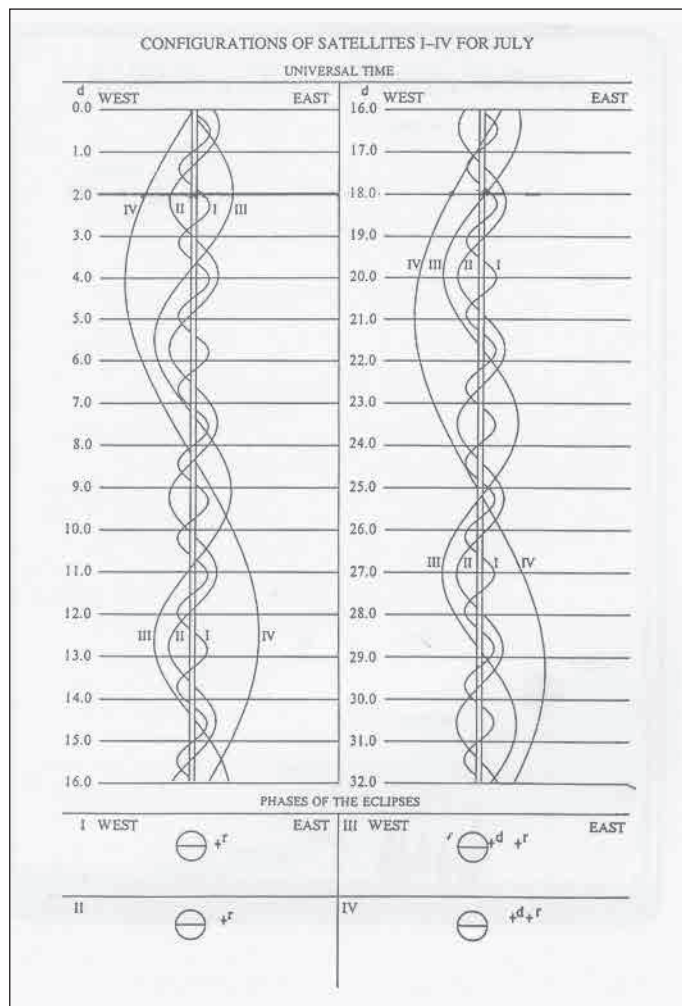
NEPTUNE at magnitude 7.9 and diameter $2.3''$ reaches opposition 38 hours after Uranus and is available throughout the entire night during July. On the 14th at 7pm Neptune appears $1^\circ 20'$ south of the 14 day old Moon. On the 31st, the planet is 1° south of the 3rd magnitude star Pi Sagittarii.

PLUTO transits the Meridian during mid-month at 7:45pm at an altitude of 60° . This provides a good opportunity to photograph or observe this faint 13.7 magnitude world. A detailed finder chart can be found on page 86.

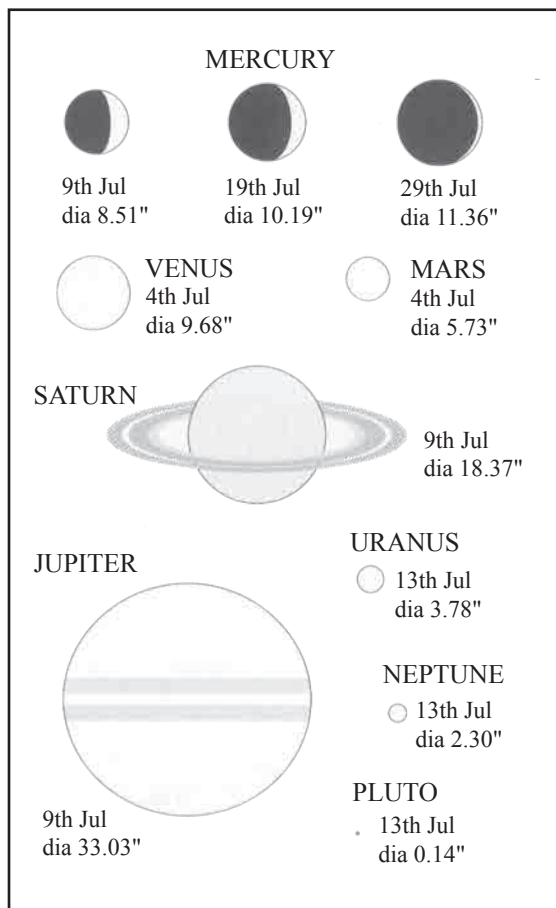
DAILY EVENTS

- | | | |
|-----|----------|--|
| 1st | 05:44 PM | Jupiter's moon, Europa, shadow transit begins. |
| | 06:15 PM | Jupiter's moon, Europa, transit ends. |
| | 08:25 PM | Jupiter's moon, Europa, shadow transit ends. |
| 2nd | 11 AM | Moon at perigee. |

JUPITER



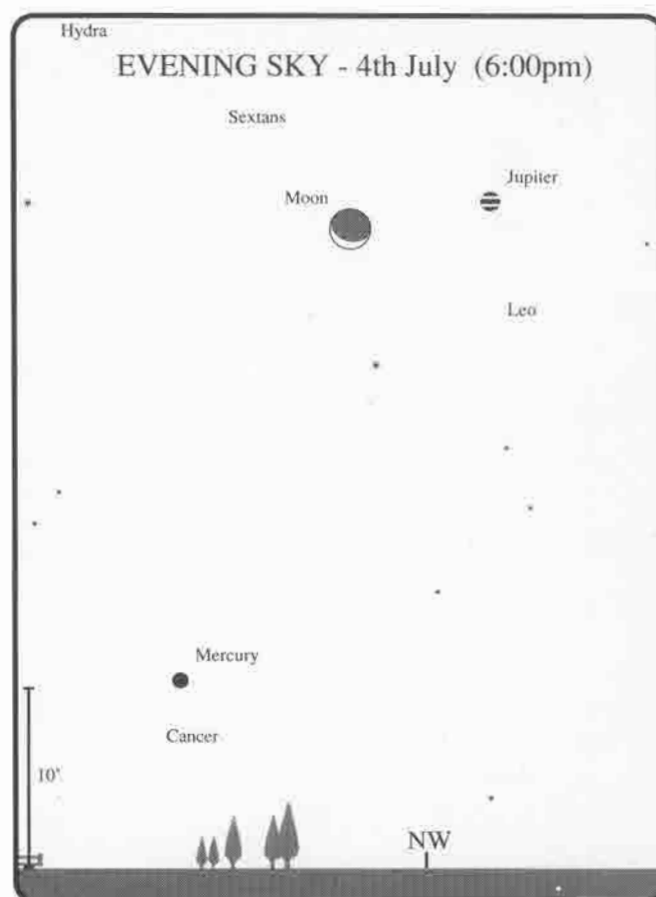
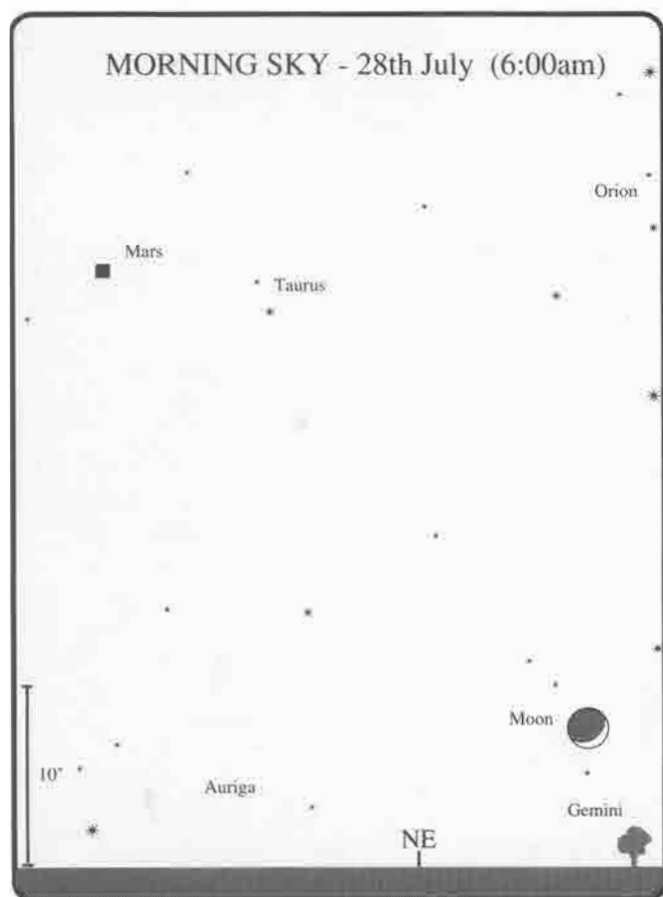
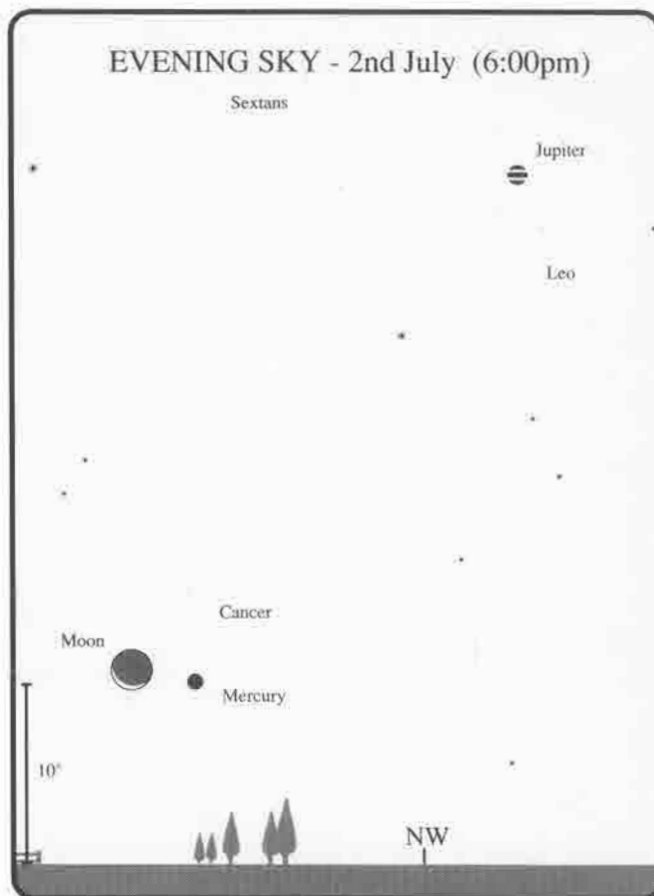
APPEARANCE OF THE PLANETS



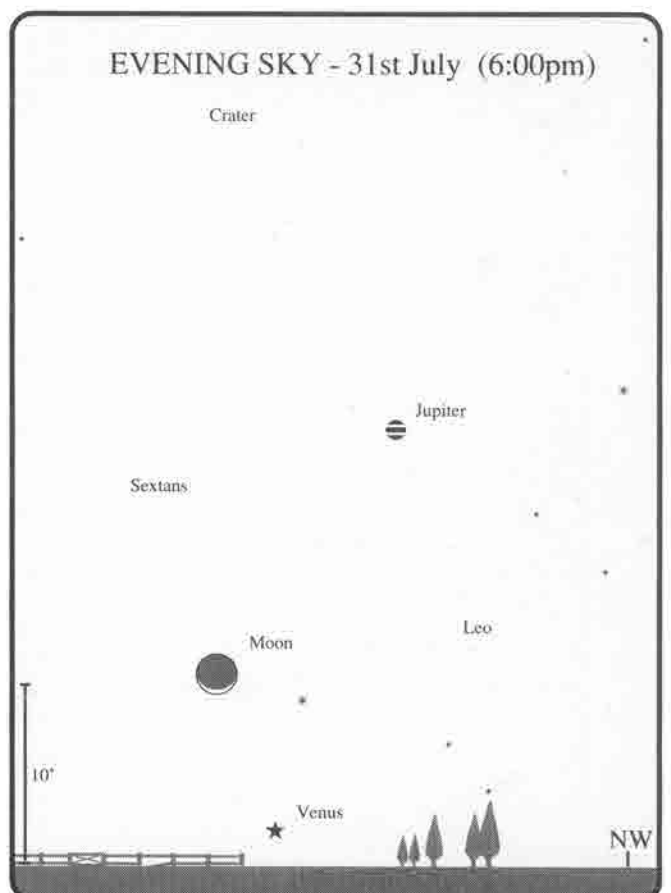
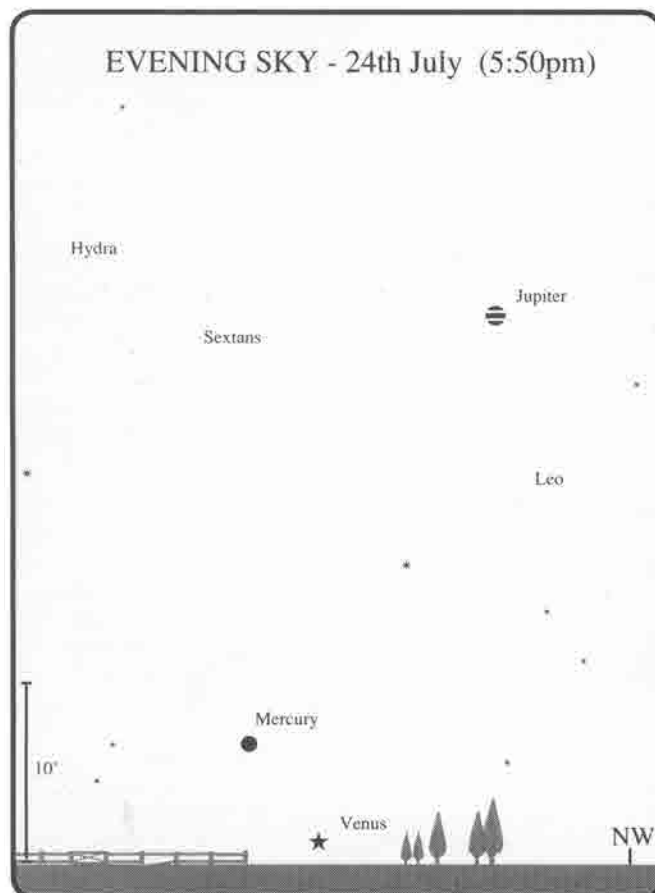
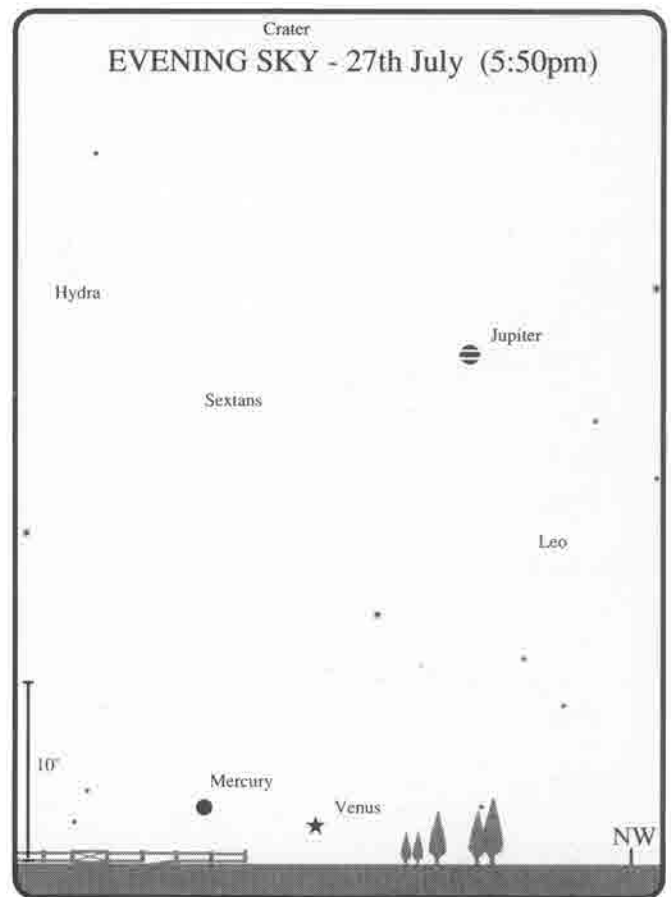
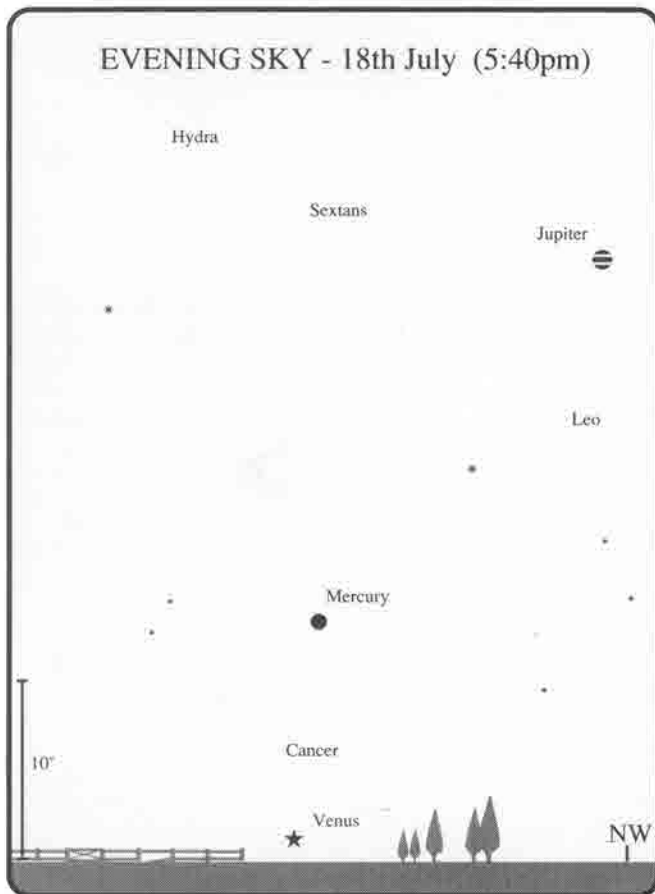
2nd	8 PM	Mercury 4° North of the Moon.
3rd	10:00 PM	Sun at Apogee.
4th	07:43 PM	Lunar occultation of ZC 1526, disappearance.
	08:38 PM	Jupiter's moon, Io, transit begins
5th		Mercury at descending node.
	6 AM	Jupiter 7° North of the Moon
	05:58 PM	Jupiter's moon, Io, occultation disappearance.
	09:18 PM	Jupiter's moon, Io, eclipse
6th	11 AM	Mercury at greatest elongation East (26°)
	05:23 PM	Jupiter's moon, Io, transit ends.
	06:25 PM	Jupiter's moon, Io, shadow transit ends
	10:18 PM	Lunar occultation of ZC 1761, disappearance
7th	12:43 PM	First quarter Moon.
	07:29 PM	Jupiter's moon, Ganymede, occultation reappearance.
	07:55 PM	Lunar occultation of ZC 1872, disappearance.
	08:17 PM	Jupiter's moon, Ganymede, eclipse disappearance.
8th	9 AM	Uranus at opposition.
	05:32 PM	Lunar occultation of ZC 1990, disappearance.
	06:13 PM	Jupiter's moon, Europa, transit begins.
	07:41 PM	Jupiter's moon, Callisto, occultation reappearance.
	08:20 PM	Jupiter's moon, Europa, shadow transit begins.
	08:59 PM	Jupiter's moon, Europa, transit ends
9th	07:14 PM	Lunar occultation of ZC 2115 disappearance.
	11 PM	Neptune at opposition.
10th	05:11 PM	Jupiter's moon, Europa, eclipse reappearance.
	08:44 PM	Lunar occultation of ZC 2249, disappearance.
11th	01:44 AM	Lunar occultation of ZC 2274, disappearance.
12th	07:58 PM	Jupiter's moon, Io, occultation disappearance.
13th		Venus at perihelion.
	05:07 PM	Jupiter's moon, Io, transit begins.
	06:05 PM	Jupiter's moon, Io, shadow transit begins.
	07:22 PM	Jupiter's moon, Io, transit ends.
	08:20 PM	Jupiter's moon, Io, shadow transit ends.
14th	4 PM	Uranus 1° 8' South of the Moon.
	05:42 PM	Jupiter's moon, Io, eclipse reappearance.
	7 PM	Neptune 0° 8' South of the Moon.
	08:16 PM	Jupiter's moon, Ganymede, occultation disappearance.
15th		Mercury at aphelion.
	05:06 AM	Full Moon.
	08:59 PM	Jupiter's moon, Europa, transit begins.
17th	9 AM	Saturn 5° South of the Moon.
	07:47 PM	Jupiter's moon, Europa, eclipse reappearance
	9 PM	Moon at apogee.
	09:54 PM	Lunar occultation of 46 Cap, reappearance

JULY

18th	05:22 PM	Jupiter's moon, Ganymede, shadow transit ends.
19th	1 PM	Mercury stationary.
20th	07:06 PM	Jupiter's moon, Io, transit begins.
	08:00 PM	Jupiter's moon, Io, shadow transit begins.
21st	07:37 PM	Jupiter's moon, Io, eclipse reappearance.
23rd	08:12 AM	Last quarter Moon.
24th	04:22 AM	Lunar occultation of 26 Ari, reappearance.
	05:57 PM	Jupiter's moon, Europa, occultation disappearance.
25th		Ceres at opposition.
	06:07 AM	Lunar occultation of 66 Ari, reappearance.
	2 PM	Mars 4° South of the Moon.
	06:03 PM	Jupiter's moon, Ganymede, shadow transit begins.
	06:04 PM	Jupiter's moon, Ganymede, transit ends.
	08:16 PM	Jupiter's moon, Callisto, eclipse disappearance.
26th	1 AM	Mercury 6° South of Venus
	05:30 PM	Jupiter's moon, Europa, shadow transit ends.
28th	06:28 PM	Jupiter's moon, Io, occultation disappearance.
29th	05:52 PM	Jupiter's moon, Io, transit ends.
	06:38 PM	Jupiter's moon, Io, shadow transit ends.
30th	05:35 AM	New Moon.
	6 PM	Moon at perigee.

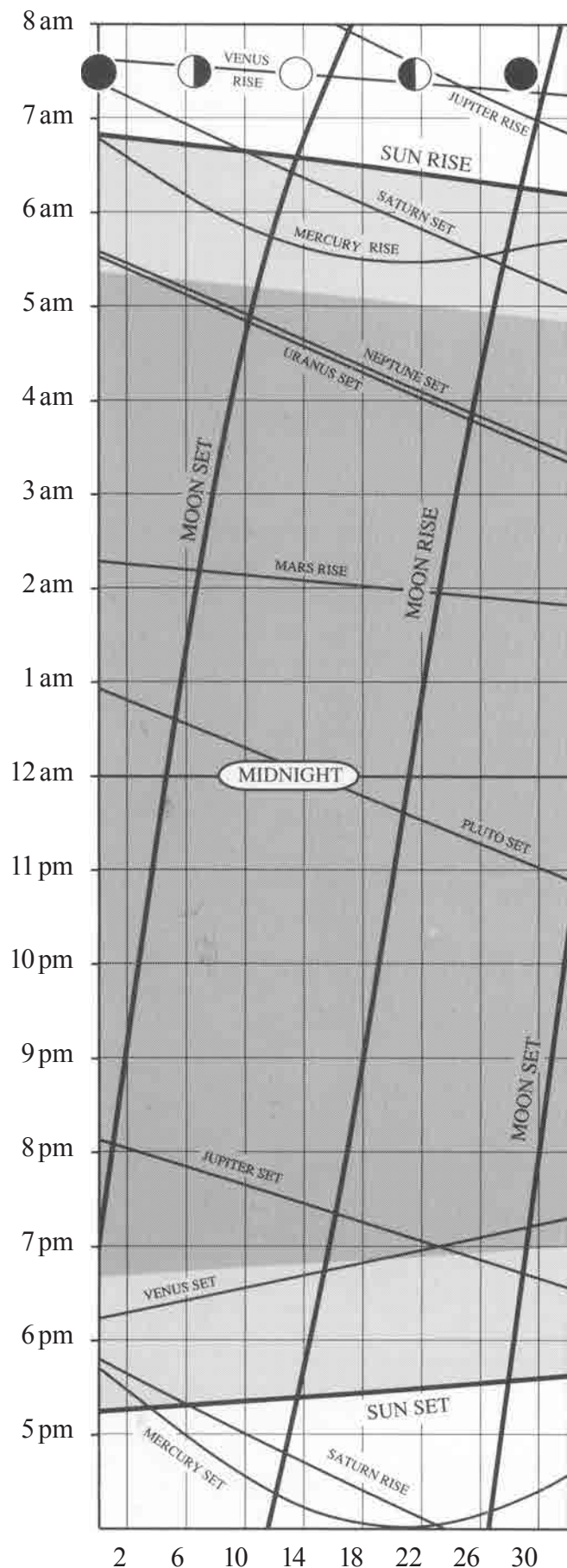


JULY



AUGUST

RISE/SET CHART



THE MOON

- 5th First Quarter, 8:58pm.
- 11th Occultation of Neptune by the Moon, 12:00am, visible only from parts of Asia and Japan.
- 13th Full Moon, 8:27pm.
- 14th Moon at apogee.
- 21st Last Quarter, 8:01pm.
- 28th New Moon, 12:42pm (Lunation number 862)
- Moon at perigee.

THE PLANETS

MERCURY returns briefly to the morning sky this month. The planet will be difficult to see as it rises during twilight only an hour before the Sun in the northeastern sky; it is best between the 14th and the 22nd. Mercury is at inferior conjunction (between the Earth and Sun) on the 3rd, and at it's greatest elongation (18) west of the Sun on the 21st.

VENUS, at magnitude -3.9, sets in the western sky an hour after the Sun early in the month, and after the end of twilight from the 18th. On the 7th Venus will be 1° north of the 1st magnitude star Alpha Leonis (Regulus) at an altitude of 5° at 6pm. On the 23rd at 6:30pm Venus will approach to within $0^\circ 17'$ of -1.7 mag Jupiter (see sky view diagram). This encounter should prove a fine sight to the unaided eye or binocular; spectacular in a telescope! The planets will be in twilight at this time and a good western horizon will be necessary as their altitude is only 6° .

MARS is still a planet for the insomniac, rising about 2am early in August. By month's end the planet will be shining at magnitude 0.6 and have a disk diameter of $7''$. Of most interest during the month to the unaided eye, will be the close approach of Mars to the Pleiades and Hyades star clusters. On the 4th at 4am, Mars will be situated midway between the two clusters. On the 12th at 4am Mars will be 5° from the reddish/orange giant star Alpha Tauri (Aldebaran) in the Hyades cluster. The colour of Aldebaran and Mars will make an interesting comparison, and the presence of this interloper will distort the cluster into an unfamiliar pattern. Mars remains in the constellation of Taurus for the entire month.

JUPITER's eastern elongation continues to decrease as it moves towards conjunction in mid September. Setting earlier each night, the planet's altitude does not lend itself to serious telescopic observations this month. On the 1st at 6:30pm Jupiter (altitude 19°) will be seen 6° north of the 3 day old Moon (see sky view diagram). As the planet moves closer to the horizon each night, Venus gradually gains altitude and on the 23rd they approach to within $0^\circ 17'$ of each other (see Venus for details)

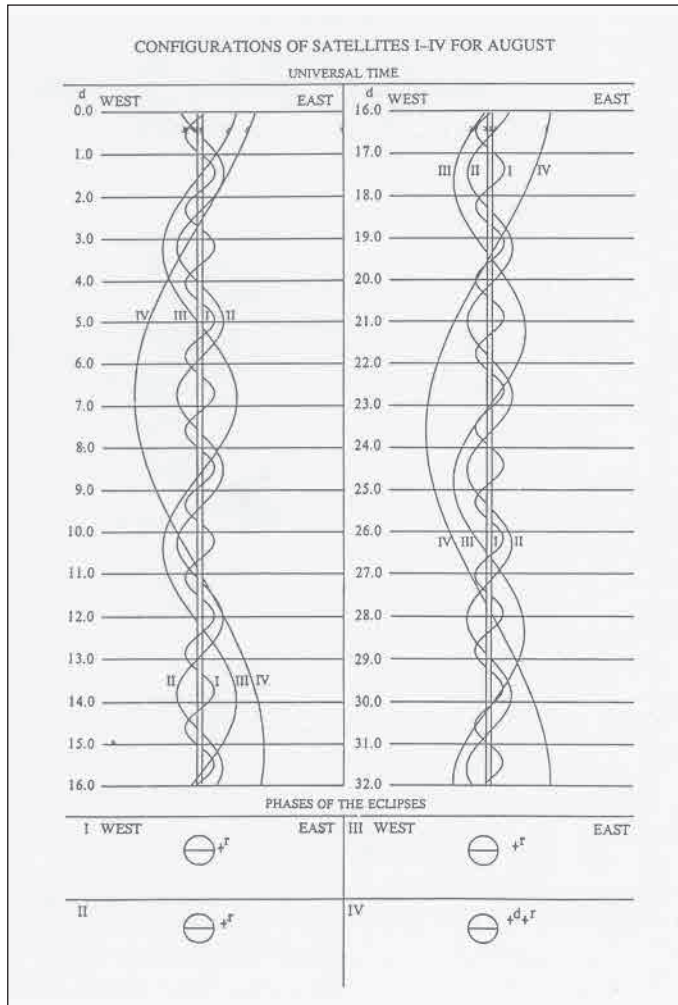
SATURN is visible during the entire night, rising in the east before the end of evening twilight. The planet is at opposition (closest approach to the Earth) on the 7th reaching it's maximum brightness for the year at magnitude 0.2, with a disk diameter of 18.6. The planet transits the meridian at 11:30pm mid month at an altitude of 41° . August is the optimum period for observing Saturn, however it's southern declination provides a reasonably good view through to the end of the year. On the 13th Saturn rises 8° south of the 14 day old Moon and by 3am the separation is reduced to 5° .

URANUS at the end of evening twilight is situated 45° above the eastern horizon in the constellation of Sagittarius. On the 10th at 7pm Uranus is situated 2° south of the 12 day old Moon, with Neptune 2° below the planet and 2° from the Moon. Uranus is available most of the night, setting at 4:30am

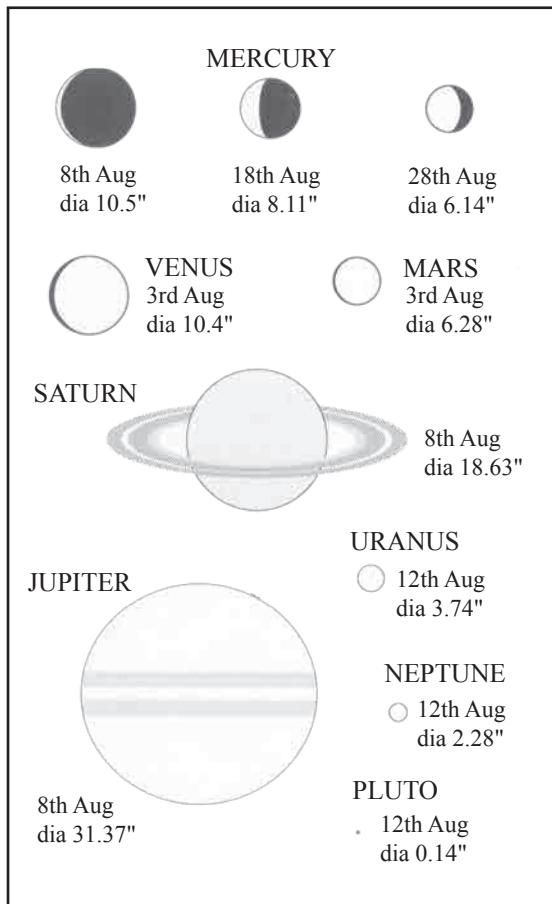
NEPTUNE trails just over 2° behind Uranus during the month. From Australian latitudes the closest that Neptune and the Moon are "seen" together during the occultation on the 11th is just over 1° at 12:00am. Interestingly the 3rd magnitude star P Sagittarii, that has been Neptune's close companion over the past few months, is occulted by the Moon about 2 hours earlier (refer p. 67 for details of this lunar occultation).

PLUTO transits the meridian at 5:45pm mid month and will be in the northwestern sky by end of twilight. The planet sets at lam early in the month and towards the end at around 11 pm.

JUPITER



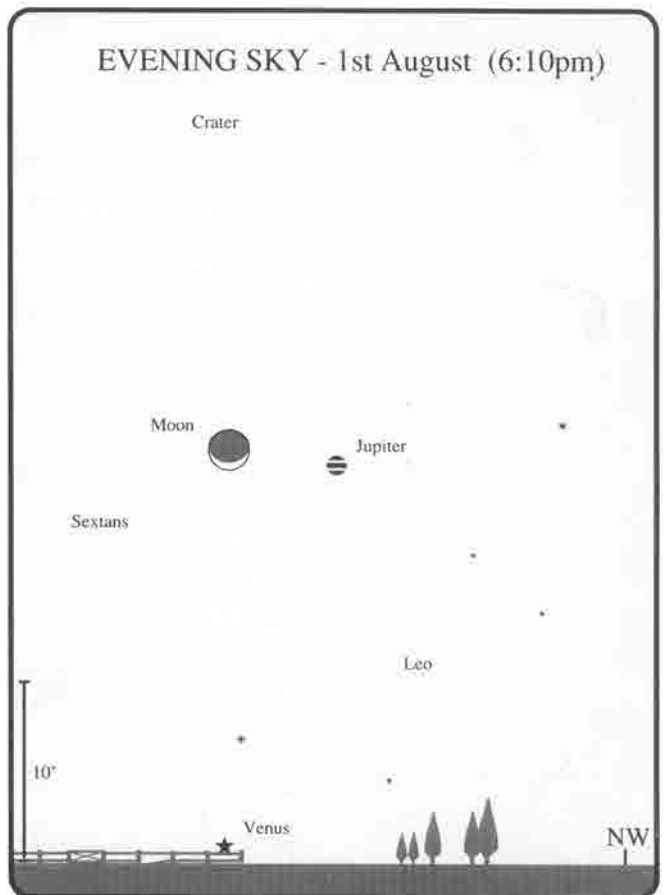
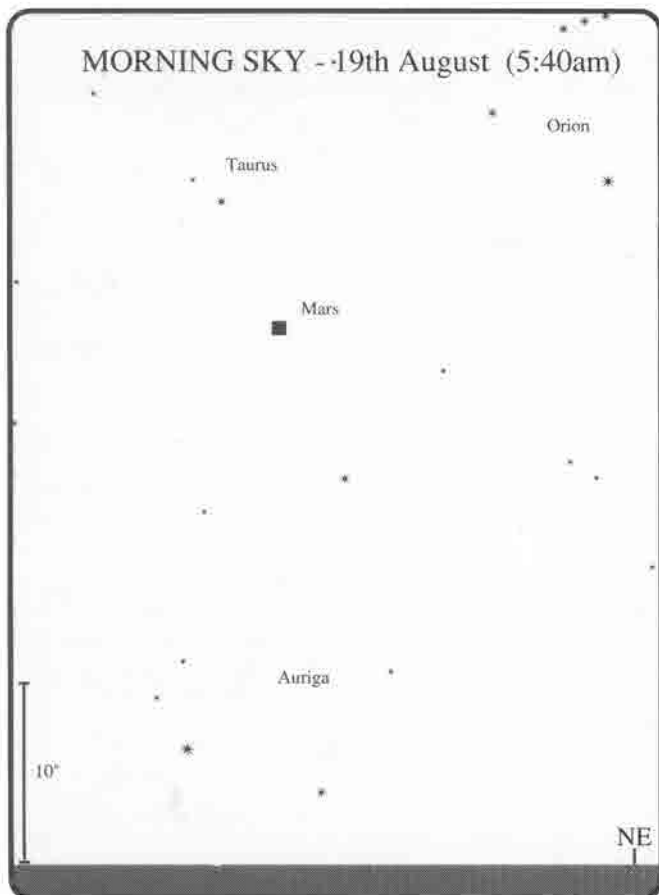
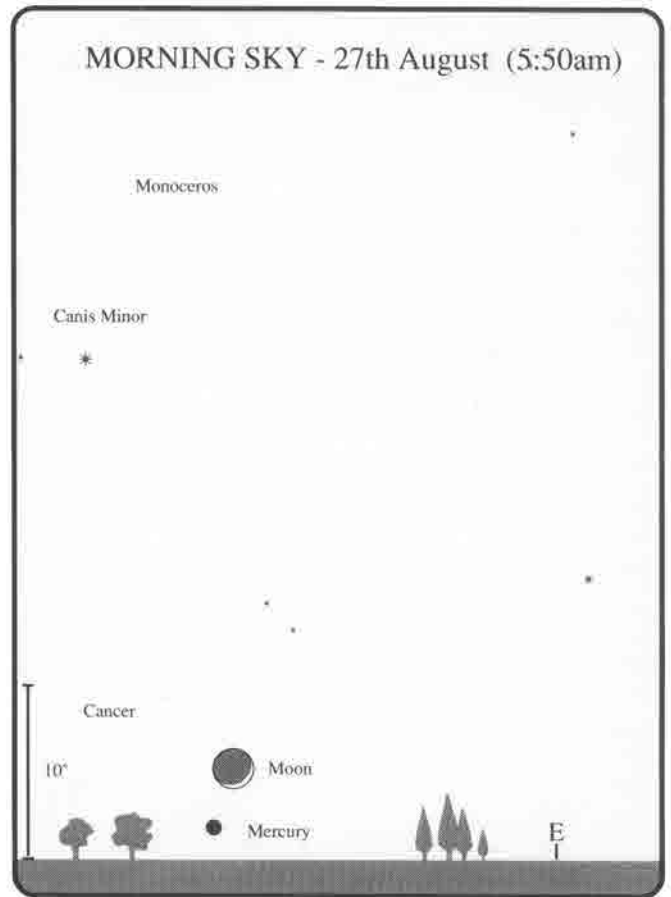
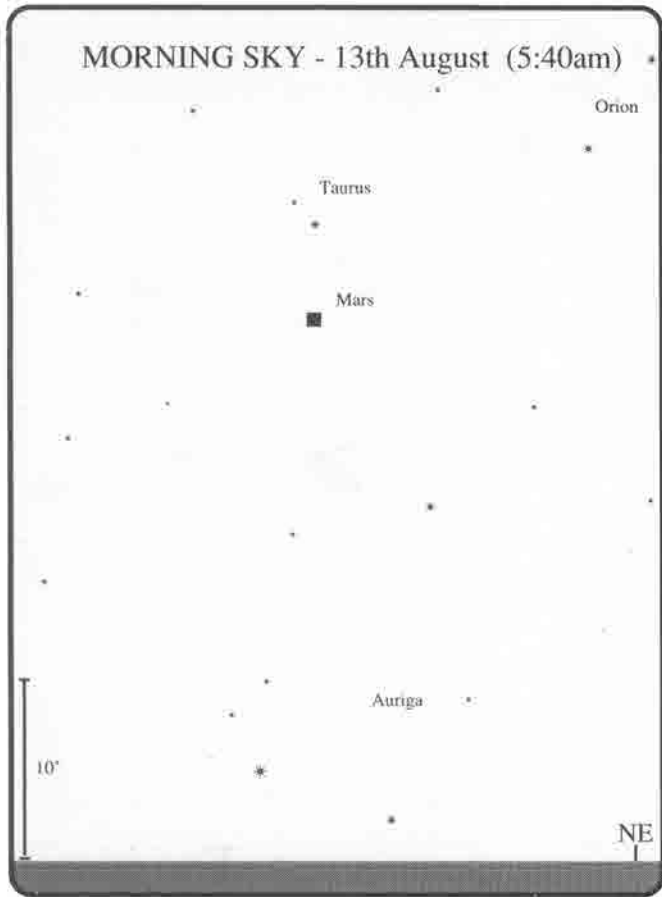
APPEARANCE OF THE PLANETS



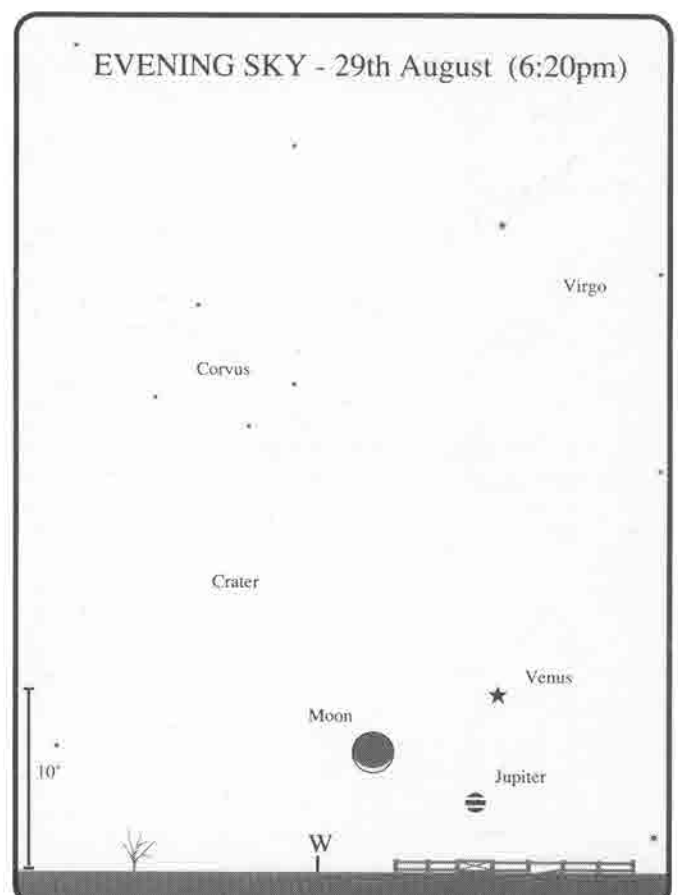
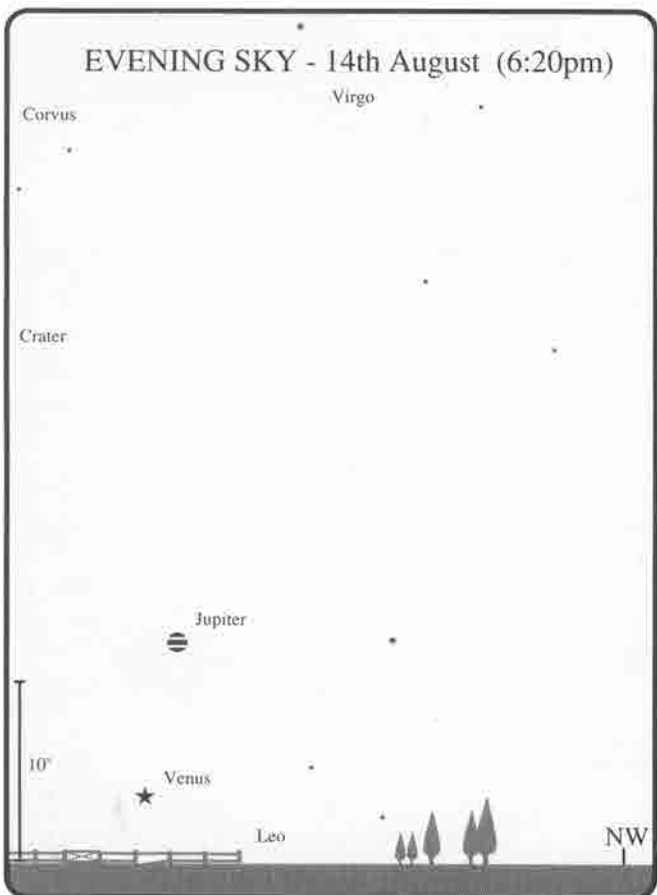
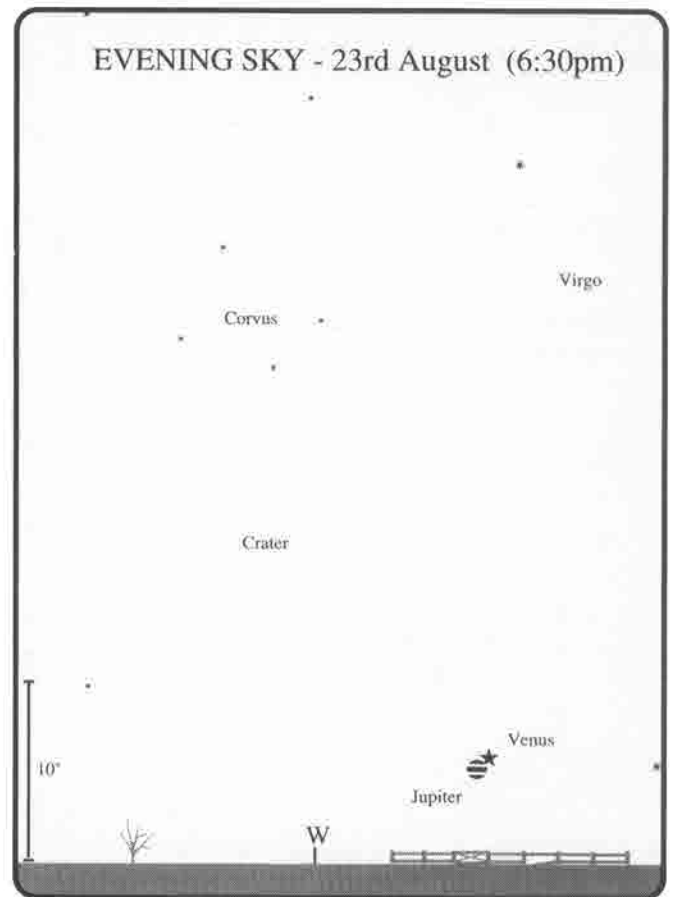
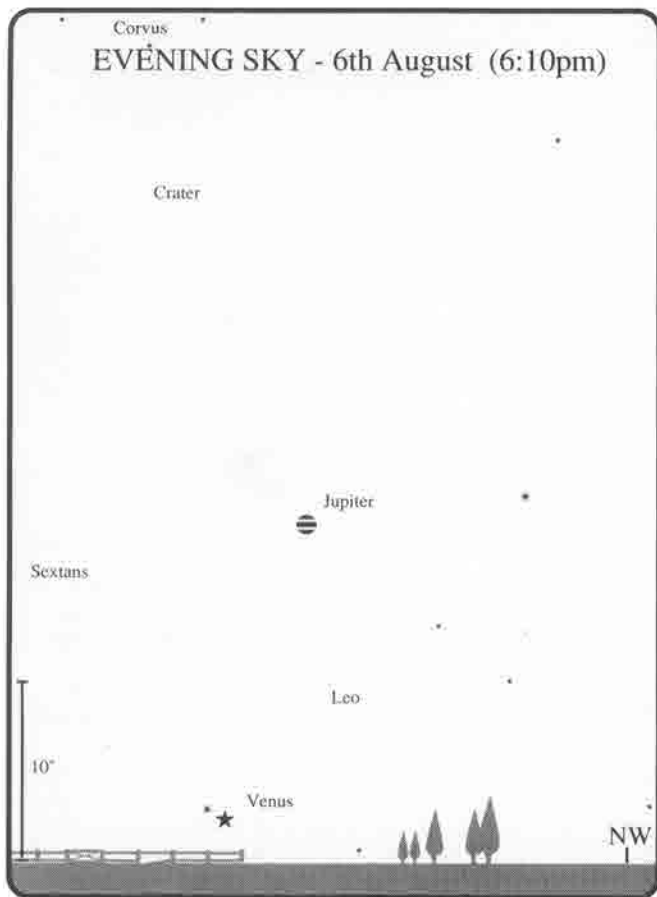
DAILY EVENTS

1st	06:58 PM	Jupiter's moon, Ganymede, transit begins.
	10 PM	Jupiter 7° North of the Moon.
2nd	05:25 PM	Jupiter's moon, Europa, shadow transit begins.
	06:40 PM	Jupiter's moon, Europa, transit ends.
	08:05 PM	Jupiter's moon, Europa, shadow transit ends.
3rd	7 AM	Mercury in inferior conjunction.
4th		Mercury at greatest latitude South.
		Venus at greatest latitude North.
	06:13 PM	Lunar occultation of ZC 1954, disappearance.
	7 PM	Pluto stationary.
	07:13 PM	Lunar occultation of ZC 1958, disappearance.
5th	05:37 PM	Jupiter's moon, Io, transit begins.
	06:18 PM	Jupiter's moon, Io, shadow transit begins.
	07:53 PM	Jupiter's moon, Io, transit ends.
	08:58 PM	First quarter Moon.
6th	05:54 PM	Jupiter's moon, Io, eclipse reappearance.
7th	08:52 PM	Lunar occultation of ZC 2216, disappearance.
8th	11:53 PM	Lunar occultation of ZC 2226, disappearance.
7th	4 AM	Venus 1° 1' North of Regulus.
	05:47 PM	Lunar occultation of ZC 2351, disappearance.
	07:18 PM	Lunar occultation of ZC 2357, disappearance.
	07:25 PM	Lunar occultation of ρ Oph, disappearance.
	8 PM	Saturn at opposition.
8th	09:52 PM	Lunar occultation of ZC 2507, disappearance.
9th	06:44 PM	Jupiter's moon, Europa, transit begins.
10th	8 PM	Uranus 1° 8' South of the Moon.
	09:54 PM	Lunar occultation of π Sgr, disappearance.
11th	12 AM	Neptune 0° 8' South of the Moon.
	7 PM	Mars 5° North of Aldebaran.
12th	07:31 PM	Jupiter's moon, Ganymede, eclipse reappearance.
	11 PM	Mercury stationary.
13th	11 AM	Saturn 5° South of the Moon.
	08:27 PM	Full Moon.
14th		Pallas stationary.
	2 AM	Moon at apogee.
19th	06:12 PM	Jupiter's moon, Ganymede, occultation disappearance.
	06:19 PM	Jupiter's moon, Callisto, transit begins.
20th	07:00 PM	Jupiter's moon, Io, occultation disappearance.
21st	12 PM	Mercury at greatest elongation West (18°)
	06:25 PM	Jupiter's moon, Io, transit ends.
	06:51 PM	Jupiter's moon, Io, shadow transit ends.
	08:01 PM	Last quarter Moon.
23rd	7 AM	Mars 1° 4' South of the Moon.
	1 PM	Venus 0° 3' North of Jupiter.
24th		Mercury at ascending node.
25th	06:35 PM	Jupiter's moon, Europa, occultation disappearance.
27th	11 AM	Mercury 5° North of the Moon.
28th		Mercury at perihelion.
	4 AM	Moon at perigee.
	12:42 PM	New Moon.
	06:10 PM	Jupiter's moon, Io, transit begins.
	06:30 PM	Jupiter's moon, Io, shadow transit begins.
29th	06:05 PM	Jupiter's moon, Io, eclipse reappearance.
30th	5 AM	Venus 7° North of the Moon.
31st	06:18 PM	Lunar occultation of ZC 1906, disappearance.

AUGUST

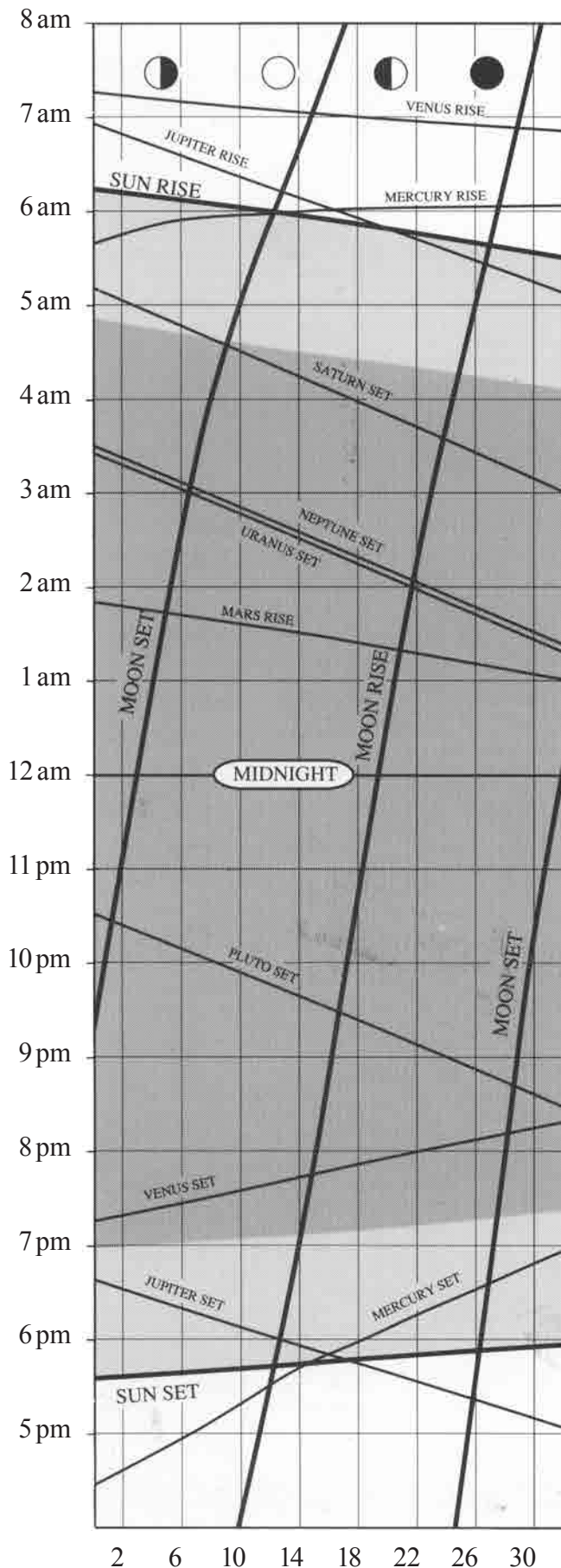


AUGUST



SEPTEMBER

RISE/SET CHART



THE MOON

- 4th First Quarter, 8:39 am.
- 7th Occultation of Neptune by the Moon, 5:00 am, visible only from parts of Africa, Europe, Middle East and U.S.S.R.
- 10th Moon at apogee.
- 12th Full Moon, 12:17 pm.
- 20th Last Quarter, 5:53 am.
- Occultation of Mars by the Moon, 7:00 pm, visible only from parts of South America, Antarctic Peninsula and the Atlantic Ocean.
- 25th Moon at perigee.
- 26th New Moon, 8:40 pm (Lunation number 863)

THE PLANETS

MERCURY will be disappointing during September as superior conjunction (on the opposite side of the Sun) occurs on the 15th. Early in the month, Mercury rises during twilight just before sunrise then swings behind the Sun and rises during daylight. Hence, in the evening sky, Mercury sets before the Sun early in the month and after sunset in the later half (after the 15th). The best time to observe the planet during the remainder of the year will be from mid October to early November in the western evening sky.

VENUS is now becoming prominent in the western evening sky for the first time this year. At magnitude -3.9 and still above the horizon after the end of evening twilight, the planet will tend to dominate the early western sky. On the 20th at 6:30 pm Venus will be 2° north of the 1st magnitude star Alpha Virginis (Spica). The 2 day old Moon will be 5° south of Venus on the 28th in the early evening.

MARS now displays a disc that grows in size from 7" early in the month to 8" at the end, it's brightness increases slightly from magnitude 0.6 to 0.4 during the same period. Rising mid month about 1:30 am, the planet attains an altitude of 25° at the beginning of twilight. Unfortunately the northerly declination of Mars (23°30' in September) means that it remains low in the sky. Even during opposition early next year it will transit the meridian at an altitude of only 30°. On the 21st, Mars rises within 5° of the 23 day old Moon. On the 14th at 3 am Mars will be only 0°09' from the 4th magnitude orange/yellow star 1 Geminorum. On the 21st it will be 5° north of the 23 day old Moon. Mars is situated in the constellation of Taurus until mid month when it then crosses over into Gemini.

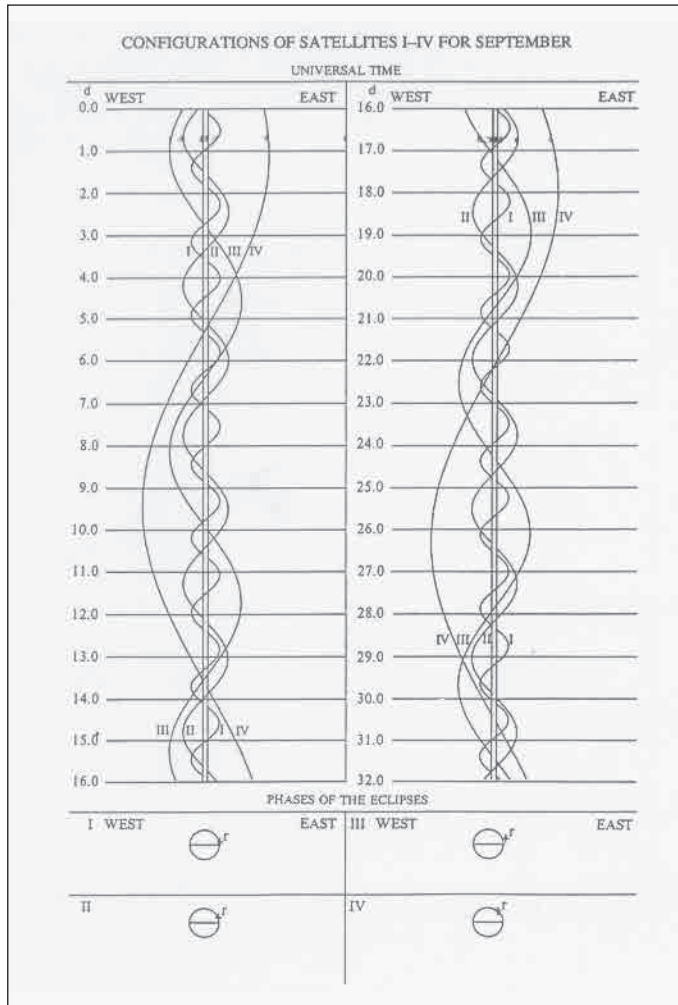
JUPITER moves towards conjunction (behind the Sun) on the 17th and is too close to the Sun for observations. The planet will reappear in the morning twilight next month in Virgo, where it remains for the rest of the year.

SATURN by mid month will be visible at the end of evening twilight at an altitude of 55° in the eastern sky, setting just before morning twilight. Saturn transits the meridian around 9:15 pm at an altitude of 74° at mid month. This is a convenient time to observe the planet at it's highest elevation. Saturn is still worthwhile observing one month after opposition (7th August) although it's diameter has decreased slightly to 18.1" and the magnitude faded to 0.4. On the 9th, at 7 pm, Saturn will be seen in the eastern sky 7° south of the 12 day old Moon (see sky view diagram).

URANUS transits the meridian at 7:15 pm mid month at an altitude of 78°. Under good dark skies Uranus, magnitude 5.7, may be seen with the unaided eye and Neptune (magnitude 7.9) viewed with binoculars. On the 6th at 7 pm Uranus will be 3° east from the 10 day old Moon. By lam on the 7th the separation decreases to 2°25' with the planet 24° above the western horizon.

SEPTEMBER

JUPITER



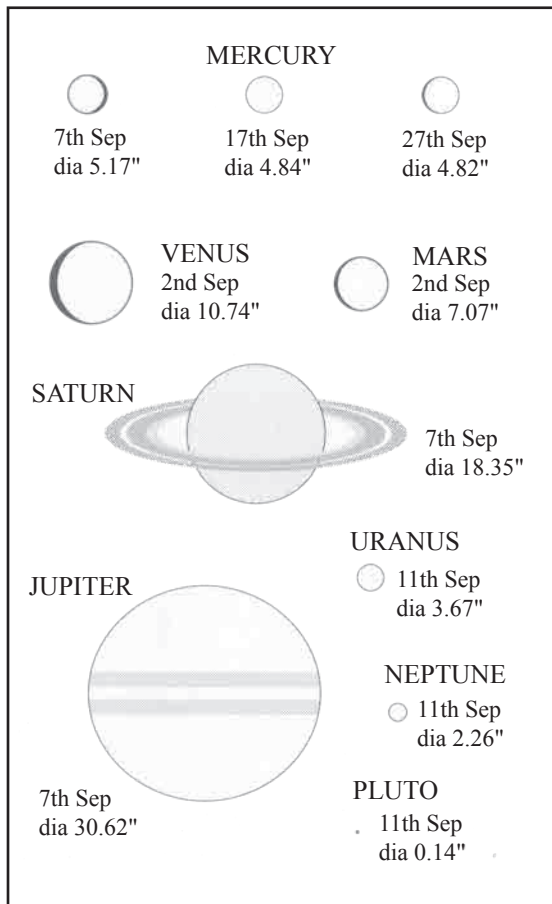
NEPTUNE transits the meridian about 15 minutes later than Uranus at an altitude of 76° . The planet remains approximately $0^\circ 45'$ from the 3rd magnitude star Pi Sagittarii throughout the month. From Australian latitudes the closest Neptune approaches the Moon during the occultation of the 7th is approx. 2° .

PLUTO rises at 9:30am mid month and sets at 10pm. This month is the last reasonable opportunity to observe Pluto as it heads towards conjunction with the Sun in November.

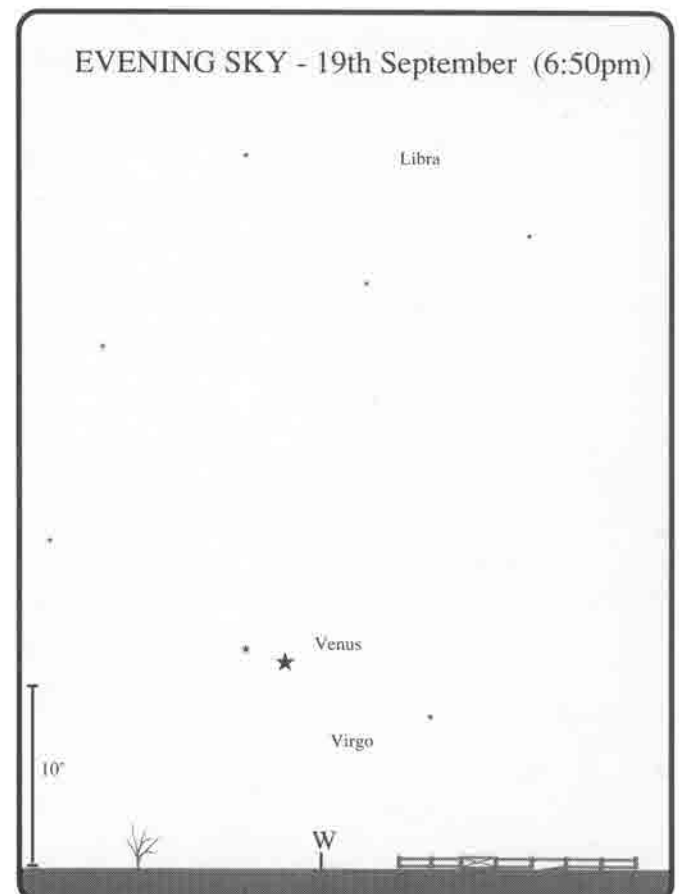
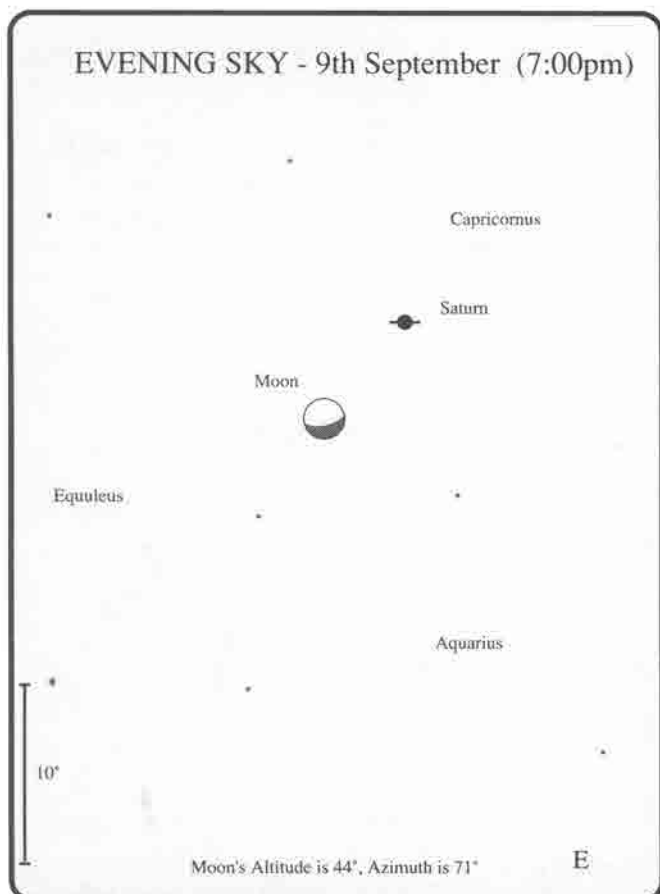
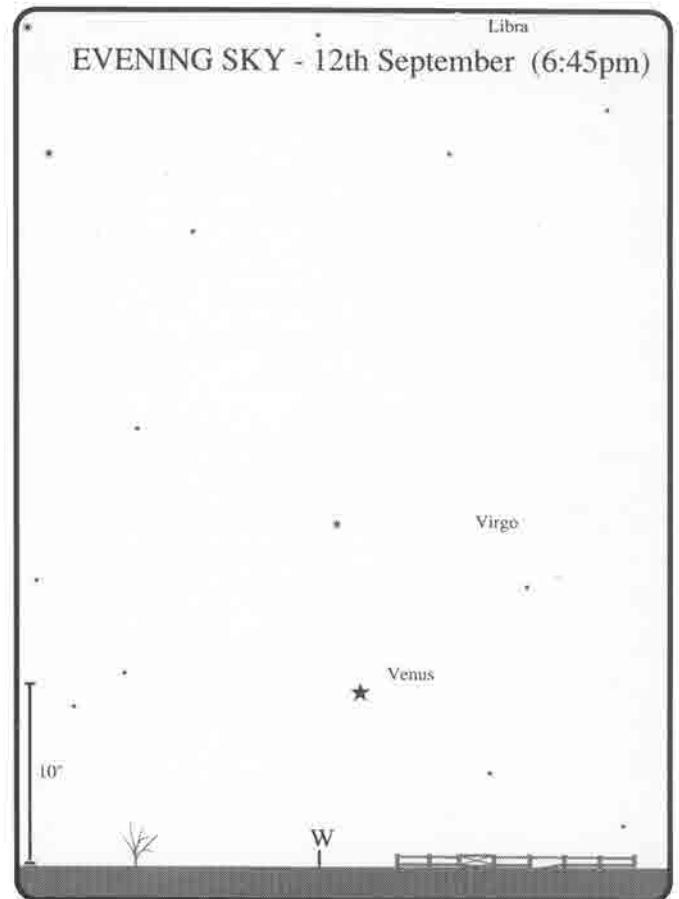
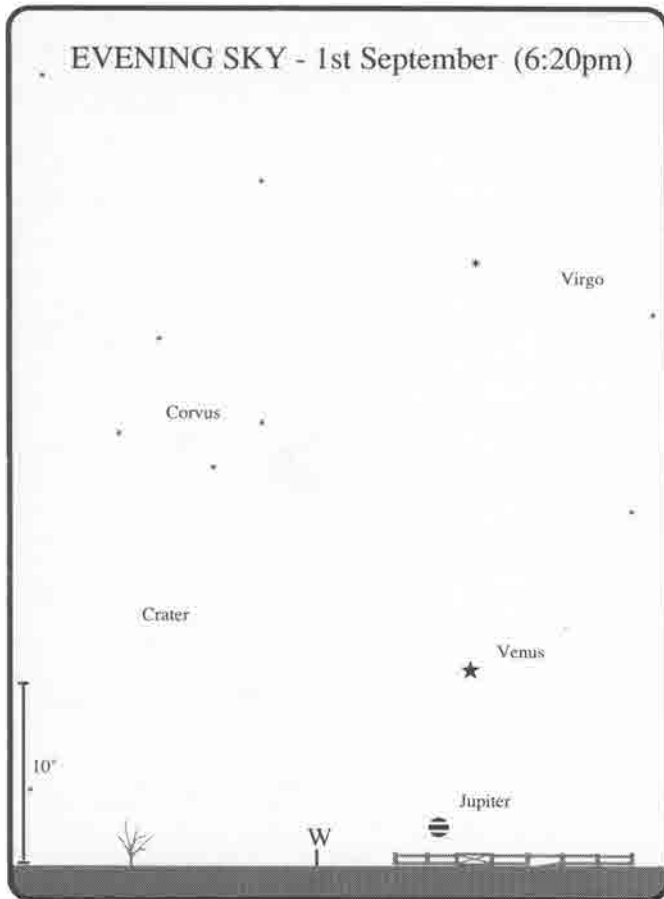
DAILY EVENTS

2nd	10:19 PM	Lunar occultation of ZC 2187, disappearance.
3rd	9 AM	Mercury $1^\circ 2'$ North of Regulus.
	02:06 PM	Lunar occultation of & Sco, disappearance.
	03:16 PM	Lunar occultation of & Sco, reappearance.
	09:40 PM	Lunar occultation of ZC 2321, disappearance.
4th	08:39 AM	First quarter Moon.
	10:02 PM	Lunar occultation of ZC 2461, disappearance.
5th	06:04 PM	Jupiter's moon, Callisto, transit ends.
	09:16 PM	Lunar occultation of 216 Sgr, disappearance.
	09:26 PM	Lunar occultation of ZC 2597, disappearance.
	09:58 PM	Lunar occultation of ZC 2604, disappearance.
	10:21 PM	Lunar occultation of ZC 2608, disappearance.
6th	05:57 PM	Jupiter's moon, Ganymede, shadow transit begins.
	08:38 PM	Lunar occultation of 33 Sgr, disappearance.
	11:16 PM	Lunar occultation of 2 x Sgr, disappearance.
7th		Mercury at greatest latitude North.
	1 AM	Uranus $1^\circ 9'$ South of the Moon.
	5 AM	Neptune $0^\circ 9'$ South of the Moon.
	11:16 PM	Lunar occultation of ZC 2891, disappearance.
9th	1 PM	Saturn 5° South of the Moon.
10th	5 AM	Moon at apogee.
12th	12:17 PM	Full Moon.
15th		Mars at ascending node.
	2 PM	Mercury in superior conjunction.
16th		Ceres stationary.
18th	5 AM	Jupiter in conjunction.
19th	03:10 AM	Lunar occultation of 95 Tau, reappearance.
	3 PM	Venus 3° North of Spica.
20th	05:53 AM	Last quarter Moon.
	7 PM	Mars $0^\circ 9'$ North of the Moon.
23rd	04:43 AM	Solar equinox.
	10 AM	Uranus stationary.
25th	1 PM	Moon at perigee.
26th	08:40 PM	New Moon.
28th	2 AM	Neptune stationary.
29th		Venus at descending node.
	1 AM	Venus 4° North of the Moon.

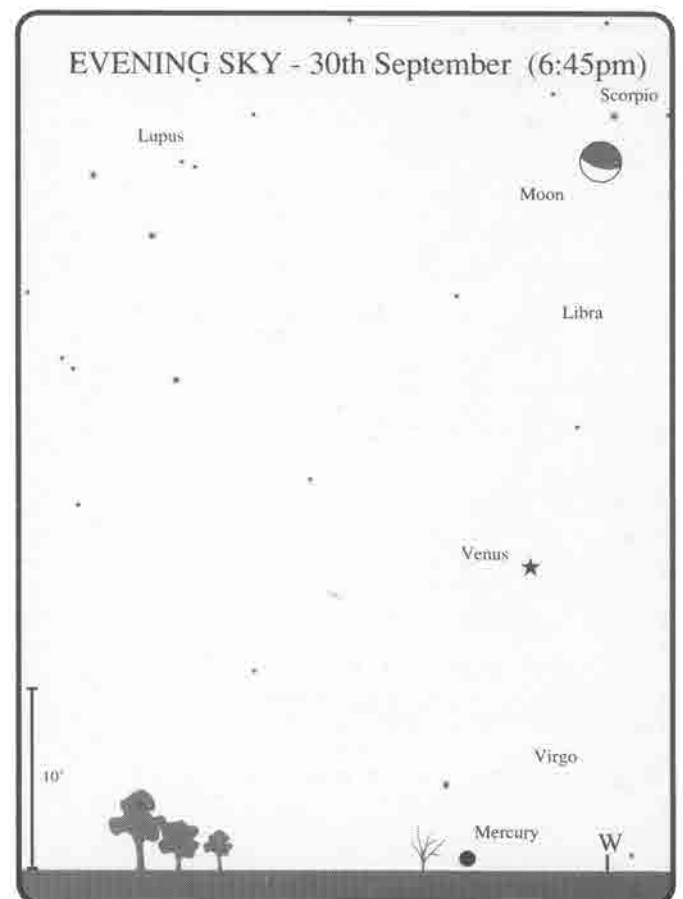
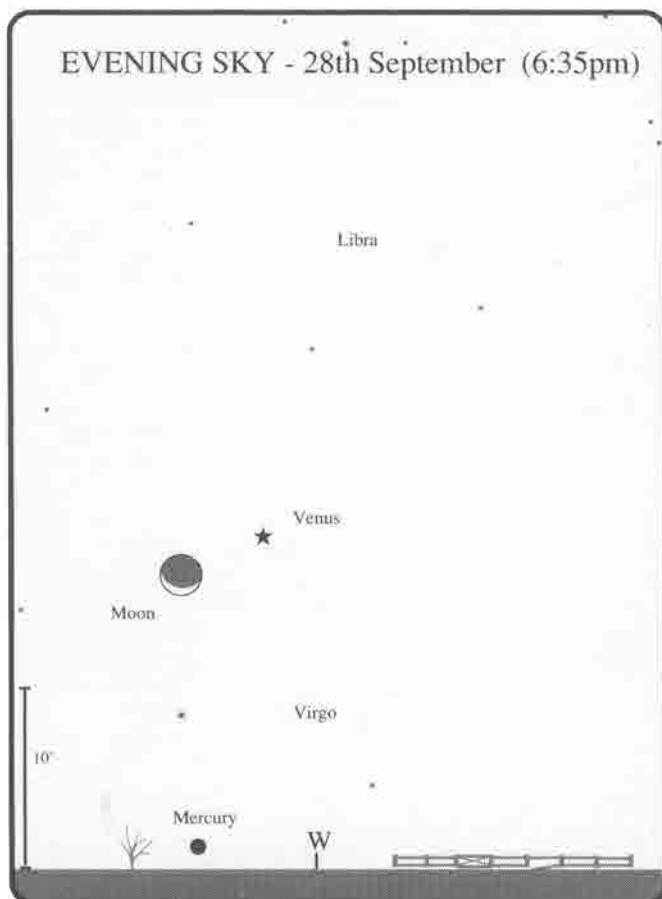
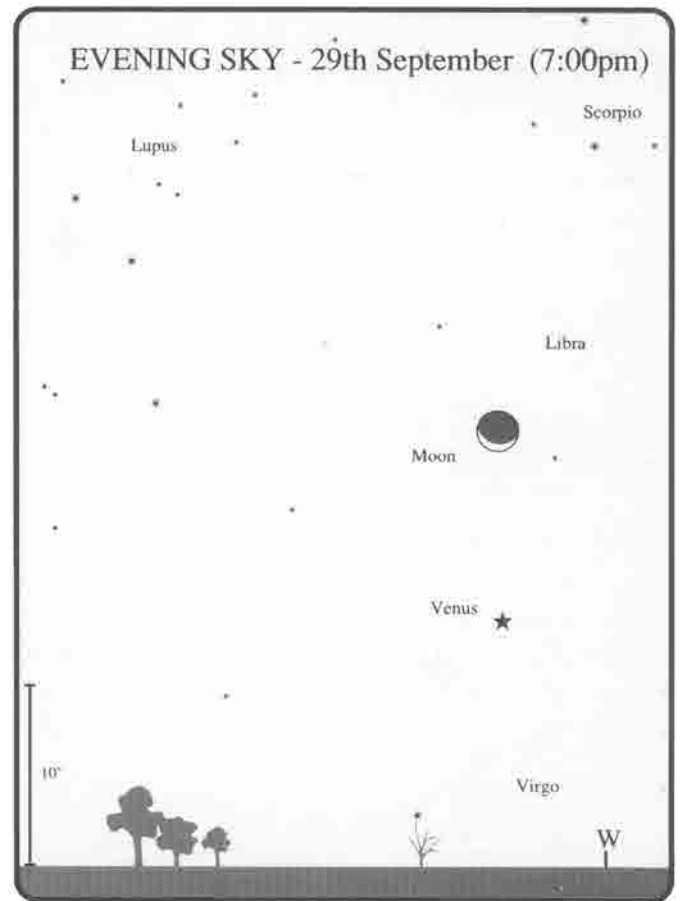
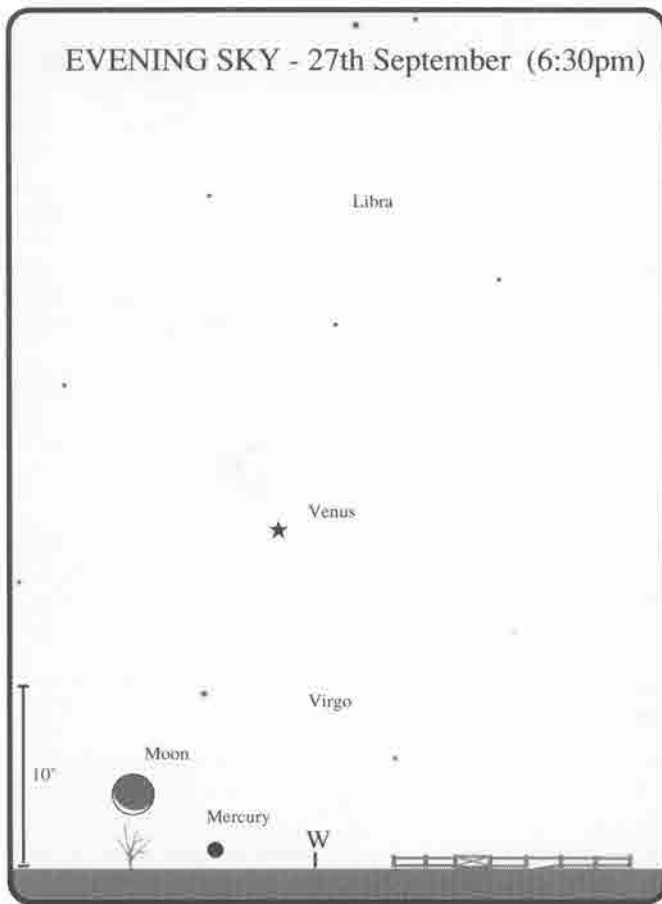
APPEARANCE OF THE PLANETS



SEPTEMBER

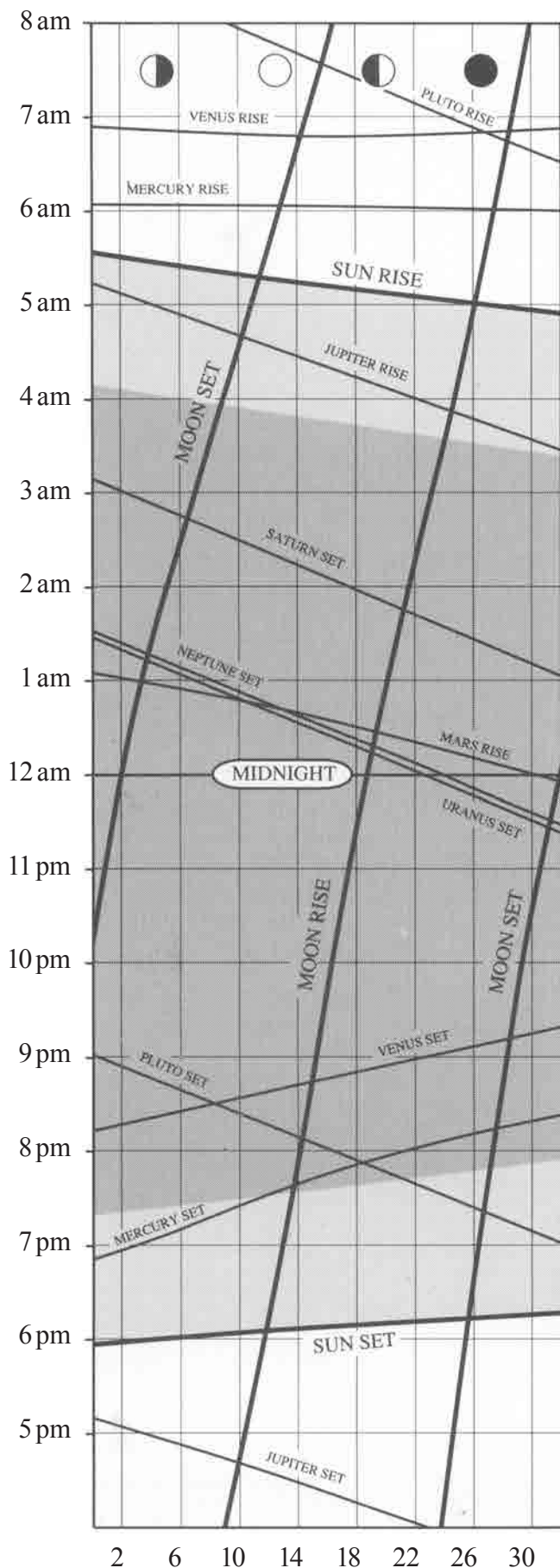


SEPTEMBER



OCTOBER

RISE/SET CHART



THE MOON

- 4th First Quarter, 12.12am.
Occultation of Neptune by the Moon, 12.00pm, visible only from north west Canada.
- 7th Moon at apogee.
- 12th Full Moon, 4.03am.
- 19th Last Quarter, 2.12pm.
- 23rd Moon at perigee.
- 26th New Moon, 6.34am (Lunation number 864).
- 28th Occultation of Mercury by the Moon, 1.00am, visible only from West Indies, Greece and parts of North America, Africa, Italy and the Atlantic Ocean.
- 29th Occultation of Venus by the Moon, 1.00am, visible only from Saudi Arabia and parts of South America, Atlantic Ocean, and Africa.

THE PLANETS

MERCURY is in the evening twilight early in the month. It begins setting after the end of evening twilight from the 10th. The best time to observe the planet is from about the 15th October to the 10th November. Mercury reaches its greatest elongation east of the Sun (24°) on the 1st November. Around this time, the Sun will be 9° below the horizon at 7pm with Mercury (-0.2 magnitude) at an altitude of 15° . On the 27th at 7pm, Mercury, appearing like a gibbous Moon (through a telescope), will be seen 4° above the 2 day old Moon (see sky view diagram). Venus, at a dazzling -4 magnitude, will be 12° above and to the north of Mercury. VENUS, at magnitude -4 will dominate the western evening sky and the planet will remain like this for the rest of the year. On the 7th, Venus will appear $0^\circ 45'$ south of the 3rd magnitude star Alpha 2 Librae and on the 21st it will be within 1° (north) of 2.5 magnitude Delta Scorpii (see sky view diagram). A splendid triangular alignment occurs on the 28th when Venus appears $3^\circ 30'$ above the 3 day old thin crescent Moon with the orange 1st magnitude star Alpha Scorpii (Antares) 3° south of Venus (see sky view diagram).

MARS in Gemini (for the rest of the year) reaches -0.1 magnitude with a disc diameter of $10''$ by the end of the month. The planet rises around 12.30am mid month, which suggests a 3am observing session if the planet is to be viewed at a reasonable altitude. On the 19th Mars is situated 3° away from the 22 day old Moon in the early morning northern sky. From the end of the month and throughout November, Mars will be within 6° of the 1st magnitude star Beta Geminorum (Pollux).

JUPITER, after conjunction (passing behind the Sun), moves into the eastern morning sky. By month's end Jupiter, at -1.7 magnitude, will be visible low towards the eastern horizon in the morning twilight.

SATURN, at 0.6 magnitude, transits the meridian about 7.00pm mid month at an altitude of 74° . As transit occurs at the end of evening twilight serious observations can begin at this time. This is providing the image quality does not suffer too much from turbulent air from a warm October day. On the 6th, Saturn will be 6° south of the 10 day old Moon.

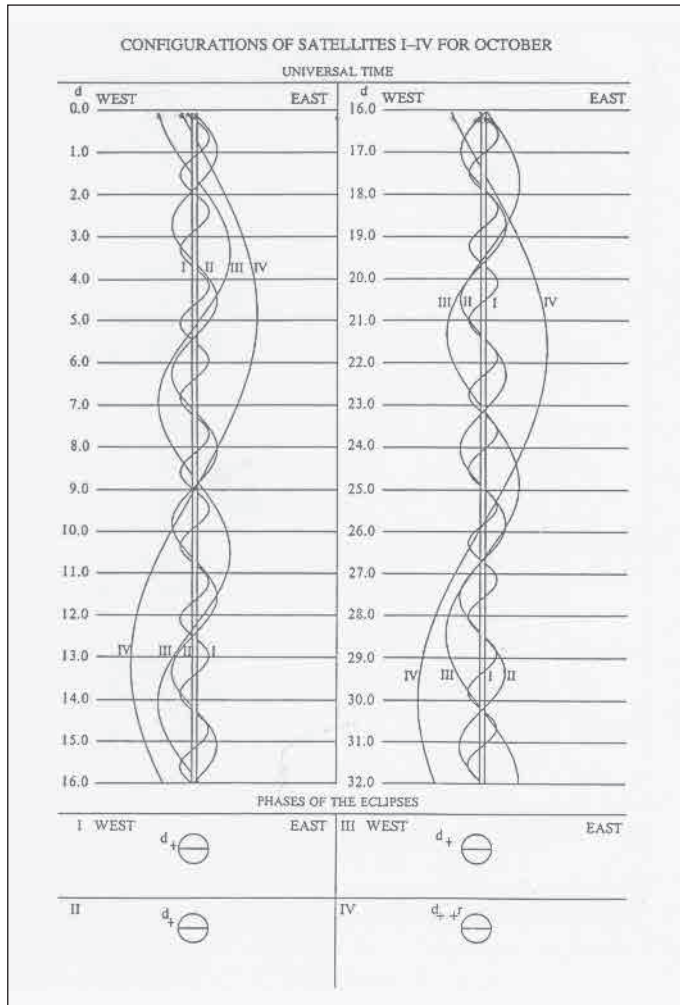
URANUS at magnitude 5.7 sets at 12.30am mid month. The planet has two encounters with the Moon. On the 4th at 7pm Uranus will be within $6^\circ 30'$ south of the 8 day old Moon high in the northwestern sky with Neptune in between and $4^\circ 10'$ from the Moon. Also on the 31st at 7pm Uranus will be 3° south of the 6 day old Moon with Neptune above the pair forming a triangle.

NEPTUNE, at magnitude 7.9, sets at 12.30am mid month. On the 4th at 7pm Neptune will be 4° south of the 8 day old Moon and on the 31st at 7pm the planet will be 2° south of the 8 day old Moon.

PLUTO sets mid month just after the end of twilight and will soon be lost from the evening sky as it heads towards conjunction next month.

OCTOBER

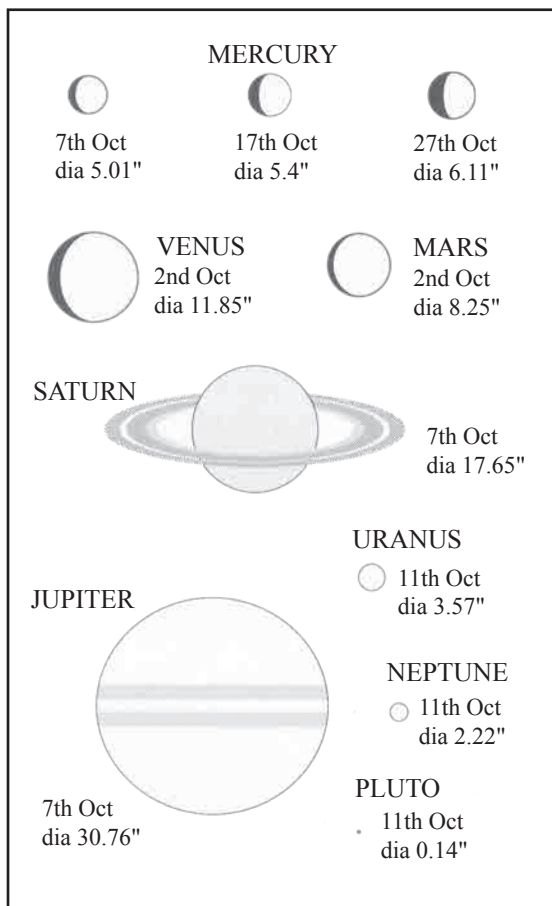
JUPITER



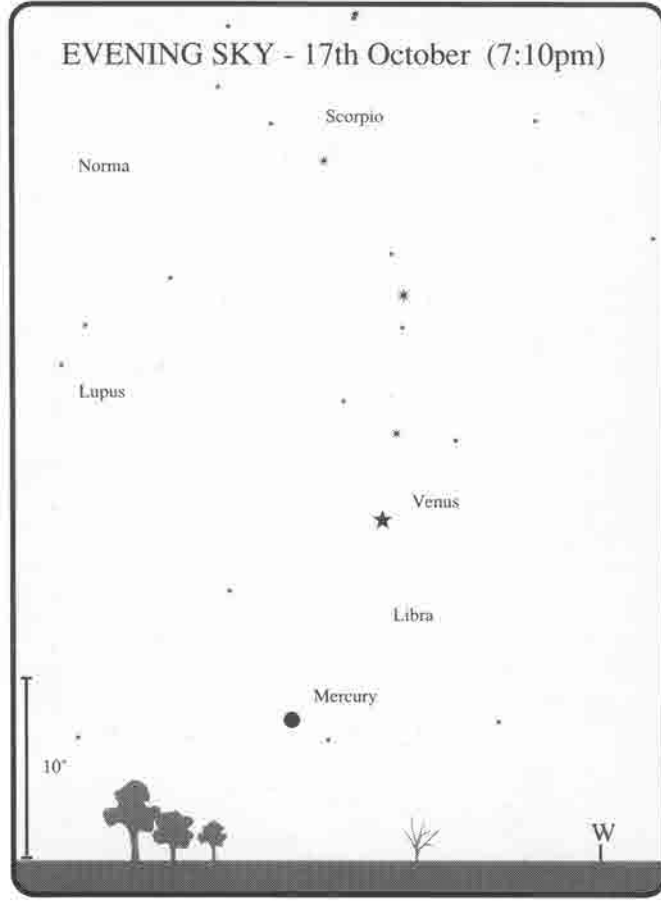
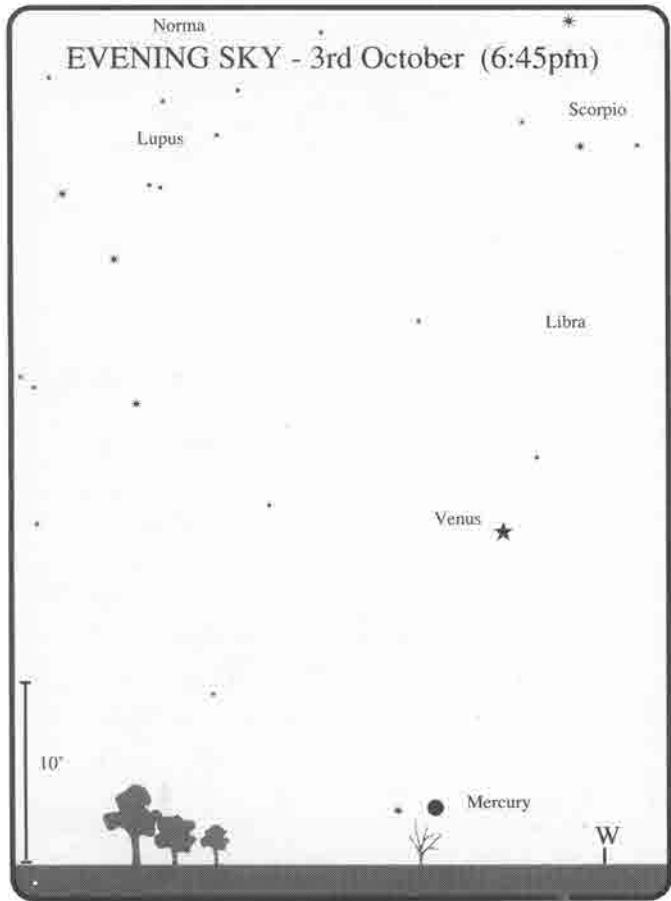
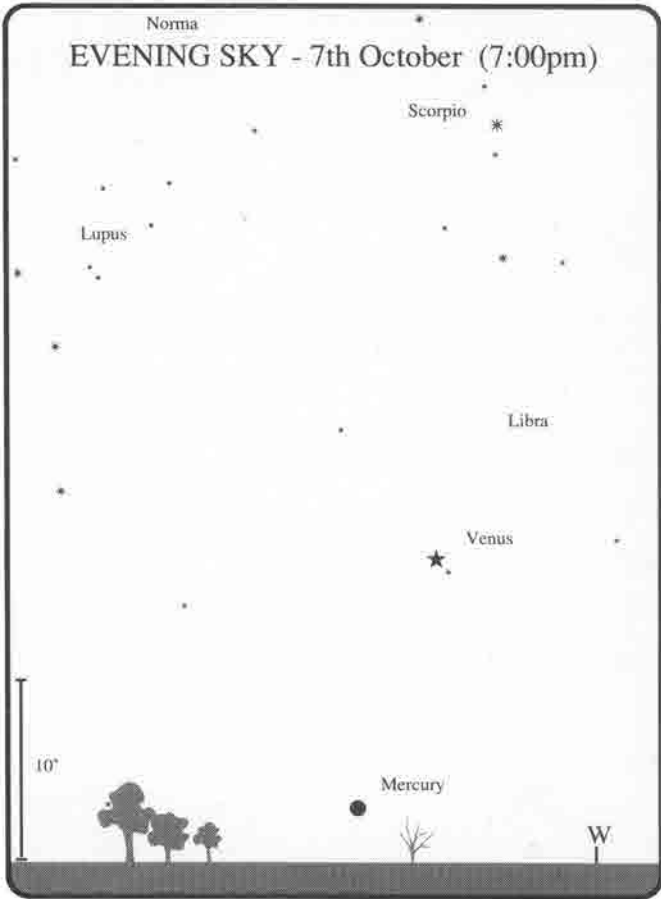
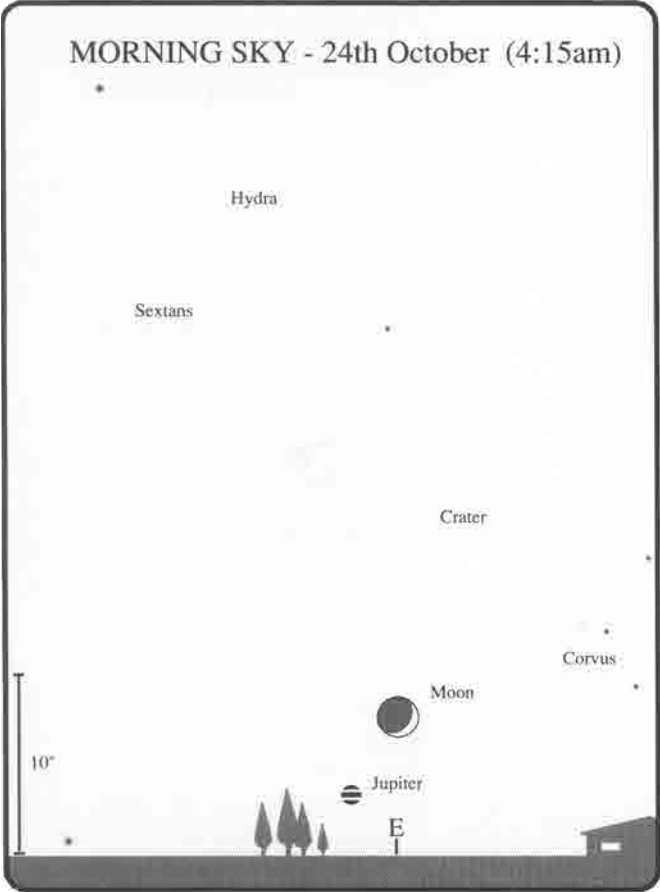
DAILY EVENTS

1 st		Mercury at descending node.
	07:35 PM	Lunar occultation of 15 Oph, disappearance.
2nd	09:37 PM	Lunar occultation of ZC 2551, disappearance.
	11:03 PM	Lunar occultation of ZC 2557, disappearance.
3rd	09:13 PM	Lunar occultation of 115B Sgr, disappearance.
4th	12:12 AM	First quarter Moon.
	8 AM	Uranus 2° South of the Moon.
	12 PM	Neptune 1°.2 South of the Moon.
	08:08 PM	Lunar occultation of ZC 2844, disappearance.
6th	6 PM	Saturn 5° South of the Moon.
7th	12:35 AM	Lunar occultation of v Aql, disappearance.
	4 PM	Moon at apogee.
	09:18 PM	Lunar occultation of ZC 3201, disappearance.
8th	01:26 AM	Lunar occultation of ZC 3212, disappearance.
11th		Mercury at aphelion.
12th	04:03 AM	Full Moon.
16th	2 PM	Saturn stationary.
18th	05:07 AM	Jupiter's moon, Io, eclipse disappearance.
19th	1 AM	Mars 3° North of the Moon.
	01:24 AM	Lunar occultation of 56 Gem, reappearance.
	04:23 AM	Lunar occultation of 61 Gem, reappearance.
	04:34 AM	Jupiter's moon, Io, shadow transit ends.
	05:04 AM	Jupiter's moon, Io, transit ends.
	02:12 PM	Last quarter Moon.
23rd	3 PM	Moon at perigee.
26th	04:13 AM	Jupiter's moon, Io, shadow transit begins.
	04:50 AM	Jupiter's moon, Io, transit begins.
	06:34 AM	New Moon.
27th	04:05 AM	Jupiter's moon, Europa, transit ends.
	04:19 AM	Jupiter's moon, Io, occultation reappearance.
	5 PM	Venus 3° North of Antares.
28th	1 AM	Mercury 0°.5 South of the Moon.
29th	1 AM	Venus 0°.4 South of the Moon.
	07:29 PM	Lunar occultation of ZC 2493, disappearance.
31 st		Mercury at greatest latitude South.
	5 PM	Uranus 2° South of the Moon.
	8 PM	Neptune 1°.4 South of the Moon.
	08:25 PM	Lunar occultation of 195B Sgr, disappearance.

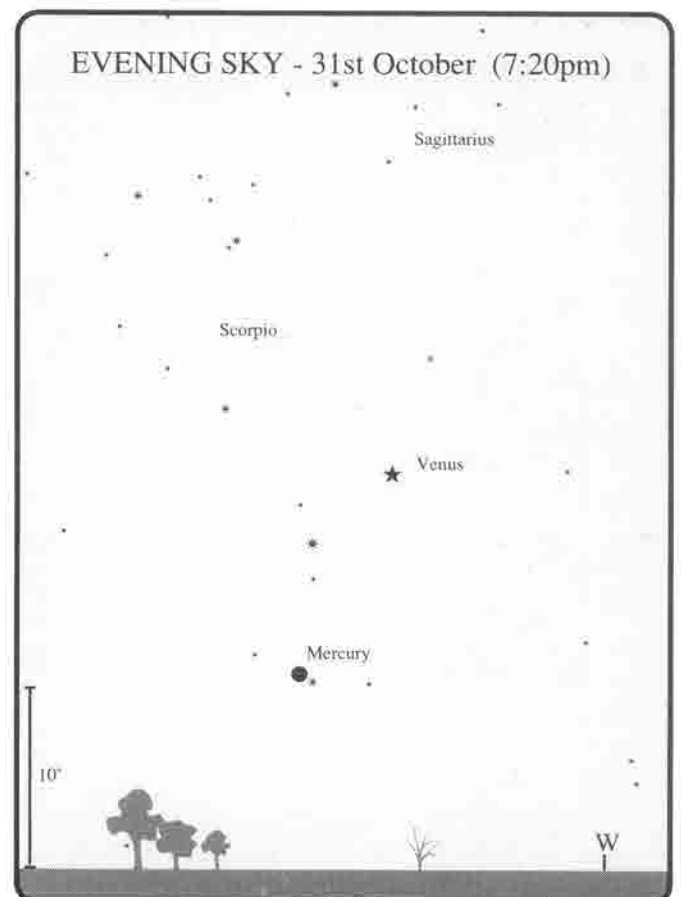
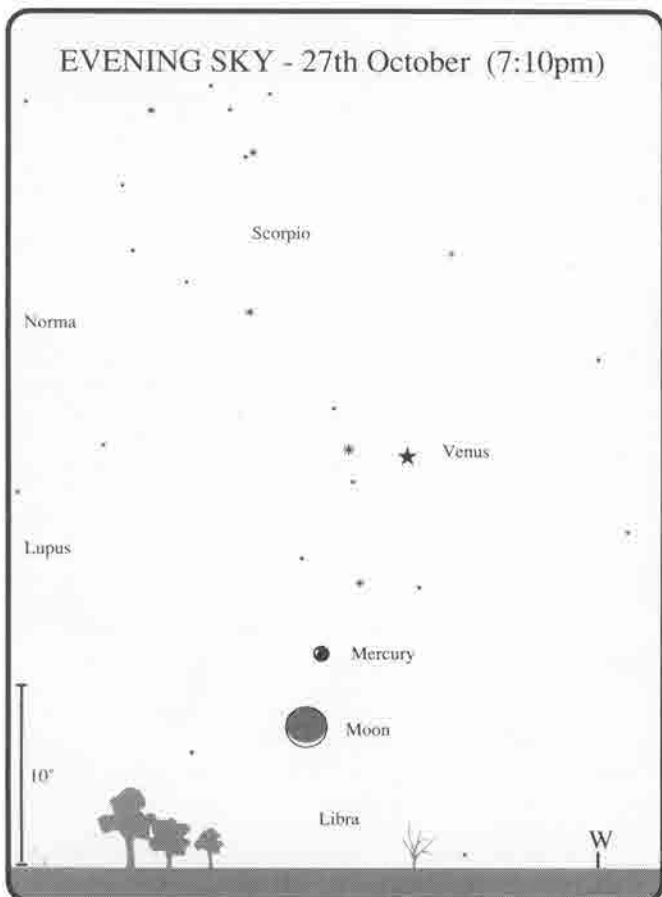
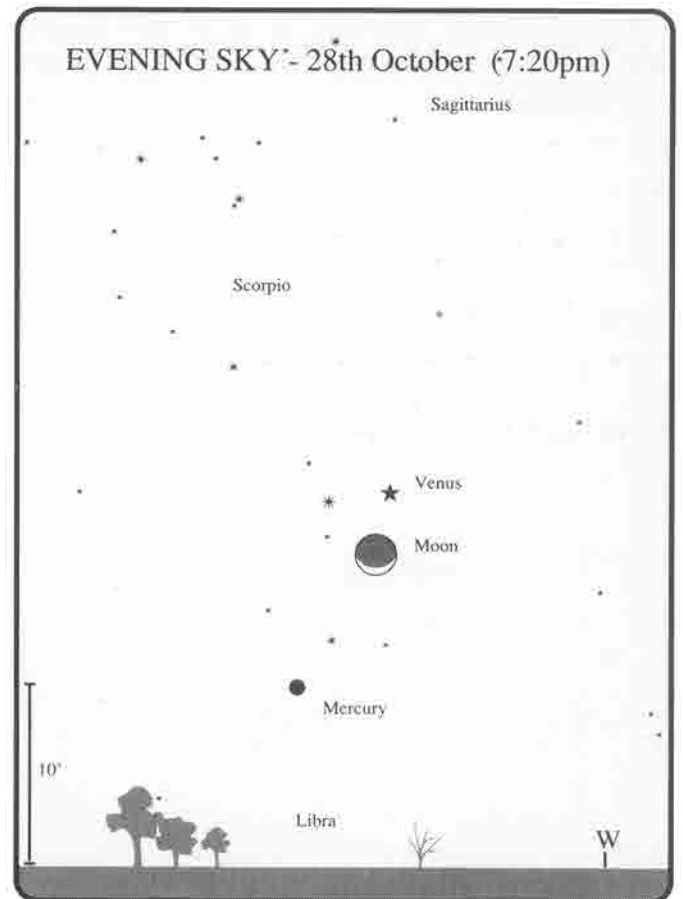
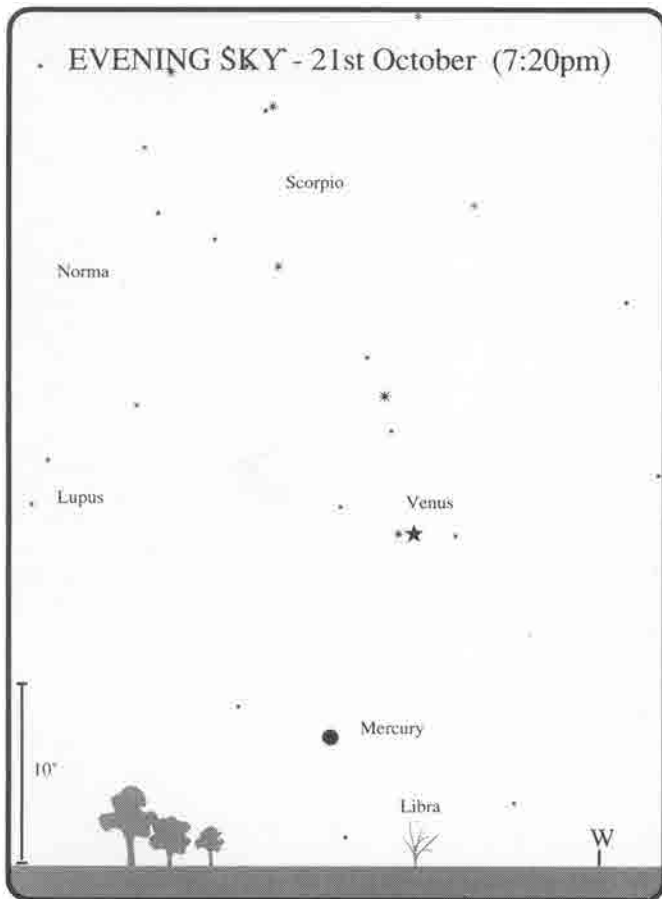
APPEARANCE OF THE PLANETS



OCTOBER

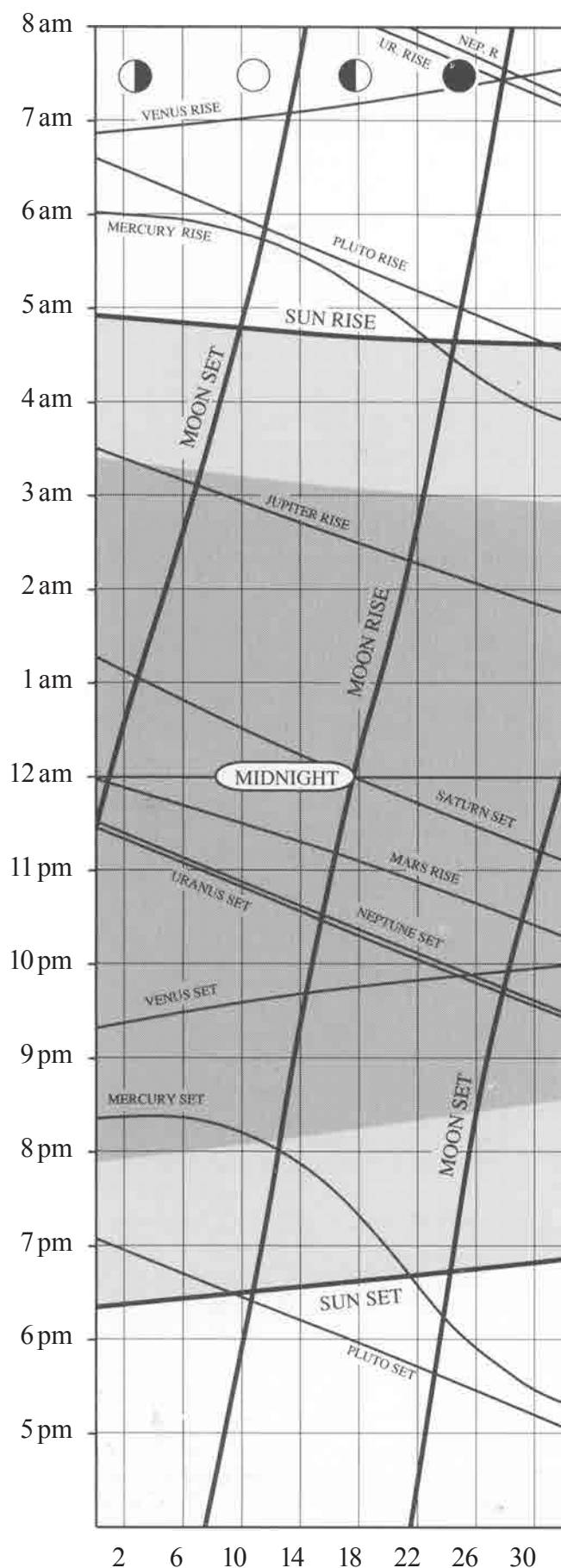


OCTOBER



NOVEMBER

RISE/SET CHART



THE MOON

2nd	First Quarter, 7:11 pm.
4th	Moon at apogee.
10th	Full Moon, 7:20 pm.
17th	Last Quarter, 9:39 pm.
19th	Moon at perigee.
24th	New Moon, 7:11 pm (Lunation number 865).

THE PLANETS

MERCURY reaches it's greatest elongation east of the Sun (24°) on the 1st and remains suitable for observation until the 10th ie low in the western early evening sky. It then moves rapidly towards inferior conjunction (between the Earth and Sun) on the 22nd, swinging to the west of the Sun to reappear in the morning twilight. After the 10th Mercury will not be favourable for observations again until 1993. By the 6th, Mercury's "gibbous" look shrinks to a first quarter phase. Just after greatest eastern elongation, the Sun will be 9° below the horizon at 7pm with Mercury (-0.0 magnitude) at an altitude of 15° .

VENUS sets around 10pm during November. At the end of evening twilight the planet will still be at an altitude of 19° above the horizon. At -4.0 magnitude and 38° from the Sun there should be no reason to wait until dark to observe the planet, binoculars will aid in it's location even in daylight. During the month the planet approaches two 3rd magnitude stars; on the 6th Venus will be $0^\circ 10'$ north of Theta Ophiuchi and on the 18th will be $0^\circ 20'$ south of Lambda Sagittarii (see sky view diagram). On the 26th Venus will be 2° south of Uranus and $3^\circ 30'$ south of Neptune. The planet will be seen near the thin crescent Moon on two occasions; on the 27th Venus will be 7° above a three day old Moon and on the 28th, 8° south of the four day old Moon.

MARS rises mid month just after 11 pm at magnitude -0.4 , the diameter of the disc increases from $10''$ early in the month to almost $13''$ by the end; Mars remains close to the 1st magnitude star Pollux for the entire month. On the 16th the planet will be seen rising within 5° (north) of the 20 day old Moon (see sky view diagram).

JUPITER rises in the morning sky just prior to the beginning of twilight and does not gain sufficient altitude for serious observations to begin before the sky brightens. On the 21st Jupiter rises 7° north of the 26 day old Moon.

SATURN, at mid month, will be visible at the end of twilight 50° above the western horizon, having passed meridian transit an hour and a half prior to sunset. This makes November and early December the last good chance this year to observe the planet at a reasonable altitude. On the 2nd, Saturn can be seen $5^\circ 30'$ above the 7 day old Moon (1st Quarter). During the month Saturn will appear near the 4th magnitude star Theta Capricorni and on the 30th it will be $0^\circ 30'$ south of the star with the 6 day old Moon $7^\circ 30'$ further north (see sky view diagram).

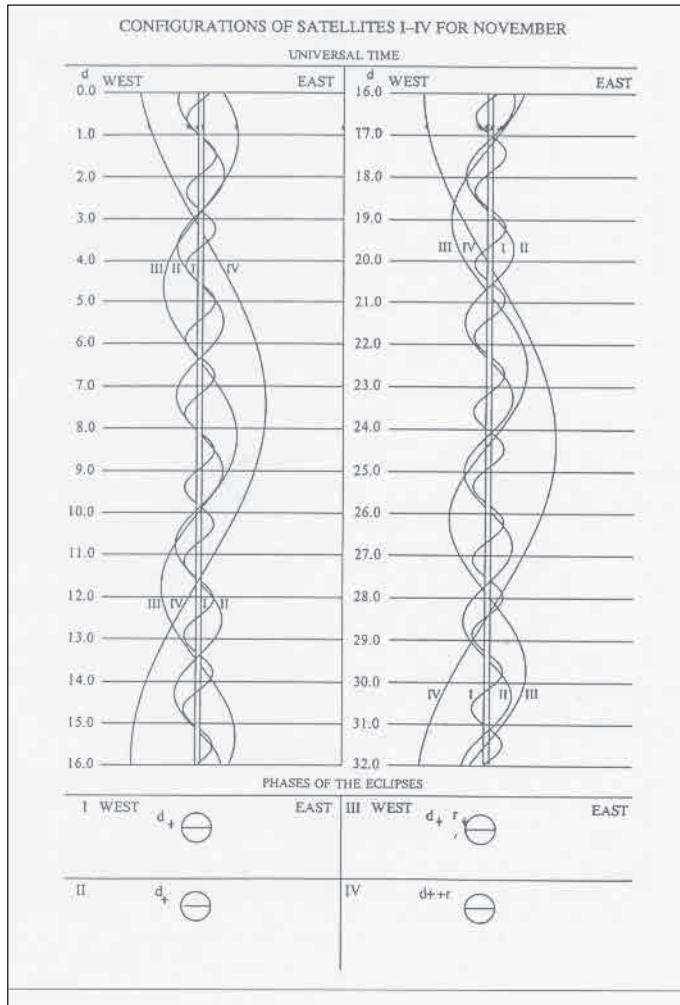
URANUS begins to lose altitude as the planet moves toward the Sun. By mid month, at the end of evening twilight, the 5.8 magnitude planet will be less than 30° above the western horizon. On the 26th at 8pm, Uranus will be 2° north of Venus low in the western evening sky. On the 27th the two planets approach within 2° of each other with the 3 day old thin crescent Moon below the pair (S° away).

NEPTUNE, 2° north of Uranus, is now at 8th magnitude; it's diameter is $2.2''$, slightly less than it's $2.3''$ opposition size. On the 26th Neptune will be $3^\circ 30'$ north of Venus, and on the 27th the separation decreases to 3° with the 3 day old Moon 6° to the south (see Uranus).

PLUTO is in conjunction with the Sun (behind the Sun) on the 15th then swings to the west of the Sun to reappear in morning twilight later in December.

NOVEMBER

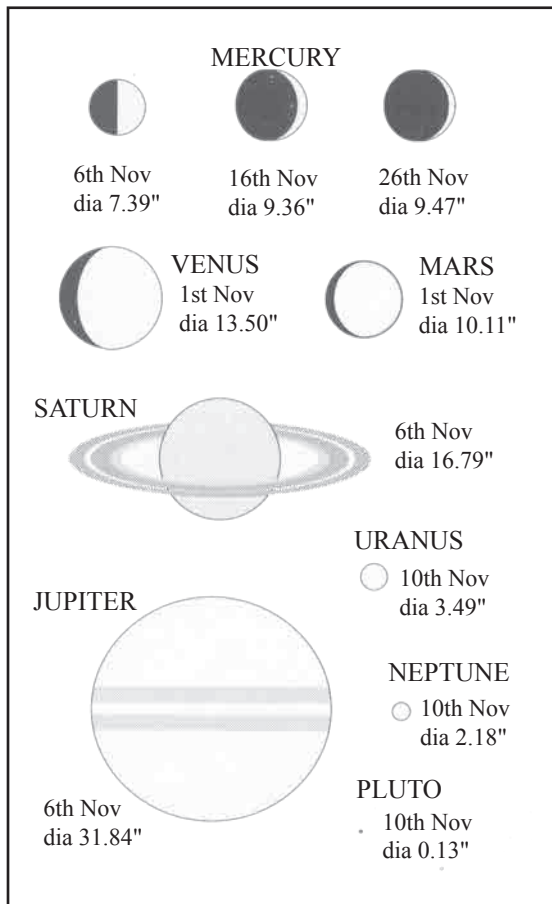
JUPITER



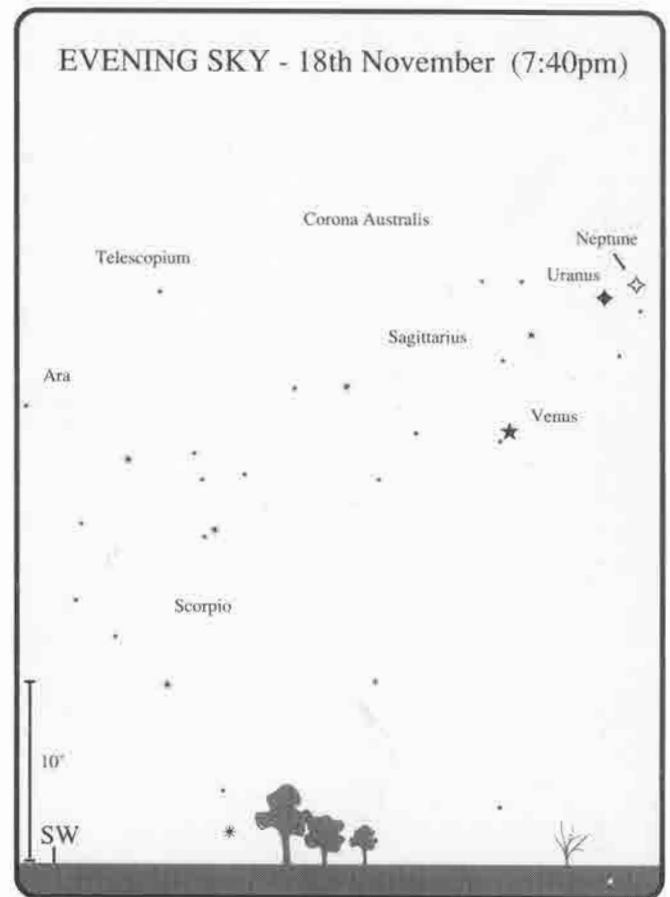
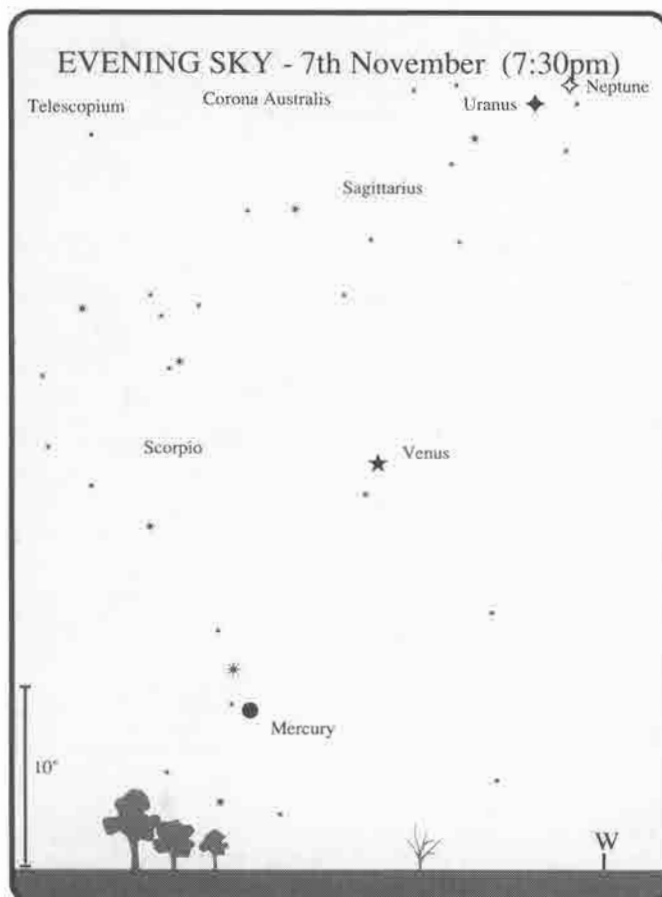
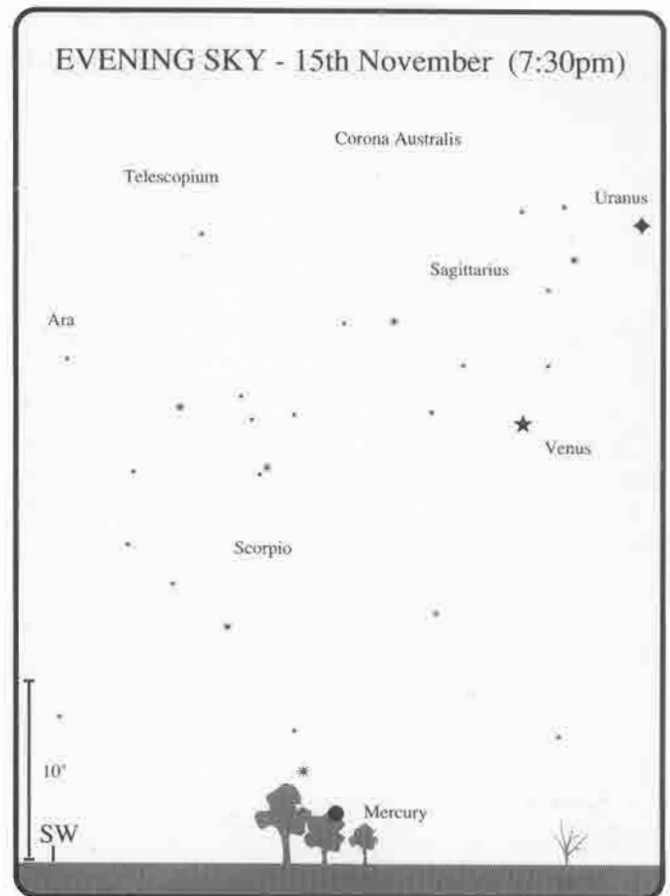
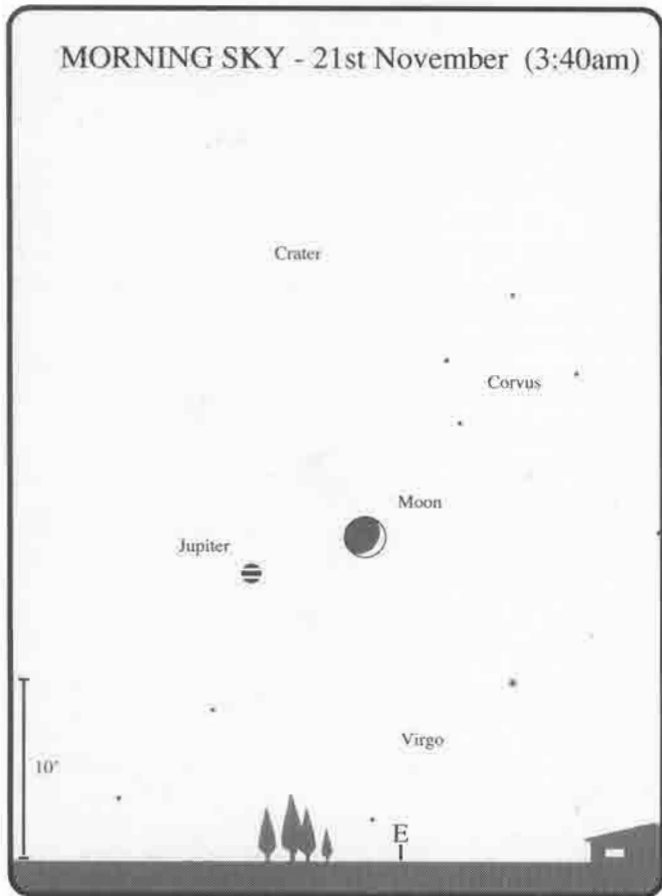
DAILY EVENTS

1 st	2 AM	Mercury at greatest elongation East (24°)
	09:12 PM	Lunar occultation of ZC 2922, disappearance.
2 nd	07:11 PM	First quarter Moon.
3 rd		Venus at aphelion.
	2 AM	Saturn 5° South of the Moon.
	03:22 AM	Jupiter's moon, Io, eclipse disappearance.
	04:15 AM	Jupiter's moon, Europa, transit begins.
	04:42 AM	Jupiter's moon, Ganymede, transit begins.
	08:54 PM	Lunar occultation of ZC 3159, disappearance.
4 th	03:34 AM	Jupiter's moon, Io, transit ends.
	9 AM	Moon at apogee.
5 th	7 AM	Mars 5° South of Pollux.
10 th	07:20 PM	Full Moon.
11 th	03:19 AM	Jupiter's moon, Io, transit begins.
	04:43 AM	Jupiter's moon, Io, shadow transit ends.
12 th	12 AM	Mercury stationary
	04:22 AM	Jupiter's moon, Europa, occultation reappearance.
13 th	01:18 AM	Lunar occultation of 103 Tau, reappearance.
	11:12 PM	Lunar occultation of 1 Gem, reappearance.
14 th	02:27 AM	Lunar occultation of 3 Gem, reappearance.
15 th	02:54 AM	Lunar occultation of 120B Gem, reappearance.
	10 AM	Pluto in conjunction.
	10 PM	Mars 5° North of the Moon.
17 th		Juno stationary.
	09:39 PM	Last quarter Moon.
18 th	02:53 AM	Lunar occultation of 89B Leo, reappearance.
	04:23 AM	Jupiter's moon, Io, shadow transit begins.
19 th	02:39 AM	Jupiter's moon, Europa, eclipse disappearance.
	04:45 AM	Jupiter's moon, Io, occultation reappearance.
	10 AM	Moon at perigee.
20 th		Mercury at ascending node.
21 st	2 AM	Jupiter 7° North of the Moon.
	02:54 AM	Jupiter's moon, Ganymede, eclipse reappearance.
	03:42 AM	Jupiter's moon, Ganymede, occultation disappearance.
22 nd	8 AM	Mercury in inferior conjunction.
24 th		Mercury at perihelion.
	07:11 PM	New Moon.
25 th		Venus at greatest latitude South.
26 th	03:29 AM	Jupiter's moon, Io, eclipse disappearance.
	10 PM	Venus 1° 9' South of Uranus.
27 th	02:59 AM	Jupiter's moon, Io, shadow transit ends.
	03:59 AM	Jupiter's moon, Io, transit ends.
	08:32 PM	Lunar occultation of 29 Sgr, disappearance.
	11 PM	Venus 3° South of Neptune.
28 th	02:19 AM	Jupiter's moon, Europa, shadow transit ends.
	03:45 AM	Jupiter's moon, Ganymede, eclipse disappearance.
	4 AM	Uranus 3° South of the Moon.
	04:18 AM	Jupiter's moon, Europa, transit ends.
	7 AM	Neptune 1° 6' South of the Moon.
	7 AM	Venus 5° South of the Moon.
30 th	2 AM	Mars stationary.
	1 PM	Saturn 5° South of the Moon.

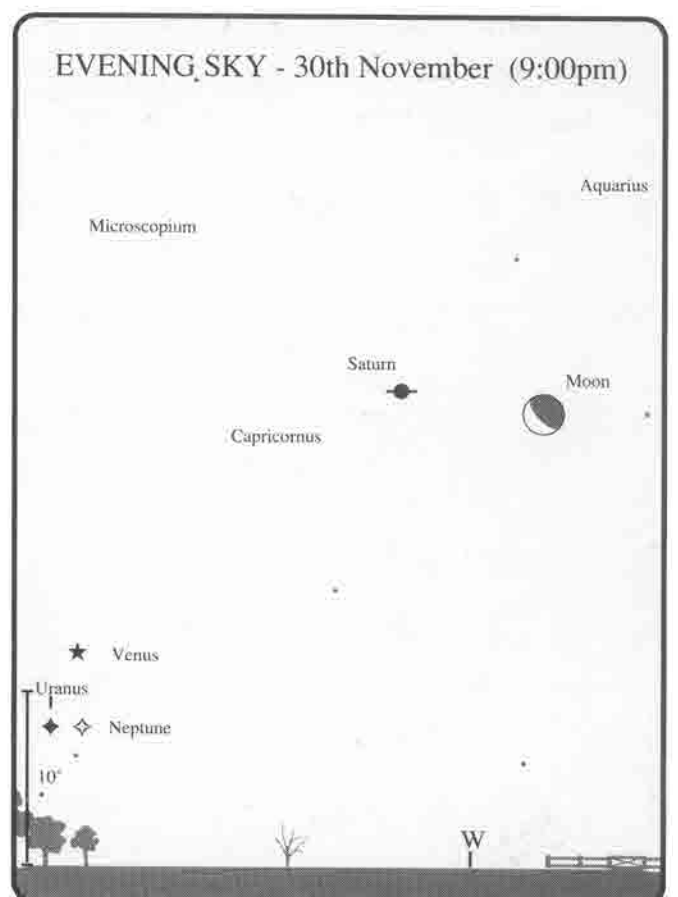
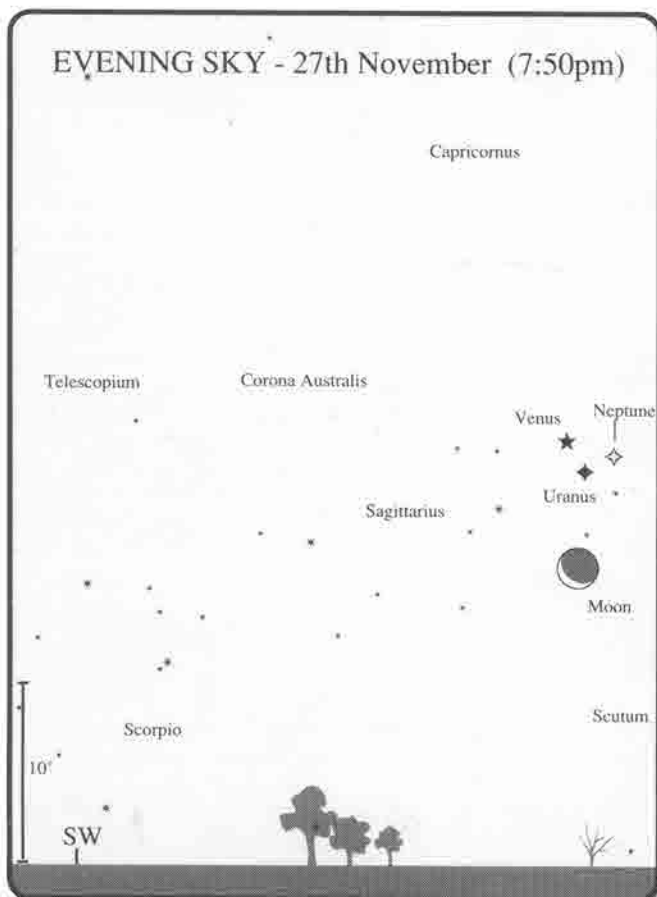
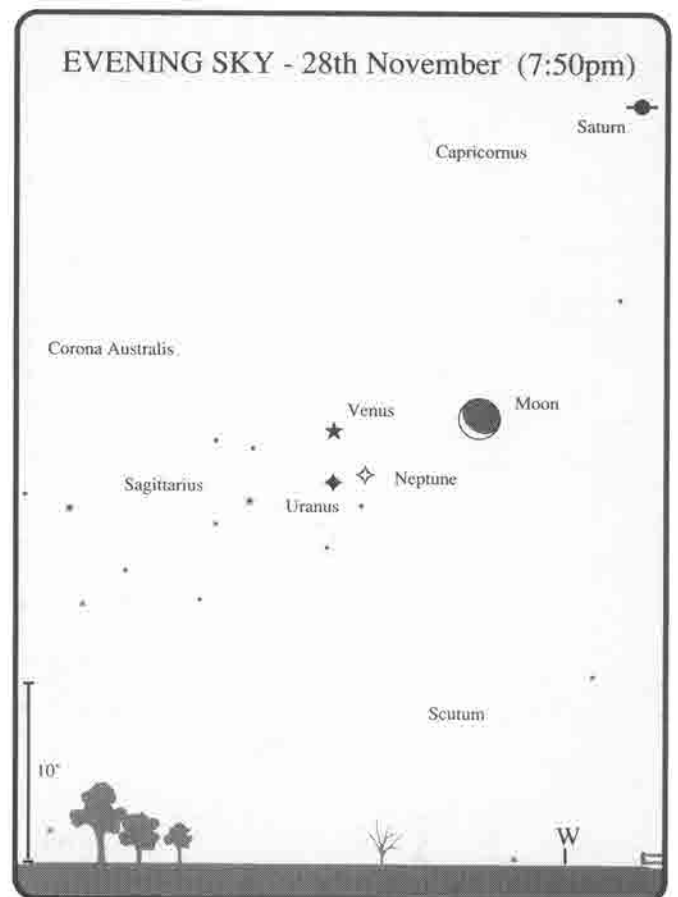
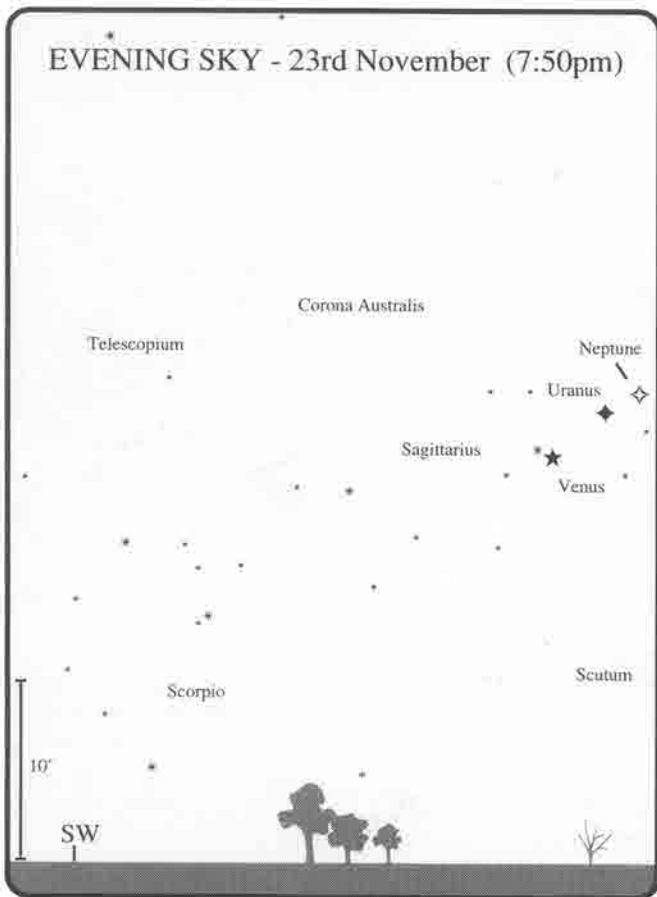
APPEARANCE OF THE PLANETS



NOVEMBER

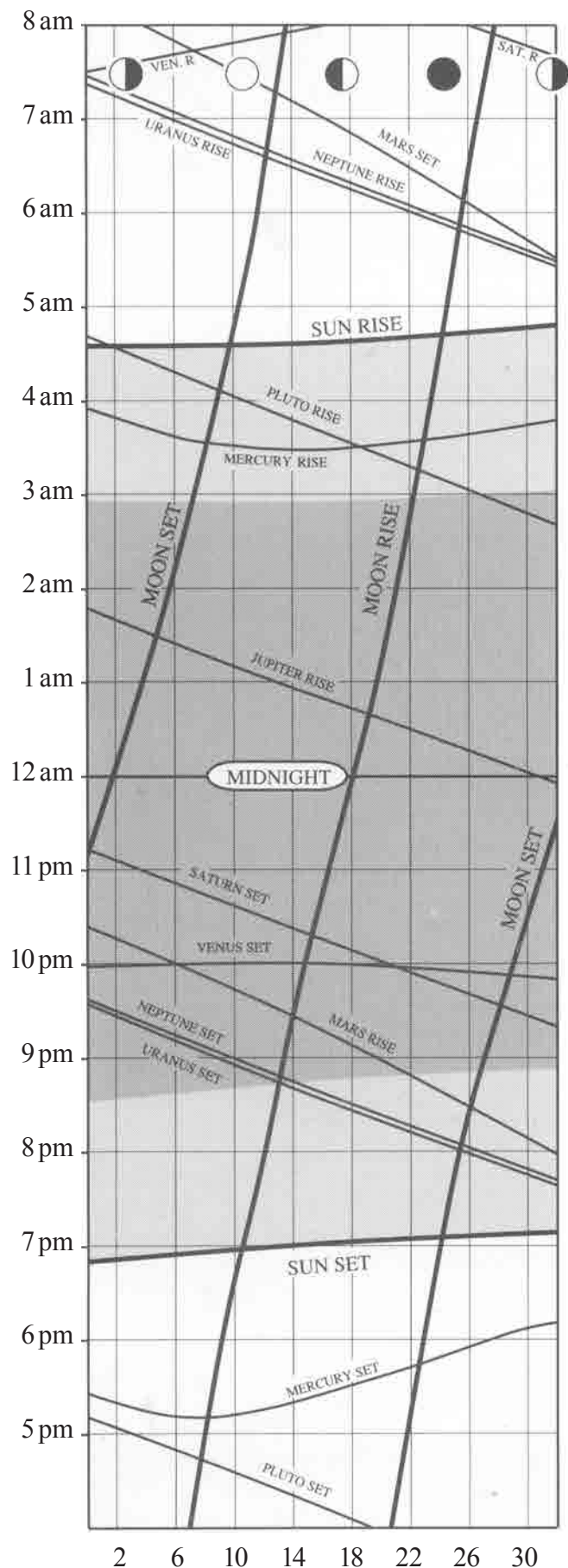


NOVEMBER



DECEMBER

RISE/SET CHART



THE MOON

- 2nd First Quarter, 4:17pm.
Moon at apogee.
- 10th Full Moon, 9:41 am.
Total eclipse of the Moon, 10:00am, only visible from the northern hemisphere.
- 14th Moon at perigee.
- 17th Last Quarter, 5:13 am.
- 24th New Moon, 10:43 am (Lunation number 866).
- 24th Partial eclipse of the Sun, 11:00am, not visible from Australian latitudes.
- 30th Moon at apogee.

THE PLANETS

MERCURY rises mid month about 30 minutes before the Sun in the early morning twilight, too close for observation and best left until it's greatest eastern and western elongations next year.

VENUS reaches it's brightest magnitude (-4.3) for the year at the end of December making it a splendid sight in the western evening sky. As Saturn sets earlier each night it gradually approaches Venus. On the 21st the two planets will be $1^{\circ}10'$ apart (see sky view diagram). Again this month (as in November) the planet will be seen near the thin crescent Moon on two occasions. On the 27th Venus will be 10° above a three day old Moon and on the 28th, 8° south of the four day old Moon (see sky view diagram).

MARS provides it's best show this year as it nears opposition in January 1993 (see page 73 for full details). From the beginning to the end of the month the observer will see an increase in brightness from -0.8 to -1.4, and a disc growing from $12.8''$ to $14.9''$. With a disc size smaller than Saturn the opposition is not a favourable one, but nonetheless worthy of telescope time. The planet rises during evening twilight near the end of the month and reaches it's highest altitude (30°) when it transits the meridian at 1:30am. Mars remains close to the 1st magnitude star Pollux for the entire month, coming within 3° on the 23rd. On the 13th Mars appears 5° below the 18 day old Moon in the early morning sky.

JUPITER, at -2.0 magnitude, rises mid month around 1 am. It's disc, which has been steadily increasing in size since September, is now $36''$ in diameter (opposition occurs on 31st March 1993). By the end of December, Jupiter will reach an altitude of 37° above the eastern horizon by the beginning of morning twilight. For the best views observers should wait a month or so, when the planet will be more favourably situated. On the 18th, Jupiter will be 7° below the 23 day old Moon.

SATURN, moving towards conjunction early next year, sets just after 10pm mid month. It will be seen low (21°) in the western evening sky after the end of twilight. Throughout the month Venus rises up to meet Saturn and on the 21st the two planets will be only $1^{\circ}10'$ apart. On the 27th the 3 day old Moon will be 6° below Saturn with Venus 6° to the north.

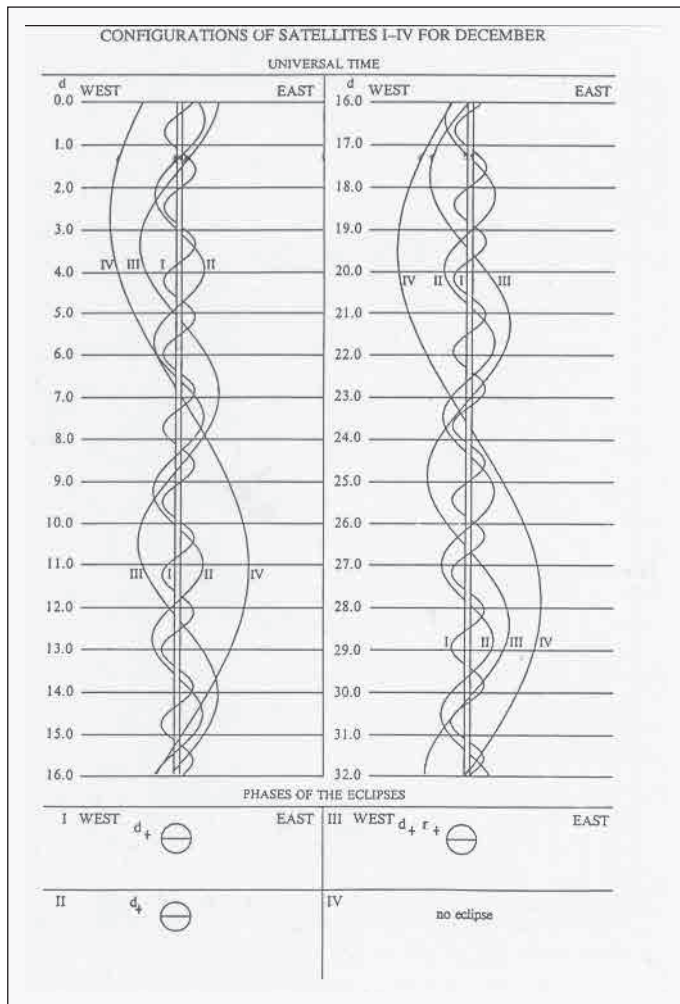
URANUS by mid month will be lost in the evening twilight as it heads towards conjunction in January 1993.

NEPTUNE follows the fate of Uranus, and will not be visible until it returns to the morning sky in 1993.

PLUTO rises in the early morning twilight and will not be observable until January/February 1993.

DECEMBER

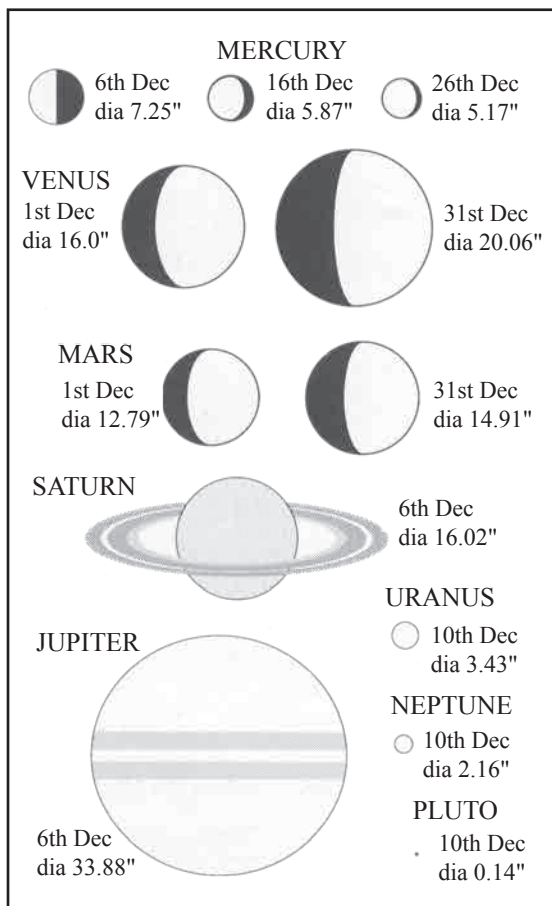
JUPITER



DAILY EVENTS

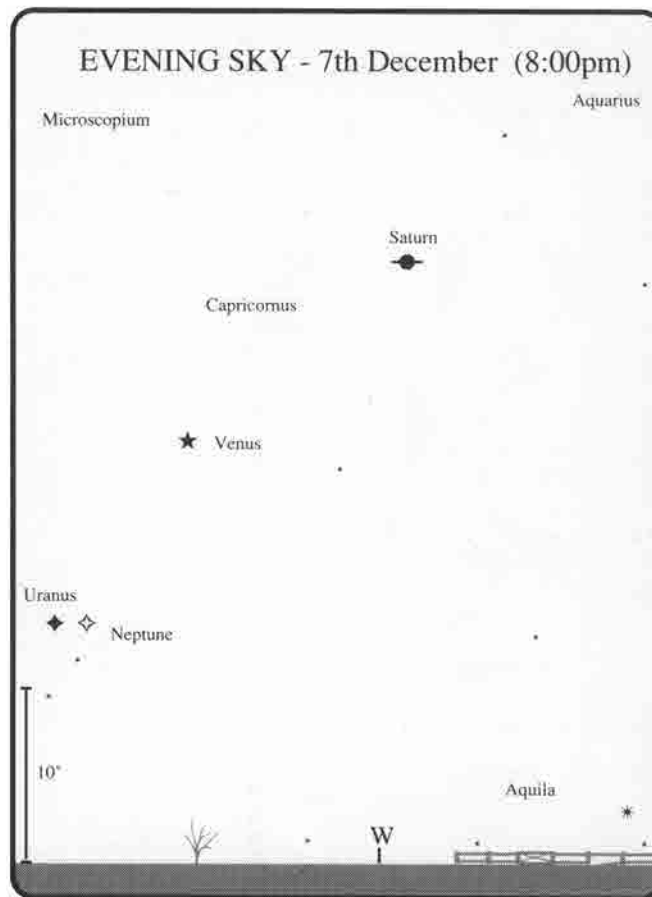
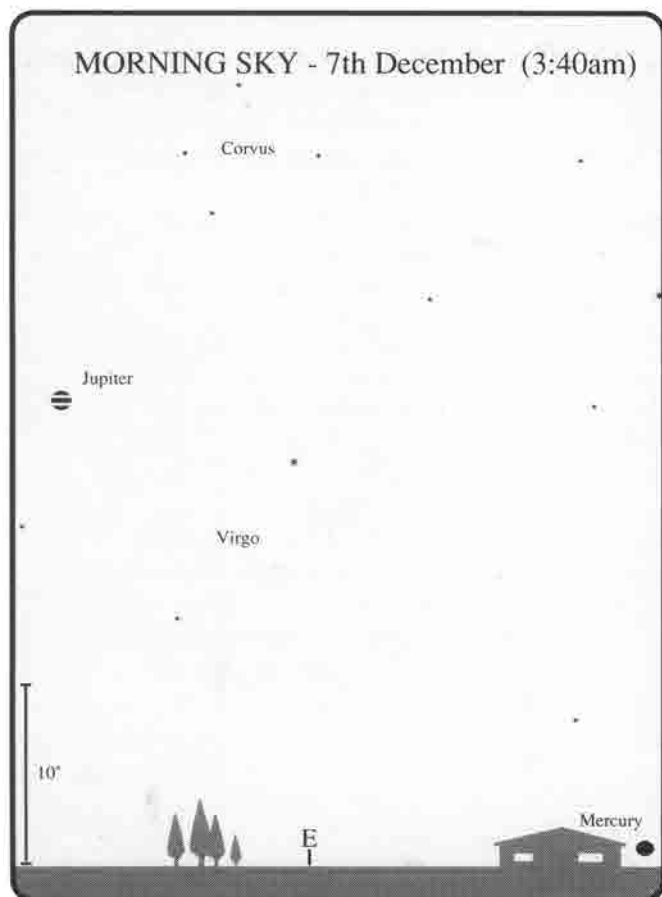
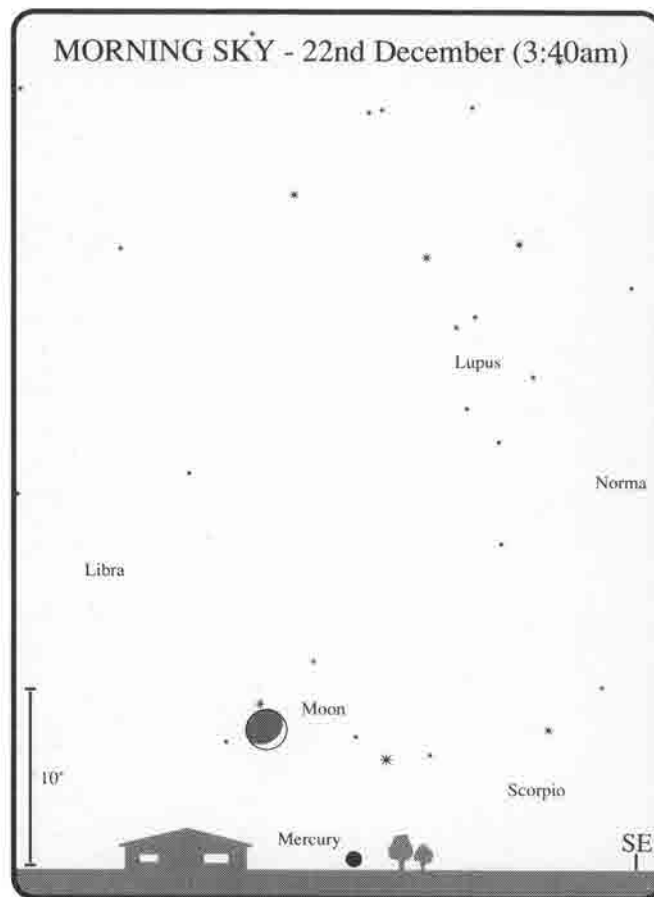
1 st	4 PM	Mercury stationary.
2nd	6 AM	Moon at apogee.
	04:17 PM	First quarter Moon.
3rd	10:20 PM	Lunar occultation of ZC 3471, disappearance.
4th		Mercury at greatest latitude North.
		Vesta in conjunction.
	02:39 AM	Jupiter's moon, Io, shadow transit begins.
	03:44 AM	Jupiter's moon, Io, transit begins.
	09:31 PM	Lunar occultation of 36 Psc, disappearance.
5th	02:19 AM	Jupiter's moon, Europa, shadow transit begins.
	03:08 AM	Jupiter's moon, Io, occultation reappearance.
	04:29 AM	Jupiter's moon, Europa, transit begins.
	11:40 PM	Lunar occultation of 75 Psc, disappearance.
7th	01:57 AM	Jupiter's moon, Europa, occultation reappearance.
	07:38 PM	Lunar occultation of 34 u Ari, disappearance.
9th	02:14 AM	Jupiter's moon, Ganymede, transit begins.
10th	12 AM	Mercury at greatest elongation West (21°)
	09:41 AM	Full Moon.
12th	01:43 AM	Jupiter's moon, Io, eclipse disappearance.
	03:36 AM	Lunar occultation of 36 Gem, reappearance.
13th	01:14 AM	Jupiter's moon, Io, shadow transit ends.
	02:22 AM	Jupiter's moon, Io, transit ends.
	5 AM	Mars 6° North of the Moon.
14th	7 AM	Moon at perigee.
15th	12:57 AM	Lunar occultation of o Leo, reappearance.
16th	01:34 AM	Jupiter's moon, Ganymede, shadow transit begins.
	04:36 AM	Jupiter's moon, Ganymede, shadow transit ends.
17th	01:24 AM	Lunar occultation of 388B Leo, reappearance.
	05:13 AM	Last quarter Moon.
18th	3 PM	Jupiter 7° North of the Moon.
19th	03:36 AM	Jupiter's moon, Io, eclipse disappearance.
	1 PM	Mercury 6° North of Antares.
20th	12:55 AM	Jupiter's moon, Io, shadow transit begins.
	02:06 AM	Jupiter's moon, Io, transit begins.
	3 AM	Moon at apogee.
	03:05 AM	Lunar occultation of 40H Vir, reappearance.
	03:08 AM	Jupiter's moon, Io, shadow transit ends.
	04:18 AM	Jupiter's moon, Io, transit ends.
21 st	01:28 AM	Jupiter's moon, Io, occultation reappearance.
	02:19 AM	Jupiter's moon, Europa, eclipse disappearance.
22nd	00:43 AM	Solar solstice.

APPEARANCE OF THE PLANETS

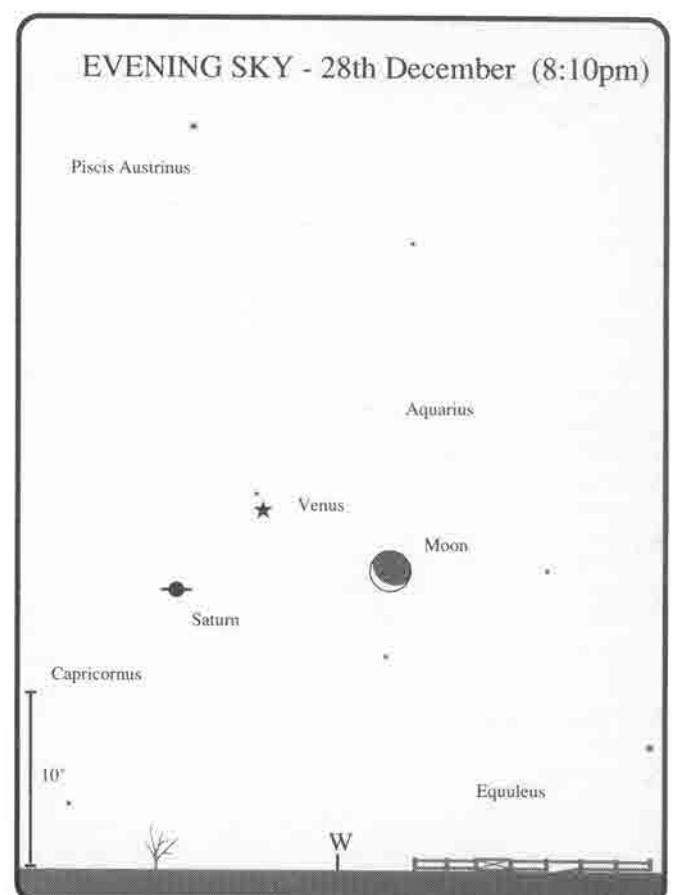
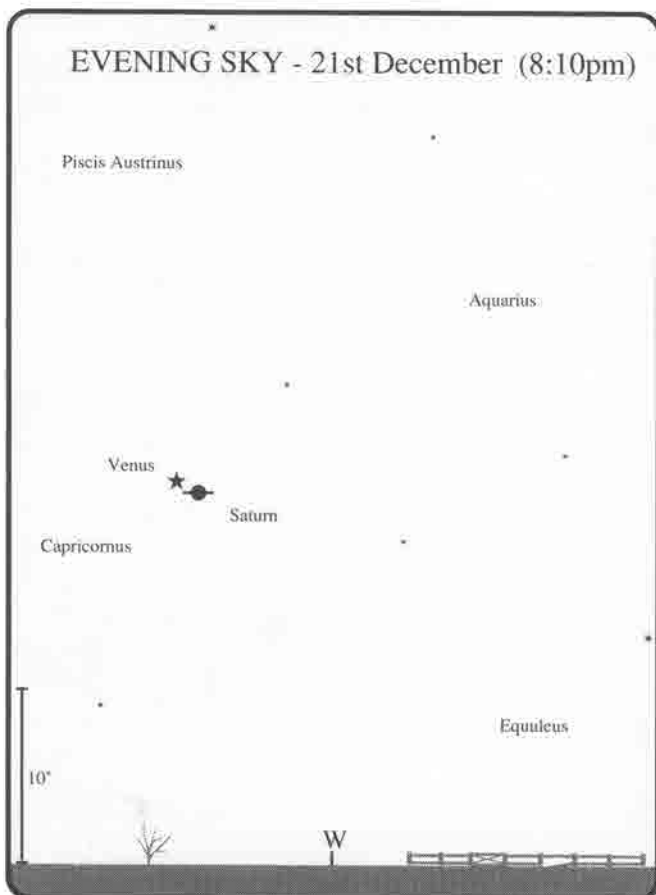
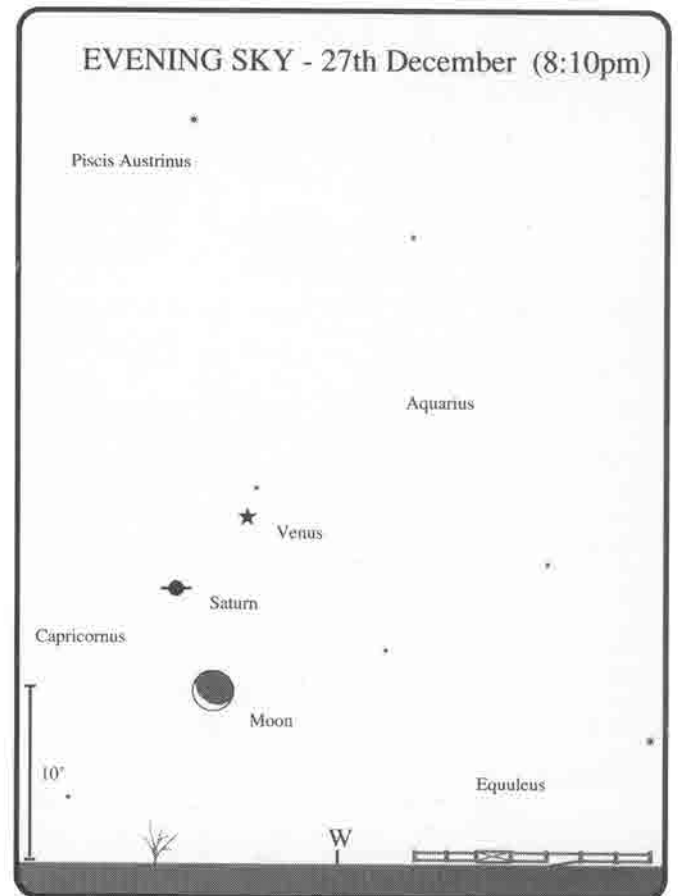
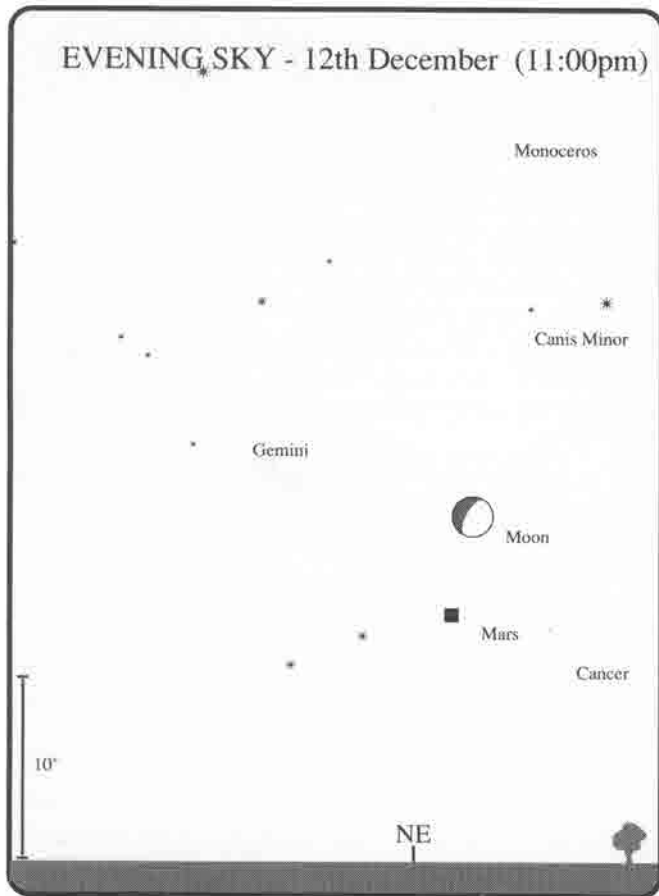


DECEMBER

22nd	2 AM	Venus 1°.1 South of Saturn.
23rd	12 AM	Mercury 1°.5 North of the Moon.
	01:33 AM	Jupiter's moon, Europa, transit ends.
	7 AM	Mars 3° South of Pollux
24th	10:43 AM	New Moon.
27th	12:38 AM	Jupiter's moon, Ganymede, occultation disappearance.
	02:48 AM	Jupiter's moon, Io, shadow transit begins.
	03:25 AM	Jupiter's moon, Ganymede, occultation reappearance.
	04:01 AM	Jupiter's moon, Io, transit begins.
28th		Mercury at descending node.
		Juno at opposition.
	3 AM.	Saturn 6° South of the Moon.
	03:23 AM	Jupiter's moon, Io, occultation reappearance.
	5 PM	Venus 7° South of the Moon.
29th	12:41 AM	Jupiter's moon, Io, transit ends.
	08:46 PM	Lunar occultation of 187B Aqr, disappearance.
30th	01:42 AM	Jupiter's moon, Europa, transit begins.
	01:46 AM	Jupiter's moon, Europa, shadow transit ends.
	3 AM	Moon at apogee
	04:08 AM	Jupiter's moon, Europa, transit ends.



DECEMBER



PART 2

THE SOLAR SYSTEM

EXPLANATION

General Comments

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. 73, 75 & 81) 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.

MARS (p. 73)

The determination of Central Meridian, when you make an observation (sketch?) of the disc features, is important in monitoring the planet. 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 it's latitude; hence the multiple systems used (see p. 75). 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 (see p. 81). The appearance of the planets diagrams in part 1, show how "open" (or face-on) the rings are for 1992. 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. 81 presents the semi-major and semi-minor axes (in arc seconds). The following factors can be applied (multiplied) to this data to derive the following:

Ring A : Inner edge of outer ring = 0.8801

Ring B : Outer edge of inner ring = 0.8599

Ring C: Inner edge of inner ring = 0.6650

Ring D : Inner edge of dusky ring = 0.5486

On this same table (p. 81), "U" and "B" equal the Geocentric longitude and the tilt of the rings respectively.

The Satellites (pp. 82, 83). To estimate the configuration or positions of the satellites, the "Apparent Orbits" diagram (p. 82) and the times of "Greatest Eastern Elongation" (pp. 82, 83) 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. 82) and that gives the moon's position directly.

SATELLITES OF URANUS (see p. 84)

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 86% that of the apparent major axis (north/south). For example, Oberon, at opposition, has a maximum elongation of 44" (see p. 59). It's minimum elongation would be 86% of this or 38". 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. 84)

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 1992, Triton's apparent orbit as seen from Earth is a pronounced ellipse (not as circular as Uranus' satellites) with the minor axis being 72% of the major axis. Therefore Triton, at opposition, varies from 17" (see p. 59) down to 12". 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. 86)

The finder chart shows stars down to magnitude 14. 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. 88, 89)

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 4200 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, presented on pages 88 and 89, are positions for 19 of the minor planets, returning to opposition during 1992, that are expected to reach magnitude 10 or brighter. Some dates do not have magnitude estimates. The reason for this relates to the mathematics used to calculate the brightness. Although the equations used, predict quite accurately the expected magnitudes near opposition, they become unreliable at phase angles greater than 120° . The “phase” is the Sun - minor planet - Earth angle ie when the asteroid is at opposition this angle is at it's minimum.

ECLIPSES

During 1992 there will be five eclipses, three of the Sun and two of the Moon as listed below. Unfortunately, all except for one are not visible from Australia.

- | | |
|-----------------|--|
| 1 January 5th | Annular eclipse of the Sun, visible only from the central Pacific Ocean. |
| 2 June 15th | Partial eclipse of the Moon*. |
| 3 June 30th | Total eclipse of the Sun, visible only from the south Atlantic Ocean. |
| 4 December 10th | Total eclipse of the Moon, visible mainly from northern hemisphere. |
| 5 December 24th | Partial eclipse of the Sun, visible only from the Arctic. |

*Only the very last part of the partial lunar eclipse of June 15th can be seen from Australia. Mid eclipse happens at 2.57pm when the Moon is 19° below the southeastern horizon. The Moon leaves the umbral shadow before rising at 4.51pm. It finally leaves the penumbra at 5.45pm, about three quarters of an hour prior to the end of astronomical twilight, at an altitude of 8° .

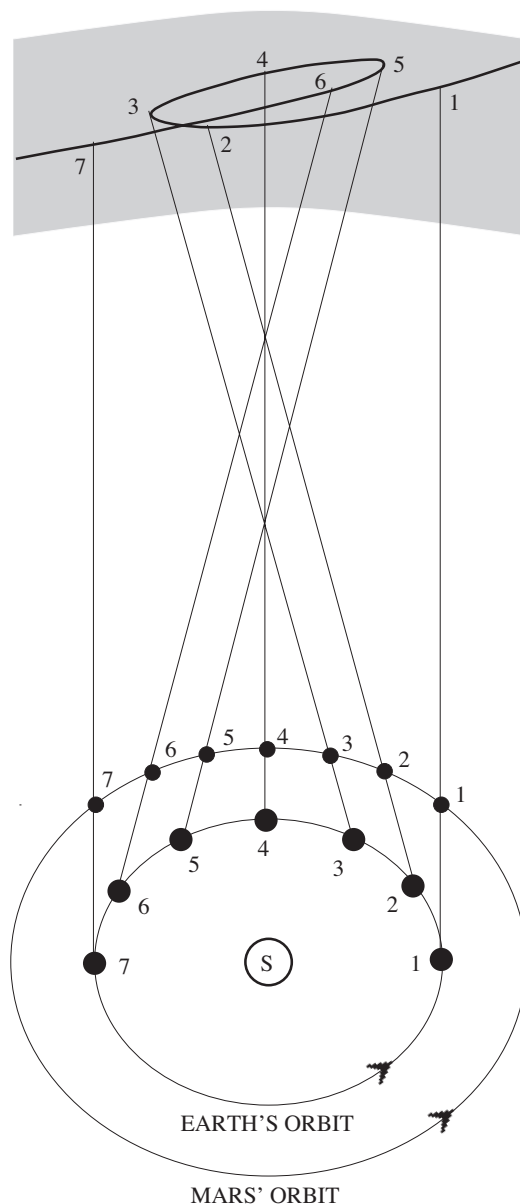
RETROGRADE MOTION

The diagram below illustrates the combined effects of the orbital motions of Earth and Mars and explains the loop shown in the Mars finder chart on page 72. In the diagram 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 a 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 it's 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 it's 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:

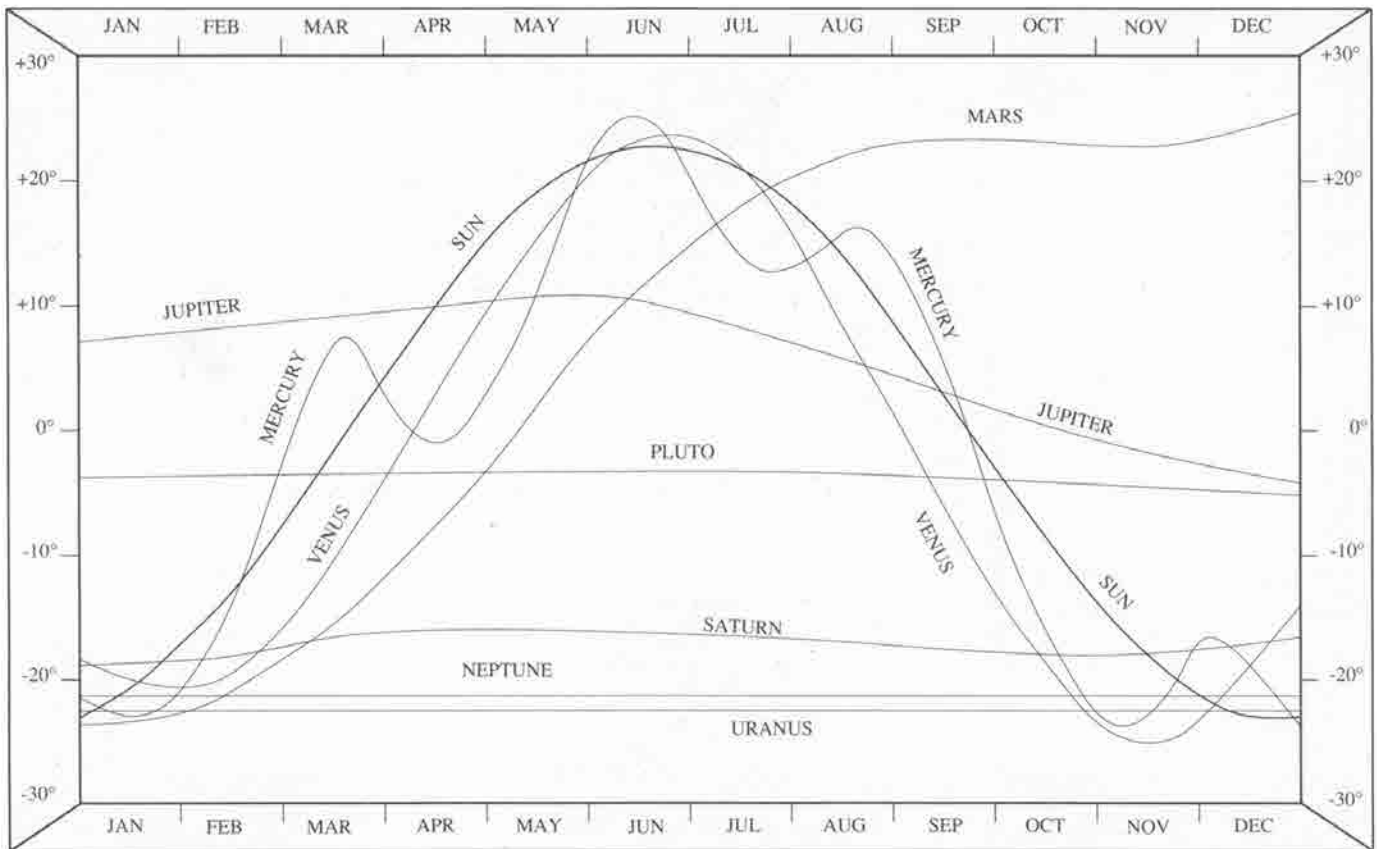
- The ratio of the difference of the equatorial and polar radii to the equatorial radius.
- The planet's year.
- The period of the planet's orbit with respect to the Earth.
- The planet's day. A negative sign indicates the rotation is retrograde with respect to the North pole.
- The ratio of the sunlight reflected to that received.
- The measure of how long or thin the ellipse of the planet's orbit is.
- The angle of the planet's orbit from the plane of the ecliptic.
- The degree of inclination of the planet's equator to its orbit
- The equatorial region (the polar areas of the Sun rotate in a period of 29 to 30 days).
- To the ecliptic.
- From the Earth.
- At mean greatest elongation.
- As seen from the Sun.
- 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

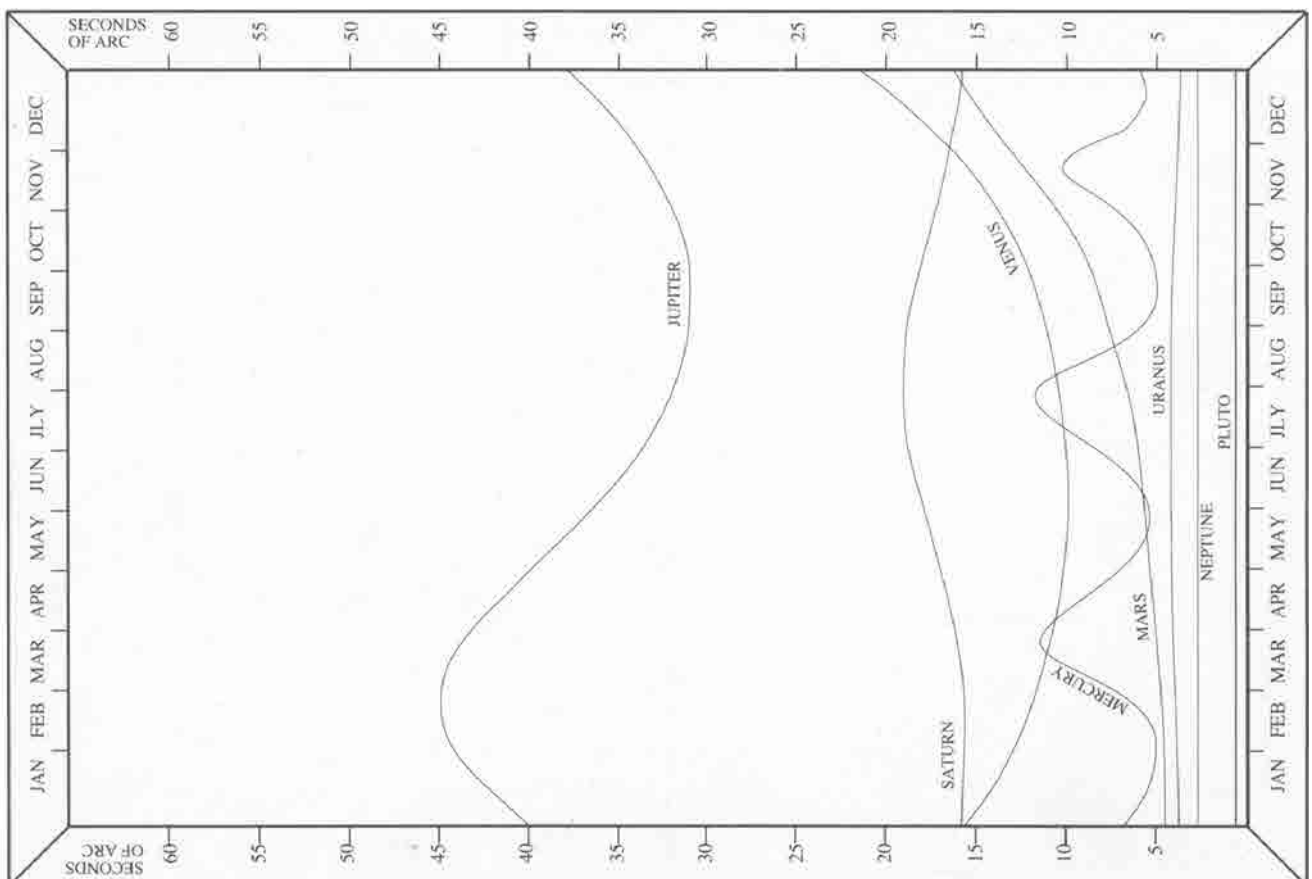
PLANET	SATELLITE	ORBITAL ¹ PERIOD (days) (R=retrograde)	MAX. ELONG AT MEAN OPPOSITION	SEMIMAJOR AXIS (x10 ³ km)	ORBITAL ECCENTRICITY	INCLINATION TO PLANET'S EQUATOR (°)	MASS (1/PLANET)	RADIUS (km)	SIDEREAL PERIOD OF ROTATION (days) ⁴	MAGNITUDE AT OPPOSITION
Earth										
Moon		27.321661		384.400	0.054900489	18.28-28.58	0.01230002	1737.4	S	-12.74
Mars										
Phobos	I	0.31891023	25"	9.378	0.015	1.0	1.65x10 ⁻⁸	13.4x11.2x9.2	S	11.3
Deimos	II	1.2624407	1' 02"	23.459	0.0005	0.9-2.7	3.71x10 ⁻⁹	7.5x6.1x5.2	S	12.40
Jupiter										
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.

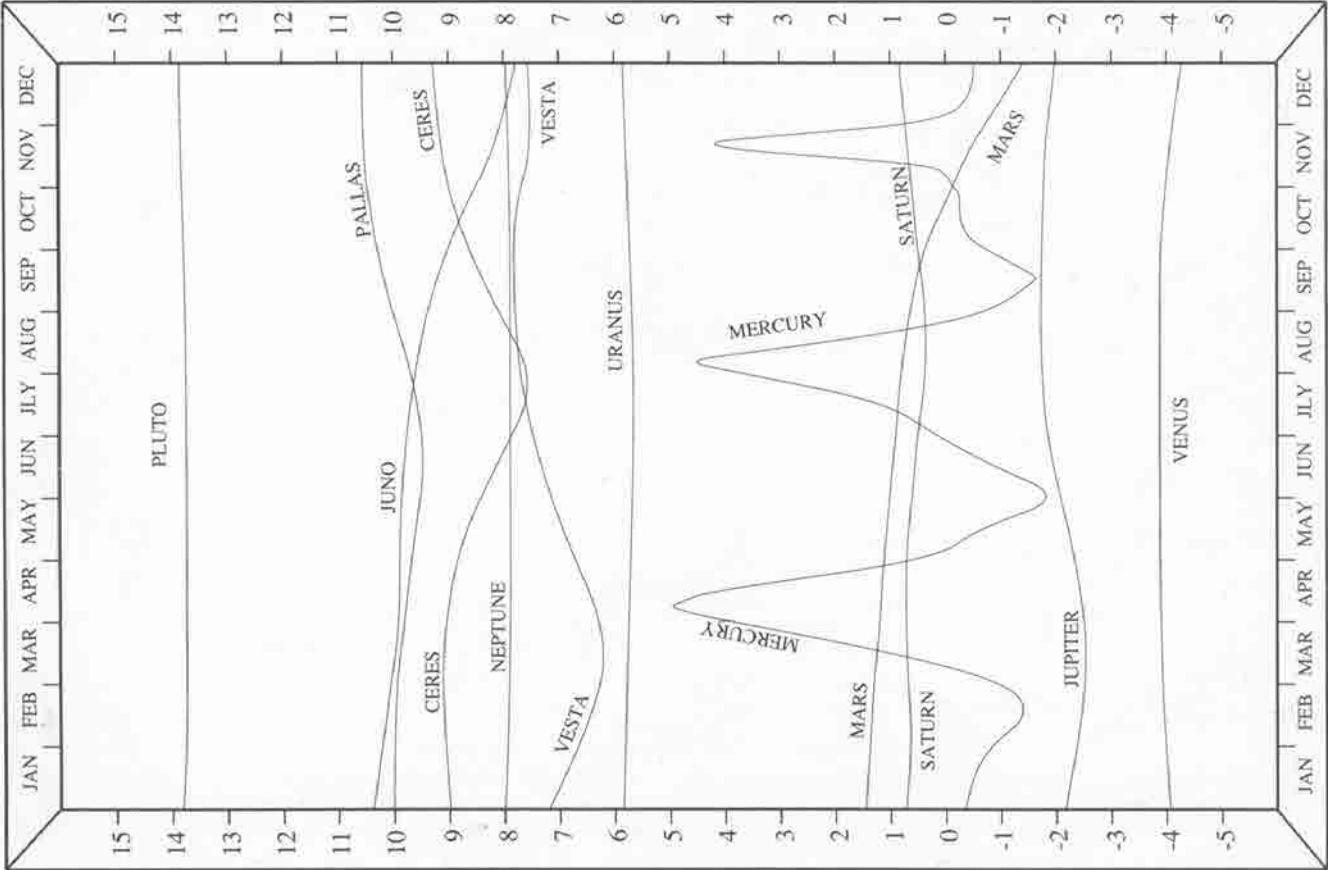
DECLINATIONS of the SUN and PLANETS



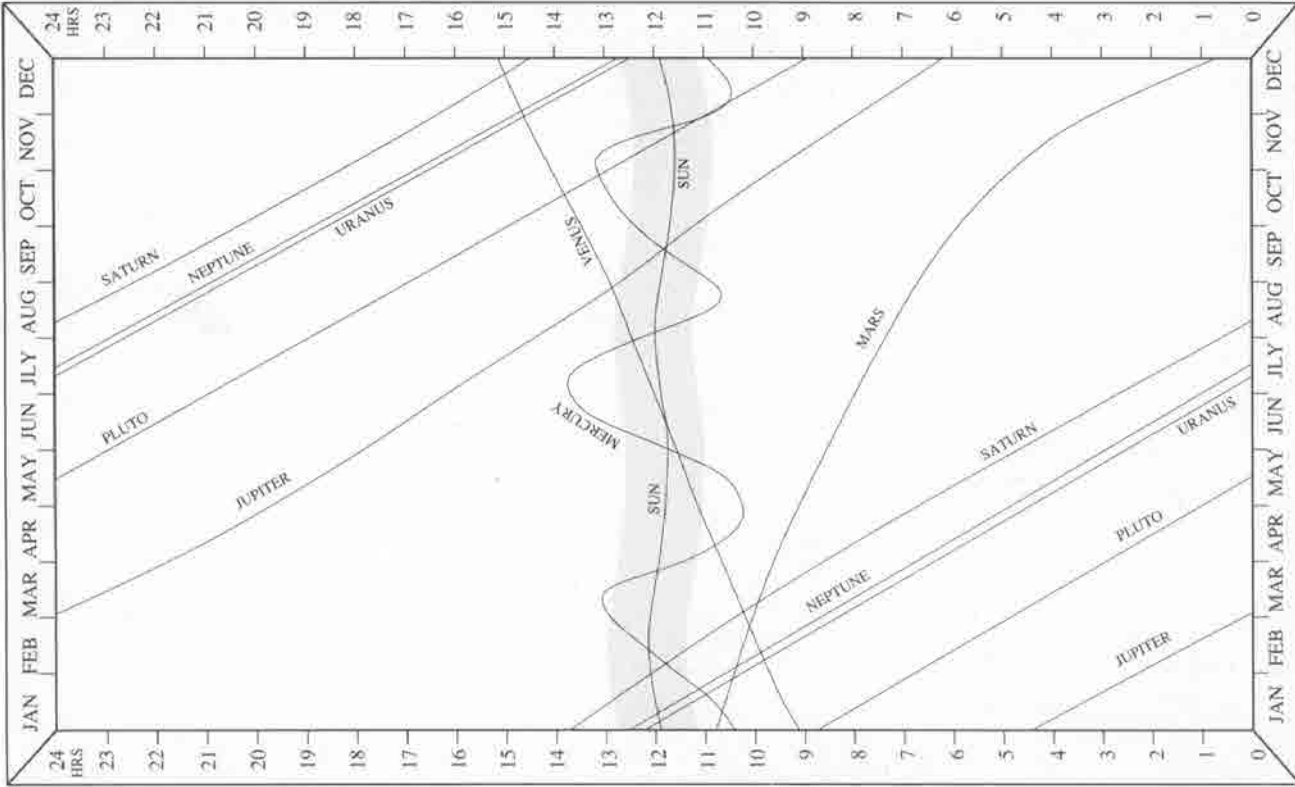
PLANETARY ANGULAR SIZE



MAGNITUDES of the PLANETS and MAJOR ASTEROIDS



MERIDIAN PASSAGE of the SUN and PLANETS



GEOCENTRIC POSITION OF THE SUN (0hr UT, Epoch 2000.0)

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

SUN

RISE/SET AND ORIENTATION

RISE/SET (EAST)

ORIENTATION

PHYSICAL EPHEMERIS DATA

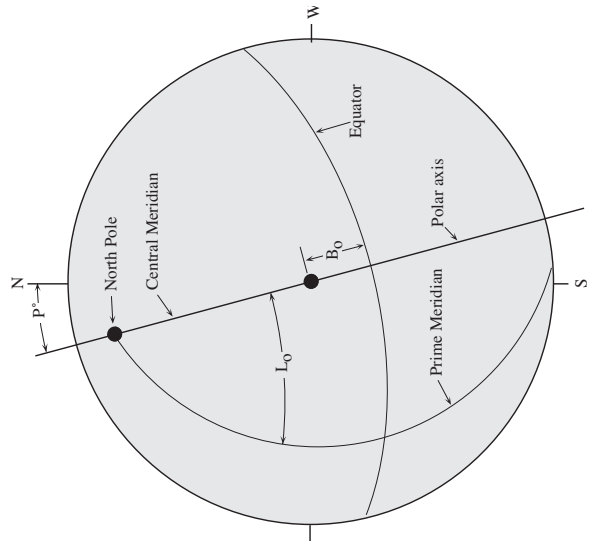
At the date of commencement of each synodic rotation period the value of L_0 is zero; that is, the prime meridian passes through the central point of the disk.

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

Bo° Heliocentric Latitude of
centre of Sun

Lo° 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.



SYNODIC ROTATION NUMBERS (UT)	d.dd		
	1851	Jan.	5.17
1852	Feb.	1.51	
1853	Feb.	28.85	
1854	Mar.	27.1	
1855	Apr.	23.43	
1856	May	20.67	
1857	June	16.87	
1858	July	14.07	
1859	Aug.	10.28	
1860	Sept.	6.53	
1861	Oct.	3.80	
1862	Nov.	27.40	
1863	Dec.	24.72	

DATE	SUN SET h:m	TWILIGHT ENDS h:m	TWILIGHT BEGINS h:m	SUN RISE h:m	p°	B ₀	L ₀	DATE	VARIATION OF L ₀					
									DAILY					
Jan	4 19:10 11 19:10 18 19:08 25 19:05	20:53 20:48 20:42	03:06 03:13 03:22 03:31	04:49 04:55 05:01 05:08	+ 0.94 - 2.44 - 5.74 - 8.90	- 3.31 - 4.08 - 4.79 - 5.43	015.38 283.19 191.02 098.85	Jan	4 11 283.19 18 39.55 25 52.73 65.91 79.10					
Feb	1 19:01 8 18:55 15 18:49 22 18:41 29 18:33	20:36 20:28 20:19 20:09 19:59	03:41 03:50 03:59 04:07 04:15	05:15 05:22 05:29 05:36 05:42	- 11.89 - 14.65 - 17.17 - 19.41 - 21.36	- 5.99 - 6.45 - 6.81 - 7.06 - 7.21	006.68 274.52 182.35 090.17 357.97	Feb	1 8 274.52 15 182.35 22 090.17 29 357.97					
Mar	7 18:24 14 18:15 21 18:05 28 17:56	19:49 19:39 19:28 19:19	04:23 04:29 04:35 04:41	05:48 05:53 05:59 06:04	- 23.00 - 24.33 - 25.32 - 25.98	- 7.25 - 7.18 - 7.00 - 6.73	265.76 173.51 081.24 348.93	Mar	7 14 173.51 21 081.24 28 348.93					
Apr	4 17:46 11 17:37 18 17:29 25 17:21	19:09 19:00 18:52 18:45	04:46 04:51 04:56 05:01	06:09 06:15 06:20 06:25	- 26.28 - 26.23 - 25.83 - 25.06	- 6.35 - 5.88 - 5.34 - 4.71	256.58 164.20 071.77 339.30	Apr	4 11 164.20 18 071.77 25 339.30					
May	2 17:13 9 17:07 16 17:02 23 16:57 30 16:55	18:38 18:33 18:28 18:25 18:23	05:05 05:10 05:14 05:18 05:22	06:30 06:36 06:41 06:46 06:50	- 23.93 - 22.46 - 20.64 - 18.51 - 16.10	- 4.03 - 3.29 - 2.51 - 1.70 - 0.86	246.80 154.27 061.69 329.09 236.47	May	2 9 154.27 16 061.69 23 329.09 30 236.47					
Jun	6 16:53 13 16:53 20 16:53 27 16:55	18:22 18:22 18:23 18:25	05:25 05:28 05:30 05:31	06:54 06:57 07:00 07:01	- 13.43 - 10.56 - 7.53 - 4.40	- 0.02 + 0.83 + 1.66 + 2.46	143.84 051.18 318.52 225.87	Jun	6 13 051.18 20 318.52 27 225.87					
Jul	4 16:58 11 17:02 18 17:06 25 17:10	18:27 18:30 18:34 18:37	05:32 05:31 05:29 05:26	07:01 06:59 06:57 06:53	- 1.23 + 1.94 + 5.05 + 8.05	+ 3.24 + 3.97 + 4.65 + 5.26	133.22 040.57 307.94 215.33	Jul	4 11 040.57 18 307.94 25 215.33					
Aug	1 17:15 8 17:20 15 17:25 22 17:30 29 17:35	18:41 18:45 18:50 18:54 18:58	05:22 05:16 05:10 05:03 04:54	06:48 06:41 06:34 06:26 06:17	+ 10.91 + 13.60 + 16.09 + 18.34 + 20.36	+ 5.81 + 6.28 + 6.66 + 6.95 + 7.15	122.74 030.17 297.63 205.11 112.63	Aug	1 8 030.17 15 297.63 22 205.11 29 112.63					
Sep	5 17:40 12 17:44 19 17:49 26 17:54	19:03 19:07 19:12 19:18	04:45 04:36 04:26 04:16	06:08 05:59 05:49 05:39	+ 22.11 + 23.57 + 24.74 + 25.60	+ 7.24 + 7.24 + 7.13 + 6.92	020.17 287.73 195.31 102.92	Sep	5 12 287.73 19 195.31 26 102.92					
Oct	3 17:59 10 18:04 17 18:10 24 18:16 31 18:22	19:24 19:30 19:37 19:45 19:53	04:05 03:55 03:44 03:34 03:25	05:30 05:20 05:11 05:03 04:56	+ 26.12 + 26.30 + 26.13 + 25.58 + 24.64	+ 6.60 + 6.19 + 5.69 + 5.11 + 4.44	010.55 278.20 185.85 093.53 001.22	Oct	3 10 278.20 17 185.85 24 093.53 31 001.22					
Nov	7 18:29 14 18:35 21 18:42 28 18:49	20:02 20:11 20:20 20:29	03:16 03:08 03:02 02:57	04:49 04:44 04:40 04:38	+ 23.33 + 21.63 + 19.56 + 17.15	+ 3.71 + 2.92 + 2.08 + 1.21	268.92 176.63 084.36 352.10	Nov	7 14 176.63 21 084.36 28 352.10					
Dec	5 18:55 12 19:00 19 19:04 26 19:08	20:37 20:44 20:52 20:52	02:55 02:54 02:55 02:59	04:37 04:37 04:40 04:43	+ 14.42 + 11.44 + 8.26 + 4.93	+ 0.32 - 0.57 - 1.46 - 2.33	259.85 167.61 075.39 343.18	Dec	5 12 167.61 19 075.39 26 343.18					

GEOCENTRIC POSITION OF THE MOON (0hr UT, Epoch 2000.0)

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

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

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

MOON PHASES

Lunation	New Moon	First Quarter	Full Moon	Last Quarter
854	Jan 5 09 10	Jan 13 12 32	Jan 20 07 28	Jan 27 01 27
855	Feb 4 05 10	Feb 12 02 15	Feb 18 18 04	Feb 25 17 56
856	Mar 4 23 22	Mar 12 12 36	Mar 19 04 18	Mar 26 12 30
857	Apr 3 15 01	Apr 10 20 06	Apr 17 14 42	Apr 25 07 40
858	May 3 03 44	May 10 01 44	May 17 02 03	May 25 01 53
859	Jun 1 13 57	Jun 8 06 47	Jun 15 14 50	Jun 23 18 11
860	Jun 30 22 18	Jul 7 12 43	Jul 15 05 06	Jul 23 08 12
861	Jul 30 05 35	Aug 5 20 59	Aug 13 20 27	Aug 21 20 01
862	Aug 28 12 42	Sep 4 08 39	Sep 12 12 17	Sep 20 05 53
863	Sep 26 20 40	Oct 4 00 12	Oct 12 04 03	Oct 19 14 12
864	Oct 26 06 34	Nov 2 19 11	Nov 10 19 20	Nov 17 21 39
865	Nov 24 19 11	Dec 2 16 17	Dec 10 09 41	Dec 17 05 13
866	Dec 24 10 43	—	—	—

PERIGEE		APOGEE	
d	h	d	h
Jan	20 08	Jan	6 22
Feb	17 21	Feb	2 22
Mar	17 04	Mar	1 07
Apr	13 17	Mar	29 00
May	8 22	Apr	25 20
Jun	4 12	May	23 15
Jul	2 11	Jun	20 08
Jul	30 18	Jul	17 21
Aug	28 04	Aug	14 02
Sep	25 13	Sep	10 05
Oct	23 15	Oct	7 16
Nov	19 10	Nov	4 09
Dec	14 07	Dec	2 06
—	—	Dec	30 03
—	—	Dec	31 09

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.

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 1992. 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.

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 79).

LUNAR OCCULTATION TABLES

- **DATE** - hr & min are in E.A.S.T.
- **STAR NAME** is indicated by Flamsteed Numbers and Bayer letters. Sometimes the number of the star in the catalogues of Bode, Gould or Hevelius is used and they are noted by the letters B,G or H respectively. The star's constellation uses the standard 3 letter abbreviation (see also the "Observing the Constellations" appendix p. 92). If the constellation name is in (), precession has moved the star out of the constellation since the star was named.
- **ZC** is the number of the star in the Zodiacal Catalogue.

• **Mag** is the magnitude of the star.

• **PH** - Phenomena.

D = Disappearance R - Reappearance

• **EL** is the elongation of the Moon from the Sun or how far the Moon is east of the Sun measured in degrees.

• **A** Coefficient of Longitude (see below)

• **B** Coefficient of Latitude (see below)

**** NB. For some stars the values for A and B were not available.

• **P** The position angle on the lunar limb of the event. This is traditionally expressed as degrees east of North.

CALCULATING EVENT TIME FOR OTHER LOCATIONS

Unless the event is close to a "graze" (ie. P is close to 0° or 180°) this calculation will give a good approximation for any location within about 500km from Sydney

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.

WORKED EXAMPLE

An observer wishes to calculate a more accurate time for the disappearance of π Sag on May 21 for their location in Canberra (149° 06' E, -35° 12' S).

-The change in longitude from Sydney (decimal degrees)

$$= 150^{\circ}.25 - 149^{\circ}.1 = 1^{\circ}.15 \quad \text{---} \quad 'n' (-)$$

-The change in latitude from Sydney (decimal degrees)

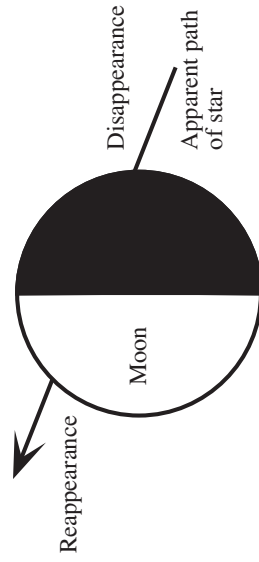
$$= 33^{\circ}.9 - 35^{\circ}.2 = -1^{\circ}.3$$

Note p is negative because the change is in a southerly direction therefore p = -1°.3 --- 'p' (-)

From the table, the values of A and B are -2.2 and 1.3 respectively. Therefore the equation becomes:-

$$52 + (-2.2 \times 1.15) + (1.3 \times -1.3) = 47.8 \text{ minutes.}$$

The event will be visible from Canberra approx. 4 mins earlier than Sydney, i.e., about 1:48 AM on May 21st.



OCCULTATIONS

LUNAR OCCULTATION TABLE

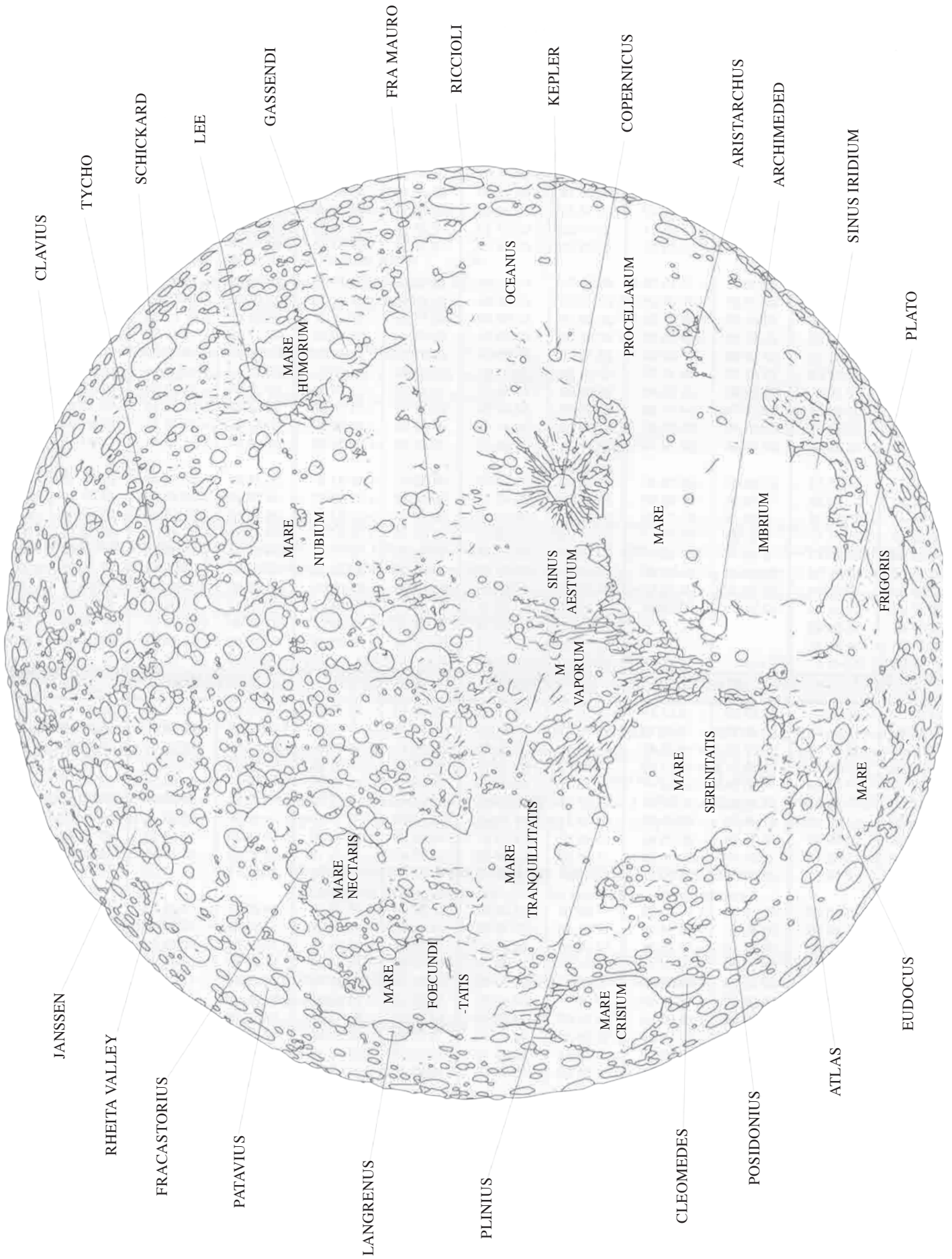
DATE	TIME	STAR NAME	ZC	MAG	PH	EL	A	B	P
Jan 13	21:57.6		223	8.1	D	95	-1.1	2.4	39
Jan 14	22:29.9		356	8.0	D	107	-1.5	2.6	34
Jan 24	03:17.1	431B Leo	1688	6.3	R	233	0.0	-3.5	0
Feb 08	19:28.9		56	8.0	D	51	-0.9	1.5	81
Feb 12	14:16.7	25 η Tau	552	3.0	D	96	0.8	2.1	13
Feb 12	14:52.9	25 η Tau	552	3.0	R	97	-2.4	-3.0	308
Feb 12	19:40.8		587	6.4	D	99	-2.2	0.6	85
Feb 15	00:35.4	5 Gem	936	5.9	D	128	-0.2	-0.2	132
Feb 20	04:19.5	69 Leo	1623	5.4	R	201	-1.3	0.5	282
Feb 27	00:59.5	44 Oph	2513	4.3	R	284	0.0	-1.0	269
Mar 11	18:50.2		703	6.3	D	81	-2.3	1.2	66
Mar 13	20:59.0		1036	6.5	D	108	-1.7	0.2	105
Mar 14	19:55.9	79 Gem	1171	6.3	D	120	-1.7	-1.4	139
Mar 15	18:43.2		1306	7.8	D	133	-1.9	-0.4	74
Mar 15	20:53.3		1316	8.8	D	134	-2.8	0.4	77
Mar 15	23:52.5	54 Cnc	1323	6.3	D	136	-1.9	1.4	79
Apr 07	18:13.7		649	7.2	D	51	-1.0	-0.1	127
Apr 07	18:48.2	62 Tau	652	6.4	D	51	-	-	163
Apr 09	19:41.7		990	8.2	D	77	-1.3	0.3	111
Apr 11	18:59.0		1260	7.0	D	103	-1.2	-1.8	153
Apr 11	19:42.1	25 Cnc	1262	6.2	D	103	-1.0	-1.6	153
Apr 13	18:48.4		1502	8.9	D	129	-1.8	-1.3	110
Apr 14	00:02.5	155B Leo	1519	6.5	D	132	-1.3	0.7	98
Apr 14	01:25.5		1526	8.6	D	133	-0.3	-0.5	136
Apr 14	22:37.5	69 Leo	1623	5.4	D	144	-1.1	-1.7	149
May 08	20:09.5	ζ Cnc	1236	5.1	D	74	-0.3	-1.0	150
May 08	20:55.6		1241	6.4	D	74	-0.9	0.8	97
May 09	21:40.2		1367	8.5	D	88	-1.2	1.3	86
May 10	18:34.8	π Leo	1468	4.9	D	99	-1.3	-1.8	147
May 12	20:00.9		1705	7.5	D	126	-1.6	-1.5	130
May 21	01:52.0	π Sgr	2797	3.0	R	226	-2.2	1.3	235
May 25	01:27.1	44 Aqr	3272	5.8	R	270	-0.7	-1.2	268
Jun 04	18:07.3	209B Gem	1186	6.1	D	43	-1.8	1.9	70
Jun 07	22:33.9	36 Sex	1566	6.6	D	86	0.0	-2.6	173
Jun 09	22:28.0	163B Vir	1788	6.7	D	111	-0.9	-1.8	154
Jun 10	20:04.6		1906	7.7	D	123	-1.9	-1.4	126
Jun 13	20:19.3	δ Sco	2290	2.5	D	159	-	-	27
Jun 13	20:34.7	δ Sco	2290	2.5	R	159	-	-	6
Jun 17	05:54.3	2 χ Sgr	2759	3.6	R	198	-0.4	1.5	256
Jun 18	23:49.8	31B Cap	2986	6.5	R	218	-1.8	-0.5	259
Jun 24	04:41.7	41 Psc	42	5.6	R	275	0.1	3.2	182
Jun 25	04:14.5	75 Psc	160	6.2	R	286	-1.5	-0.3	254
Jul 04	19:43.0		1526	8.6	D	54	-1.1	2.3	70
Jul 06	22:18.5		1761	8.0	D	82	-0.4	-0.2	130
Jul 07	19:55.8		1872	7.3	D	94	-	-	190
Jul 08	17:32.9		1990	8.0	D	105	-2.2	-0.8	97
Jul 09	19:14.1		2115	7.1	D	118	-2.4	-0.5	97
Jul 10	20:44.4		2249	6.9	D	131	-	-	164
Jul 11	01:44.0		2274	6.7	D	133	-0.8	0.1	123
Jul 17	21:54.3	46 Cap	3185	5.3	R	210	-	-	184
Jul 24	04:22.0	26 Ari	370	6.1	R	280	-	-	319
Jul 25	06:07.3	66 Ari	501	6.1	R	293	-2.4	-0.5	273

DATE	TIME	STAR NAME	ZC	MAG	PH	EL	A	B	P
Aug 04	18:13.3		1954	7.9	D	76	-	-	37
Aug 04	19:13.1		1958	7.5	D	77	-1.4	-2.4	155
Aug 06	20:52.3		2216	7.0	D	102	-1.9	-0.1	112
Aug 06	23:53.4		2226	7.0	D	103	-0.8	-0.4	133
Aug 07	17:47.5		2351	7.5	D	112	-	-	40
Aug 07	19:18.6		2357	6.6	D	113	-2.5	-0.7	103
Aug 07	19:25.5	ρ Oph	2359	4.8	D	113	-2.5	-0.4	99
Aug 08	21:52.5		2507	6.7	D	126	-2.6	-0.8	117
Aug 10	21:54.8	π Sgr	2797	3.0	D	148	-	-	135
Aug 31	18:18.2		1906	7.7	D	45	-	-	174
Sep 02	22:19.8		2187	8.1	D	73	0.4	2.2	53
Sep 03	14:06.2	δ Sco	2290	2.5	D	81	-0.7	-2.5	135
Sep 03	15:16.6	δ Sco	2290	2.5	R	81	-2.3	-0.2	258
Sep 03	21:40.6		2321	8.4	D	85	-	-	13
Sep 04	22:02.9		2461	8.7	D	96	0.0	3.5	32
Sep 05	21:16.4	216 Sgr	2595	5.7	D	107	-1.1	2.7	46
Sep 05	21:26.3		2597	7.0	D	108	-2.3	-0.1	111
Sep 05	21:58.7		2604	6.6	D	108	-0.8	2.5	48
Sep 05	22:21.5		2608	6.9	D	108	-1.3	1.2	88
Sep 06	20:38.3	33 Sgr	2746	5.8	D	118	-2.5	0.6	87
Sep 06	23:16.5	2 χ Sgr	2759	3.6	D	119	-1.7	0.5	107
Sep 07	23:16.3		2891	8.2	D	130	-2.0	0.8	96
Sep 19	03:10.2	95 Tau	714	6.2	R	256	-1.7	0.4	236
Oct 01	19:35.1	15 Oph	2407	6.9	D	65	-1.4	0.3	110
Oct 02	21:37.7		2551	9.2	D	77	-0.8	0.7	103
Oct 02	23:03.0		2557	6.2	D	78	0.6	2.2	40
Oct 03	21:13.6	115B Sgr	2704	5.8	D	89	-0.6	2.3	51
Oct 04	20:08.3		2844	7.9	D	99	-2.1	1.2	79
Oct 07	00:35.6	ν Aql	3093	4.5	D	123	-0.1	2.5	33
Oct 07	21:18.8		3201	7.8	D	132	-2.8	0.5	86
Oct 08	01:26.4		3212	7.5	D	134	-0.5	1.8	65
Oct 19	01:24.8	56 Gem	1113	5.2	R	263	-0.6	0.0	235
Oct 19	04:23.4	61 Gem	1127	5.9	R	265	-2.4	0.2	250
Oct 29	19:29.1		2493	9.2	D	45	0.0	2.2	50
Oct 31	20:25.0	195B Sgr	2798	6.3	D	68	-0.6	1.9	63
Nov 01	21:12.1		2922	7.4	D	80	-1.0	1.3	88
Nov 03	20:54.9		3159	8.0	D	102	-1.6	1.7	67
Nov 13	01:18.9	103 Tau	767	5.5	R	208	-2.5	-2.1	323
Nov 13	23:12.4	1 Gem	916	4.3	R	219	-1.1	-0.5	253
Nov 14	02:27.5	3 Gem	929	5.8	R	221	-2.6	1.1	236
Nov 15	02:54.0	120B Gem	1086	6.5	R	234	-1.9	-1.6	319
Nov 18	02:53.7	89B Leo	1465	6.3	R	273	-1.0	-2.5	332
Nov 27	20:32.7	29 Sgr	2734	5.4	D	37	0.6	2.1	36
Dec 03	22:20.1		3471	8.4	D	104	-1.8	-0.2	122
Dec 04	21:31.6	36 Psc	31	6.2	D	114	-1.4	2.3	39
Dec 05	23:40.7	75 Psc	160	6.2	D	126	-1.2	1.8	65
Dec 07	19:38.3	34 μ Ari	399	5.7	D	148	-0.1	2.3	13
Dec 12	03:36.4	36 Gem	1047	5.2	R	203	-1.5	0.3	285
Dec 15	00:57.2	o Leo	1428	3.8	R	241	-1.1	-2.1	319
Dec 17	01:24.7	388B Leo	1662	6.3	R	268	-	-	228
Dec 20	03:05.0	40H Vir	2029	5.1	R	307	0.2	-2.3	330
Dec 29	20:46.7	187B Aqr	3309	6.3	D	61	-0.3	2.1	48

MOON

OCCULTATIONS

MOON



MERCURY

GEOCENTRIC POSITION OF MERCURY (0hr UT, Epoch 2000.0)

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

MERCURY

VENUS

MERCURY & VENUS

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

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

VENUS

GEOCENTRIC POSITION OF VENUS (0hr UT, Epoch 2000.0)

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

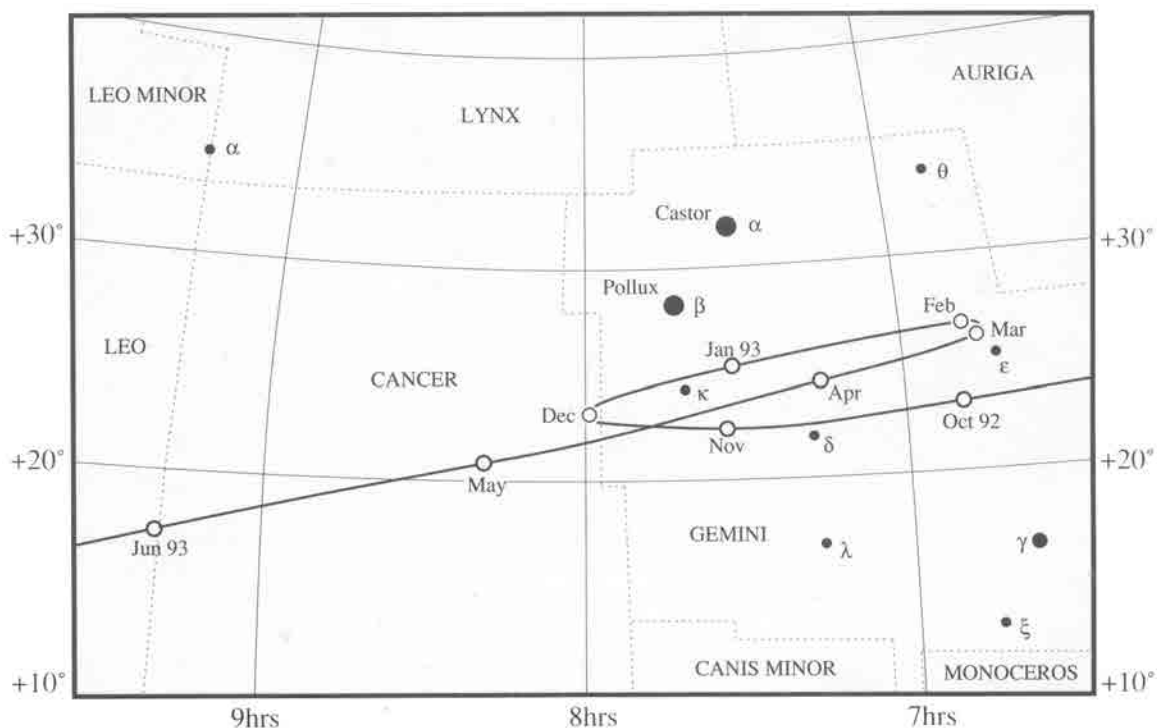
MARS

RISE, SET (EAST) AND GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

THE PATH OF MARS FROM MID-SEPTEMBER 1992 TO JUNE 1993.

Epoch 2000



MAGNITUDE SCALE • • •
3 2 1

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.

FIGURE 1

COMPARATIVE SIZES OF MARS AT:

- A - Conjunction
- B - Poor opposition
- C - Perihelic opposition

A
3.5"

B
14"

C
25"

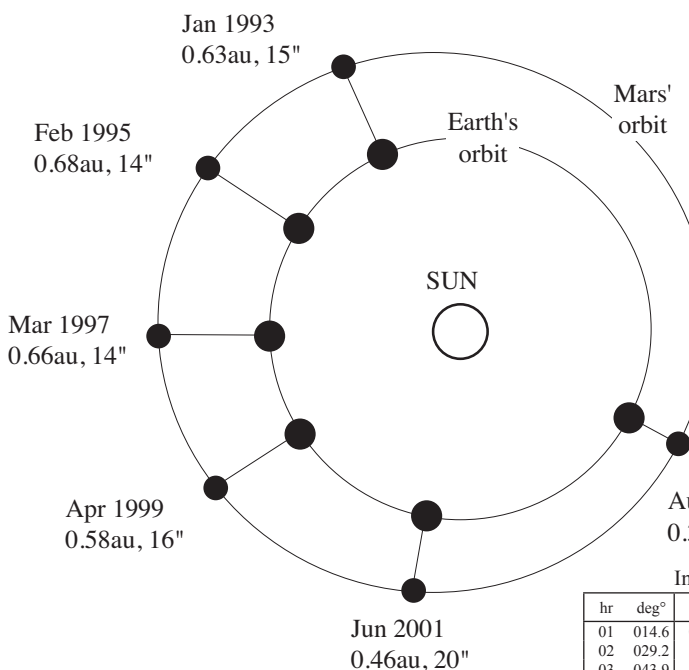


FIGURE 2

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.

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

LONGITUDE OF CENTRAL MERIDIAN OF MARS				
DATE	Nov '92	Dec '92	Jan '93	Feb '93
1	186.2	268.5	352.4	076.8
2	176.8	259.4	343.6	067.8
3	167.5	250.4	334.9	058.7
4	158.1	241.3	326.1	049.6
5	148.7	232.3	317.4	040.6
6	139.3	223.2	308.6	031.4
7	130.0	214.2	299.8	022.3
8	120.6	205.2	291.0	013.2
9	111.3	196.2	282.2	004.1
10	102.0	187.2	273.4	354.9
11	092.7	178.3	264.6	345.8
12	083.4	169.3	255.8	336.6
13	074.1	160.4	246.9	327.4
14	064.8	151.4	238.1	318.3
15	055.5	142.5	229.2	309.1
16	046.2	133.6	220.3	299.9
17	037.0	124.7	211.4	290.6
18	027.7	115.9	202.5	281.4
19	018.5	107.0	193.6	272.2
20	009.2	098.1	184.7	262.9
21	000.0	089.3	175.8	253.7
22	350.8	080.5	166.8	244.4
23	341.6	071.6	157.9	235.1
24	332.4	062.8	148.9	225.8
25	323.3	054.0	140.0	216.5
26	314.1	045.2	131.0	207.2
27	305.0	036.4	122.0	197.9
28	295.8	027.6	113.0	188.5
29	286.7	018.9	104.0	
30	277.6	010.1	094.9	
31		001.3	085.9	

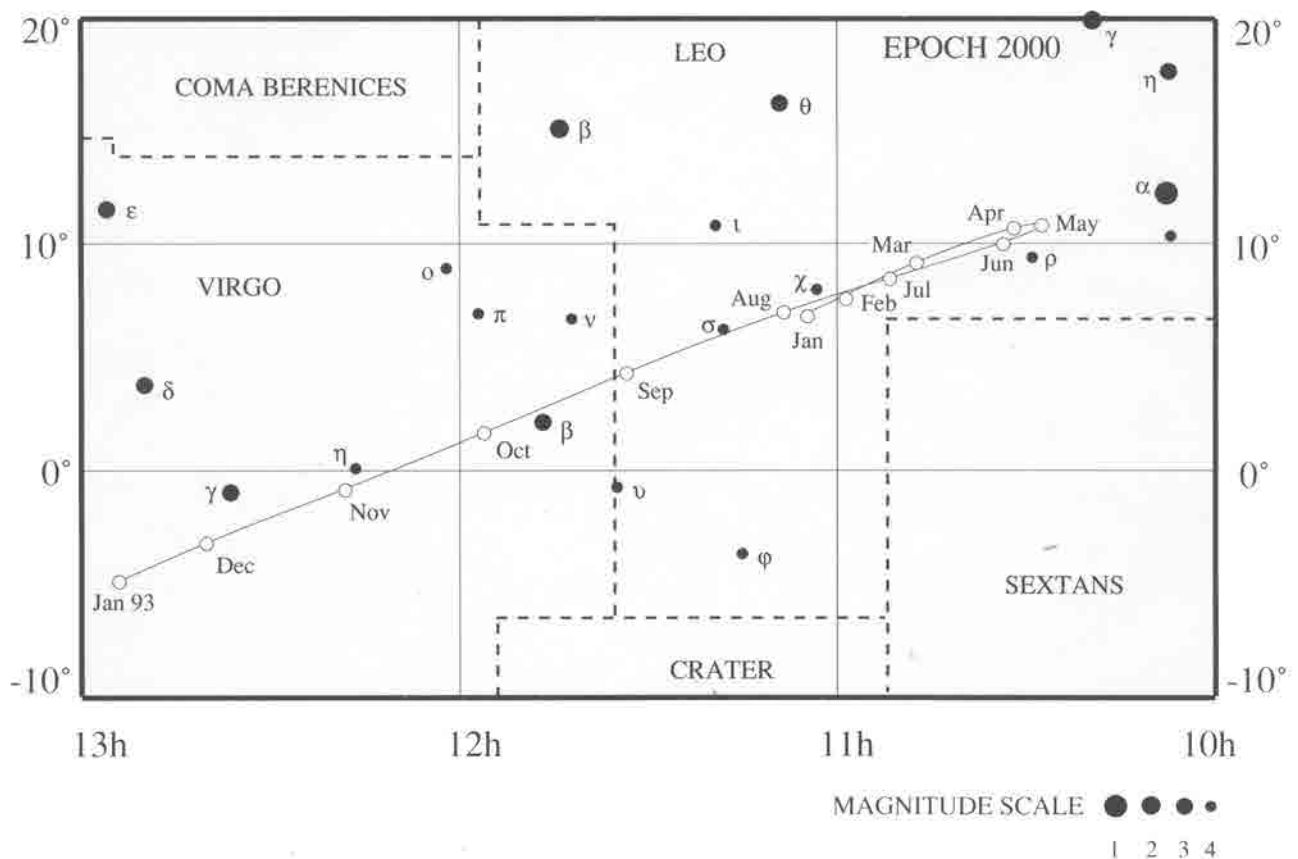
JUPITER

RISE, SET (EAST) AND GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

JUPITER FINDER CHART



SYSTEM I		JUPITER — LONGITUDE OF CENTRAL MERIDIAN										SYSTEM II	
JAN ◌	FEB ◌	MAR ◌	APR ◌	MAY ◌	JUN ◌	Date	JAN ◌	FEB ◌	MAR ◌	APR ◌	MAY ◌	JUN ◌	
113.7	332.0	235.2	092.9	149.4	000.4	1	068.8	050.6	092.5	073.7	261.3	235.8	
271.6	130.1	033.2	250.9	307.2	158.2	2	219.1	201.0	242.9	224.0	051.5	025.9	
069.6	288.1	191.3	048.8	105.0	315.9	3	009.5	351.4	033.3	014.3	201.6	176.0	
227.6	086.1	349.3	206.7	262.9	113.6	4	159.8	141.8	183.7	164.6	351.8	326.1	
025.6	244.2	147.3	004.6	060.7	271.3	5	310.2	292.2	334.1	314.9	142.0	116.2	
183.6	042.2	305.3	162.6	218.5	069.1	6	100.5	082.6	124.4	105.2	292.2	266.3	
341.6	200.3	103.4	320.5	016.3	226.8	7	250.9	233.0	274.8	255.5	082.4	056.4	
139.6	358.3	261.4	118.4	174.1	024.5	8	041.2	023.4	065.2	045.7	232.5	206.4	
297.6	156.4	059.4	276.3	331.9	182.2	9	191.6	173.9	215.6	196.0	022.7	356.5	
095.6	314.4	217.4	074.2	129.7	339.9	10	342.0	324.3	006.0	346.3	172.9	146.6	
						11							
253.6	112.5	015.4	232.1	287.5	137.6	12	132.3	114.7	156.4	136.6	323.0	296.7	
051.6	270.5	173.4	030.0	085.3	295.4	13	282.7	265.1	306.7	286.8	113.2	086.8	
209.6	068.5	331.4	187.9	243.1	093.1	14	073.1	055.5	097.1	077.1	263.4	236.9	
007.6	226.6	129.4	345.8	040.8	250.8	15	223.5	205.9	247.5	227.4	053.5	026.9	
165.6	024.6	287.4	143.7	198.6	048.5	16	013.8	356.3	037.9	017.6	203.7	177.0	
323.6	182.7	085.4	301.6	356.4	206.2	17	164.2	146.8	188.2	167.9	353.8	327.1	
121.6	340.7	243.4	099.5	154.2	003.9	18	314.6	297.2	338.6	318.1	144.0	117.1	
279.6	138.8	041.4	257.3	311.9	161.6	19	105.0	087.6	129.0	108.4	294.1	267.2	
077.6	296.8	199.4	055.2	109.7	319.3	20	255.4	238.0	279.3	258.6	084.2	057.3	
235.7	094.8	357.4	213.1	267.5	117.0	21	045.8	028.4	069.7	048.9	234.4	207.3	
						22							
033.7	252.9	155.3	011.0	065.2	274.7	23	196.2	178.8	220.0	199.1	024.5	357.4	
191.7	050.9	313.3	168.8	223.0	072.3	24	346.6	329.2	010.4	349.3	174.6	147.5	
349.7	209.0	111.3	326.7	020.8	230.0	25	137.0	119.6	160.7	139.6	324.8	297.5	
147.8	007.0	269.3	124.5	178.5	027.7	26	287.3	270.0	311.1	289.8	114.9	087.6	
305.8	165.0	067.2	282.4	336.3	185.4	27	077.7	060.5	101.4	080.0	265.0	237.7	
103.8	323.1	225.2	080.2	134.0	343.1	28	228.1	210.9	251.7	230.2	055.1	027.7	
261.9	121.1	023.2	238.1	291.8	140.8	29	018.5	001.3	042.1	020.4	205.2	177.8	
059.9	279.1	181.1	035.9	089.5	298.5	30	168.9	151.7	192.4	170.7	355.4	327.8	
217.9	077.2	339.1	193.7	247.2	096.1	31	319.4	302.1	342.7	320.9	145.5	117.9	
016.0		137.0	351.6	045.0	253.8		109.8		133.0	111.1	295.6	267.9	
174.0		295.0		202.7			260.2		283.3		085.7		
JUL ◌	AUG ◌	SEP ◌	OCT ◌	NOV ◌	DEC ◌		JUL ◌	AUG ◌	SEP ◌	OCT ◌	NOV ◌	DEC ◌	
051.5	259.2	106.7	157.2	006.7	060.1	1	058.0	029.1	000.2	181.8	154.7	339.2	
209.2	056.8	264.4	314.9	164.4	217.9	2	208.0	179.2	150.2	331.8	304.8	129.4	
006.9	214.5	062.1	112.6	322.2	015.8	3	358.1	329.2	300.2	121.9	094.9	279.6	
164.5	012.2	219.7	270.3	119.9	173.6	4	148.1	119.2	090.3	272.0	245.0	069.8	
322.2	169.8	017.4	068.0	277.7	331.4	5	298.2	269.2	240.3	062.0	035.2	220.0	
119.9	327.5	175.1	225.7	075.4	129.2	6	088.2	059.3	030.4	212.1	185.3	010.2	
277.6	125.1	332.8	023.4	233.2	287.1	7	238.2	209.3	180.4	002.2	335.4	160.4	
075.2	282.8	130.4	181.2	031.0	084.9	8	028.3	359.3	330.5	152.3	125.5	310.6	
232.9	080.5	288.1	338.9	188.7	242.7	9	178.3	149.4	120.5	302.4	275.7	100.8	
030.6	238.1	085.8	136.6	346.5	040.6	10	328.4	299.4	270.5	092.4	065.8	251.0	
						11							
188.2	035.8	243.5	294.3	144.3	198.4	12	118.4	089.4	060.6	242.5	216.0	041.2	
345.9	193.4	041.1	092.0	302.0	356.2	13	268.5	239.5	210.6	032.6	006.1	191.4	
143.6	351.1	198.8	249.7	099.8	154.1	14	058.5	029.5	000.7	182.7	156.2	341.6	
301.2	148.8	356.5	047.4	257.6	311.9	15	208.5	179.5	150.7	332.8	306.4	131.8	
098.9	306.4	154.2	205.2	055.4	109.8	16	358.6	329.6	300.8	122.9	096.5	282.0	
256.6	104.1	311.9	002.9	213.1	267.6	17	148.6	119.6	090.8	273.0	246.7	072.3	
054.2	261.7	109.5	160.6	010.9	065.5	18	298.6	269.6	240.9	063.1	036.8	222.5	
211.9	059.4	267.2	318.3	168.7	223.4	19	088.7	059.7	030.9	213.2	187.0	012.7	
009.6	217.1	064.9	116.1	326.5	021.2	20	238.7	209.7	181.0	003.3	337.1	162.9	
167.2	014.7	222.6	273.8	124.3	179.1		028.7	359.7	331.1	153.3	127.3	313.2	
						21							
324.9	172.4	020.3	071.5	282.1	336.9	22	178.8	149.8	121.1	303.4	277.5	103.4	
122.6	330.1	178.0	229.3	079.9	134.8	23	328.8	299.8	271.2	093.5	067.6	253.6	
280.2	127.7	335.7	027.0	237.7	292.7	24	118.8	089.8	061.2	243.7	217.8	043.9	
077.9	285.4	133.4	184.7	035.5	090.6	25	268.9	239.9	211.3	033.8	008.0	194.1	
235.5	083.1	291.0	342.5	193.3	248.4	26	058.9	029.9	001.4	183.9	158.1	344.4	
033.2	240.7	088.7	140.2	351.1	046.3	27	208.9	179.9	151.4	334.0	308.3	134.6	
190.9	038.4	246.4	297.9	148.9	204.2	28	359.0	330.0	301.5	124.1	098.5	284.9	
348.5	196.0	044.1	095.7	306.7	002.1	29	149.0	120.0	091.6	274.2	248.7	075.1	
146.2	353.7	201.8	253.4	104.5	160.0	30	299.0	270.0	241.6	064.3	038.8	225.4	
303.9	151.4	359.5	051.2	262.3	317.9	31	089.1	060.1	031.7	214.4	189.0	015.7	
101.5	309.1		208.9		115.8		239.1	210.1		004.5		165.9	

Rotation: 9h 50m 30.003s

Rotation: 9h 55m 40.062s

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

SYSTEM I applies to all features situated on or between the north component of the South Equatorial Belt and the south component of the North Equatorial Belt.

SYSTEM II applies to the remainder of the surface.

SYSTEM II

SYSTEM I

SYSTEM II

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

SYSTEM I applies to all features situated on or between the north component of the South Equatorial Belt and the south component of the North Equatorial Belt.

SYSTEM II applies to the remainder of the surface.

SYSTEM II

SYSTEM I

SYSTEM II

Increase in longitude

See introduction to part 2 (p. 56) for further information.

Increase in longitude

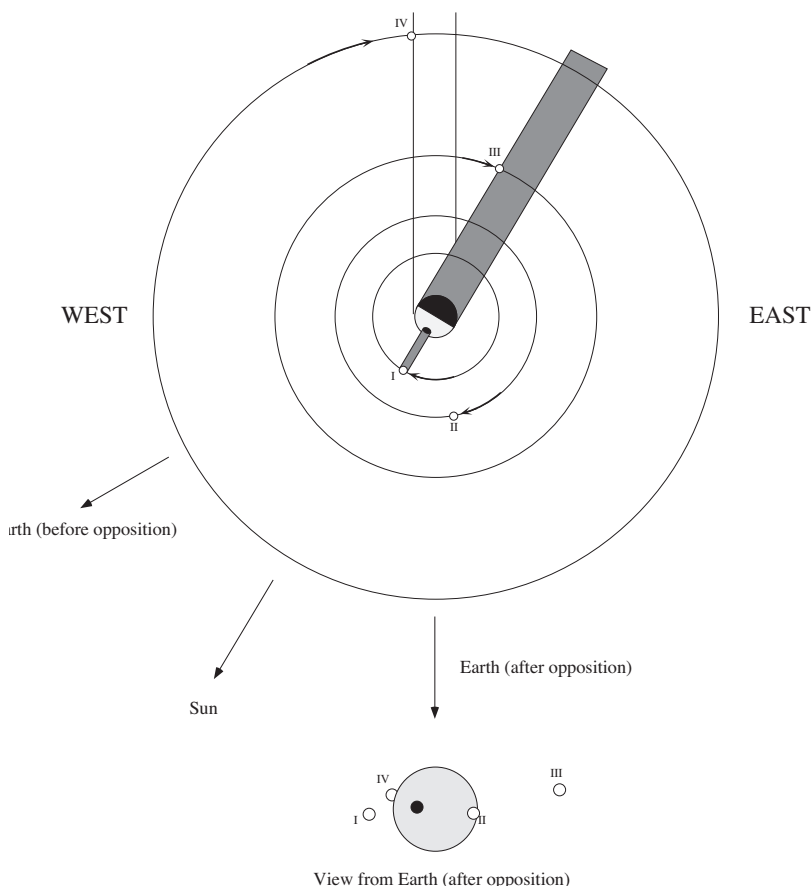
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JUPITER SATELLITE EVENTS

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 1992 is February 29.
- 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 1992

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																			
11:46 I Sh I 2:52 I Tr I 4:02 I Sh E 22:52 I Ec D					100:23 I Sh E 1:23 I Tr E 22:32 I Oc R					180:12 III Ec R 0:19 I Oc R 0:24 III Oc D 3:48 III Oc R 21:37 I Tr E					250:36 III Ec D 2:06 I Oc R 21:08 I Tr I 22:38 I Sh E 23:23 I Tr E				
22:16 I Oc R 23:34 I Tr E					110:16 III Oc R					220:40 II Ec D					2820:52 III Tr E				
60:25 II Sh I 2:37 II Tr I 3:13 II Sh E 23:48 IV Ec R					1422:06 II Ec D					234:33 I Ec D 21:41 II Sh E 21:42 IV Oc D 23:17 II Tr E					293:14 II Ec D				
72:38 III Sh I					162:39 I Ec D					241:04 IV Oc R 1:53 I Sh I 2:41 I Tr I 4:09 I Sh E 4:56 I Tr E 23:01 I Ec D					310:17 II Sh E 1:36 II Tr E 3:46 I Sh I 4:27 I Tr I 22:53 IV Sh I				
80:23 II Oc R 3:39 I Sh I 4:41 I Tr I					170:00 I Sh I 0:55 I Tr I 2:16 I Sh E 3:10 I Tr E														
90:46 I Ec D 4:05 I Oc R 22:07 I Sh I 23:08 I Tr I																			
FEBRUARY																			
10:55 I Ec D 2:58 IV Sh E 3:51 I Oc R 4:34 III Ec D 20:32 II Oc R 22:15 I Sh I 22:53 I Tr I					90:08 I Sh I 0:37 I Tr I 2:24 I Sh E 2:53 I Tr E 21:17 I Ec D					161:02 II Oc R 2:02 I Sh I 2:21 I Tr I 4:18 I Sh E 4:36 I Tr E 23:11 I Ec D					230:12 II Ec D 3:15 II Oc R 3:55 I Sh I 4:05 I Tr I				
20:31 I Sh E 1:08 I Tr E 22:18 I Oc R					100:02 I Oc R 20:53 I Sh E 21:19 I Tr E					171:46 I Oc R 19:48 IV Tr I 20:30 I Sh I 20:47 I Tr I 20:51 IV Sh E 22:46 I Sh E 23:02 I Tr E 23:08 IV Tr E					241:06 I Ec D 3:30 I Oc R 21:23 II Sh E 21:35 II Tr E 22:24 I Sh I 22:31 I Tr I				
420:51 III Tr I 22:00 III Sh E					120:11 III Tr I 1:58 III Sh E 3:34 III Tr E					1820:13 I Oc R					250:40 I Sh E 0:46 I Tr E 19:34 I Ec D 21:56 I Oc R				
50:14 III Tr E					142:40 II Sh I 3:27 II Tr I					192:24 III Sh I 3:28 III Tr I					261:33 IV Ec D 19:08 I Sh E 19:12 I Tr E				
70:04 II Sh I 1:10 II Tr I 2:52 II Sh E 3:54 II Tr E					154:43 I Ec D 21:38 II Ec D					215:16 II Sh I					2920:27 III Oc D 23:59 III Ec R				
82:49 I Ec D 22:47 II Oc R										2220:37 III Oc R									
MARCH																			
12:45 II Oc D 5:32 II Ec R					94:42 I Oc D 23:21 II Tr I 23:48 II Sh I					171:37 II Tr I 2:25 II Sh I 3:42 I Tr I 4:05 I Sh I 4:23 II Tr E					243:54 II Tr I				
22:58 I Oc D 5:17 I Ec R 21:05 II Tr I 21:11 II Sh I 23:50 II Tr E 23:59 II Sh E					101:58 I Tr I 2:06 II Tr E 2:11 I Sh I 2:36 II Sh E 4:13 I Tr E 4:27 I Sh E 23:08 I Oc D					180:52 I Oc D 3:35 I Ec R 18:17 III Sh I 19:59 III Tr E 20:20 II Oc D 21:46 III Sh E 22:08 I Tr I 22:34 I Sh I 23:56 II Ec R					252:38 I Oc D 19:53 III Tr I 22:16 III Sh I 22:35 II Oc D 23:20 III Tr E 23:53 I Tr I				
30:14 I Tr I 0:17 I Sh I 2:29 I Tr E 2:34 I Sh E 21:24 I Oc D 23:46 I Ec R					111:40 I Ec R 20:24 I Tr I 20:40 I Sh I 21:23 II Ec R 22:39 I Tr E 22:56 I Sh E					190:23 I Tr E 0:50 I Sh E 19:19 I Oc D 22:04 I Ec R					260:28 I Sh I 1:44 III Sh E 2:08 I Tr E 2:30 II Ec R 2:44 I Sh E 21:04 I Oc D 23:59 I Ec R				
418:40 I Tr I 18:46 I Sh I 18:49 II Ec R 20:55 I Tr E 21:02 I Sh E					1220:09 I Ec R					2018:31 II Sh E 18:49 I Tr E 19:18 I Sh E					2718:19 I Tr I 18:21 II Sh I 18:57 I Sh I 19:50 II Tr E 20:35 I Tr E 21:07 II Sh E 21:12 I Sh E				
723:44 III Oc D					153:01 III Oc D					220:10 IV Tr I 3:47 IV Tr E					2818:27 I Ec R				

JUPITER SATELLITE EVENTS (Times are EAST)

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

JUPITER SATELLITE EVENTS (Times are EAST)

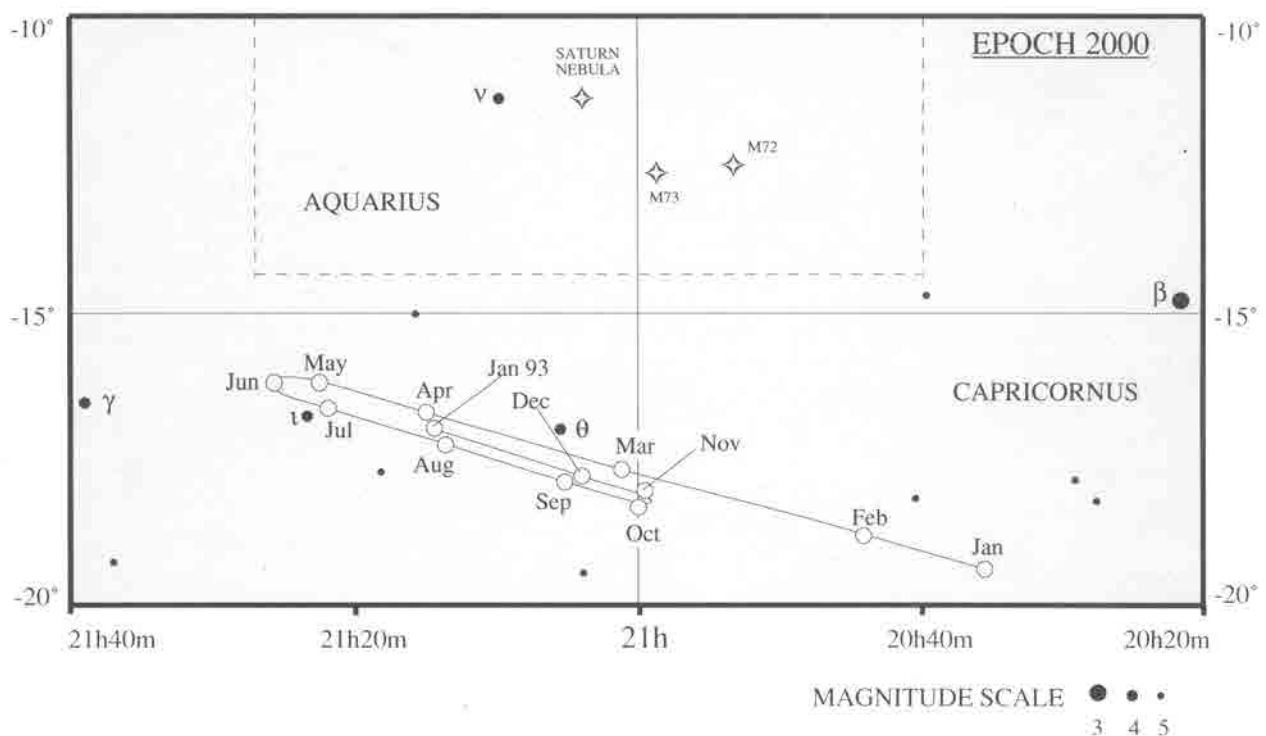
1 18:58 III Tr I				AUGUST								25 18:35 II Oc D			
2 17:25 II Sh I				6 17:54 I Ec R				19 18:12 III Oc D				28 18:10 I Tr I			
18:40 II Tr E				9 18:44 II Tr I				18:19 IV Tr I				18:30 I Sh I			
20:05 II Sh E				12 19:31 III Ec R				20 19:00 I Oc D				29 18:05 I Ec R			
5 17:37 I Tr I								21 18:25 I Tr E							
18:18 I Sh I								18:51 I Sh E							
19:53 I Tr E															
				SEPTEMBER											
				5 18:04 IV Tr E				6 17:57 III Sh I							
				OCTOBER											
18 5:07 I Ec D				19 4:34 I Sh E				26 4:13 I Sh I				27 4:05 II Tr E			
				5:04 I Tr E				4:50 I Tr I				4:19 I Oc R			
				NOVEMBER											
3 3:22 I Ec D				11 3:19 I Tr I				19 2:39 II Ec D				27 2:59 I Sh E			
4:15 II Tr I				4:43 I Sh E				4:45 I Oc R				3:59 I Tr E			
4:42 III Tr I															
4 3:34 I Tr E				12 4:22 II Oc R				21 2:54 III Ec R				28 2:19 II Sh E			
				18 4:23 I Sh I				3:42 III Oc D				3:45 III Ec D			
								26 3:29 I Ec D				4:18 II Tr E			
				DECEMBER											
4 2:39 I Sh I				9 2:14 III Tr I				20 0:55 I Sh I				27 0:38 III Oc D			
3:44 I Tr I				12 1:43 I Ec D				2:06 I Tr I				2:48 I Sh I			
								3:08 I Sh E				3:25 m Oc R			
5 2:19 II Sh I				13 1:14 I Sh E				4:18 I Tr E				4:01 I Tr I			
3:08 I Oc R				2:22 I Tr E											
4:29 II Tr I				16 1:34 III Sh I				21 1:28 I Oc R				28 3:23 I Oc R			
				4:36 III Sh E				2:19 II Ec D							
7 1:57 II Oc R				19 3:36 I Ec D				23 1:33 II Tr E				29 0:41 I Tr E			
												30 1:42 II Tr I			
												1:46 II Sh E			
												4:08 II Tr E			

SATURN

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

SATURN FINDER CHART



SATURN—LONGITUDE OF CENTRAL MERIDIAN

JAN	FEB	MAR	APR	MAY	JUN	Date
147.6	036.8	038.9	290.9	060.3	315.5	1
271.8	161.0	163.1	055.2	184.6	079.8	2
035.9	285.2	287.3	179.5	309.0	204.2	3
160.1	049.4	051.6	303.8	073.3	328.6	4
284.3	173.6	175.8	068.1	197.6	093.0	5
048.4	297.8	300.0	192.3	322.0	217.4	6
172.6	062.0	064.3	316.6	086.3	341.7	7
296.7	186.2	188.5	080.9	210.7	106.1	8
060.9	310.4	312.8	205.2	335.0	230.5	9
185.0	074.6	077.0	329.5	099.4	354.9	10
309.2	198.8	201.3	093.9	223.7	119.3	11
073.4	323.0	325.5	218.2	348.1	243.7	12
197.5	087.2	089.8	342.5	112.5	008.1	13
321.7	211.4	214.0	106.8	236.8	132.5	14
085.9	335.6	338.3	231.1	001.2	256.9	15
210.0	099.8	102.5	355.4	125.5	021.2	16
334.2	224.0	226.8	119.7	249.9	145.6	17
098.4	348.2	351.1	244.0	014.3	270.0	18
222.5	112.4	115.3	008.3	138.6	034.4	19
346.7	236.6	239.6	132.7	263.0	158.8	20
110.9	000.9	003.8	257.0	027.3	283.2	21
235.0	125.1	128.1	021.3	151.7	047.6	22
359.2	249.3	252.4	145.6	276.1	172.0	23
123.4	013.5	016.7	270.0	040.5	296.4	24
247.6	137.7	140.9	034.3	164.8	060.8	25
011.8	262.0	265.2	158.6	289.2	185.2	26
135.9	026.2	029.5	282.9	053.6	309.6	27
260.1	150.4	153.8	047.3	177.9	074.0	28
024.3	274.6	278.0	171.6	302.3	198.4	29
148.5	042.3	045.3	295.9	066.7	322.8	30
272.7	166.6	169.6	169.1	191.1	347.2	31
JUL	AUG	SEP	OCT	NOV	DEC	
087.2	343.3	238.3	007.1	258.0	023.2	1
211.6	107.7	002.6	131.3	022.2	147.3	2
336.0	232.0	127.0	255.6	146.4	271.5	3
100.4	356.4	251.3	019.8	270.6	035.7	4
224.8	120.8	015.6	144.1	034.8	159.8	5
349.1	245.2	139.9	268.3	158.9	284.0	6
113.5	009.5	264.2	032.6	283.1	048.1	7
237.9	133.9	028.5	156.8	047.3	172.3	8
002.3	258.3	152.8	281.0	171.5	296.4	9
126.7	022.7	277.2	045.3	295.7	060.6	10
251.1	147.0	041.5	169.5	059.9	184.7	11
015.5	271.4	165.8	293.8	184.0	308.9	12
139.9	035.7	290.1	058.0	308.2	073.0	13
264.3	160.1	054.4	182.2	072.4	197.2	14
028.7	284.5	178.7	306.4	196.6	321.3	15
153.1	048.8	302.9	070.7	320.7	085.5	16
277.5	173.2	067.2	194.9	084.9	209.6	17
041.9	297.5	191.5	319.1	209.1	333.8	18
166.3	061.9	315.8	083.3	333.2	097.9	19
290.7	186.2	080.1	207.5	097.4	222.1	20
055.1	310.6	204.4	331.8	221.6	346.2	21
179.4	074.9	328.7	096.0	345.7	110.4	22
303.8	199.3	092.9	220.2	109.9	234.5	23
068.2	323.6	217.2	344.4	234.1	358.7	24
192.6	088.0	341.5	108.6	358.2	122.9	25
317.0	212.3	105.8	232.8	122.4	247.0	26
081.4	336.6	230.0	357.0	246.5	011.2	27
205.8	101.0	354.3	121.2	010.7	135.3	28
330.1	225.3	118.5	245.4	134.9	259.5	29
094.5	349.6	242.8	009.6	259.0	023.6	30
218.9	114.0	117.0	133.8	147.8	347.2	31

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

SATURN'S RINGS

Date	major	minor	U	B
Jan 03	34.9	11.6	180.6	19.4
Jan 11	34.7	11.3	181.5	19.1
Jan 19	34.6	11.1	182.4	18.7
Jan 27	34.6	10.9	183.4	18.4
Feb 04	34.6	10.7	184.3	18.0
Feb 12	34.6	10.5	185.2	17.7
Feb 20	34.7	10.3	186.1	17.3
Feb 28	34.9	10.2	187.0	17.0
Mar 07	35.1	10.1	187.8	16.6
Mar 15	35.4	09.9	188.6	16.3
Mar 23	35.7	09.8	189.4	16.0
Mar 31	36.1	09.8	190.1	15.7
Apr 08	36.4	09.7	190.7	15.5
Apr 16	36.9	09.7	191.2	15.3
Apr 24	37.3	09.7	191.7	15.1
May 02	37.8	09.8	192.1	14.9
May 10	38.3	09.8	192.4	14.8
May 18	38.9	09.9	192.5	14.8
May 26	39.4	10.0	192.6	14.8
Jun 03	39.9	10.2	192.6	14.8
Jun 11	40.4	10.4	192.5	14.9
Jun 19	40.9	10.6	192.3	15.0
Jun 27	41.3	10.8	192.0	15.1
Jul 05	41.7	11.0	191.7	15.3
Jul 13	42.0	11.3	191.2	15.5
Jul 21	42.3	11.5	190.7	15.8
Jul 29	42.4	11.7	190.2	16.0
Aug 06	42.5	11.9	189.6	16.3
Aug 14	42.4	12.1	189.1	16.5
Aug 22	42.3	12.2	188.5	16.7
Aug 30	42.1	12.3	188.0	17.0
Sep 07	41.8	12.4	187.5	17.2
Sep 15	41.5	12.4	187.1	17.3
Sep 23	41.1	12.3	186.8	17.5
Oct 01	40.6	12.3	186.5	17.6
Oct 09	40.1	12.2	186.4	17.6
Oct 17	39.6	12.0	186.3	17.6
Oct 25	39.1	11.8	186.4	17.6
Nov 02	38.5	11.6	186.6	17.5
Nov 10	38.0	11.4	186.8	17.4
Nov 18	37.5	11.1	187.2	17.3
Nov 26	37.1	10.9	187.7	17.1
Dec 04	36.6	10.6	188.2	16.8
Dec 12	36.2	10.3	188.8	16.6
Dec 20	35.9	10.1	189.5	16.3
Dec 28	35.6	09.8	190.3	16.0

See Introduction to Part 2 (p. 56) for explanation.

SATELLITES OF SATURN

TITAN (EAST)

GREATEST EASTERN ELONGATION			INFERIOR CONJUNCTION			GREATEST WESTERN ELONGATION			SUPERIOR CONJUNCTION		
Month	day	hh.m	Month	day	hh.m	Month	day	hh.m	Month	day	hh.m
Jan	1	12.2	Jan	5	14.5	Jan	9	19.1	Jan	13	17.1
Jan	17	12.8	Jan	21	15.2	Jan	25	19.8	Jan	29	17.6
Feb	2	13.5	Feb	6	16.0	Feb	10	20.5	Feb	14	18.2
Feb	18	14.1	Feb	22	16.8	Feb	26	21.2	Mar	1	18.7
Mar	5	14.6	Mar	9	17.4	Mar	13	21.6	Mar	17	19.0
Mar	21	14.9	Mar	25	17.7	Mar	29	21.8	Apr	2	19.0
Apr	6	15.0	Apr	10	17.8	Apr	14	21.8	Apr	18	18.8
Apr	22	14.7	Apr	26	17.5	Apr	30	21.4	May	4	18.2
May	8	14.1	May	12	16.9	May	16	20.6	May	20	17.3
May	24	13.1	May	28	15.8	Jun	1	19.3	Jun	5	16.0
Jun	9	11.7	Jun	13	14.2	Jun	17	17.7	Jun	21	14.3
Jun	25	09.9	Jun	29	12.3	Jul	3	15.7	Jul	7	12.3
Jul	11	07.8	Jul	15	10.0	Jul	19	13.5	Jul	23	10.0
Jul	27	05.4	Jul	31	07.6	Aug	4	11.0	Aug	8	07.6
Aug	12	02.9	Aug	16	05.0	Aug	20	08.5	Aug	24	05.2
Aug	28	00.5	Sep	1	02.5	Sep	5	06.1	Sep	9	02.9
Sep	12	22.3	Sep	17	00.3	Sep	21	04.0	Sep	25	00.9
Sep	28	20.3	Oct	2	22.4	Oct	7	02.2	Oct	10	23.3
Oct	14	18.8	Oct	18	20.9	Oct	23	00.9	Oct	26	22.1
Oct	30	17.7	Nov	3	20.0	Nov	8	00.0	Nov	11	21.3
Nov	15	17.0	Nov	19	19.4	Nov	23	23.6	Nov	27	20.9
Dec	1	16.7	Dec	5	19.3	Dec	9	23.5	Dec	13	20.8
Dec	17	16.7	Dec	21	19.5	Dec	25	23.7	Dec	29	21.0

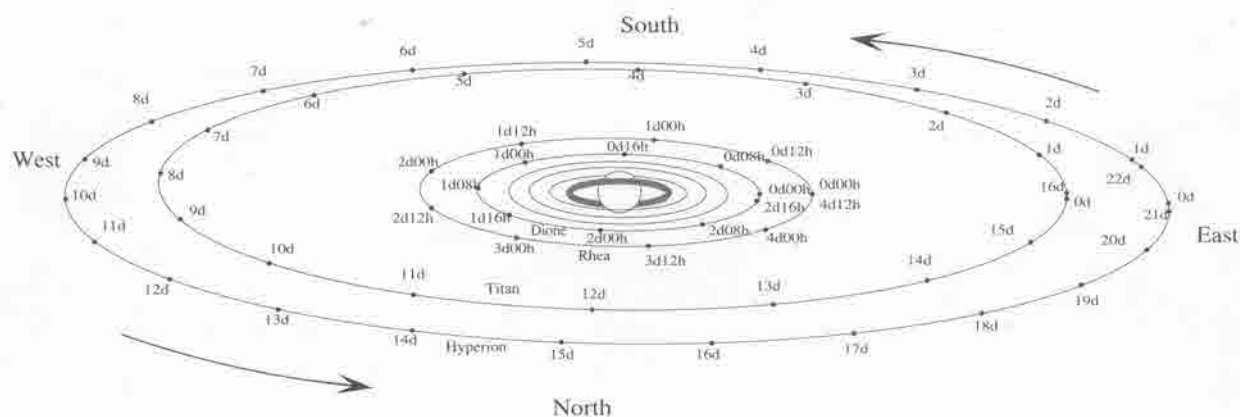
HYPERION (EAST)

GREATEST EASTERN ELONGATION			INFERIOR CONJUNCTION			GREATEST WESTERN ELONGATION			SUPERIOR CONJUNCTION		
Month	day	hh.m	Month	day	hh.m	Month	day	hh.m	Month	day	hh.m
Jan	9	00.1	Jan	14	01.6	Jan	18	17.9	Jan	2	21.8
Jan	30	10.6	Feb	4	10.9	Feb	9	03.7	Jan	24	09.0
Feb	20	20.2	Feb	25	19.5	Mar	1	12.7	Feb	14	19.7
Mar	13	05.0	Mar	18	03.3	Mar	22	21.0	Mar	7	05.5
Apr	3	12.8	Apr	8	10.1	Apr	13	04.1	Mar	28	14.4
Apr	24	19.2	Apr	29	15.9	May	4	10.1	Apr	18	22.0
May	16	00.6	May	20	20.6	May	25	14.9	May	10	04.2
Jun	6	04.7	Jun	11	00.2	Jun	15	18.7	May	31	09.1
Jun	27	07.9	Jul	2	03.0	Jul	6	21.4	Jun	21	12.8
Jul	18	10.4	Jul	23	05.2	Jul	27	23.6	Jul	12	15.4
Aug	8	12.5	Aug	13	07.3	Aug	18	01.6	Aug	2	17.6
Aug	29	14.8	Sep	3	09.7	Sep	8	04.0	Aug	23	19.7
Sep	19	17.9	Sep	24	12.9	Sep	29	07.5	Sep	13	22.6
Oct	10	22.3	Oct	15	17.3	Oct	20	12.2	Oct	5	02.6
Nov	1	04.2	Nov	5	23.1	Nov	10	18.6	Oct	26	08.3
Nov	22	11.8	Nov	27	06.2	Dec	2	02.5	Nov	16	15.7
Dec	13	20.5	Dec	18	14.7	Dec	23	11.6	Dec	8	00.8
									Dec	29	11.3

IAPETUS (EAST)

GREATEST EASTERN ELONGATION			INFERIOR CONJUNCTION			GREATEST WESTERN ELONGATION			SUPERIOR CONJUNCTION		
Month	day	hh.m	Month	day	hh.m	Month	day	hh.m	Month	day	hh.m
Jan	28	12.8	Feb	17	15.0	Mar	9	23.6	Jan	9	04.7
Apr	18	12.1	May	8	10.2	May	29	08.5	Mar	30	08.9
Jul	6	20.9	Jul	26	07.4	Aug	15	19.8	Jun	18	04.7
Sep	23	04.6	Oct	12	17.4	Nov	2	14.7	Sep	4	12.6
Dec	11	22.9							Nov	22	19.6

APPARENT ORBITS OF SATELLITES I-VIII, AT DATE OF OPPOSITION, AUGUST 7



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

See Introduction to Part 2 (p. 56) for explanation.

SATELLITES OF SATURN — GREATEST EASTERN ELONGATIONS (E.A.S.T.)

TETHYS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m
2 02.4	1 07.8	2 13.1	1 18.3	1 04.3	3 01.6	1 09.1	2 11.0	1 15.7	1 20.5	1 01.5	1 06.7
3 23.7	3 05.1	4 10.4	3 15.6	1 23.4	4 22.9	3 06.4	4 08.3	3 13.0	3 17.8	2 22.8	3 04.0
5 21.1	5 02.4	6 07.8	5 13.0	3 20.7	6 20.2	5 03.7	6 05.6	5 10.3	5 15.1	4 20.1	5 01.3
7 18.4	6 23.8	8 05.1	7 10.3	5 18.0	8 17.5	7 01.0	8 02.9	7 07.6	7 12.4	6 17.4	6 22.6
9 15.7	8 21.1	10 02.4	9 07.6	7 15.3	10 14.8	8 22.2	10 00.2	9 04.9	9 09.7	8 14.8	8 20.0
11 13.1	10 18.4	11 23.7	11 04.9	9 12.6	12 12.1	10 19.5	11 21.5	11 02.2	11 07.0	10 12.1	10 17.3
13 10.4	12 15.8	13 21.1	13 02.2	11 10.0	14 09.4	12 16.8	13 18.8	12 23.5	13 04.3	12 09.4	12 14.6
15 07.8	14 13.1	15 18.4	14 23.6	13 07.3	16 06.7	14 14.1	15 16.1	14 20.8	15 01.6	14 06.7	14 12.0
17 05.1	16 10.4	17 15.7	16 20.9	15 04.6	18 04.0	16 11.4	17 13.3	16 18.1	16 23.0	16 04.0	16 09.3
19 02.4	18 07.8	19 13.0	18 18.2	17 01.9	20 01.3	18 08.7	19 10.6	18 15.4	18 20.3	18 01.4	18 06.6
20 23.7	20 05.1	21 10.4	20 15.5	18 23.2	21 22.6	20 06.0	21 07.9	20 12.7	20 17.6	19 22.7	20 04.0
22 21.1	22 02.4	23 07.7	22 12.8	20 20.5	23 19.9	22 03.3	23 05.2	22 10.0	22 14.9	21 20.0	22 01.3
24 18.4	23 23.8	25 05.0	24 10.1	22 17.8	25 17.2	24 00.6	25 02.5	24 07.3	24 12.2	23 17.3	23 22.6
26 15.8	25 21.1	27 02.3	26 07.5	24 15.1	27 14.5	25 21.9	26 23.8	26 04.6	26 09.5	25 14.7	25 19.9
28 13.1	27 18.4	28 23.7	28 04.8	26 12.4	29 11.8	27 19.2	28 21.1	28 01.9	28 06.8	27 12.0	27 17.3
30 10.4	29 15.8	30 21.0	30 02.1	28 09.7	30 07.0	29 16.4	30 18.4	29 23.2	30 04.2	29 09.3	29 14.6
											31 11.9

DIONE

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h:h	d h:h	d h:h	d h:h	d h:h	d h:h	d h:h	d h:h	d h:h	d h:h	d h:h	d h:h
1 15.9	3 12.8	1 22.2	1 01.2	1 04.0	3 00.3	3 02.6	2 04.8	1 07.0	1 09.4	3 05.7	3 08.6
4 09.6	6 06.6	4 15.9	3 18.9	3 21.7	5 18.0	5 20.3	4 22.5	4 00.7	4 03.0	5 23.4	6 02.3
7 03.4	9 00.3	7 09.7	6 12.7	6 15.4	8 11.7	8 14.0	7 16.1	6 18.3	6 20.7	8 17.1	8 20.0
9 21.1	11 18.0	10 03.4	9 06.4	9 09.1	11 05.3	11 07.6	10 09.8	9 12.0	9 14.4	11 10.8	11 13.8
12 14.8	14 11.8	12 21.2	12 00.1	12 02.8	13 23.0	14 01.3	13 03.4	12 05.7	12 08.1	14 04.5	14 07.5
15 08.6	17 05.5	15 14.9	14 17.8	14 20.5	16 16.7	16 18.9	15 21.1	14 23.3	15 01.8	16 22.3	17 01.2
18 02.3	19 23.3	18 08.6	17 11.5	17 14.2	19 10.3	19 12.6	18 14.7	17 17.0	17 19.5	19 16.0	19 19.0
20 20.1	22 17.0	21 02.3	20 05.2	20 07.9	22 04.0	22 06.2	21 08.4	20 10.7	20 13.2	22 09.7	22 12.7
23 13.8	25 10.7	23 20.1	22 22.9	23 01.6	24 21.7	24 23.9	24 02.0	23 04.3	23 06.9	25 03.4	25 06.5
26 07.6	28 04.5	26 13.8	25 16.6	25 19.3	27 15.3	27 17.5	26 19.7	25 22.0	26 00.6	27 21.1	28 00.2
29 01.3	29 07.5		28 10.3	28 13.0	30 09.0	30 11.2	29 13.3	28 15.7	28 18.3	30 14.9	30 17.9
31 19.1			31 06.6						31 12.0		

RHEA

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m
3 21.5	4 13.5	2 16.9	3 08.7	5 00.1	1 02.7	2 17.3	3 07.6	3 21.9	1 00.2	1 15.2	3 06.7
8 10.0	9 02.1	7 05.5	7 21.2	9 12.6	5 15.1	7 05.6	7 19.9	8 10.3	5 12.6	6 03.7	7 19.2
12 22.6	13 14.7	11 18.0	12 09.7	14 01.0	10 03.5	11 18.0	12 08.3	12 22.6	10 01.0	10 16.2	12 07.8
17 11.2	18 03.2	16 06.6	16 22.2	18 13.4	14 15.8	16 06.3	16 20.6	17 11.0	14 13.4	15 04.6	16 20.3
21 23.8	22 15.8	20 19.1	21 10.7	23 01.9	19 04.2	20 18.6	21 08.9	21 23.4	19 01.8	19 17.2	21 08.9
26 12.4	27 04.4	25 07.6	25 23.2	27 14.3	23 16.6	25 07.0	25 21.3	26 11.8	23 14.3	24 05.7	25 21.4
31 00.9	29 20.2		30 11.6			28 04.9	29 19.3	30 09.6	28 02.7	28 18.2	30 10.0

ENCELADUS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m	d h.m
1 15.3	2 04.0	1 22.9	1 02.6	1 06.1	1 18.5	1 21.8	1 01.1	1 13.3	1 16.7	2 05.1	2 08.8
3 00.2	3 12.9	3 07.8	2 11.5	2 15.0	3 03.4	3 06.7	2 10.0	2 22.2	3 01.6	3 14.0	3 17.7
4 09.1	4 21.8	4 16.7	3 20.3	3 23.9	4 12.2	4 15.6	3 18.9	4 07.0	4 10.5	4 22.9	5 02.6
5 18.0	6 06.7	6 01.6	5 05.2	5 08.8	5 21.1	6 00.5	5 03.7	5 15.9	5 19.3	6 07.8	6 11.5
7 02.9	7 15.6	7 10.5	6 14.1	6 17.7	7 06.0	7 09.3	6 12.6	7 00.8	7 04.2	7 16.7	7 20.4
8 11.8	9 00.5	8 19.4	7 23.0	8 02.6	8 14.9	8 18.2	7 21.5	8 09.7	8 13.1	9 01.6	9 05.3
9 20.7	10 09.4	10 04.3	9 07.9	9 11.5	9 23.8	10 03.1	9 06.4	9 18.6	9 22.0	10 10.5	10 14.2
11 05.6	11 18.3	11 13.2	10 16.8	10 20.3	11 08.6	11 12.0	10 15.2	11 03.4	11 06.9	11 19.4	11 23.1
12 14.5	13 03.2	12 22.0	12 01.7	12 05.2	12 17.5	12 20.8	12 00.1	12 12.3	12 15.8	13 04.3	13 08.0
13 23.4	14 12.1	14 06.9	13 10.6	13 14.1	14 02.4	14 05.7	13 09.0	13 21.2	14 00.7	14 13.2	14 16.9
15 08.3	15 21.0	15 15.8	14 19.5	14 23.0	15 11.3	15 14.6	14 17.9	15 06.1	15 09.5	15 22.0	16 01.8
16 17.2	17 05.9	17 00.7	16 04.4	16 07.9	16 20.2	16 23.5	16 02.7	16 15.0	16 18.4	17 06.9	17 10.7
18 02.1	18 14.8	18 09.6	17 13.3	17 16.8	18 05.0	18 08.3	17 11.6	17 23.8	18 03.3	18 15.8	18 19.6
19 11.0	19 23.7	19 18.5	18 22.1	19 01.7	19 13.9	19 17.2	18 20.5	19 08.7	19 12.2	20 00.7	20 04.5
20 19.9	21 08.6	21 03.4	20 07.0	20 10.5	20 22.8	21 02.1	20 05.4	20 17.6	20 21.1	21 09.6	21 13.4
22 04.8	22 17.5	22 12.3	21 15.9	21 19.4	22 07.7	22 11.0	21 14.3	22 02.5	22 06.0	22 18.5	22 22.3
23 13.7	24 02.4	23 21.2	23 00.8	23 04.3	23 16.6	23 19.8	22 23.1	23 11.4	23 14.9	24 03.4	24 07.2
24 22.6	25 11.3	25 06.1	24 09.7	24 13.2	25 01.4	25 04.7	24 08.0	24 20.3	24 23.8	25 12.3	25 16.1
26 07.5	26 20.2	26 15.0	25 18.6	25 22.1	26 10.3	26 13.6	25 16.9	26 05.1	26 08.7	26 21.2	27 01.0
27 16.4	28 05.1	27 23.9	27 03.5	27 07.0	27 19.2	27 22.5	27 01.8	27 14.0	27 17.5	28 06.1	28 09.9
29 01.3	29 14.0	29 08.8	28 12.4	28 15.8	29 04.1	29 07.3	28 10.6	28 22.9	29 02.4	29 15.0	29 18.8
30 10.2	30 17.7		29 21.3	30 00.7	30 12.9	30 16.2	29 19.5	30 07.8	30 11.3	30 23.9	31 03.7
31 19.1					31 09.6			31 04.4	31 20.2		

URANUS, NEPTUNE & PLUTO

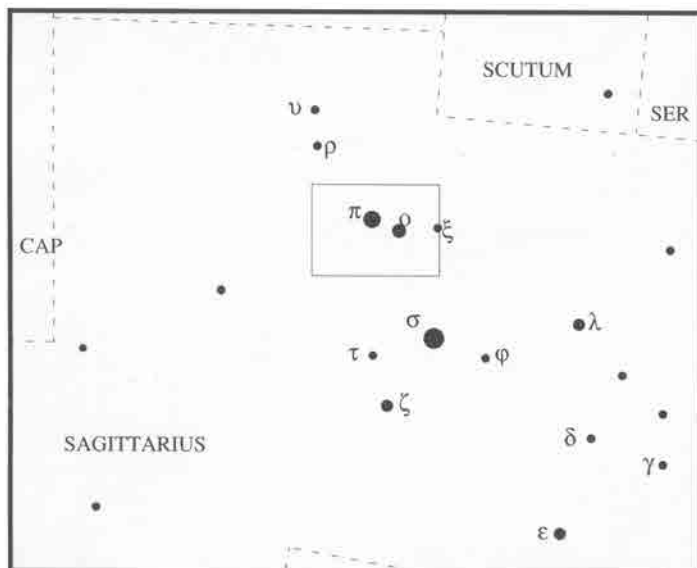
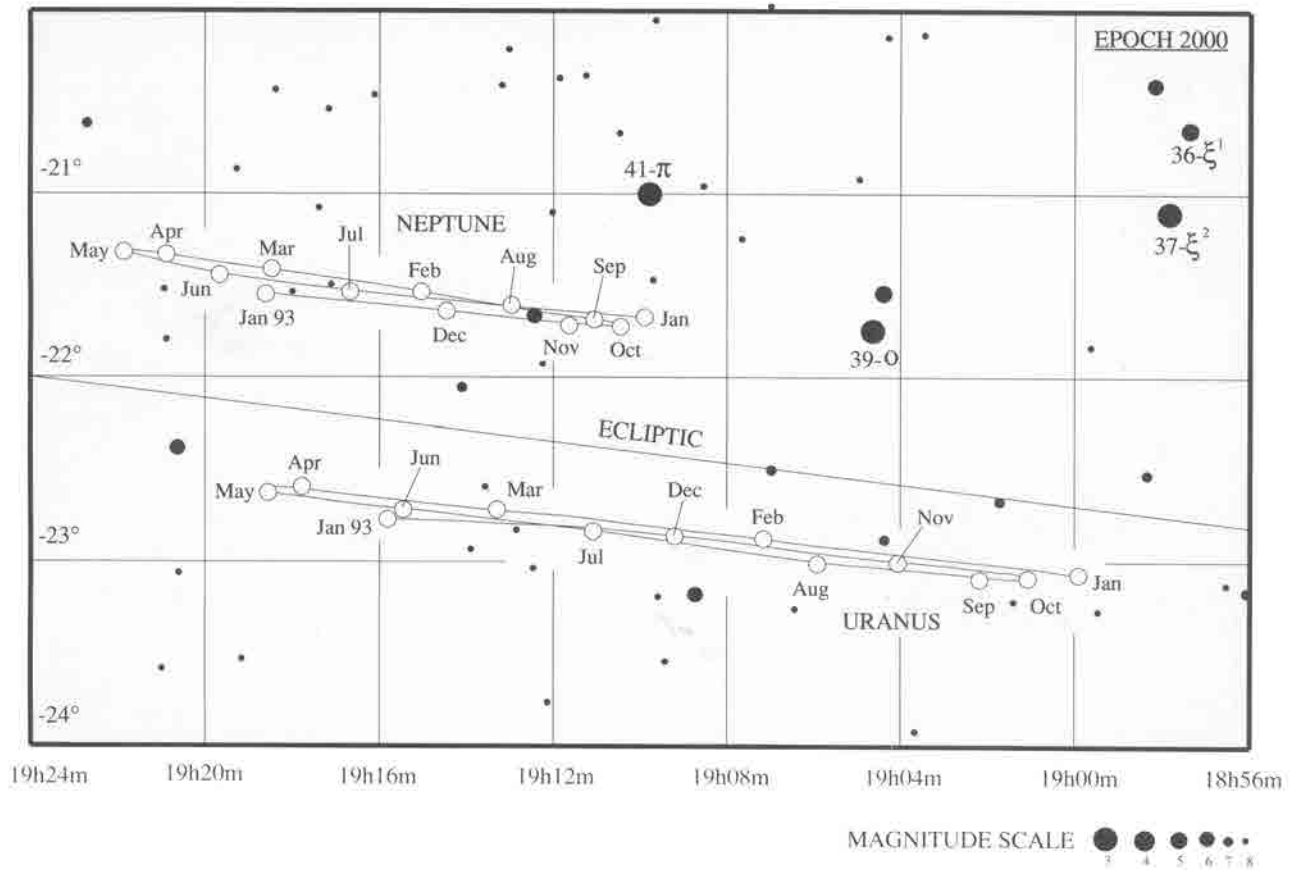
GEOCENTRIC POSITION (Epoch 2000.0) RISE AND SET TIMES E.A.S.T.

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

See Introduction to Part 2 (p. 56) for explanation.

SATELLITES OF URANUS — GREATEST NORTHERN ELONGATION (E.A.S.T.)											
JAN	FEB	MAR	APR	MAY	UMBRIAL		AUG	SEP	OCT	NOV	DEC
^d ^h 4 22.1	^d ^h 2 21.9	^d ^h 2 21.9	^d ^h 5 01.6	^d ^h 4 01.6	^d ^h 2 01.7	^d ^h 1 02.1	^d ^h 3 06.2	^d ^h 1 06.6	^d ^h 4 10.2	^d ^h 2 10.5	^d ^h 1 10.5
9 01.5	7 01.3	7 01.4	9 05.0	8 05.0	6 05.1	5 05.6	7 09.7	5 10.0	8 13.7	6 13.7	5 14.0
13 04.9	11 04.7	11 04.8	13 08.4	12 08.4	10 08.6	9 09.2	11 13.2	9 13.6	12 17.1	10 17.2	9 17.4
17 08.3	15 08.2	15 08.3	17 11.8	16 11.9	14 12.1	13 12.6	15 16.7	13 17.0	16 20.5	14 20.7	13 20.9
21 11.7	19 11.7	19 11.8	21 15.4	20 15.4	18 15.6	17 16.1	19 20.2	17 20.5	21 00.0	19 00.2	18 00.3
25 15.1	23 14.9	23 15.2	25 18.8	24 18.8	22 19.0	21 19.6	23 23.7	21 23.9	25 03.5	23 03.7	22 03.8
29 18.5	27 18.4	27 18.6	29 22.2	28 22.2	26 22.6	25 23.2	28 03.1	26 03.3	29 07.0	27 07.1	26 07.1
		31 22.1				30 02.7		30 06.8			30 10.6
TITANIA											
3 10.8	7 05.9	4 08.3	8 03.6	4 06.4	8 02.3	4 05.4	8 01.6	3 04.8	8 00.8	3 03.3	7 22.4
12 03.6	15 22.7	13 01.1	16 20.5	12 23.3	16 19.3	12 22.4	16 18.7	11 21.8	16 17.6	11 20.1	16 15.1
20 20.3	24 15.5	21 17.9	25 13.4	21 16.3	25 12.3	21 15.5	25 11.7	20 14.8	25 10.5	20 12.9	25 07.9
29 13.1		30 10.7		30 09.2		30 08.5		29 07.9		29 05.6	
OBERON											
6 22.9	2 20.0	14 04.5	10 02.2	7 00.4	2 23.1	13 09.1	9 08.0	5 06.3	2 04.5	11 13.7	8 11.3
20 09.3	16 06.7	27 15.5	23 13.3	20 11.8	16 10.3	26 20.5	22 19.3	18 17.5	15 15.6	25 00.5	21 22.2
	29 17.6				29 21.7				29 02.7		
SATELLITE OF NEPTUNE— GREATEST EASTERN ELONGATION (E.A.S.T.)											
JAN	FEB	MAR	APR	MAY	TRITON		AUG	SEP	OCT	NOV	DEC
^d ^h 5 11.4	^d ^h 3 20.1	^d ^h 4 04.8	^d ^h 2 13.6	^d ^h 1 22.8	^d ^h 6 05.2	^d ^h 5 14.9	^d ^h 4 00.5	^d ^h 2 10.1	^d ^h 1 19.5	^d ^h 6 01.6	^d ^h 5 10.5
11 08.4	9 17.0	10 01.7	8 10.6	7 19.8	12 02.4	11 12.0	9 21.6	8 07.2	7 16.5	11 22.6	11 07.4
17 05.3	15 13.9	15 22.7	14 07.7	13 16.9	17 23.5	17 09.1	15 18.8	14 04.3	13 13.6	17 19.6	17 04.3
23 02.2	21 10.9	21 19.7	20 04.7	19 14.0	23 20.6	23 06.2	21 15.9	20 01.3	19 10.6	23 16.5	23 01.3
28 23.1	27 07.8	27 16.6	26 01.7	25 11.0	29 17.7	29 03.4	27 13.0	25 22.4	25 07.6	29 13.5	28 22.2
				31 08.1					31 04.6		

URANUS & NEPTUNE FINDER CHARTS

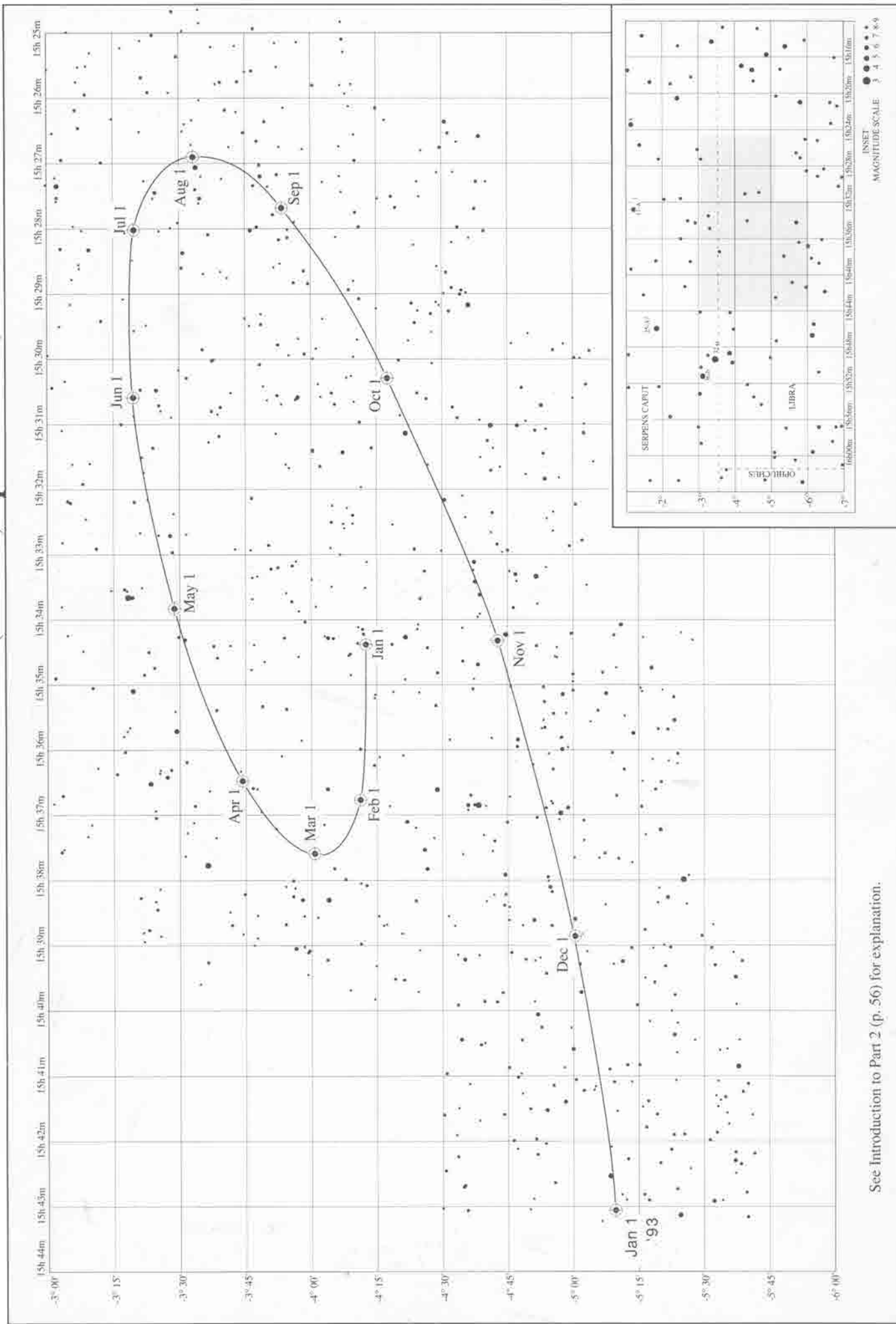


The rectangle in the coarse finder chart at left represents the narrow field view above. Uranus and Neptune can be easily located throughout the year by star-hopping from 2nd magnitude Sigma (σ) Sagittarius to nearby Pi (π) (3rd mag) and Omicron (o) (4th mag).

With a magnitude of about 5.7 Uranus may be seen with the unaided eye under dark sky conditions. Its greenish disk can be resolved in telescopes as small as 75 mm.

At 8th magnitude Neptune can be located with low power binoculars. Using a telescope and at least 200x magnification the planet can be resolved into a bluish disc.

PLUTO FINDER CHART (0hr UT, Epoch 2000.0)



See Introduction to Part 2 (p. 56) for explanation.

METEOR SHOWERS

In addition to the meteor showers listed in the accompanying table, an average of about five to ten 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 last half of the year than the first half.

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).
FM Full Moon NM New Moon FQ First Quarter LQ Last Quarter	
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	NM	Jan 01 - Jan 05	15 20	+49°	5°	41	100
Delta Cancrids	14-Jan	FQ	Jan 05 - Jan 24	08 40	+20°	10°-5°	28	5
Alpha Crucids	19-Jan	FM	Jan 06 - Jan 28	12 48	-63°	10°-5°	50	5
Alpha Carinids	1-Feb	NM	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	FQ	Jan 28 - Feb 21	14 00	-59°	4°	56	5 to 30
Omicron Centaurids	12-Feb	FQ	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	FQ	Feb 25 - Mar 22	16 36	-51°	5°	56	3 to 10
Delta Pavonids	6-Apr	NM	Mar 11 - Apr 16	20 32	-63°	10°-15°	59	13
Lyrids	22-Apr	LQ	Apr 16 - Apr 25	18 04	+34°	5°	49	20
Pi Puppids*	23-Apr	LQ	Apr 15 - Apr 28	07 20	-45°	5°	18	40
Alpha Bootids	28-Apr	LQ	Apr 14 - May 12	14 32	+19°	8°	20	3
Eta Aquarids	4-May	NM	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	FM	Jun 11 - Jun 21	18 32	+35°	5°	31	5
Bootids (Jun)	28-Jun	NM	Jun 28 - Jun 28	14 36	+49°	8°	14	2
Pegasids (Jul)	9-Jul	FQ	Jul 07 - Jul 11	22 40	+15°	5°	70	8
Phoenicids (Jul)	11-Jul	FQ	Jun 24 - Jul 18	01 24	-43°	7°	47	5
Piscis Austrinids	28-Jul	NM	Jul 09 - Aug 17	22 44	-30°	5°	35	8
Alpha Capricornids	30-Jul	NM	Jul 03 - Aug 25	20 32	-10°	8°	23	8
Delta Aquarids S	29-Jul	NM	Jul 08 - Aug 19	22 44	-16°	5°	41	20
Delta Aquarids N	12-Aug	FM	Jul 15 - Aug 25	22 48	-04°	5°	42	5
Iota Aquarids S	5-Aug	FQ	Jul 15 - Aug 25	22 20	-15°	5°	34	3
Iota Aquarids N	20-Aug	LQ	Aug 11 - Sep 20	21 48	-06°	5°	31	3
Perseids	12-Aug	FM	Jul 17 - Aug 24	03 20	+58°	5°	59	100
Kappa Cygnids	18-Aug	FM	Aug 03 - Aug 31	19 04	+59°	6°	25	5
Pi Eridanids	28-Aug	NM	Aug 20 - Sep 05	03 28	-15°	6°	59	7
Alpha Aurigids	1-Sep	NM	Aug 24 - Sep 05	05 36	+42°	5°	66	15
Piscids	24-Sep	NM	Aug 15 - Oct 14	00 32	00°	8°	26	3
Kappa Aquarids	20-Sep	LQ	Sep 08 - Sep 30	22 36	-02°	5°	16	3
Capricornids (Oct)	3-Oct	FQ	Sep 20 - Oct 14	20 12	-10°	5°	15	3
Sigma Orionids	5-Oct	FQ	Sep 10 - Oct 26	05 44	-03°	5°	65	3
Draconids*	9-Oct	FM	Oct 06 - Oct 10	17 28	+54°	5°	20	storm
Epsilon Geminids	19-Oct	LQ	Oct 14 - Oct 27	06 56	+27°	5°	71	5
Orionids	22-Oct	LQ	Oct 02 - Nov 07	06 20	+16°	10°	66	30
Taurids S	3-Nov	FQ	Sep 15 - Nov 26	03 20	+13°	10°-5°	27	12
Taurids N	13-Nov	FM	Sep 13 - Dec 01	03 52	+22°	10°-5°	29	8
Leonids*	17-Nov	LQ	Nov 14 - Nov 21	10 08	+22°	5°	71	storm
Monocerotids (Nov)	20-Nov	LQ	Nov 15 - Nov 25	07 48	-06°	5°	60	5
Phoenicids (Dec)	5-Dec	FQ	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	FM	Nov 27 - Dec 17	06 04	+14°	5°	42	5
Chi Orionids N	2-Dec	FQ	Nov 16 - Dec 15	05 28	+23°	8°	28	3
Sigma Hydrids	11-Dec	FM	Dec 03 - Dec 15	08 28	+02°	5°	58	5
Geminids	14-Dec	LQ	Dec 07 - Dec 17	07 28	+33°	4°	35	100
Coma Berenicids	17-Dec	LQ	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			8 FLORA		
			R. A. hr min	Dec. ° ' "	Mag.	R. A. hr min	Dec. ° ' "	Mag.	R. A. hr min	Dec. ° ' "	Mag.	R. A. hr min	Dec. ° ' "	Mag.	R. A. hr min	Dec. ° ' "	Mag.
Jan	2		17 55.1	-23.54		16 40.0	03.18	12.1	21 16.0	-12.17	13.0	11 49.5	08.23	07.3	08 57.4	18.39	09.1
	9		18 07.5	-24.06		16 50.5	03.39	11.8	21 28.5	-11.41	13.5	11 53.6	08.31	07.1	08 51.5	19.31	08.9
	16		18 19.8	-24.14		17 00.8	04.06	11.5	21 41.1	-10.59	14.1	11 56.6	08.47	07.0	08 44.4	20.26	08.8
	23		18 31.9	-24.19	13.1	17 10.8	04.40	11.2	21 53.9	-10.14		11 58.2	09.13	06.9	08 36.7	21.20	08.6
	30		18 43.9	-24.21	12.5	17 20.3	05.19	11.0	22 06.9	-09.25		11 58.5	09.49	06.7	08 28.9	22.11	08.8
Feb	6		18 55.6	-24.21	11.9	17 29.4	06.04	10.7	22 20.0	-08.32		11 57.3	10.34	06.5	08 21.6	22.56	09.0
	13		19 07.2	-24.18	11.5	17 38.0	06.55	10.4	22 33.2	-07.36		11 54.7	11.27	06.4	08 15.3	23.32	09.2
	20		19 18.4	-24.14	11.1	17 46.1	07.51	10.1	22 46.5	-06.37		11 50.7	12.25	06.2	08 10.5	24.00	09.4
	27		19 29.3	-24.07	10.7	17 53.6	08.53	10.0	22 59.9	-05.35		11 45.5	13.25	06.1	08 07.4	24.19	09.6
Mar	6		19 39.8	-24.00	10.3	18 00.4	09.59	10.0	23 13.4	-04.32		11 39.5	14.24	06.0	08 06.0	24.31	09.8
	13		19 49.9	-23.52	10.0	18 06.5	11.10	09.9	23 27.0	-03.27		11 33.1	15.19	06.0	08 06.4	24.35	10.0
	20		19 59.6	-23.44	09.6	18 11.8	12.25	09.9	23 40.8	-02.20		11 26.6	16.04	06.1	08 08.4	24.32	10.1
	27		20 08.8	-23.36	09.3	18 16.3	13.43	09.8	23 54.6	-01.13		11 20.6	16.39	06.2	08 11.9	24.23	10.3
Apr	3		20 17.5	-23.30	09.1	18 19.8	15.03	09.8	00 08.5	+00.05		11 15.4	17.01	06.3	08 16.7	24.09	10.4
	10		20 25.5	-23.25	09.0	18 22.3	16.24	09.8	00 22.5	+01.03		11 11.4	17.11	06.4	08 22.7	23.50	10.6
	17		20 32.9	-23.23	09.0	18 23.8	17.44	09.7	00 36.6	+02.11		11 08.8	17.07	06.6	08 29.7	23.27	10.7
	24		20 39.6	-23.23	08.9	18 24.2	19.04	09.7	00 50.9	+03.17		11 07.6	16.52	06.7	08 37.5	22.58	10.8
May	1		20 45.5	-23.28	08.8	18 23.5	20.19	09.6	01 05.2	+04.22	13.8	11 07.8	16.27	06.8	08 46.0	22.26	10.9
	8		20 50.5	-23.36	08.7	18 21.7	21.29	09.6	01 19.7	+05.25	13.2	11 09.5	15.52	06.9	08 55.1	21.49	11.0
	15		20 54.6	-23.49	08.6	18 18.8	22.32	09.5	01 34.3	+06.26	12.7	11 12.4	15.09	07.0	09 04.7	21.09	11.1
	22		20 57.8	-24.08	08.5	18 15.0	23.25	09.5	01 49.1	+07.24	12.3	11 16.6	14.19	07.1	09 14.7	20.24	11.2
	29		20 59.8	-24.32	08.4	18 10.3	24.07	09.4	02 03.9	+08.19	11.9	11 21.8	13.22	07.2	09 25.0	19.36	11.2
Jun	5		21 00.6	-25.02	08.3	18 05.0	24.36	09.4	02 18.9	+09.09	11.6	11 28.0	12.20	07.3	09 35.6	18.45	11.4
	12		21 00.3	-25.37	08.2	17 59.2	24.51	09.4	02 34.0	+09.56	11.3	11 35.0	11.14	07.4	09 46.4	17.51	11.7
	19		20 58.7	-26.17	08.1	17 53.3	24.51	09.4	02 49.2	+10.37	11.0	11 42.8	10.03	07.5	09 57.3	16.53	12.0
	26		20 55.9	-27.01	07.9	17 47.4	24.36	09.4	03 04.4	+11.13	10.8	11 51.2	08.49	07.5	10 08.4	15.53	12.3
Jul	3		20 51.9	-27.47	07.8	17 41.8	24.06	09.5	03 19.6	+11.43	10.5	12 00.2	07.32	07.6	10 19.6	14.50	12.6
	10		20 47.0	-28.33	07.7	17 36.8	23.24	09.5	03 34.9	+12.07	10.2	12 09.7	06.12	07.6	10 30.8	13.45	13.0
	17		20 41.2	-29.18	07.6	17 32.6	22.30	09.6	03 50.1	+12.25	10.0	12 19.7	04.50	07.7	10 42.1	12.39	13.3
	24		20 34.9	-30.00	07.5	17 29.2	21.27	09.7	04 05.2	+12.36	09.8	12 30.1	03.26	07.8	10 53.5	11.30	13.7
	31		20 28.4	-30.35	07.5	17 26.8	20.16	09.7	04 20.1	+12.40	09.6	12 40.9	02.00	08.1	11 04.9	10.20	14.1
Aug	7		20 22.1	-31.04	07.7	17 25.4	18.59	09.8	04 34.8	+12.37	09.5	12 52.0	00.34	08.3	11 16.3	09.08	14.6
	14		20 16.3	-31.26	07.8	17 25.0	17.39	09.9	04 49.3	+12.26	09.5	13 03.6	00.53	08.6	11 27.7	07.56	15.2
	21		20 11.3	-31.39	08.0	17 25.7	16.17	10.0	05 03.4	+12.08	09.4	13 15.4	-02.20	08.8	11 39.1	06.42	
	28		20 07.3	-31.46	08.1	17 27.3	14.55	10.0	05 17.0	+11.43	09.3	13 27.6	-03.47	09.1	11 50.6	05.28	
Sep	4		20 04.5	-31.45	08.2	17 29.8	13.33	10.1	05 30.1	+11.11	09.3	13 40.0	-05.13	09.4	12 02.1	04.14	
	11		20 03.0	-31.39	08.4	17 33.2	12.14	10.2	05 42.6	10.33	09.2	13 52.8	-06.38	09.7	12 13.6	03.00	
	18		20 02.9	-31.27	08.5	17 37.3	10.57	10.2	05 54.4	09.48	09.1	14 05.8	-08.02	10.1	12 25.1	01.46	
	25		20 04.0	-31.11	08.6	17 42.2	09.44	10.3	06 05.3	08.58	09.0	14 19.2	-09.24	10.5	12 36.6	00.33	
Oct	2		20 06.3	-30.51	08.7	17 47.7	08.36	10.3	06 15.3	08.03	08.9	14 32.8	-10.44	10.9	12 48.1	00.39	
	9		20 09.7	-30.27	08.8	17 53.9	07.31	10.4	06 24.2	07.04	08.8	14 46.8	-12.01	11.5	12 59.7	-01.50	
	16		20 14.1	-30.01	08.9	18 00.6	06.32	10.7	06 31.9	06.02	08.7	15 01.0	-13.14		13 11.2	-03.00	
	23		20 19.5	-29.31	09.0	18 07.7	05.37	11.0	06 38.3	04.59	08.6	15 15.5	-14.25		13 22.8	-04.09	
	30		20 25.7	-28.59	09.0	18 15.3	04.48	11.3	06 43.1	03.56	08.5	15 30.2	-15.31		13 34.3	-05.15	
Nov	6		20 32.6	-28.24	09.1	18 23.3	04.04	11.6	06 46.5	02.54	08.4	15 45.2	-16.33		13 45.9	-06.19	
	13		20 40.2	-27.47	09.2	18 31.6	03.26	11.9	06 48.1	01.57	08.3	16 00.5	-17.30		13 57.4	-07.21	
	20		20 48.3	-27.07	09.4	18 40.2	02.53	12.3	06 48.0	01.06	08.1	16 16.0	-18.22		14 09.0	-08.20	15.5
	27		20 56.9	-26.24	09.8	18 49.0	02.26	12.6	06 46.2	00.24	08.0	16 31.6	-19.09		14 20.4	-09.17	14.8
Dec	4		21 05.8	-25.40	10.2	18 58.0	02.04	13.0	06 42.9	00.06	07.9	16 47.5	-19.50		14 31.8	-10.10	14.3
	11		21 15.1	-24.52	10.5	19 07.2	01.48	13.4	06 38.2	00.22	07.8	17 03.4	-20.25		14 43.1	-11.00	13.8
	18		21 24.7	-24.03	10.9	19 16.5	01.36	13.8	06 32.6	00.22	07.7	17 19.5	-20.54		14 54.3	-11.46	13.4
	25		21 34.5	-23.11	11.3	19 25.9	01.30	14.3	06 26.5	00.07	07.7	17 35.7	-21.17		15 05.3	-12.28	13.0

		9 METIS				11 PARTENOPE				14 IRENE				15 EUNOMIA				20 MASSALIA		
Jan	2	15 22.8	-15.52	12.8		14 06.7	-08.36	11.8		10 26.0	20.24	10.0		13 44.6	-22.35	11.2	08 28.5	17.44	08.9	
	9	15 33.3	-16.33	12.5		14 15.5	-09.11	11.7		10 26.5	21.13	09.8		13 50.7	-23.31	11.1	08 22.5	18.03	08.7	
	16	15 43.4	-17.10	12.1		14 23.8	-09.41	11.6		10 25.5	22.10	09.6		13 56.2	-24.25	11.0	08 15.7	18.25	08.5	
	23	15 53.2	-17.44	11.8		14 31.6	-10.06	11.5		10 22.9	23.13	09.4		14 00.9	-25.17	11.0	08 08.5	18.48	08.5	
	30	16 02.5	-18.14	11.5		14 38.8	-10.26	11.4		10 18.9	24.19	09.2		14 04.8	-26.05	10.9	08 01.6	19.10	08.7	
Feb	6	16 11.3	-18.41	11.5		14 45.2	-10.41	11.3		10 13.6	25.24	09.1		14 07.9	-26.50	10.8	07 55.6	19.29	09.0	
	13	16 19.5	-19.05	11.4		14 50.8	-10.50	11.2		10 07.5	26.24	09.0		14 09.9	-27.32	10.7	07 51.0	19.45	09.1	
	20	16 27.0	-19.26	11.3		14 55.4	-10.54	11.1		10 01.1	27.16	09.1		14 10.9	-28.08	10.6	07 47.9	19.57	09.3	
	27	16 33.8	-19.44	11.3		14 58.9	-10.52	11.0		09 54.9	27.55	09.2		14 10.7	-28.40	10.5	07 46.6	20.04	09.5	
Mar	6	16 39.6	-20.00	11.2		15 01.3	-10.43	10.9		09 49.3	28.20	09.3		14 09.3	-29.05	10.4	07 47.1	20.06	09.7	
	13	16 44.5	-20.13	11.1		15 02.3	-10.29	10.7		09 44.9	28.31	09.5		14 06.7	-29.23	10.3	07 49.3	20.05	09.9	
	20	16 48.2	-20.25	11.0		15 02.0	-10.10	10.6		09 41.9	28.27	09.7		14 03.0	-29.33	10.2	07 53.1	19.58	10.0	
	27	16 50.8	-20.35	10.9		15 00.4	-09.45	10.4		09 40.6	28.12	09.8		13 58.2	-29.33	10.1	07 58.3	19.48	10.2	
Apr	3	16 52.0	-20.44	10.8		14 57.3	-09.16	10.2		09 40.9	27.45	10.0		13 52.6	-29.24	10.0	08 04.7	19.32	10.3	
	10	16 51.9	-20.51	10.6		14 53.1	-08.43	10.1		09 42.8	27.08	10.1		13 46.3	-29.05	09.9	08 12.2	19.13	10.4	
	17	16 50.3	-20.57	10.5		14 47.7	-08.09	09.9		09 46.2	26.24	10.2		13 39.8	-28.37	09.8	08 20.7	18.48	10.6	
	24	16 47.3	-21.01	10.4		14 41.7	-07.35	09.7		09 50.9	25.32	10.3		13 33.4	-28.01	09.8	08 29.9	18.19	10.7	
May	1	16 42.9	-21.04	10.2		14 35.2	-07.02	09.7		09 56.9	24.33	10.5		13 27.3	-27.18	09.8	08 39.8	17.46	10.8	
	8	16 37.3	-21.05	10.1		14 28.7	-06.34	09.8		10 03.9	23.29	10.6		13 21.8	-26.31	09.9	08 50.2	17.08	10.9	
	15	16 30.7	-21.04	09.9		14 22.7	-06.11	09.9		10 11.8	22.21	10.7		13 17.2	-25.42	10.0	09 01.0	16.26	11.0	
	22	16 23.5	-21.02	09.8		14 17.3	-05.55	10.1		10 20.5	21.07	10.7		13 13.7	-24.54	10.2	09 12.2	15.39	11.0	
	29	16 16.1	-20.58	09.7		14 13.0	-05.48	10.2		10 29.8	19.50	10.8		13 11.2	-24.08	10.3	09 23.6	14.49	11.1	
Jun	5	16 08.8	-20.53	09.9		14 09.9	-05.49	10.3		10 39.6	18.30	10.9		13 09.9	-23.26	10.4	09 35.3	13.55	11.2	
	12	16 02.1	-20.49	10.1		14 08.1	-05.59	10.5		10 49.9	17.05	10.9		13 09.8	-22.49	10.5	09 47.2	12.57	11.4	
	19	15 56.2	-20.45	10.2		14 07.7	-06.16	10.6		11 00.6	15.39	11.0		13 10.7	-22.19	10.6	09 59.1	11.55	11.7	
	26	15 51.4	-20.44	10.3		14 08.5	-06.41	10.7		11 11.6	14.09	11.0		13 12.7	-21.54	10.7	10 11.2	10.51	12.0	
Jul	3	15 47.9	-20.45	10.5		14 10.7	-07.12	10.8		11 22.9	12.37	11.1		13 15.6	-21.37	10.8	10 23.4	09.44	12.3	
	10	15 45.8	-20.49	10.6		14 14.0	-07.49	10.9		11 34.5	11.04	11.4		13 19.4	-21.25	10.8	10 35.5	08.34	12.6	
	17	15 45.1	-20.56	10.7		14 18.5	-08.31	11.0		11 46.3	09.29	11.7		13 24.1	-21.19	10.9	10 47.8	07.22	12.9	
	24	15 45.7	-21.07	10.9		14 24.0	-09.17	11.1		11 58.2	07.53	12.0		13 29.5	-21.20	11.0	11 00.0	06.09	13.2	
	31	15 47.6	-21.20	11.0		14 30.4	-10.05	11.2		12 10.3	06.16	12.3		13 35.5	-21.25	11.0	11 12.3	04.53	13.6	
Aug	7	15 50.6	-21.37	11.1		14 37.7	-10.56	11.2		12 22.6	04.39	12.6		13 42.2	-21.34	11.1	11 24.5	03.36	14.0	
	14	15 54.9	-21.56	11.2		14 45.8	-11.49	11.3		12 35.0	03.01	12.8		13 49.4	-21.48	11.2	11 36.8	02.19	14.5	
	21	16 00.1	-22.17	11.3		14 54.6	-12.43	11.3		12 47.6	01.24	13.2		13 57.2	-22.05	11.5	11 49.1	01.00	15.0	
	28	16 06.3	-22.39	11.3		15 04.2	-13.37	11.4		13 00.3	00.12	13.5		14 05.4	-22.26	11.9	12 01.4	00.18		
Sep	4	16 13.3	-23.02	11.4		15 14.3	-14.31	11.4		13 13.1	-01.47	13.8		14 14.1	-22.48	12.2	12 13.7	-01.37		
	11	16 21.1	-23.25	11.5		15 25.1	-15.24	11.7		13 26.1	-03.21	14.2		14 23.2	-23.13	12.5	12 26.0	-02.56		
	18	16 29.7	-23.48	11.5		15 36.4	-16.16	11.9		13 39.3	-04.53	14.7		14 32.6	-23.39	12.8	12 38.4	-04.14		
	25	16 38.9	-24.11	11.6		15 48.3	-17.06	12.2		13 52.6	-06.23	15.2		14 42.4	-24.07	13.2	12 50.7	-05.31		
Oct	2	16 48.7	-24.32	12.0		16 00.6	-17.54	12.5		14 06.0	-07.51			14 52.6	-24.34	13.6	13 03.1	-06.47		
	9	16 59.0	-24.52	12.3		16 13.4	-18.38	12.8		14 19.6	-09.16			15 03.0	-25.02	14.1	13 15.5	-08.02		
	16	17 09.9	-25.09	12.6		16 26.7	-19.19	13.1		14 33.3	-10.37			15 13.8	-25.30	14.7	13 27.9	-09.15		
	23	17 21.2	-25.24	12.9		16 40.3	-19.57	13.4		14 47.1	-11.55			15 24.8	-25.57		13 40.4	-10.26		
	30	17 32.9	-25.37	13.2		16 54.3	-20.30	13.8		15 01.1	-13.09			15 36.0	-26.24		13 52.8	-11.35		
Nov	6	17 44.9	-25.46	13.6		17 08.7	-20.58	14.2		15 15.2	-14.20			15 47.5	-26.48		14 05.3	-12.41		
	13	17 57.3	-25.52	14.0		17 23.3	-21.22	14.7		15 29.3	-15.26			15 59.1	-27.12		14 17.7	-13.44		
	20	18 09.9	-25.54	14.5		17 38.2	-21.40	15.3		15 43.6	-16.27			16 11.0	-27.33		14 30.2	-14.45		
	27	18 22.8	-25.53	15.1		17 53.4	-21.53			15 58.0	-17.23			16 22.9	-27.52		14 42.6	-15.42		
Dec	4	18 35.8	-25.47			18 08.7	-22.00			16 12.4	-18.15			16 35.1	-28.08		14 54.9	-16.36	15.5	
	11	18 49.0	-25.38			18 24.2	-22.01			16 26.8	-19.02			16 47.3	-28.22		15 07.2	-17.26	14.9	
	18	19 02.4	-25.24			18 39.8	-21.56			16 41.2	-19.43			16 59.5	-28.33		15 19.3	-18.13	14.3	
	25	19 15.8	-25.06			18 55.4	-21.45			16 55.6	-20.20			17 11.8	-28.41		15 31.3	-18.55	13.9	

MINOR PLANET POSITIONS (0hr UT, Epoch 2000.0)

		21 LUTETIA				29 AMPHITRITE				39 LAETITIA				40 HARMONIA				44 NYSA											
		R. A.		Dec.		Mag.		R. A.		Dec.		Mag.		R. A.		Dec.		Mag.		R. A.		Dec.		Mag.					
		hr	min	°	'			hr	min	°	'			hr	min	°	'			hr	min	°	'						
Jan	2	16	10.9	-19.49	14.8			06	52.1	32.52	08.9			21	06.8	-14.59	14.4			08	39.3	21.14	10.2			08	02.1	18.01	09.2
	9	16	24.0	-20.24	14.4			06	44.1	32.50	09.0			21	19.6	-14.18	15.0			07	32.9	21.55	10.0			07	55.7	18.35	09.0
	16	16	37.1	-20.55	14.1			06	36.8	32.41	09.2			21	32.4	-13.33				08	25.6	22.37	09.8			07	48.7	19.11	08.9
	23	16	50.1	-21.22	13.7			06	30.6	32.25	09.3			21	45.3	-12.45				08	17.8	23.16	09.8			07	41.9	19.47	09.1
	30	17	03.0	-21.44	13.4			06	25.9	32.04	09.5			21	58.1	-11.53				08	10.1	23.51	10.0			07	35.7	20.22	09.2
Feb	6	17	15.8	-22.03	13.0			06	23.0	31.40	09.6			22	11.0	-10.58				08	03.0	24.21	10.1			07	30.8	20.52	09.4
	13	17	28.4	-22.18	12.7			06	21.7	31.14	09.8			22	23.8	-10.01				07	57.1	24.43	10.3			07	27.3	21.19	09.6
	20	17	40.7	-22.29	12.3			06	22.2	30.46	09.9			22	36.7	-09.01				07	52.6	24.58	10.5			07	25.6	21.40	09.7
	27	17	52.7	-22.37	12.2			06	24.4	30.19	10.1			22	49.5	-08.00				07	49.7	25.07	10.6			07	25.8	21.56	09.9
Mar	6	18	04.4	-22.41	12.2			06	28.0	29.51	10.2			23	02.2	-06.57				07	48.6	25.10	10.8			07	27.8	22.07	10.1
	13	18	15.5	-22.43	12.1			06	32.9	29.23	10.3			23	14.9	-05.53				07	49.2	25.07	10.9			07	31.4	22.13	10.2
	20	18	26.2	-22.43	12.0			06	39.0	28.55	10.5			23	27.5	-04.48				07	51.3	24.59	11.1			07	36.6	22.13	10.4
	27	18	36.3	-22.41	11.9			06	46.2	28.27	10.6			23	40.1	-03.44				07	54.9	24.47	11.2			07	43.2	22.08	10.5
Apr	3	18	45.6	-22.38	11.8			06	54.2	27.57	10.7			23	52.6	-02.39				07	59.8	24.30	11.3			07	50.9	21.58	10.6
	10	18	54.2	-22.34	11.7			07	03.0	27.26	10.7			00	05.0	-01.34				08	05.8	24.10	11.4			07	59.7	21.43	10.7
	17	19	01.9	-22.31	11.5			07	12.5	26.54	10.8			00	17.4	00.31				08	12.9	23.45	11.5			08	09.3	21.23	10.8
	24	19	08.5	-22.30	11.4			07	22.5	26.19	10.9			00	29.7	00.31	14.8			08	20.8	23.17	11.6			08	19.6	20.57	11.0
May	1	19	14.1	-22.30	11.2			07	32.9	25.42	10.9			00	41.9	01.32	14.3			08	29.4	22.44	11.7			08	30.5	20.26	11.0
	8	19	18.3	-22.32	11.1			07	43.7	25.03	11.2			00	54.1	02.30	13.8			08	38.7	22.08	11.8			08	41.9	19.50	11.1
	15	19	21.2	-22.38	10.9			07	54.8	24.21	11.5			01	06.1	03.26	13.4			08	48.5	21.28	11.9			08	53.7	19.09	11.2
	22	19	22.5	-22.48	10.7			08	06.1	23.37	11.8			01	18.0	04.20	13.1			08	58.7	20.45	11.9			09	05.8	18.23	11.3
	29	19	22.3	-23.03	10.5			08	17.6	22.49	12.1			01	29.8	05.10	12.8			09	09.3	19.57	12.1			09	18.2	17.33	11.4
Jun	5	19	20.4	-23.21	10.3			08	29.2	21.59	12.4			01	41.4	05.57	12.5			09	20.2	19.06	12.4			09	30.7	16.38	11.5
	12	19	17.0	-23.42	10.1			08	40.9	21.05	12.8			01	52.9	06.40	12.2			09	31.3	18.12	12.6			09	43.3	15.40	11.7
	19	19	12.1	-24.07	09.9			08	52.7	20.09	13.1			02	04.2	07.19	11.9			09	42.6	17.14	12.9			09	56.0	14.38	12.0
	26	19	06.0	-24.32	09.7			09	04.5	19.10	13.5			02	15.2	07.53	11.6			09	54.1	16.14	13.2			10	08.8	13.32	12.2
	3	18	59.2	-24.56	09.4			09	16.4	18.09	14.0			02	25.9	08.23	11.3			10	05.7	15.10	13.5			10	21.6	12.23	12.5
Jul	10	18	52.2	-25.19	09.6			09	28.2	17.05	14.5			02	36.3	08.47	11.2			10	17.4	14.04	13.8			10	34.4	11.12	12.8
	17	18	45.5	-25.38	09.8			09	39.9	15.58	15.1			02	46.4	09.07	11.1			10	29.1	12.55	14.2			10	47.2	09.58	13.1
	24	18	39.6	-25.53	09.9			09	51.7	14.50				02	55.9	09.20	11.1			10	41.0	11.44	14.6			11	00.0	08.42	13.4
	31	18	35.0	-26.04	10.1			10	03.3	13.39				03	05.0	09.28	11.0			10	52.9	10.30	15.0			11	12.8	07.25	13.8
	7	18	32.0	-26.12	10.3			10	15.0	12.27				03	13.4	09.30	10.9			11	04.8	09.16	15.6			11	25.6	06.06	14.2
Aug	14	18	30.8	-26.17	10.4			10	26.5	11.13				03	21.1	09.26	10.8			11	16.8	07.59				11	38.3	04.46	14.7
	21	18	31.4	-26.18	10.6			10	38.0	09.58				03	28.1	09.16	10.8			11	28.8	06.41				11	51.1	03.25	15.2
	28	18	33.8	-26.18	10.7			10	49.4	08.41				03	34.1	08.59	10.7			11	40.9	05.23				12	03.8	02.05	
	4	18	37.9	-26.14	10.8			11	00.7	07.23				03	39.1	08.36	10.6			11	53.0	04.03				12	16.5	00.44	
	11	18	43.6	-26.08	11.0			11	12.0	06.05				03	43.0	08.07	10.5			12	05.1	02.43				12	29.2	00.37	
Sep	18	18	50.8	-25.59	11.1			11	23.1	04.47				03	45.6	07.32	10.3			12	17.3	01.23				12	42.0	-01.56	
	25	18	59.2	-25.46	11.2			11	34.2	03.28				03	47.0	06.53	10.2			12	29.6	00.04				12	54.7	-03.15	
	2	19	08.7	-25.30	11.3			11	45.2	02.09				03	46.9	06.09	10.1			12	41.8	-01.16				13	07.4	-04.32	
	9	19	19.2	-25.09	11.4			11	56.1	00.50				03	45.5	05.22	10.0			12	54.2	-02.34				13	20.2	-05.48	
	16	19	30.6	-24.44	11.5			12	06.9	00.28				03	42.7	04.34	09.9			13	06.5	-03.52				13	32.9	-07.02	
Oct	23	19	42.7	-24.15	11.6			12	17.5	-01.46	15.2			03	38.8	03.46	09.7			13	18.9	-05.08				13	45.7	-08.13	
	30	19	55.3	-23.40	11.6			12	28.1	-03.02	14.6			03	33.8	03.01	09.6			13	31.4	-06.22				13	58.4	-09.22	
	6	20	08.5	-23.00	11.7			12	38.5	-04.18	14.0			03	28.2	02.21	09.6			13	43.9	-07.35				14	11.2	-10.28	
	13	20	22.1	-22.14	11.7			12	48.8	-05.32	13.6			03	22.3	01.49	09.6			13	56.5	-08.45				14	23.9	-11.31	
	20	20	35.9	-21.23	11.8			12	58.9	-06.44	13.2			03	16.4	01.25	09.7			14	09.1	-09.53	16.0			14	36.7	-12.31	
Nov	27	20	50.0	-20.27	11.9			13	08.8	-07.54	12.8			03	11.0	01.12	09.8			14	21.7	-10.58	15.3			14	49.3	-13.27	
	4	21	04.3	-19.26	12.2			13	18.4	-09.03	12.5			03	06.3	01.09	09.9			14	34.3	-11.59	14.8			15	01.9	-14.19	15.8
	11	21	18.7	-18.20	12.5			13	27.8	-10.08	12.1			03	02.6	01.17	10.1			14	46.9	-12.58	14.3			15	14.5	-15.08	15.2
	18	21	33.2	-17.09	12.8			13	36.8	-11.12	11.8			03	00.1	01.34	10.2			14	59.4	-13.53	13.9			15	26.9	-15.52	14.6
	25	21	47.8	-15.54	13.0			13	45.5	-12.13	11.5			02	58.9	02.00	10.4			15	11.9								

		68 LETO				349 DEMBOWSKA				471 PAPAGENA				532 HERCULINA			
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COMETS FOR 1992

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” and those comets more recently discovered (during 1991), that are expected to reach perihelion during 1992. The table below lists these objects. The tables on the following page, give “ephemerides” (a list of expected positions in the sky for different dates) for some of these brighter comets. Most of the comets expected in 1992 are extremely faint and would require professional size telescopes or long exposure astrophotographs to detect them.

NOTES ON SELECTED COMETS FOR 1992

COMET SHOEMAKER-LEVY (1991a1)

This is possibly “the” comet for 1992 (at least for those comets known about at the time of publication). The comet starts the year off, low in the north-western evening sky and moves west until it is lost from the night sky by mid February. It stays in the daylight sky until early June, when it’s high inclination takes it below the northern horizon. 1991 a1 reappears in the north-western evening sky in mid July, just before perihelion. The last week

in July may be the best time to observe the comet. By then it will have cleared twilight (before setting), still at or near maximum brightness and there is no moon to interfere. For the remainder of the year, the comet’s high inclination continues to sweep it further south, until early December when it becomes circumpolar. “Circumpolar”, for Australian latitudes, means the comet’s (or any object’s) declination is far enough south (south of -57° for Sydney) so that it does not set.

COMET HELIN-LAWRENCE (1991I)

At the start of the year, the comet is at maximum brightness being close to perihelion passage. Like 1991 a (see above) this comet has a very high inclination. For the whole of January, “Helin-Lawrence” is circumpolar from anywhere in Australia. However, for the month, during the night, it stays low in the sky being under the “south celestial pole” As it moves north it slowly moves into the western morning sky. It mid February, it rises at around 6:00am- setting at midnight. It continues to rise earlier each day until in late July when it rises at around midnight.

Both comets, Helin-Lawrence(1991I) and Shoemaker-Levy (1991 a1) have unusually high inclinations of 95° and 114° respectively. The inclination is the tilt (or angle) of the plane of the comet’s orbit to the plane of the ecliptic. Most comets have much lower inclinations. With inclinations exceeding 90°, these two comet orbits are effectively going around the Sun in the opposite direction compared to the planets ie they are in retrograde orbits.

EXPLANATION OF COMET EPHEMERIDES

DATE is for 0 hr UT or 10am E.A.S.T. of date.

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

Δ 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 yardstick for measuring distances in the Solar System.)

ELONG. is the Sun-Earth-Comet angle, in degrees. It gives the observer an indication of how close the comet is to the Sun. Will it be difficult to observe because it is in the twilight?

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 :

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

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 1992

NAME	PERIHELION DATE	PERIHELION DISTANCE (AU)	NAME	PERIHELION DATE	PERIHELION DISTANCE (AU)
Helin-Lawrence (1991I) (*)	Jan-20	0.829	p Shoemaker 2	Aug-06	1.327
p Chernykh (*)	Jan-27	2.36	p du Toit-Hartley	Aug-27	1.197
Helin-Alu (1991r)	Feb-17	4.873	p Wolf	Aug-28	2.428
p Giacobini-Zinner (*)	Apr-13	1.034	p Daniel	Sep-01	1.649
p Tsuchinshan 2	May-20	1.782	p Schuster	Sep-06	1.539
p Kowal 1	Jun-12	4.673	p Giclas	Sep-13	1.846
p Grigg-Skjellerup (*)	Jul-22	0.994	p Singer-Brewster	Oct-28	2.027
Shoemaker-Levy (1991 a1) (*)	Jul-23	0.829	p Gale	Dec-18	1.214
p Smirnova-Chernykh	Aug-05	3.572			

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

“p” prefix means the comet is known to be periodic.

p CHERNYKH

Year	Mon	Day	R.A. h m	Dec °	Δ AU	R AU	Elong °	Mag
1992	Jan	4	00 15.3	-03 45	2.344	2.364	079	12.6
1992	Jan	11	00 25.4	-02 32	2.419	2.360	075	12.6
1992	Jan	18	00 36.0	-01 16	2.494	2.357	071	12.7
1992	Jan	25	00 47.1	+00 02	2.568	2.356	067	12.7
1992	Feb	1	00 58.6	+01 22	2.642	2.357	063	12.8
1992	Feb	8	01 10.4	+02 42	2.714	2.359	059	12.9
1992	Feb	15	01 22.6	+04 03	2.786	2.363	055	12.9
1992	Feb	22	01 35.1	+05 24	2.856	2.368	051	13.0
1992	Feb	29	01 47.8	+06 44	2.924	2.375	048	13.1
1992	Mar	7	02 00.8	+08 02	2.991	2.383	044	13.1
1992	Mar	14	02 14.0	+09 18	3.056	2.393	041	13.2
1992	Mar	21	02 27.4	+10 32	3.118	2.404	037	13.2
1992	Mar	28	02 41.0	+11 44	3.179	2.417	034	13.3
1992	Apr	4	02 54.7	+12 51	3.237	2.431	031	13.4
1992	Apr	11	03 08.6	+13 55	3.293	2.446	027	13.4
1992	Apr	18	03 22.5	+14 56	3.346	2.463	024	13.5
1992	Apr	25	03 36.5	+15 51	3.396	2.481	021	13.6
1992	May	2	03 50.6	+16 43	3.443	2.500	017	13.6
1992	May	9	04 04.7	+17 29	3.487	2.520	014	13.7
1992	May	16	04 18.8	+18 11	3.527	2.542	011	13.7

p GIACOBINI-ZINNER

Year	Mon	Day	R.A. h m	Dec °	Δ AU	R AU	Elong °	Mag
1992	May	23	03 39.8	+09 13	2.143	1.174	012	12.0
1992	May	30	04 05.9	+08 53	2.180	1.222	014	12.2
1992	Jun	6	04 31.0	+08 26	2.221	1.273	016	12.4
1992	Jun	13	04 55.0	+07 51	2.265	1.329	017	12.6
1992	Jun	20	05 17.9	+07 10	2.311	1.387	019	12.8
1992	Jun	27	05 39.7	+06 23	2.358	1.447	020	13.1
1992	Jul	4	06 00.4	+05 31	2.406	1.508	022	13.3
1992	Jul	11	06 20.0	+04 34	2.454	1.571	023	13.5
1992	Jul	18	06 38.6	+03 34	2.501	1.634	025	13.7
1992	Jul	25	06 56.2	+02 30	2.546	1.698	026	13.9
1992	Aug	1	07 12.9	+01 22	2.589	1.762	028	14.1
1992	Aug	8	07 28.6	+00 13	2.629	1.826	030	14.3
1992	Aug	15	07 43.5	-00 59	2.665	1.890	032	14.5
1992	Aug	22	07 57.5	-02 13	2.698	1.954	035	14.7
1992	Aug	29	08 10.7	-03 28	2.726	2.017	037	14.8
1992	Sep	5	08 23.1	-04 45	2.749	2.080	040	15.0
1992	Sep	12	08 34.7	-06 02	2.766	2.142	043	15.1
1992	Sep	19	08 45.5	-07 20	2.779	2.204	046	15.3
1992	Sep	26	08 55.6	-08 39	2.785	2.265	049	15.4
1992	Oct	3	09 04.9	-09 57	2.786	2.325	053	15.5

HELIN-LAWRENCE (19911)

Year	Mon	Day	R.A. h m	Dec °	Δ AU	R AU	Elong °	Mag
1992	Jan	4	16 23.5	-82 31	1.741	1.536	061	08.5
1992	Jan	11	21 10.9	-82 49	1.723	1.525	062	08.5
1992	Jan	18	23 19.3	-76 12	1.731	1.520	061	08.5
1992	Jan	25	00 02.9	-68 29	1.764	1.521	059	08.5
1992	Feb	1	00 25.3	-60 57	1.821	1.528	057	08.6
1992	Feb	8	00 40.0	-53 55	1.896	1.542	054	08.7
1992	Feb	15	00 51.0	-47 31	1.985	1.561	051	08.9
1992	Feb	22	01 00.1	-41 45	2.084	1.586	047	09.1
1992	Feb	29	01 07.9	-36 35	2.189	1.617	043	09.3
1992	Mar	7	01 14.9	-31 58	2.294	1.652	039	09.5
1992	Mar	14	01 21.4	-27 51	2.399	1.692	036	09.7
1992	Mar	21	01 27.4	-24 09	2.499	1.735	032	09.9
1992	Mar	28	01 33.1	-20 48	2.593	1.783	029	10.1
1992	Apr	4	01 38.5	-17 47	2.679	1.833	026	10.3
1992	Apr	11	01 43.6	-15 02	2.756	1.886	024	10.5
1992	Apr	18	01 48.4	-12 31	2.822	1.942	023	10.7
1992	Apr	25	01 53.0	-10 11	2.878	2.000	024	10.9
1992	May	2	01 57.2	-08 03	2.923	2.060	026	11.0
1992	May	9	02 01.2	-06 03	2.956	2.122	028	11.2
1992	May	16	02 04.8	-04 11	2.978	2.185	032	11.4

SHOEMAKER-LEVY (1991a1)

Year	Mon	Day	R.A. h m	Dec °	Δ AU	R AU	Elong °	Mag
1992	Jan	4	00 18.5	+31 19	2.935	3.162	094	14.8
1992	Jan	11	00 14.7	+30 37	2.975	3.079	087	14.8
1992	Jan	18	00 12.2	+30 03	3.014	2.996	080	14.7
1992	Jan	25	00 10.7	+29 38	3.048	2.912	073	14.6
1992	Feb	1	00 10.3	+29 23	3.077	2.827	066	14.5
1992	Feb	8	00 10.8	+29 16	3.098	2.742	060	14.3
1992	Feb	15	00 12.0	+29 19	3.110	2.655	054	14.2
1992	Feb	22	00 13.9	+29 31	3.111	2.568	049	14.1
1992	Feb	29	00 16.3	+29 52	3.101	2.481	044	13.9
1992	Mar	7	00 19.3	+30 22	3.078	2.392	039	13.7
1992	Mar	14	00 22.7	+31 00	3.043	2.303	035	13.5
1992	Mar	21	00 26.5	+31 48	2.993	2.212	032	13.3
1992	Mar	28	00 30.7	+32 45	2.930	2.121	030	13.1
1992	Apr	4	00 35.1	+33 53	2.853	2.030	028	12.9
1992	Apr	11	00 39.9	+35 11	2.761	1.938	028	12.6
1992	Apr	18	00 45.0	+36 41	2.656	1.845	029	12.3
1992	Apr	25	00 50.4	+38 25	2.537	1.752	031	12.0
1992	May	2	00 56.2	+40 25	2.404	1.658	033	11.6
1992	May	9	01 02.6	+42 45	2.260	1.565	036	11.2
1992	May	16	01 09.7	+45 29	2.104	1.472	040	10.8
1992	May	23	01 17.9	+48 44	1.937	1.380	043	10.3
1992	May	30	01 28.2	+52 39	1.763	1.289	046	09.8
1992	Jun	6	01 42.3	+57 25	1.583	1.201	049	09.3
1992	Jun	13	02 04.9	+63 19	1.403	1.117	052	08.7
1992	Jun	20	02 50.7	+70 28	1.229	1.038	054	08.1
1992	Jun	27	04 58.6	+77 22	1.074	0.968	055	07.5
1992	Jul	4	09 04.4	+74 54	0.955	0.908	055	07.0
1992	Jul	11	10 55.7	+60 51	0.894	0.863	053	06.6
1992	Jul	18	11 34.3	+43 40	0.905	0.836	051	06.5
1992	Jul	25	11 51.2	+27 41	0.985	0.830	049	06.7
1992	Aug	1	11 59.7	+14 43	1.114	0.844	046	07.0
1992	Aug	8	12 04.2	+04 44	1.268	0.877	043	07.4
1992	Aug	15	12 06.8	-02 58	1.431	0.928	040	08.0
1992	Aug	22	12 08.5	-09 03	1.591	0.992	037	08.5
1992	Aug	29	12 09.9	-14 03	1.743	1.065	034	09.0
1992	Sep	5	12 11.2	-18 17	1.884	1.146	031	09.5
1992	Sep	12	12 12.6	-21 60	2.012	1.232	029	09.9
1992	Sep	19	12 14.0	-25 22	2.127	1.321	028	10.3
1992	Sep	26	12 15.5	-28 30	2.227	1.412	027	10.7
1992	Oct	3	12 17.0	-31 29	2.315	1.505	028	11.1
1992	Oct	10	12 18.3	-34 23	2.389	1.598	030	11.4
1992	Oct	17	12 19.4	-37 14	2.452	1.691	032	11.7
1992	Oct	24	12 20.1	-40 04	2.503	1.785	035	12.0
1992	Oct	31	12 20.3	-42 55	2.544	1.878	039	12.3
1992	Nov	7	12 19.7	-45 47	2.577	1.971	043	12.5
1992	Nov	14	12 18.1	-48 42	2.601	2.063	047	12.7
1992	Nov	21	12 15.0	-51 38	2.620	2.154	052	12.9
1992	Nov	28	12 10.0	-54 36	2.633	2.245	056	13.1
1992	Dec	5	12 02.5	-57 34	2.643	2.334	061	13.3
1992	Dec	12	11 51.6	-60 29	2.652	2.423	066	13.5
1992	Dec	19	11 36.3	-63 17	2.661	2.512	071	13.6
1992	Dec	26	11 15.3	-65 50	2.672	2.599	075	13.8
1993	Jan	2	10 47.4	-68 01	2.687	2.686	079	13.9

p GRIGG-SKJELLERUP

Year	Mon	Day	R.A. h m	Dec °	Δ AU	R AU	Elong °	Mag
1992	May	30	07 42.6	+07 39	1.636	1.230	049	15.0
1992	Jun	6	08 04.8	+07 49	1.602	1.179	047	14.7
1992	Jun	13	08 28.4	+07 51	1.567	1.132	046	14.5
1992	Jun	20	08 53.5	+07 44	1.530	1.090	045	14.3
1992	Jun	27	09 20.1	+07 30	1.494	1.055	045	14.1
1992	Jul	4	09 48.1	+07 07	1.459	1.027	045	13.9
1992	Jul	11	10 17.5	+06 37	1.426	1.007	045	13.8
1992	Jul	18	10 47.9	+05 58	1.398	0.996	045	13.7
1992	Jul	25	11 19.4	+05 12	1.376	0.996	046	13.7
1992	Aug	1	11 51.5	+04 19	1.361	1.004	047	13.7
1992	Aug	8	12 24.0	+03 21	1.353	1.022	049	13.8
1992	Aug	15	12 56.7	+02 18	1.355	1.049	050	13.9
1992	Aug	22	13 29.2	+01 12	1.367	1.083	052	14.0
1992	Aug	29	14 01.1	+00 05	1.389	1.124	053	14.2
1992	Sep	5	14 32.4	-01 01	1.422	1.170	054	14.4
1992	Sep	12	15 02.6	-02 04	1.465	1.221	056	14.7
1992	Sep	19	15 31.8	-03 02	1.518	1.275	056	15.0
1992	Sep	26	15 59.8	-03 55	1.580	1.332	057	15.2
1992	Oct	3	16 26.6	-04 40	1.650	1.390	057	15.5
1992	Oct	10	16 52.1	-05 17	1.729	1.451	057	15.8

PART 3

APPENDIX A - RISE/SET TIME CORRECTIONS FOR OTHER LOCATIONS

As mentioned previously, all rise/set times in this publication are calculated for Sydney (151°15'E, 33°54'S). This section is designed to help people 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 below (see table 1).
- 2). An adjustment for the difference in latitude, which 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 - 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 C for your location/ object's declination. This answer is in degrees; you need to then multiply by 4 to convert to minutes.

Example Rise/set times Correction

Calculate the rise/set times for the Sun on Jan 25 for Brisbane (27° 30'S, 153° 01'E)

	Rise	Set
From p. 69 the rise/set values are:-	5:08	19:05
Adjust for longitude (151.25-153.0)*4 (value is negative due to.....)	- :07	- :07
Brisbane being East of Syd.)		
Adjust for latitude/Declination of Sun from table 2	+ :13	- :13
(Dec. = -19°10' see p68)		
Rise/Set times for Brisbane are :-	5:14	18:45

TABLE 1
LONGITUDE ADJUSTS FOR SOME TOWNS/CITIES

Location	Latitude (° S)	Longitude (° E)	Change in Longitude (decimal °)	correction (mins.)
Adelaide	34 58	138 38	+ 12.6	+ 50
Albury	36 05	146 55	+ 4.3	+ 17
Bathurst	33 25	149 34	+ 1.7	+ 7
Brisbane	27 30	153 01	- 1.8	- 7
Canberra	35 10	149 05	+ 2.2	+ 9
Dubbo	32 15	148 37	+ 2.6	+ 11
Gosford	33 26	151 21	0	0
Goulburn	34 45	149 43	+ 1.5	+ 6
Katoomba	33 42	150 18	+ 1.0	+ 4
Melbourne	37 50	145 00	+ 6.3	+ 25
Newcastle	32 55	151 45	- 0.5	- 2
Parkes	33 05	148 10	+ 3.1	+ 12
Perth	32 00	115 50	+ 35.4	+ 142
Sydney	33 54	151 15	-----	-----
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

TABLE 2
RISE/SET CORRECTIONS FOR LATITUDE/DECLINATION

		Latitude (°)											
		-26	-28	-30	-32	-34	-36	-38	-40	-42	-44		
Declination (°)	+30	-26	-20	-13	-7	0	+8	+16	+25	+34	+44		
	+25	-20	-16	-11	-5	0	+6	+12	+19	+26	+34		
	+20	-16	-12	-8	-4	0	+5	+9	+15	+20	+26		
	+15	-11	-9	-6	-3	0	+3	+7	+10	+14	+18		
	+10	-7	-6	-4	-2	0	+2	+4	+7	+9	+12		
	+5	-4	-3	-2	-1	0	+1	+2	+3	+5	+6		
	0	0	0	0	0	0	0	0	0	0	0		
Declination (°)	-5	+4	+3	+2	+1	0	-1	-2	-3	-5	-6		
	-10	+7	+6	+4	+2	0	-2	-4	-7	-9	-12		
	-15	+11	+9	+6	+3	0	-3	-7	-10	-14	-18		
	-20	+16	+12	+8	+4	0	-5	-9	-15	-20	-26		
	-25	+20	+16	+11	+5	0	-6	-12	-19	-26	-34		
	-30	+26	+20	+13	+7	0	-8	-16	-25	-34	-44		

APPENDIX B - OBSERVING GUIDE TO THE CONSTELLATIONS

INTRODUCTION The following table has been designed to help in finding the best time to observe any of the constellations. It does this by presenting, on a monthly basis, the times of culmination for all the constellations. The time of culmination (or when it crosses the meridian) is when the constellation is at it's highest in the sky. At this time, atmospheric effects (which can make "seeing" poor) should be minimised. The "seeing" is an indication of how "sharp" an object looks. For each constellation an estimate is also given for it's times of rise and set.

EXPLANATION OF THE TABLE

THE 12 COLUMNS LABELED WITH THE MONTH: These times for culmination are only approximate and given to the nearest 0.1 hr (6 min). Because all constellations have a finite size the times were calculated for the star designated "Alpha", unless otherwise indicated in the "Notes Column" (see below). The 15th day of each month was arbitrarily chosen for this table. **For each day before or after the 15th add or subtract respectively 4 mins from the times given.**

THE RISE/SET COLUMN : This is the number of hours before(-) the time of culmination the constellation will rise or the number of hours following(+) culmination the constellation will set (once again based on the star "Alpha"). Times are decimal hours. No figure is recorded if the constellation is circumpolar (never sets) or does not rise from Sydney latitudes.

NOTES COLUMN

P/R	- Constellation only partly rises from Sydney latitudes
N/R	- Constellation never rises " " "
C	- Constellation is circumpolar (never sets) from Sydney Lat.
P/C	- Constellation is partly circumpolar from Sydney latitudes.

The following notes are for constellations where a star other than "Alpha" was used for the calculation of the times :-

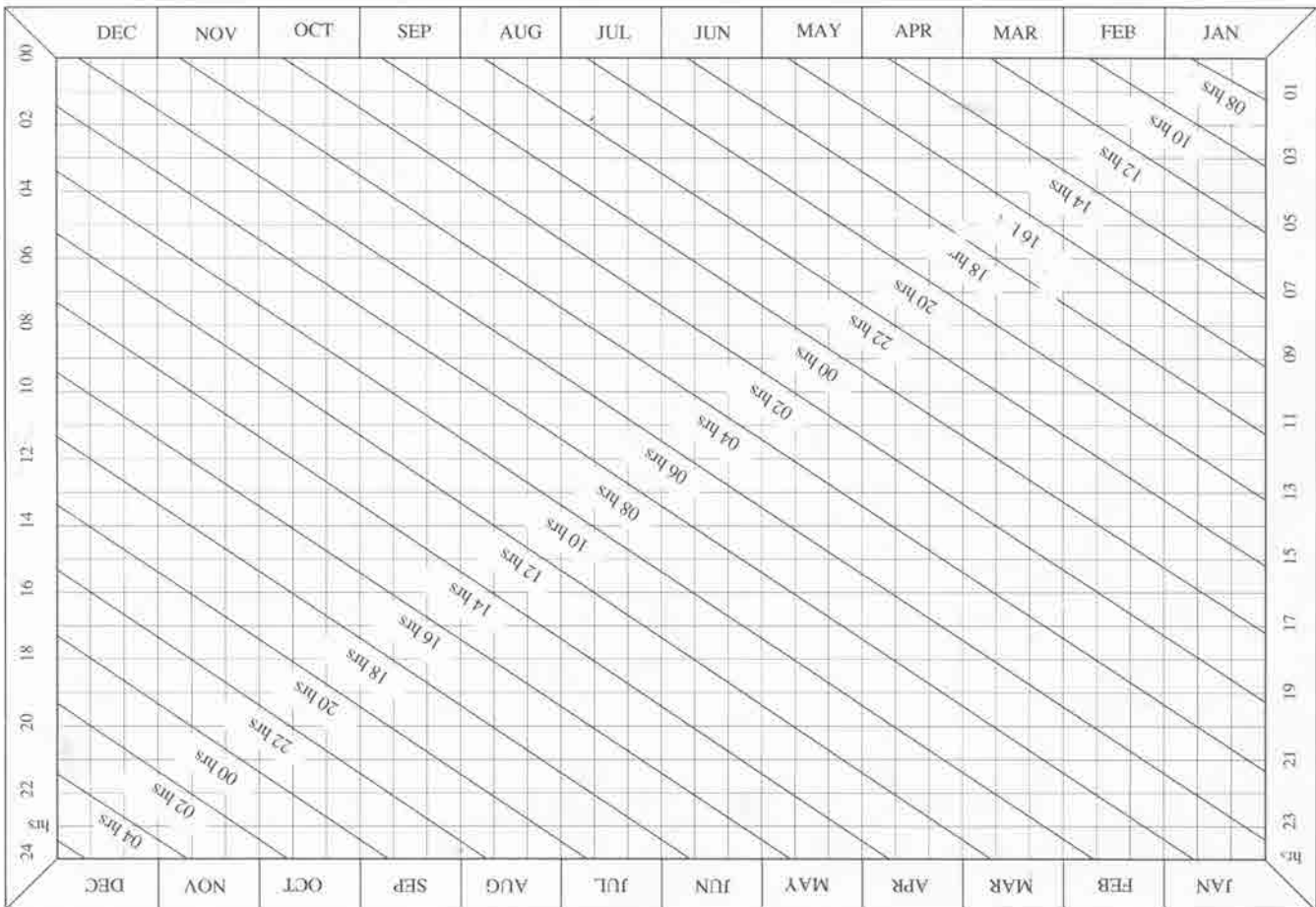
(i) - 7 Cam	(iv) - Beta Eri	(vii) - Beta Oct	(x) - Kappa Vel
(ii) - Epsilon Cen	(v) - Beta LMi	(viii) - Beta Pic	
(iii) - Gamma Dra	(vi) - Gamma Nor	(ix) - Gamma UMa	

WORKED EXAMPLE

An observer wishes to look at Virgo this evening, it is July 2nd. From the table it can be seen that Virgo reaches its highest in the sky at around 17:48 (5:48pm) and sets 6.5 hours later (around midnight). A correction of 52 minutes should be made ie. 13 days earlier than July 15 (or 13 x 4 mins). The corrected time is 6:40pm. From the "Sun Rise/Set" table, astronomical twilight ends at 18:27 (6:27pm) which is around the time that Virgo reaches culmination. Therefore, for best observing atmospheric conditions ie a minimum thickness of atmosphere to look through, it would be wise to get onto Virgo fairly early in the evening (after twilight ends). In this case, moonlight should not interfere (it sets at 7:01 PM).

GUIDE TO THE CONSTELLATIONS

CONST.	ABR.	Notes	R/S +/- hr	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JULY.	AUG.	SEP.	OCT.	NOV.	DEC.
Andromeda	And		4.5	16:24	14:24	12:30	10:30	8:30	6:30	4:30	2:24	0:24	22:24	20:24	18:24
Antila	Ant		7.7	2:48	0:48	22:54	20:54	18:54	16:54	14:54	12:48	10:48	8:48	6:48	4:48
Apus	Aps	C	-	7:06	5:06	3:12	1:12	23:12	21:12	19:12	17:06	15:06	13:06	11:06	9:06
Aquarius	Aqr		6.1	14:24	12:24	10:30	8:30	6:30	4:30	2:30	0:24	22:24	20:24	18:24	16:24
Aquila	Aql		5.6	12:12	10:12	8:18	6:18	4:18	2:18	0:18	22:12	20:12	18:12	16:12	14:12
Ara	Ara	P/C	9.6	9:48	7:48	5:54	3:54	1:54	23:54	21:54	19:48	17:48	15:48	13:48	11:48
Aries	Ari		4.9	18:24	16:24	14:30	12:30	10:30	8:30	6:30	4:24	2:24	0:24	22:24	20:24
Auriga	Aur		3.2	21:36	19:36	17:42	15:42	13:42	11:42	9:42	7:36	5:36	3:36	1:36	23:36
Bootes	Boo		5.1	6:36	4:36	2:42	0:42	22:42	20:42	18:42	16:36	14:36	12:36	10:36	8:36
Caelum	Cae		8.5	21:00	19:00	17:06	15:06	13:06	11:06	9:06	7:00	5:00	3:00	1:00	23:00
Camelopardus	Cam	P/R (i)	1.8	21:12	19:12	17:18	15:18	13:18	11:18	9:18	7:12	5:12	3:12	1:12	23:12
Cancer	Cnc		5.5	1:18	23:18	21:24	19:24	17:24	15:24	13:24	11:18	9:18	7:18	5:18	3:18
Canes Venatici	CVn		3.9	5:18	3:18	1:24	23:24	21:24	19:24	17:24	15:18	13:18	11:18	9:18	7:18
Canis Major	CMa		6.8	23:00	21:00	19:06	17:06	15:06	13:06	11:06	9:00	7:00	5:00	3:00	1:00
Canis Minor	CMi		5.8	23:54	21:54	20:00	18:00	16:00	14:00	12:00	9:54	7:54	5:54	3:54	1:54
Capricornus	Cap		6.6	12:36	10:36	8:42	6:42	4:42	2:42	0:42	22:36	20:36	18:36	16:36	14:36
Carina	Car	P/C	10.3	22:42	20:42	18:48	16:48	14:48	12:48	10:48	8:42	6:42	4:42	2:42	0:42
Cassiopeia	Cas	P/R	0.6	17:00	15:00	13:06	11:06	9:06	7:06	5:06	3:00	1:00	23:00	21:00	19:00
Centaurus	Cen	P/C (ii)	10.5	6:00	4:00	2:06	0:06	22:06	20:06	18:06	16:00	14:00	12:00	10:00	8:00
Cepheus	Cep	N/R	-	-	-	-	-	-	-	-	-	-	-	-	-
Cetus	Cet		5.9	19:18	17:18	15:24	13:24	11:24	9:24	7:24	5:18	3:18	1:18	23:18	21:18
Chamaeleon	Cha	C	-	0:42	22:42	20:48	18:48	16:48	14:48	12:48	10:42	8:42	6:42	4:42	2:42
Circinus	Cir	C	-	7:00	5:00	3:06	1:06	23:06	21:06	19:06	17:00	15:00	13:00	11:00	9:00
Columba	Col		8.0	21:54	19:54	18:00	16:00	14:00	12:00	10:00	7:54	5:54	3:54	1:54	23:54
Coma Berenices	Com		5.2	5:18	3:18	1:24	23:24	21:24	19:24	17:24	15:18	13:18	11:18	9:18	7:18
Corona Australis	CrA		8.2	11:30	9:30	7:36	5:36	3:36	1:36	23:36	21:30	19:30	17:30	15:30	13:30
Corona Borealis	CrB		4.8	7:54	5:54	4:00	2:00	0:00	22:00	20:00	17:54	15:54	13:54	11:54	9:54
Corvus	Crv		7.2	4:30	2:30	0:36	22:36	20:36	18:36	16:36	14:30	12:30	10:30	8:30	6:30
Crater	Crt		6.9	3:18	1:18	23:24	21:24	19:24	17:24	15:24	13:18	11:18	9:18	7:18	5:18
Cruce	Cru	C	-	4:48	2:48	0:54	22:54	20:54	18:54	16:54	14:48	12:48	10:48	8:48	6:48
Cygnus	Cyg	P/R	3.2	13:00	11:00	9:06	7:06	5:06	3:06	1:06	23:00	21:00	19:00	17:00	15:00
Delphinus	Del		5.3	13:00	11:00	9:06	7:06	5:06	3:06	1:06	23:00	21:00	19:00	17:00	15:00
Dorado	Dor	P/C	11.2	20:54	18:54	17:00	15:00	13:00	11:00	9:00	6:54	4:54	2:54	0:54	22:54
Draco	Drp	P/R (iii)	2.3	10:18	8:18	6:24	4:24	2:24	0:24	22:24	20:18	18:18	16:18	14:18	12:18
Eagle	Egu		5.8	13:36	11:36	9:42	7:42	5:42	3:42	1:42	23:36	21:36	19:36	17:36	15:36
Eridanus	Eri	P/C (iv)	6.3	21:24	19:24	17:30	15:30	13:30	11:30	9:30	7:24	5:24	3:24	1:24	23:24
Formax	For		7.5	19:30	17:30	15:36	13:36	11:36	9:36	7:36	5:30	3:30	1:30	23:30	21:30
Gemini	Gem		4.4	23:54	21:54	20:00	18:00	16:00	14:00	12:00	9:54	7:54	5:54	3:54	1:54
Gru	Gru		9.2	14:30	12:30	10:36	8:36	6:36	4:36	2:36	0:30	22:30	20:30	18:30	16:30
Hercules	Her		5.4	9:36	7:36	5:42	3:42	1:42	23:42	21:42	19:36	17:36	15:36	13:36	11:36
Horologium	Hor	P/C	8.6	20:30	18:30	16:36	14:36	12:36	10:36	8:36	6:30	4:30	2:30	0:30	22:30
Hydra	Hya		6.5	1:48	23:48	21:54	19:54	17:54	15:54	13:54	11:48	9:48	7:48	5:48	3:48
Hydrus	Hyl	C	-	18:18	16:18	14:24	12:24	10:24	8:24	6:24	4:18	2:18	0:18	22:18	20:18
Indus	Ind	P/C	9.2	12:54	10:54	9:00	7:00	5:00	3:00	1:00	22:54	20:54	18:54	16:54	14:54
Lacerta	Lac	P/R	2.5	14:48	12:48	10:54	8:54	6:54	4:54	2:54	0:48	22:48	20:48	18:48	16:48
Leo	Leo		5.5	2:30	0:30	22:36	20:36	18:36	16:36	14:36	12:30	10:30	8:30	6:30	4:30
Leo Minor	LMi	(v)	4.0	2:48	0:48	22:54	20:54	18:54	16:54	14:54	12:48	10:48	8:48	6:48	4:48
Lepus	Lep		6.9	21:48	19:48	17:54	15:54	13:54	11:54	9:54	7:48	5:48	3:48	1:48	23:48
Libra	Lib		6.8	7:12	5:12	3:18	1:18	23:18	21:18	19:18	17:12	15:12	13:12	11:12	9:12
Lupus	Lup		9.2	7:00	5:00	3:06	1:06	23:06	21:06	19:06	17:00	15:00	13:00	11:00	9:00
Lynx	Lyn	P/R	4.2	1:42	23:42	21:48	19:48	17:48	15:48	13:48	11:42	9:42	7:42	5:42	3:42
Lyra	Lyr		3.9	10:54	8:54	7:00	5:00	3:00	1:00	23:00	20:54	18:54	16:54	14:54	12:54
Mensa	Men	C	-	22:30	20:30	18:36	16:36	14:36	12:36	10:36	8:30	6:30	4:30	2:30	0:30
Microscopium	Mic		7.8	13:06	11:06	9:12	7:12	5:12	3:12	1:12	23:06	21:06	19:06	17:06	15:06
Monoceros	Mon		6.4	0:00	22:00	20:06	18:06	16:06	14:06	12:06	10:00	8:00	6:00	4:00	2:00
Musca	Mus	C	-	5:00	3:00	1:06	23:06	21:06	19:06	17:06	15:00	13:00	11:00	9:00	7:00
Norma	Nor	P/C (vi)	9.6	8:42	6:42	4:48	2:48	0:48	22:48	20:48	18:42	16:42	14:42	12:42	10:42
Octans	Oci	C (vii)	-	15:06	13:06	11:12	9:12	7:12	5:12	3:12	1:06	23:06	21:06	19:06	17:06
Ophiuchus	Oph		5.5	9:54	7:54	6:00	4:00	2:00	0:00	22:00	19:54	17:54	15:54	13:54	11:54
Orion	Ori		5.7	22:12	20:12	18:18	16:18	14:18	12:18	10:18	8:12	6:12	4:12	2:12	0:12
Pavo	Pav	C	-	12:42	10:42	8:48	6:48	4:48	2:48	0:48	22:42	20:42	18:42	16:42	14:42
Pegasus	Peg		5.3	15:24	13:24	11:30	9:30	7:30	5:30	3:30	1:24	23:24	21:24	19:24	17:24
Perseus	Per	P/R	2.6	19:42	17:42	15:48	13:48	11:48	9:48	7:48	5:42	3:42	1:42	23:42	21:42
Phoenix	Phe	P/C	8.6	16:48	14:48	12:54	10:54	8:54	6:54	4:54	2:48	0:48	22:48	20:48	18:48
Pictor	Pic	P/C (viii)	9.9	22:06	20:06	18:12	16:12	14:12	12:12	10:12	8:06	6:06	4:06	2:06	0:06
Pisces	Psc		5.9	18:18	16:18	14:24	12:24	10:24	8:24	6:24	4:18	2:18	0:18	22:18	20:18
Piscis Austrinus	PsA		7.6	15:18	13:18	11:24	9:24	7:24	5:24	3:24	1:18	23:18	21:18	19:18	17:18
Puppis	Pup		8.4	0:12	22:12	20:18	18:18	16:18	14:18	12:18	10:12	8:12	6:12	4:12	2:12
Pyxis	Pys		7.7	1:06	23:06	21:12	19:12	17:12	15:12	13:12	11:06	9:06	7:06	5:06	3:06
Reticulum	Ret	C	-	20:30	18:30	16:36	14:36	12:36	10:36	8:36	6:30	4:30	2:30	0:30	22:30
Sagitta	Sge		5.2	12:00	10:00	8:06	6:06	4:06	2:06	0:06	22:00	20:00	18:00	16:00	14:00
Sagittarius	Sgr		8.4	11:42	9:42	7:48	5:48	3:48	1:48	23:48	21:42	19:42	17:42	15:42	13:42
Scorpius	Sco		7.4	8:48	6:48	4:54	2:54	0:54	22:54	20:54	18:48	16:48	14:48	12:48	10:48
Sculptor	Sci		7.5	17:18	15:18	13:24	11:24	9:24	7:24	5:24	3:18	1:18	23:18	21:18	19:18
Scutum	Sct		6.4	10:54	8:54	7:00	5:00	3:00	1:00	23:00	20:54	18:54	16:54	14:54	12:54
Serpens	Ser		5.8	8:06	6:06	4:12	2:12	0:12	22:12	20:12	18:06	16:06	14:06	12:06	10:06
Sextans	Sex		6.0	2:30	0:30	22:36	20:36	18:36	16:36	14:36	12:30	10:30	8:30	6:30	4:30
Taurus	Tau		5.3	20:54	18:54	17:00	15:00	13:00	11:00	9:00	6:54	4:54	2:54	0:54	22:54
Telescopium	Tel	P/C	9.0	10:48	8:48	6:54	4:54	2:54	0:54	22:54	20:48	18:48	16:48	14:48	12:48
Triangulum	Tri		4.6	18:12	16:12	14:18	12:18	10:18	8:18	6:18	4:12	2:12	0:12	22:12	20:12
Triangulum Austrinus	TrA	C	-	9:06	7:06	5:12	3:12	1:12	23:12	21:12	19:06	17:06	15:06	13:06	11:06
Tucana	Tuc	C	-	14:36	12:36	10:42	8:42	6:42	4:42	2:42	0:36	22:36	20:36	18:36	16:36
Ursa Major	UMa	P/R (ix)	1.8	4:18	2:18	0:24	22:24	20:24	18:24	16:24	14:18	12:18	10:18	8:18	6:18
Ursa Minor	UMi	N/R	-	-	-	-	-	-	-	-	-	-	-	-	-
Vela	Vel	P/C (x)	11.2	1:42	23:42	2									



APPENDIX D JULIAN DATE — 1992

JULIAN DATE at 0hrs UT	
Month	Julian Date
Jan 0	244 8621.5
Feb 0	244 8652.5
Mar 0	244 8681.5
Apr 0	244 8712.5
May 0	244 8742.5
Jun 0	244 8773.5
Jul 0	244 8803.5
Aug 0	244 8834.5
Sep 0	244 8865.5
Oct 0	244 8895.5
Nov 0	244 8926.5
Dec 0	244 8956.5

Hours as decimal of a day.				
01	0.042	13	0.542	
02	0.083	14	0.583	
03	0.125	15	0.625	
04	0.167	16	0.667	
05	0.208	17	0.708	
06	0.250	18	0.750	
07	0.292	19	0.792	
08	0.333	20	0.833	
09	0.375	21	0.875	
10	0.417	22	0.917	
11	0.458	23	0.958	
12	0.500	24	1.000	

To calculate Julian Date (JD), 1st convert local time to UT (subtract 10 hrs from EAST) correcting the date if necessary. Next find the Julian date given in the table on the far 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. Just add the fraction of day from the second table 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.

$23 - 10 = 13:00$ hrs

From the table the JD for July is 2448803.5 Add the day of month, 17 gives us 2448820.5

Now add the hours as a fraction of a day from the 2nd table. 13hr is 0.542. Thus JD at 23:00hr 17 Jul 1992 at Sydney is 2448821.042

APPENDIX E SIDEREAL TIME — 1992

Greenwich mean sidereal time at 0hrs UT				
Jan 0	06.5950	Jul 0	18.5542	
Feb 0	08.6320	Aug 0	20.5912	
Mar 0	10.5376	Sep 0	22.6282	
Apr 0	12.5746	Oct 0	00.5995	
May 0	14.5459	Nov 0	02.6365	
Jun 0	16.5829	Dec 0	04.6078	

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

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 1992.

$23:00 \text{ local time} = 13:00 \text{ UT. GMST for July 0 is } 18.5542 \text{ hrs.}$

$\text{GMST} = 18.5542 + (0.06571 \times 17) + (1.00274 \times 13) = 32.7069$

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

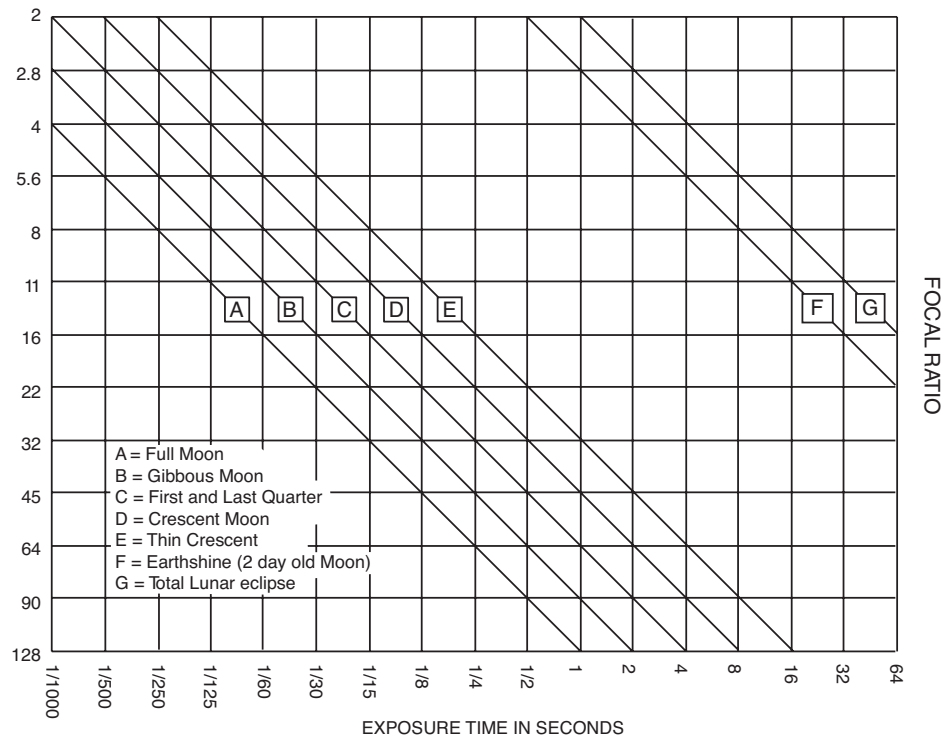
$\text{LMST} = 32.7069 + 10.0833 = 42.7902$

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

$42.7902 - 24 = 18.7902 \text{ hrs or } 18\text{h } 47\text{m } 24.7\text{s}$

APPENDIX F: PHOTOGRAPHIC EXPOSURE GUIDES

MOON



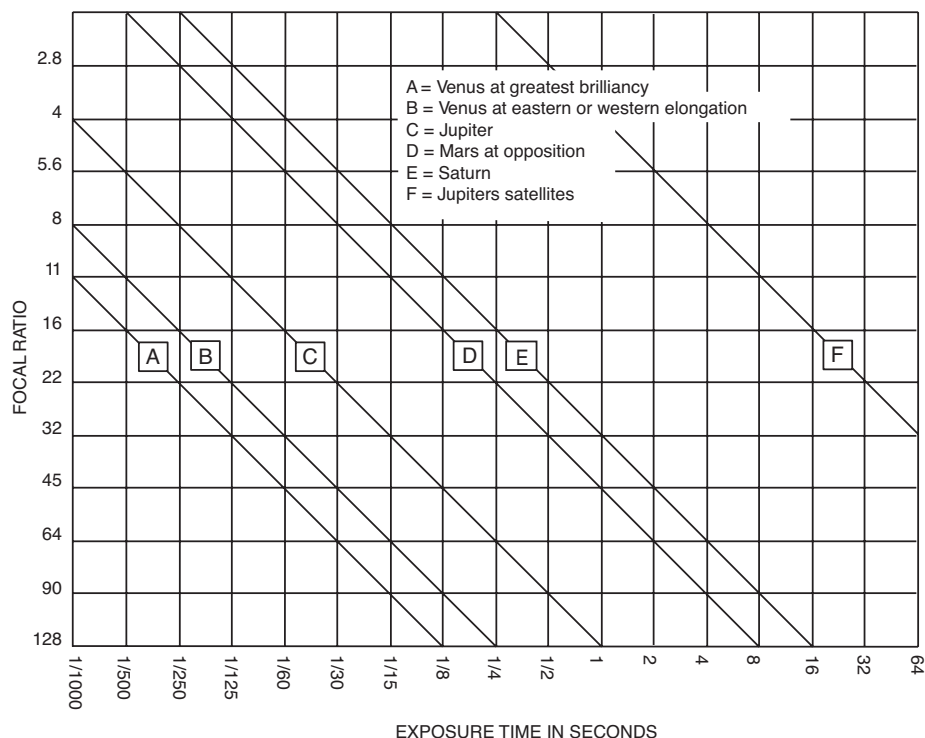
These charts provide recommended photographic exposures for the Moon (left) and selected planets (right) using 100 ISO film. The charts should only be treated as a guide as many factors will influence the exposure time.

Follow a horizontal line nearest to your systems focal ratio to the oblique line that represents the Moon aspect or planet required, then follow the intersecting vertical line down to find the correct exposure. For the best result always take one photo at the recommended speed and follow up with one at half and one at twice the exposure (bracketing). This will help smooth out variables and should provide at least one image at the required density.

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

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

PLANETS



APPENDIX G

PLACES OF ASTRONOMICAL INTEREST

The following is a list of places of astronomical interest. NSW is well blessed with the majority of Australia's major observatories located within this state. All the locations, below, cater to the public in regards to tours and/or displays.

SYDNEY OBSERVATORY

The observatory is located in a park which is 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 the running of 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 8:30pm to 10:30pm - every night except Wednesdays (closed Christmas Day, Good Friday and New Years Eve). Bookings are required for these evening tours.

Cost: There is a charge for evening sessions - \$5:00 Adults, \$2:00 Students 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, Boxing Day, Anzac Day and Good Friday.

Cost: A minimal charge is made for the Audio/Visual presentation

Contact: Richard Twardy - (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 3.9metre (3.9m) 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 for visits 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. During 1991 this exhibit was expanded.

Hours: 9:00am to 4:00pm, Monday to Friday and 10am to 4pm on Saturdays/Sundays (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 3 km 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: - 8:00am to 4:00pm. It is normally "manned" from 9:30am to 12:30pm on week days. During school holidays these hours are often extended and more activities are conducted.

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 (\$2:50 per person).

Contact -phone (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 story of the Voyager spacecraft, which has rewritten our knowledge of the Solar System, is well represented. 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.

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: J. Tebbutt - ph. (045) 77-3120

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 "Sky Theatre". The programmes are based on specific astronomical themes and are changed regularly. The "Sky Theatre" consists of an artificial sky which is projected onto the interior surface of a 12.5 metre dome. This is the only "world class" planetarium in Australia 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.

Cost: \$6:40 for Adults and \$2:95, Children (under 15 years).

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

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.

APPENDIX H

ASTRONOMY COURSES AVAILABLE IN 1992

The following lists astronomy courses, known to the authors, for the Sydney region. They are evening courses and are held at various Universities and Colleges. These programmes have been specifically designed for the lay person and are not tertiary programmes. Enquires 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.

ASTRONOMICAL ASPECTS

Conducted by Geoff McNamara. (ph 533-3473) or contact St. George Regional Evening College (540-3711).

Astronomy 1: Astronomy for Beginners

Cost: \$45, Venue: Peakhurst Primary School.

Astronomy 2 : Astronomy- The Science

Cost: \$60, Venue: Riverwood.

Astronomy 3: The Solar System

Cost: \$60, Venue: Riverwood.

Astronomy 4 : Stellar Playgrounds

Cost: \$60, Venue: Riverwood.

Astronomy 5 : Universal Concepts

Cost: \$60, Venue: Riverwood.

Astronomy 6: Amateur Astronomy

Cost: \$60, Venue: Riverwood.

Astronomy 1 is an 8 week course run 4 times per year.

Astronomy 2 to 5 make up a 1 year (36 week) course.

Astronomy 6 is an 8 week course which is run on demand.

THE NIGHT SKY. Conducted by Nick Lomb.

This starts Wednesday 22nd Jan. and goes for 9-10 weeks. It is a NEA course in conjunction with the Powerhouse Museum

Cost: \$43 Venue: Sydney Observatory (ph 241-2478).

ASTRONOMICAL CONCEPTS

6 lectures and two weekend field trips (cost not included). The course will run 2 to 3 times during the year depending on demand.

Cost: \$80 Venue: Sydney Observatory (ph 241-2478).

STAR GAZING Conducted by Sydney Community College.

An 8 week course. Contact: Judith Kuepper 555-7411.

Cost: \$65 Venue: Sydney Observatory.

PRACTICAL ASTRONOMY

An 8 week WEA course conducted by Sutherland Astronomical Society. Contact: Jon Little, ph 542-1148.

Cost: \$55 Venue: Green Point Observatory (Sutherland).

ASTRONOMY Conducted by Ben Pawlutschenko

There are two parts to this course; part 1 is in term 1, part 2 in second term. Contact ph. (045) 72-5499

Cost: \$50, 8 weeks (16hours). Venue: Liverpool G.H.S.

ASTRONOMY and STELLAR EVOLUTION Courses

Conducted by A. James. 8 weeks (16 hrs) each. Ph 764-1499

Cost: \$59 per course. Venue: Strathfield Evening College.

APPENDIX I

NEW SOUTH WALES ASTRONOMICAL SOCIETIES

The following lists the amateur societies in NSW. A common philosophy within all these organizations is the emphasis they place on public education. Enquiries from anyone, with an interest in astronomy, are most welcome. Where given, fees are correct as at the time of printing (November 1991).

ASTRONOMICAL SOCIETY OF NSW, Inc.

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) and the other is the 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.

Membership Fees \$34:00 Full, \$29:00 Associate, \$10:00 Student. There is no joining fee.

Address: PO Box 208, Eastwood NSW 2122

Contact: Tony Buckley (President) ph (02) 874-2070.

SUTHERLAND ASTRONOMICAL SOCIETY, Inc.

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 the 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.

Membership Fees: \$25:00 Full, \$15 Student/Associate, \$10:00 Junior/Pensioners and \$35:00 for families. There is also a joining fee - Full/Family \$15 and others \$5.

Address: PO Box 31, Sutherland NSW 2232.

Contact: Jon Little (02) 542-1148

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”

Membership Fees: \$30:00 Full, \$15:00 Junior (no joining fee) and there are family concessions available. There is a \$12:50 Joining fee.

Address: c/o 35 Nowland St., Seven Hills NSW 2147

Contact: George Smith. ph (02) 624-1426

ILLAWARA ASTRONOMICAL SOCIETY

Address: PO Box 1814, Wollongong NSW 2500

Contact: ph (042) 29-6696

HAWKESBURY ASTRONOMICAL ASSOCIATION

Address: c/o John Tebbutt Observatories, Palmer St., Windsor NSW 2756

Contact: ph (045) 72-1568

TAREE ASTRONOMICAL SOCIETY

Address: PO Box 111, Taree NSW 2430

Contact: Mr. Jim Ross- ph (065) 50-2213

THE ASTRONOMICAL SOCIETY OF THE HUNTER

Address: c/o Newcastle Technical College, Tighes Hill NSW 2297

Contact: Mr. C. Mudge - ph (049) 58-3880

NORTHERN DISTRICTS SOCIETY OF AMATEUR ASTRONOMERS

Address: 29 Robert St., Telopea NSW 2117

Contact: Gordon Stott - ph (02) 871-7838

PORT MACQUARIE ASTRONOMICAL ASSOCIATION

Address: 5/66 Clarence St., Port Macquarie NSW 2444

Contact: I. Benson - ph (065) 82-2100

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).

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.

Celestial equator A projection of the Earth's equator onto the celestial sphere..

Celestial poles Points on the celestial sphere directly above the Earth's poles about which all the stars seem to rotate; known as the north and south celestial poles (NCP and SCP).

Celestial sphere Imaginary sphere of infinite size surrounding the Earth and to which celestial bodies seem to be attached.

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

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. ASTRONOMY 1992 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.

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 1 st 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.

Light year The distance that light traverses in a vacuum during one year (approximately 9,460,529,700,000 km).

Lunation The period of time between two consecutive New Moons.

Magnitude Brightness scale of stellar objects. From one magnitude to the next the ratio of brightness is the 5th root of 100, or approximately 2.52. The lower the number the brighter the star. The brightest stars as seen from Earth are magnitude -1 (except for the Sun which is -26). The faintest visible to the unaided are 6 (in dark skies).

Magnitude - absolute The apparent magnitude a star would have if it were placed at a distance of 10 *parsecs* (32.6 light years).

Meridian The local meridian is an imaginary line running directly overhead from north to south. The right ascension on the meridian equals local *sidereal* time.

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.

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 An apparent or 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.; apparent planetary retrograde motion is explained in detail on page 57.

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).

GREEK ALPHABET

A, α	Alpha	I, ι	Iota	P, ρ	Rho
B, β	Beta	K, κ	Kappa	Σ, σ	Sigma
Γ, γ	Gamma	Λ, λ	Lambda	T, τ	Tau
Δ, δ	Delta	M, μ	Mu	Υ, υ	Upsilon
E, ε	Epsilon	N, ν	Nu	Φ, φ	Phi
Z, ζ	Zeta	Ξ, ξ	Xi	X, χ	Chi
H, η	Eta	O, ο	Omicron	Ψ, ψ	Psi
Θ, θ, ϑ	Theta	Π, π	Pi	Ω, ω	Omega

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ASTRONOMY 1992 is the people's guide to the night sky. It was designed as a companion to assist in your self discovery of the planets of the Solar System for 1992. The authors' goal was to produce a user friendly ephemeris that the novice and serious amateur alike would find a pleasure to use and understand. They have succeeded.

Part of its user friendly nature is the MONTHLY section in the first part of this book. This quick reference, "month by month" approach offers quick answers to:

What planets are up tonight?

When is the best time to observe them?

Are there any interesting lunar occultations or Jupiter Moon events this evening?

and so on ...

FEATURES INCLUDE:

- Sky view diagrams that make finding planets as easy as 'looking up'
- Monthly rise/set charts covering the Sun, Moon and planets - a MUST for the casual observer
- Best times to observe the planets, including interesting conjunctions and configurations
- Appearance diagrams, showing relative size and phase of the planets for each month
- Daily diary of events including those of Jupiter's four major moons
- Shooting Stars (Meteor showers)
- Minor Planets (Asteroids) and Comets
- Positions of the Sun, Moon and planets
- and much more ...

The Authors have had many years of experience in observational astronomy, production of astronomical publications and computer programming. They have also had extensive involvement in public education in astronomy and the amateur astronomical community. ASTRONOMY 1992 follows on from the previously successful ASTRONOMY 1991.

Overall, Astronomy 1991 is easy to read and use. This is the beginning, I hope, of a new breed of observer friendly ephemerides, and I heartily recommend it to any observer.

Southern Astronomy Magazine (Jan./Feb. 1991)