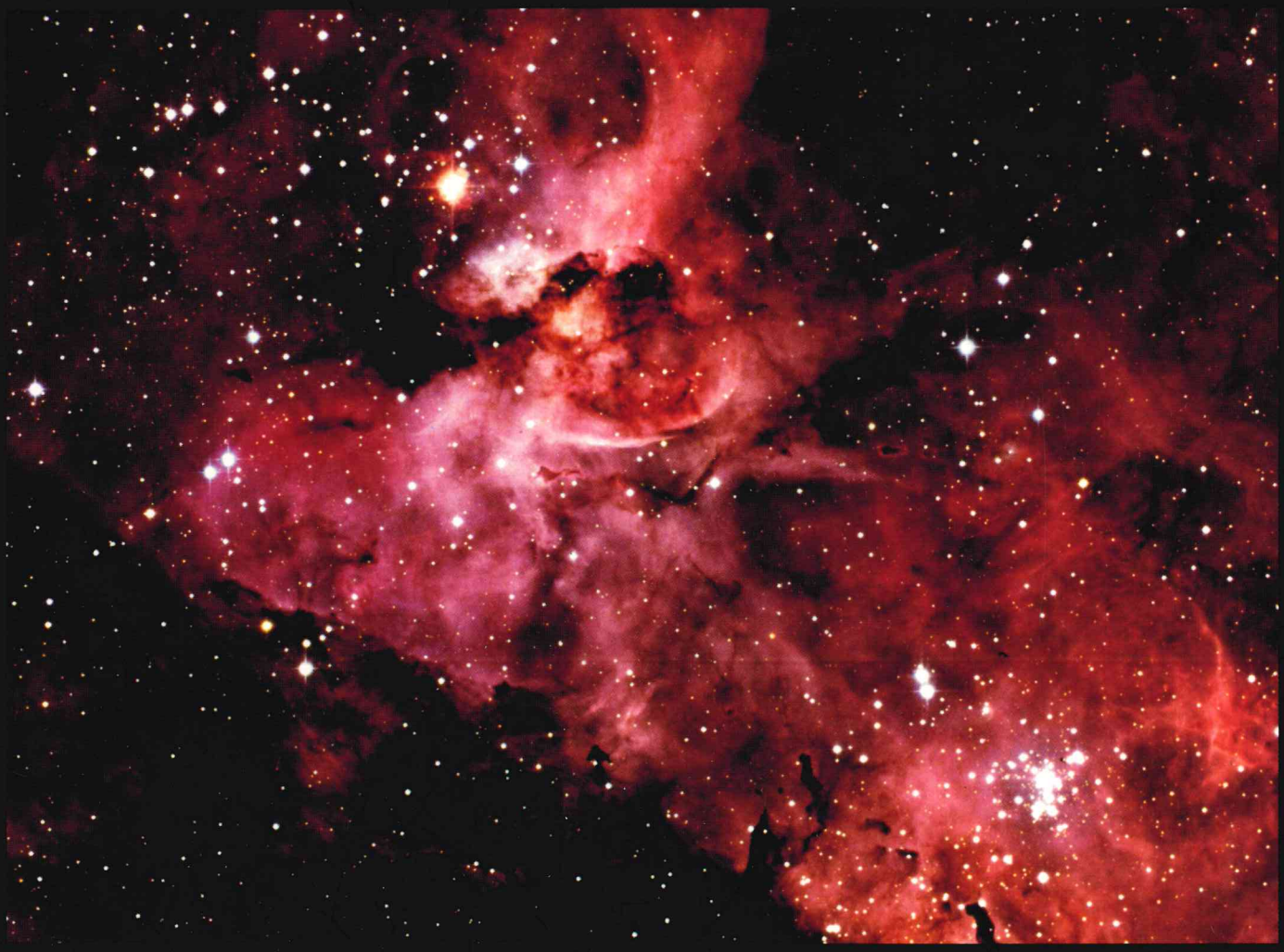
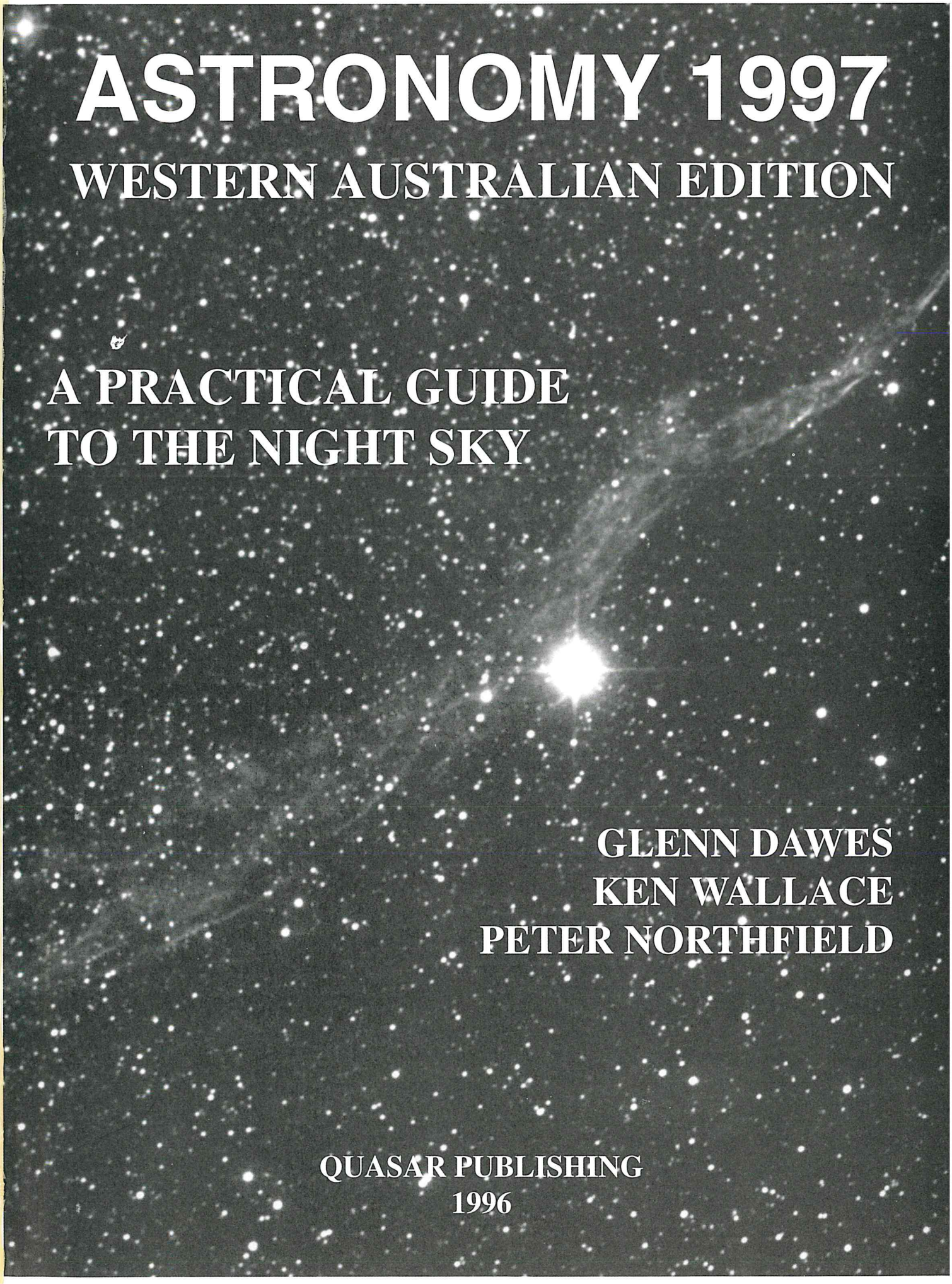
ASTRONOMY 1997

WESTERN AUSTRALIAN EDITION



Glenn Dawes Peter Northfield Ken Wallace

A PRACTICAL GUIDE TO THE NIGHT SKY



ASTRONOMY 1997

WESTERN AUSTRALIAN EDITION

A PRACTICAL GUIDE TO THE NIGHT SKY

GLENN DAWES
KEN WALLACE
PETER NORTHFIELD

QUASAR PUBLISHING
1996

ISBN 0 646 29270 6

First published November 1996 by

Quasar Publishing
PO Box 234
Strathfield NSW 2135
Australia

FAX (02) 9636 9097
email: gdawes@s054.aone.net.au

Additional copies of this **Western Australian Edition** may be purchased directly from Perth Observatory on (09) 293 8255 (ph) or (09) 293 8138 (fax).

Contact the publisher for more information on or copies of **ASTRONOMY 1997, Eastern Australian Edition**; Contact Quasar Publishing, PO Box 234, Strathfield NSW 2135. Fax (02) 9626 9097

TABLE OF CONTENTS

INTRODUCTION TO 1997 EDITION

Welcome to **ASTRONOMY 1997 - Western Australian Edition**. Produced for Perth Observatory by Quasar Publishing, this book has been designed for observers specifically in Western Australia. A separate edition has been produced to cover the rest of Australia (Eastern Edition). These two editions (Eastern and Western) represent a truly national approach in the preparation of these user-friendly yearbooks.

Part I is intended as a general quick reference section for those wishing to see which planets are up tonight and when, during the year, is the best time to observe them. This section, in particular, is ideal for those just starting their exploration of the Universe. The 'sky view' diagrams are an easy way for you to find your way around the night sky. The planets can be identified and followed throughout the year as these 'wanderers' journey through the constellations.

Part II contains more detailed information needed by amateur astronomers.

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

Wishing you clear skies and many hours of enjoyable observing.

Glenn Dawes Peter Northfield Ken Wallace.

ACKNOWLEDGEMENTS

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

- Astronomical Almanac for the Year 1997. (US Naval / Royal Greenwich Observatories)
- Astronomical Tables of the Sun, Moon and Planets (Jean Meeus)
- Cambridge Guide to the Constellations (Michael E. Bakich)
- Comet Orbital Elements courtesy International Astronomical Union
- Fifty Year Canon of Lunar Eclipses 1986 - 2035 (NASA RP1216)
- Hartung's Astronomical Objects for Southern Telescopes, Second Edition by Malin/Frew (Cambridge University Press)
- International Meteor Organisation Calendar for 1997
- Sky and Telescope Magazine, October 1996.
- Uranometria 2000.0, Vol I, II & Deep Sky Field Guide

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

- MICA ver 1.0 (US Naval Observatory)
- Occult ver 3.17 (David Herald)
- Voyager II, the Interactive Desktop Planetarium ver 2.02 (Carina Software)

Special thanks are extended to Greg Bryant for general comet information and text.

We would also like to thank the following for assistance in proofreading.

Greg Bryant, Geoff McNamara, Robert McIntyre and Elise Dott.

The front cover is the "Key Hole" region of the Eta Carinae Nebula. Photograph by David Malin, copyright Anglo-Australian Observatory.

Star field on page 1 is the Veil Nebula plus star 52 Cygni. Back cover is the Spiral Galaxy, M83. Both photographs by Sydney amateur, J. Cauchi (thanks Joe). Taken on an f/4, 250mm Newtonian at prime focus using Kodak 2415 film (hypered). Exposures were 40 and 30 minutes respectively.

GETTING STARTED

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

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

ASTRONOMY 1997 can be used from anywhere in western Australia. While the charts showing the appearance of the night sky have been drawn for Perth, the change in the appearance of the sky between cities and towns - even across a country so vast as Australia - is so small you probably won't notice. The rise/set graphs are useful since they give an approximate local time of rising and setting - no matter where you live!

Times are given in Western Australian Standard Time (in part I).

SO WHAT CAN THIS BOOK HELP ME SEE?

The night sky regularly puts on displays for us called conjunctions. Since the planets including Earth are moving round the Sun, their positions change constantly with respect to the background stars. As seen in the sky, the planets seem to pass by each other and bright stars. When a planet is near another, the Moon or a star, it's called a conjunction. When the Moon joins the scene, it's a wonderful sight.

Conjunctions can be spectacular events. An example of a good conjunction this year is the one between the star Antares, the planets Mars and Venus, and the Moon on October 6. The star, Venus and the crescent Moon form a triangle shape, in the western evening sky, with Mars sitting in the centre (see the Sky View on p 48, in the October section). This is simply a chance alignment of the planets, the Moon and Antares. They only look close together; in space they are still separated by enormous distances. When talking distances, beyond the earth, it is difficult to use normal scales such as metres or kilometres because the numbers would be so large. Instead, let's use the time it takes for light to travel from these objects to get a feel of the true separations. At the time of this conjunction, the light from the Moon takes a little over 1 second to reach us, Venus is 7 minutes, Mars is 15 minutes and Antares is a massive 330 years! Distances in astronomy do challenge the imagination!

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

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

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

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

Part I is divided into months. At the beginning of each monthly section is a curious looking graph called a rise/set chart. This series of squiggly lines is your guide to knowing when the planets, Sun and Moon rise and set. To use the chart, simply look at the current date on the bottom of the chart and follow that line upwards until it intersects the object of interest. The rise or set time of the object can now be read on the left-hand edge of the chart.

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

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

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

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

Part II of ASTRONOMY 1997 contains specialised data generally designed for the more experienced enthusiast. The novice however should not miss the appendices. If you wish to pursue the hobby further, the authors strongly recommend that beginners check out the local amateur community. Learn from these experts and look through their equipment, before spending hundreds or thousands of dollars on a telescope that may not suit you or your needs. The public observatories, planetariums and courses can also be great resources. Use them.

SOME ASTRONOMICAL TERMS TO GET YOU STARTED

There are several astronomical terms you'll come across in ASTRONOMY 1997, many of which are defined in the Glossary at the end of the book. Here are a few of the more common ones, just to get you started.

Planet Just like the Earth! A planet is a sphere of either rock or gas that orbits the Sun. There are nine planets in our Solar System, and the Earth is the third planet out from the Sun. The diagram on page 73 gives a good overview. There are also a number (actually several thousand) of 'minor planets' that move around the Sun; mostly between the orbits of Mars and Jupiter. The Moon and all the planets we see in the sky do not "glow" in their right. They are only visible because of the sunlight they reflect.

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

Magnitude The brightness of a star or a planet in the night sky is described as its magnitude (sometimes abbreviated to 'mag.'). The numbers work backwards. The faintest star you're likely to see with the naked eye is about 6.0 magnitude, while the brightest stars are -1.0 magnitude. Planets can be much brighter. Venus, for example, can be as bright as -4.0 magnitude, the full Moon, -12 magnitude!

Angles in the sky are measured in **degrees**. You'll see that the 'Sky Views' have a line showing what an angle of 10° looks like on the scale of these drawings. On the back cover is a scale that can help you measure angles. It is an interesting exercise to go out on nights when there are conjunctions and doing your own measurements of the objects' separations and compare your results with the predictions in this book.

Twilight does not really end until the Sun is 18 degrees below the horizon; this is called 'astronomical twilight'. This happens about 90 minutes after sunset (or before sunrise) and is different to what people would normally call the end of twilight. This would be Civil twilight, which begins or ends when the Sun is 6° below the horizon (about 30 minutes before sunrise or after sunset). Only when astronomical twilight has ended, is the sky considered truly dark (assuming the Moon isn't above the horizon!). But keep in mind that many celestial features can be seen even during twilight, binoculars can also help. The actual time between sunset and end of twilight (beginning of twilight and sunrise) does vary with latitude. The further south, the longer the time of twilight. For example, the time for Darwin is approximately 78 minutes where Perth is 93 minutes (average).

INTRODUCTION TO PART I

GENERAL

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

Astronomical Terms. Words used in this introduction that are in *italics* have a further explanation in the Glossary.

Is This Useful for Where I Live? Part I is **useful for anywhere in Western Australia** (some of it is common for the world). The information in part I of this handbook, has been calculated for Perth, WA, Latitude = 31° 57'S, Longitude = 115° 51'E.

Time. The times used in part I are in **Western Australian Standard Time (WAST)**. WAST is the mean solar time on the meridian of longitude of 120° E.

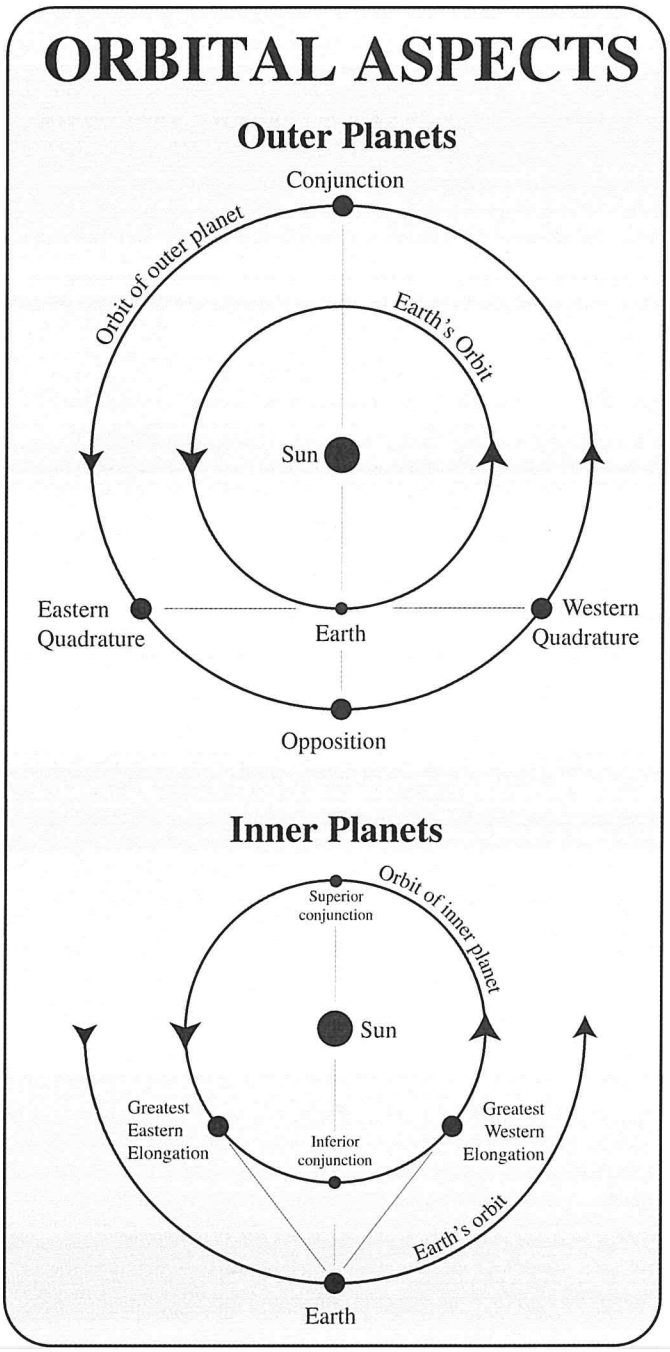
Conjunctions, Oppositions and Elongations.

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

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

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

See also the orbital aspects diagrams below.



THE MONTHLY SECTIONS

Each monthly chapter in part I contains the following :-

RISE/SET CHART

This will enable the reader to quickly determine when (or if) a planet or the Moon is visible in the night sky for any day in that month. Each chart has the midnight line centred, with the evening sky below this line and the morning sky above. The two bands of 'lighter' shading show the times of morning and evening astronomical twilight. If you are using a telescope you'll soon learn to avoid trying to observe a planet near the horizon (ie. close to rise or set times). Turbulence in the much thicker atmosphere (ie. at lower altitude) gives very poor 'boiling' images. If accurate rise/set times are required, you will need to refer to the specific tables for the object of interest in part II of this publication. You can also adjust for country (non city) locations using the appendix on page 103.

APPEARANCE OF THE PLANETS

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

MONTHLY HIGHLIGHTS

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

THE MOON

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

THE PLANETS

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

Minor Planets (or asteroids)**.** This section deals with the 20 brightest *asteroids* that reach opposition this year. An entry is included if the asteroid reaches *opposition* , ie. the time it is brightest. It lists the *magnitude* and constellation the asteroid is in at the time of *opposition*.

COMETS

This brief section deals with the comets known to be visible during 1997. It points out the comets that are bright during the month and include interesting *conjunctions*. We have seen some spectacular comets over the last 2 years. Let's hope the trend continues in 1997. Comet Hale-Bopp is showing great promise and has received close attention in this section (as well as in the Sky Views, see next page).

METEOR SHOWERS

On any clear night we can sometimes see up to five shooting stars per hour, these are known as random or sporadic meteors. There are also annual 'showers' which return at the same time each year. Each shower seems to radiate from a focal point in the sky and is named after the constellation or a bright star the radiant lies near. For example, the radiant for the Lyrids lies near or within the constellation of Lyra. The monthly section lists the major showers for 1997 that are suitable for observation. Full details for all showers are given in part II (page 98). These selected showers are those largely unaffected by moonlight during their "peak" period during 1997. It can take great patience to watch for meteors but the occasional fireball can make it all worthwhile. It is best to do your searching on moonless nights and under dark skies ie. away from light polluted cities. As a general rule, more meteors are seen after midnight.

DIARY OF EVENTS

This is a list of all general phenomena associated with the planets and Moon. The presentation is keyed to those people who would like to know 'what's happening tonight (astronomically speaking)?' Included are :-

- Lunar phases and key events in the planets' orbits.
- Selected conjunctions between the Sun, Moon, comets, asteroids (minor planets), brighter stars and deep sky objects (see also page 100 for descriptions of some of the brighter deep sky objects).

Conjunctions. Differences will be often found between the separation distances (and times quoted) and those found in the remainder of part I. The information in the daily events was designed to cater for everyone and is *geocentric* ie. as it would look from a position corresponding to the centre of the Earth. The exact time of closest approach may be in daylight from Australia or the objects of interest may not be above the horizon for us. The planetary text and sky views have been tailor made to suit Australia. Sometimes a lunar conjunction is followed by a 'Occn.'. This indicates that somewhere in the world the object will be occulted (covered) by the Moon. The distance given is measured from the centre of the Moon (remember, the Moon also has a diameter of 0.5°). *Occultations* involving the planets or the brightest stars are mentioned in the 'Moon' text. There are no bright star occultations visible from Australia during 1997. However, as highlighted in "the Moon" section, the star Aldebaran has a number of occultations this year. They are not visible from Australia, but we do see some close conjunctions.

Abbreviations. These include:

- 'G' which is for a galaxy
- 'OC' represents a open cluster
- 'GC' is a globular cluster
- 'PN' is a planetary nebula
- 'm.p.' equals a minor planet
- 'Occn.' is an occultation

There are also some astronomical catalogues

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

CONSTELLATION OF THE MONTH

This section concentrates on a particular constellation. Information includes:

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

SKY VIEWS

These diagrams are designed to help you find the planets. The date/time of each diagram has been carefully chosen to show the most interesting patterns of the planets and Moon. Sometimes the times chosen correspond to about one hour (or even down to 45 minutes) before sunrise or after sunset. Although, astronomically speaking, this would still be considered *twilight*, this is sometimes necessary to catch a glimpse of the planets when they are close to the Sun. This is especially needed for Mercury, because it never wanders more than 28° from the Sun. Sky Views which show a twilight view after sunset are called 'Evening Twilight' and morning twilights are 'Dawn Sky'. Those before midnight are 'Evening Sky' and after midnight, 'Morning Sky'.

The 'Sky Views' include:

- The Moon (showing approximate phase) and the planets visible with the naked eye.
- All stars down to about 4.5 magnitude.
- Names of the brightest stars.
- Bright star clusters, nebulae and galaxies (down to approximately 5.5 magnitude). These objects are named using the following codes. A prefix of 'N' means the object is in the New General Catalogue (NGC), an 'I' is the Index Catalogue (IC) and 'M' is a number in the Messier catalogue. Many of these deep sky objects are also listed on page 100 in 'Non Stellar Objects'.
- Constellations are labelled (capital letters) with black lines joining key stars (according to convention in astronomy atlases and books).

See also the legend in this introduction.

Although only stars down to 4.5 mag. are shown, positions of some fainter stars are sometimes indicated in the constellation lines. Where you see a bend, or end of a line, a fainter star is not shown.

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, trees and buildings, etc. The scale has been kept constant and the view is 37° in azimuth (along the horizon) by 49° in altitude (a 10° reference scale is also marked). Sometimes the altitude of an object of interest is such that the field of view is not large enough to include the horizon.

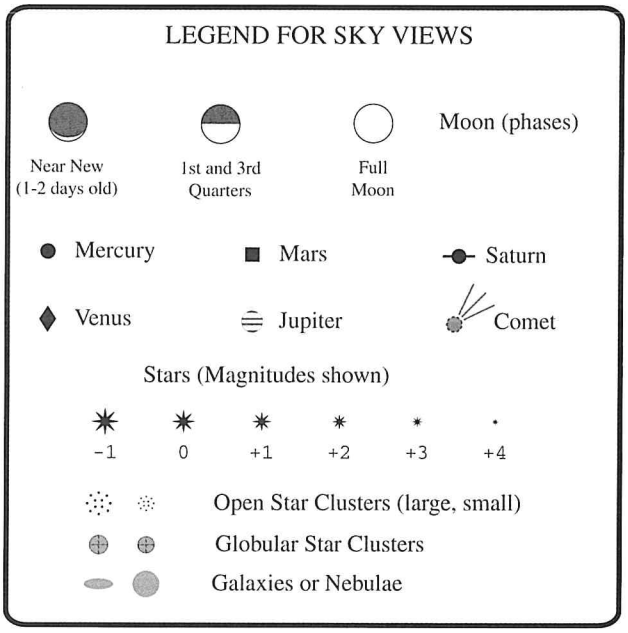
Uranus and Neptune have been excluded from the Sky Views as they are not generally visible to the naked eye. Uranus would certainly need dark sky conditions to be seen. Neptune will need at least binoculars. In either case, because of many faint stars of similar brightness close by, finder charts would be needed to identify these outer worlds. Pluto needs at least a 20cm telescope to glimpse this faint member of our Solar System and so isn't shown. Finder charts are on pages 92 - 93.

As a special addition to the sky views for 1997, the **comets Hale-Bopp and Encke has been included.** Where the comets are shown, they may be visible to the unaided eye. However, in a couple of cases the closeness to the horizon and the twilight sky may present a challenge. Binoculars will be a help at these times. Also be sure to escape the light polluted suburbs for dark country skies. In some cases, a comet may be shown on a sky view with the Moon. These are NOT exactly favourable conditions to view any comet. However, in these cases, our closest neighbour is being used as a guide, for those less experienced observers, to find the comet. It may be necessary to wait a few days for the Moon to no longer interfere. On the other hand, where the Moon is not shown, the time has been chosen to optimise the view.

The Sky View diagrams were designed for the unaided eye, but binoculars can be very useful. Binoculars can help you find:

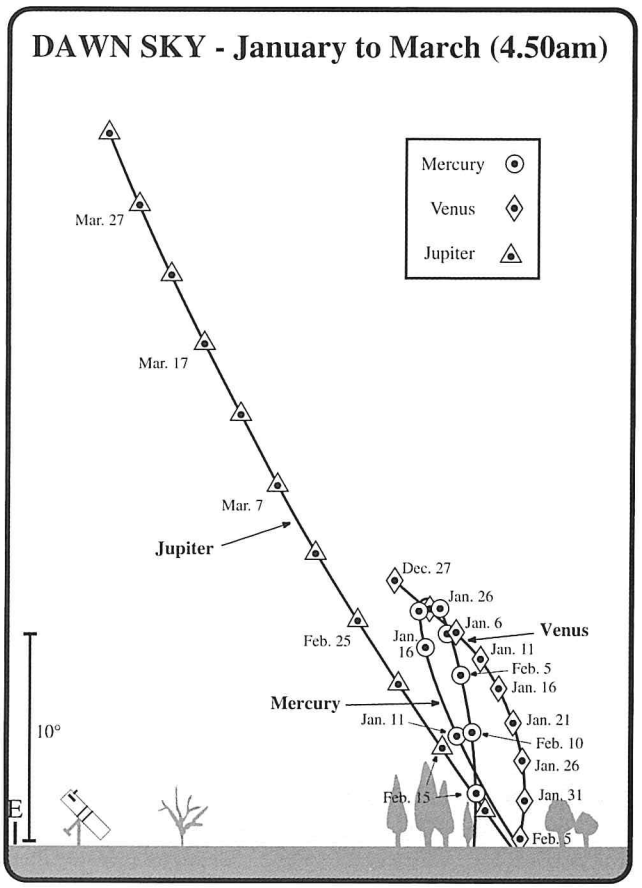
- stars and planets during twilight
- fainter stars
- stars dimmed by the nearby Moon
- stars close to the horizon.

The Sky Views are useful for more than just the date and time shown. The pattern of stars relative to the horizon is the same one month later, but 2 hours earlier. Of course the planets and the Moon will have moved. Compare Sky Views for 25th January (11pm) with 22nd February (9pm). Also a few minutes "playing" with a planisphere will also illustrate this yearly motion of the stars.

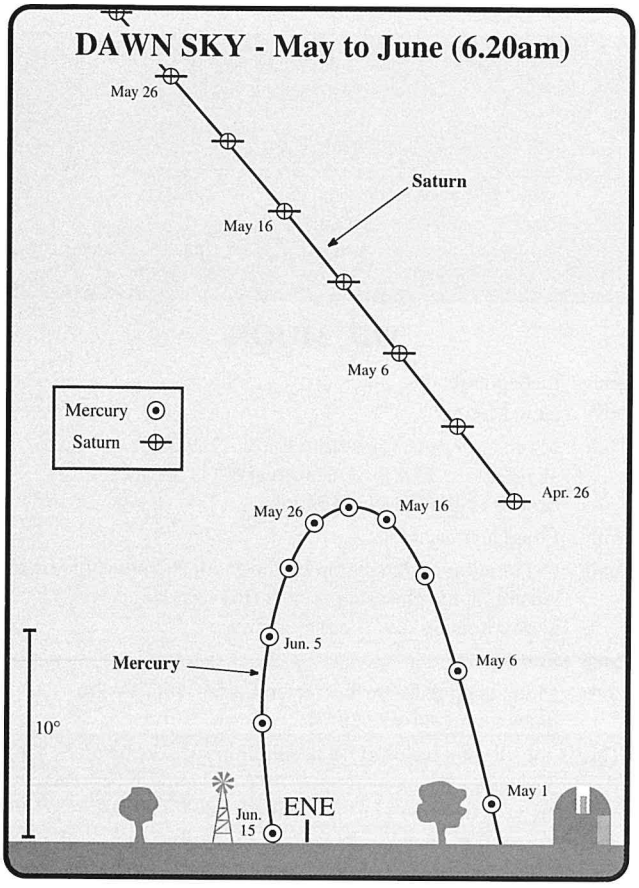


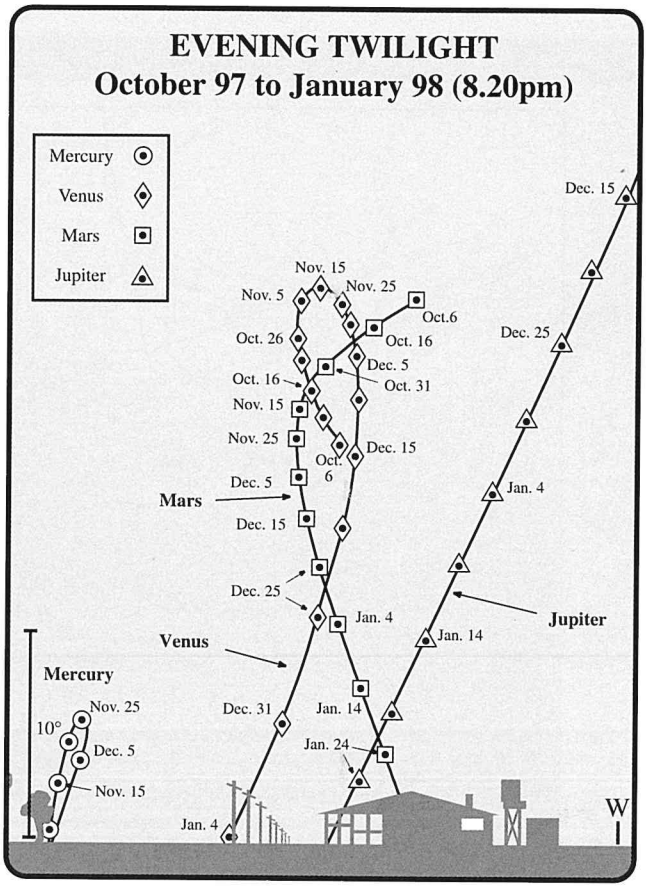
MOVEMENT OF THE PLANETS

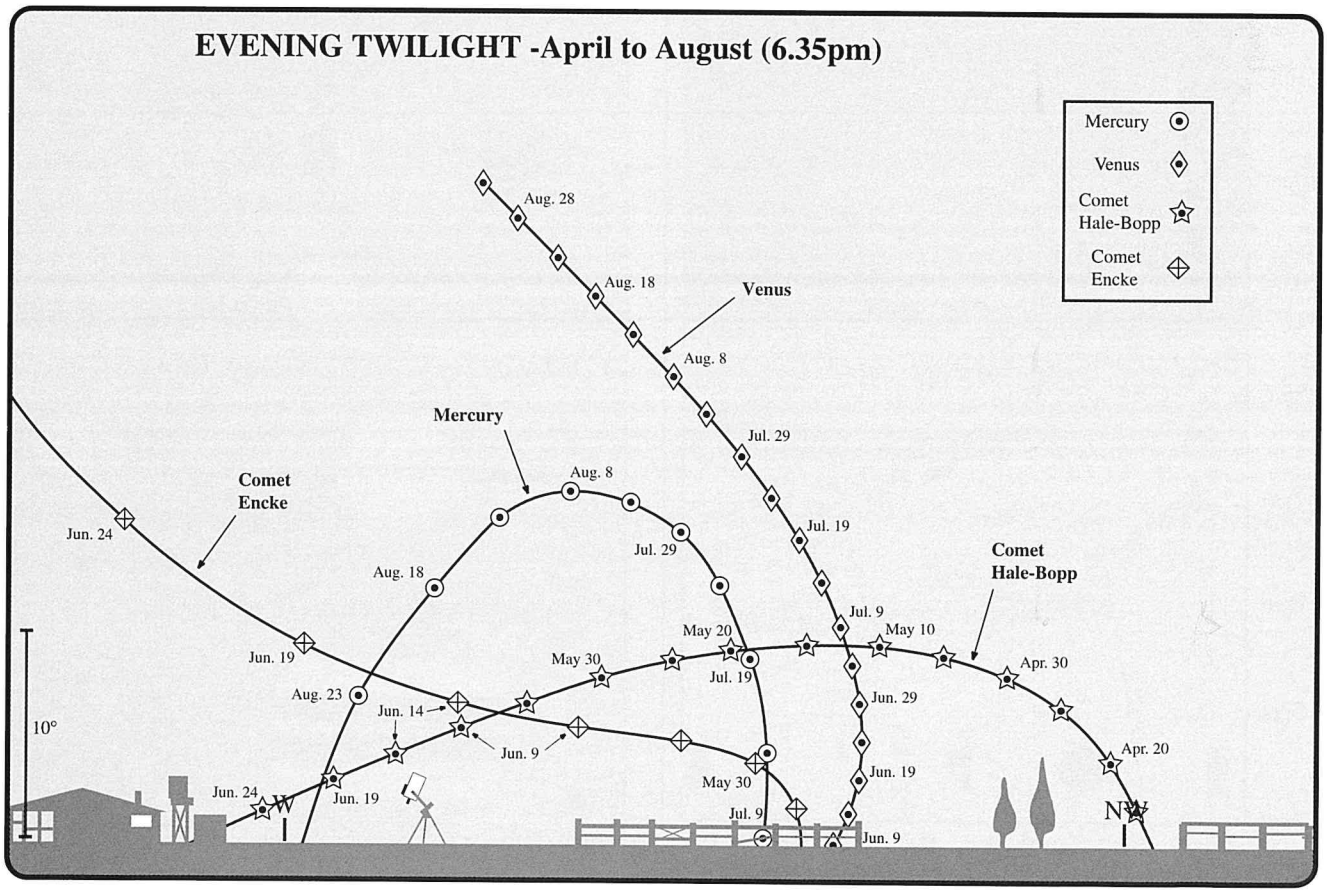
These diagrams (see below and opposite) are designed to help observers tell at a glance when the planets first become observable after being in *conjunction* with the Sun, or when they are about to go into *conjunction* with our star. The drawings are particularly useful as an observing guide for Mercury.



MOVEMENT OF THE PLANETS

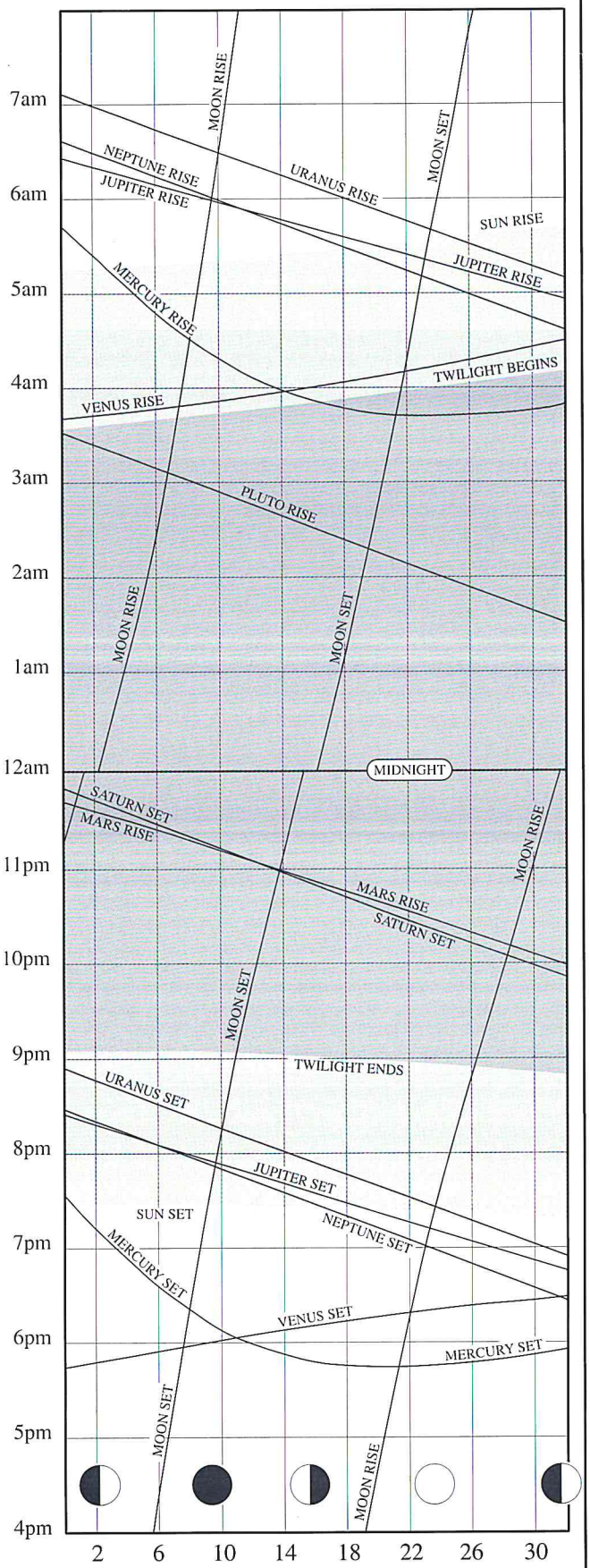






JANUARY

RISE/SET CHART



JANUARY HIGHLIGHTS

- Mercury is in the morning sky; best visible in second half of the month.
- Venus and Mercury close together mid month, in dawn sky.
- Mars, early in January is in the morning sky, but moves into the late evening by month's end.
- Saturn in western evening sky.
- Jupiter, Uranus and Neptune are not visible during January (too close to the Sun).

THE MOON

2nd Last Quarter.

9th New Moon.

10th Moon at perigee (closest to Earth - 359,233 km distant, angular size 33.4'). Distance given is between the centres of the Earth and Moon.

16th First Quarter.

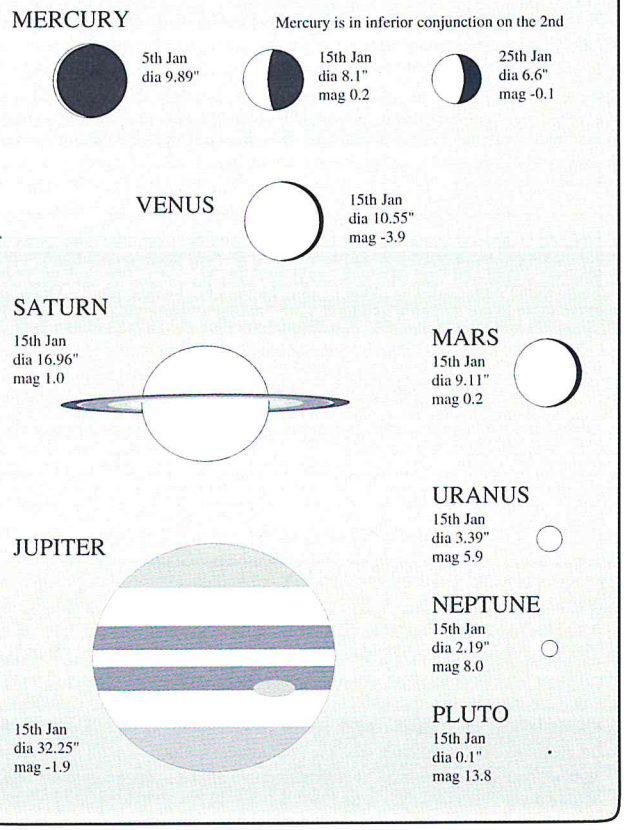
19th Occultation of Aldebaran by the Moon.* Not visible from Australia, the closest approach from our latitudes is approximately 4.5° (see sky view).

24th Full Moon.

26th Moon at apogee (furthest from Earth - 406,224 km distant, angular size 29.7').

* This is the 7th in a series of 48 occultations of Aldebaran by the Moon. The series began in August 1996 and ends in February 2000, this year there will be 13 occultations of Aldebaran. Aldebaran, at 0.85 magnitude, is the 13th brightest star in the sky. The star is prominent in the Hyades open star cluster in Taurus. This association is only by line of sight, as the star is about half the distance of the cluster from our Solar System.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is in inferior conjunction (between the Earth and the Sun) on the 2nd. It then moves into the eastern morning twilight sky approaching its greatest elongation (24.5°) west of the Sun on the 24th. Mercury, in Sagittarius, rises higher each morning and during the last half of the month the planet is visible before the beginning of astronomical twilight. Between the 12th and the 15th Mercury and the brilliant Venus are visible about 3° apart (see sky view on 13th).

VENUS moves from Ophiuchus into Sagittarius after the first week of January. Rising about an hour and a half before the Sun in the morning sky, the planet shines like a beacon at -3.9 magnitude. Three interesting events occur involving Venus this month. On the 8th, the very thin waning crescent of the Moon (just 3% lit by sunlight) is visible 6° below and a little north of Venus (see sky view). Secondly, Venus visits Mercury with a close approach to within 3° between the 12th and 15th. Finally Venus and Neptune come within 2.5° of each other by month's end and even closer in early February. With Neptune being a faint 8th magnitude, the conjunction will not be visible to the unaided eye.

MARS, in Virgo, can be seen close to the Moon on four occasions this month. On the 1st and 2nd, the two will be 4° and 8.5° apart (see sky view for 2nd). On the 28th and 29th they will be 4° and 9° apart respectively (the view will be similar to the sky view for 2nd). With the next opposition of Mars occurring in March, the planet has been steadily increasing in brightness over the past few months. Now around zero magnitude, it will peak at -1.3 during its close approach.

JUPITER is in conjunction with the Sun (on the opposite side of the Sun to the Earth) on the 19th, and therefore lost from sight. The planet moves to the west of the Sun and returns to the morning sky next month. Jupiter and Neptune have a close encounter on the 7th and 8th when they appear less than 1° from each other, although unfortunately not visible due to the close proximity of the Sun.

SATURN in the constellation of Pisces, is visible in the western evening sky. Saturn will be in conjunction with the Sun (on the opposite side of the Sun to the Earth) in March. January will be the last good opportunity to view Saturn in the evening sky, at least until the later half of the year. Any telescopic observation of the planet this month should begin early before too much altitude is lost. On the 14th, the 6 day old Moon will be 6° north of Saturn (see sky view).

URANUS & NEPTUNE. January is not the best time to observe these distant members of our Solar System. Like Jupiter, they are also in conjunction with the Sun this month (Uranus on the 25th and Neptune on the 17th), and are lost in the evening twilight. Uranus spends the entire year in Capricornus. However, Neptune begins 1997 in Sagittarius and moves into Capricornus in early April. It then returns to Sagittarius in June, where it remains for the rest of the year.

PLUTO rises in the early morning sky. Never far from the Scorpius/Ophiuchus border, Pluto begins the year in Scorpius and crosses into Ophiuchus in February.

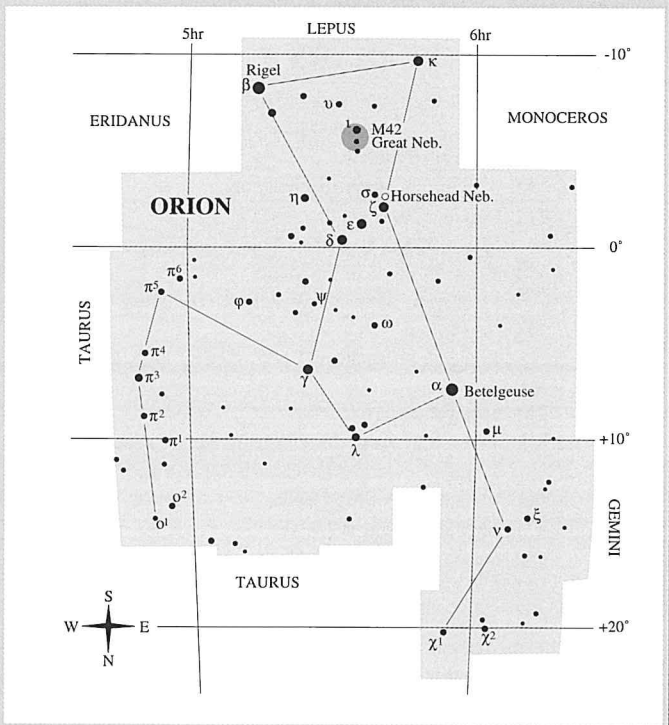
CONSTELLATION OF THE MONTH — ORION (Ori)

Orion the hunter, a constellation from antiquity, is one of the more impressive and distinguishable groups of stars. Steeped in history, Orion can be seen in the heavens accompanied by his dog (Canis Major), hunting the hare (Lepus) or the bull (Taurus). Some ancient stories have him chasing the Pleiades, the daughters of Atlas. It seems that Orion was a bit of a ladies man, not only did he hunt wild game but also women! His position on the celestial equator makes Orion visible to the entire globe. The southern hemisphere gets a grand view as the constellation culminates (is at its highest) towards the end of January, at 9pm, in the northern sky.

Orion contains an abundance of remarkable objects, two of the most famous being the Horsehead Nebula (Barnard 33) and the Orion Nebula or Great Nebula (M42). The Horsehead is difficult to glimpse, except in larger amateur telescopes under a dark sky. It is situated in a marvellous region of nebulosity nearby the western most 'belt' star Zeta Orionis (Alnitak). Like the Coal sack in Crux (see May constellation of the month), the Horsehead is a dark nebula silhouetted against a brighter background.

The Orion Nebula (M42, NGC1976) is one of the best known objects in the sky and undoubtedly the most photographed. Indeed it was the first nebula to be photographed. This feat was achieved by Henry Draper in 1880. It can be seen as the centre star in the handle of "the saucepan" and under country skies can look slightly hazy (even without binoculars). M42 lies about 1500 light years from us; the main portion visible in small telescopes is about 30 light years across. There is much more to see in this birthplace of stars, even in small telescopes. Immediately to the north another portion of the nebula, M43, can be seen in the same low power field. Imbedded in a region of the nebula known as the 'fish mouth', is a group of stars called the Trapezium (Theta Orionis). This is a close-knit group of very young stars that were formed within the nebula. The four main Trapezium stars are easy to see in small telescopes and range in magnitude from 5th down to 8th. Two 10th magnitude stars can be seen very close to two of the brighter ones, but these can be a severe test for the small telescope.

There are plenty of objects to see in the 'Sword' and 'Belt' regions of Orion. To the north of M42 lies the 4th magnitude star 42 Orionis that is immersed in a small haze of nebulosity known as NGC1977. Further to the north can be found an open star cluster of about a dozen stars of 8 to 10th magnitude (NGC1981). To the south of M42 is Iota Orionis, a triple star system made up of stars of the 3rd, 7th and 11th magnitude, separated by 11.5 and 50 arc seconds respectively.



One of the brightest stars in Orion is Betelgeuse (Alpha Orionis). This is sometimes translated as the "Armpit of the Giant"; the giant in this case being Orion. This is one of the most famous red giant stars and appears orange in colour. In contrast to the red hue of Betelgeuse, we travel now to the "Foot of the Giant", the white coloured, Rigel or Beta Orionis. A good 15 cm telescope will see Rigel's companion, a 7th magnitude star only 9 arc seconds away.

JANUARY

COMETS

Wirtanen: This comet opens the year at magnitude 12.5 in the evening sky in Aquarius, setting before 11pm. By the end of January, it lies on the border of Cetus and Pisces, not far from Saturn. At magnitude 11.5, it sets around 9.30pm.

Wild 2: Comet Wild 2 can be found in Cancer at the beginning of January, rising around 8.30pm at magnitude 11.5. It remains in Cancer throughout the month, ending January one magnitude brighter and visible for the whole night.

Tabur: Our first 1997 view of last year's third naked-eye comet will not be until mid-January. At this time it will be rising around 3.30am in Hercules at magnitude 10.5. It remains in Hercules for the rest of the month, fading by half a magnitude by month's end, when it is rising around 2am.

Hale-Bopp: 1997's hoped-for Great Comet will not be visible during January, being too close to the Sun.

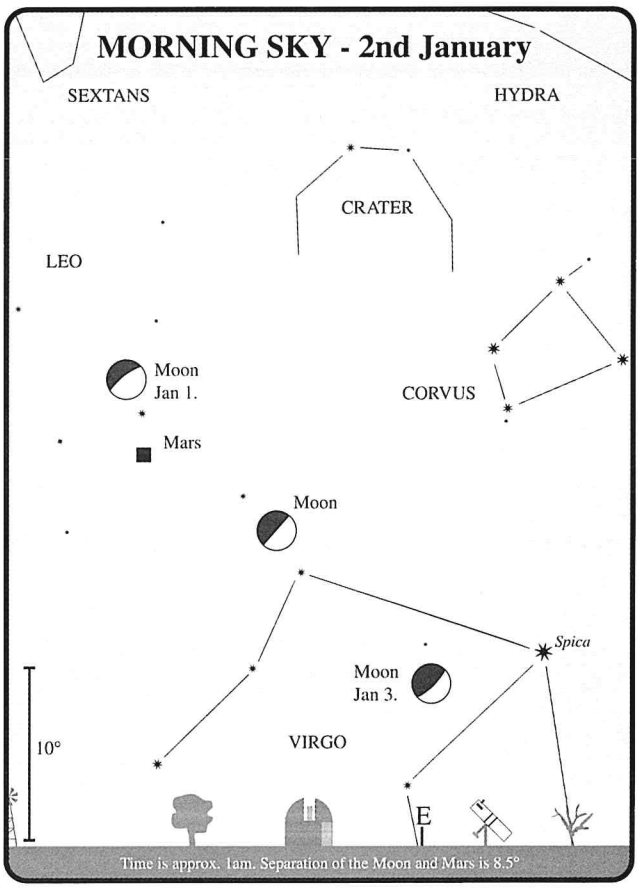
METEOR SHOWERS

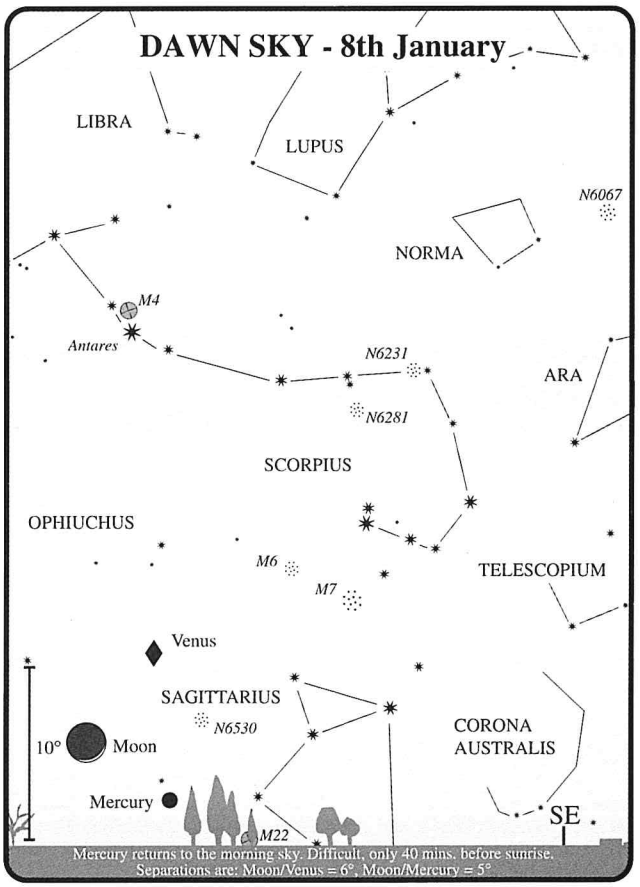
The **Quadrantids** are a strong and consistent northern shower. Unfortunately, it is difficult for southern observers, with the radiant below the early morning north eastern horizon. However, if observing before dawn, the occasional long-pathed member may be glimpsed. The Quadrantids are active from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

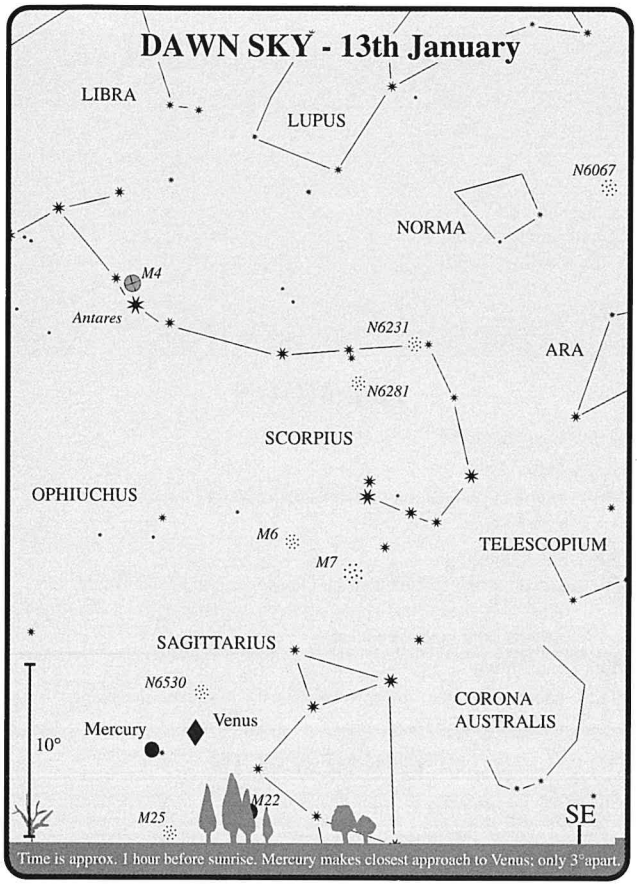
The **Alpha Centaurids** are active from 28th January through to 21st February, with maximum on the 7th of next month. Their ZHR is unpredictable, around 8 per hour at best, but high rates sometimes occur every 4 to 6 years. Most recently, in 1974 and 1980, the rates reached 20 to 30 per hour. The shower is noted for its brightly coloured fireballs that frequently reach negative magnitudes. They are predominantly yellow or blue, but their range of colour can cover the entire spectrum. The Alpha Centaurids are also well known for their long lasting trains (about 25 to 30 percent of the meteors) which may last from a few seconds to several minutes. Being circumpolar, the shower is visible throughout the night.

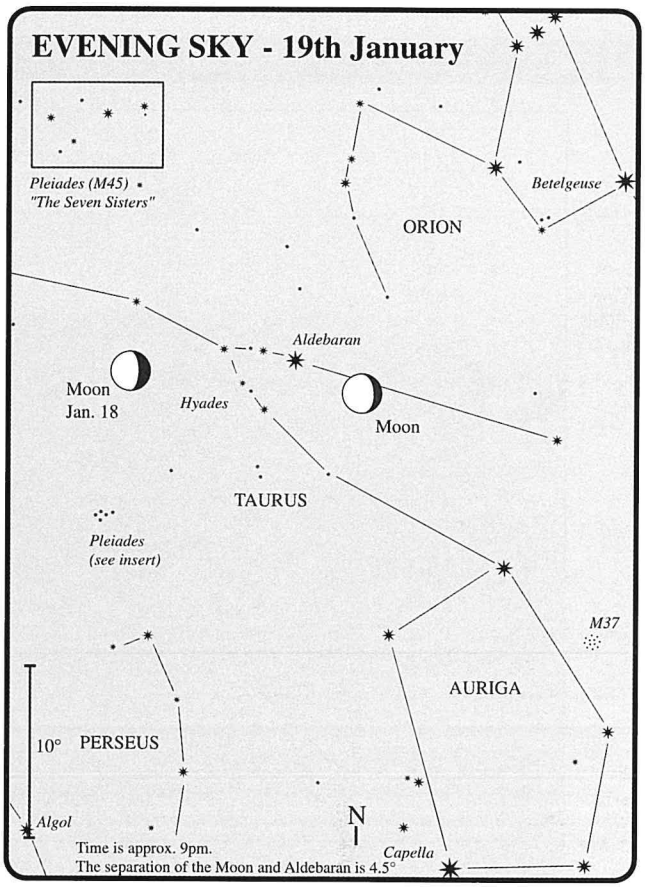
DIARY

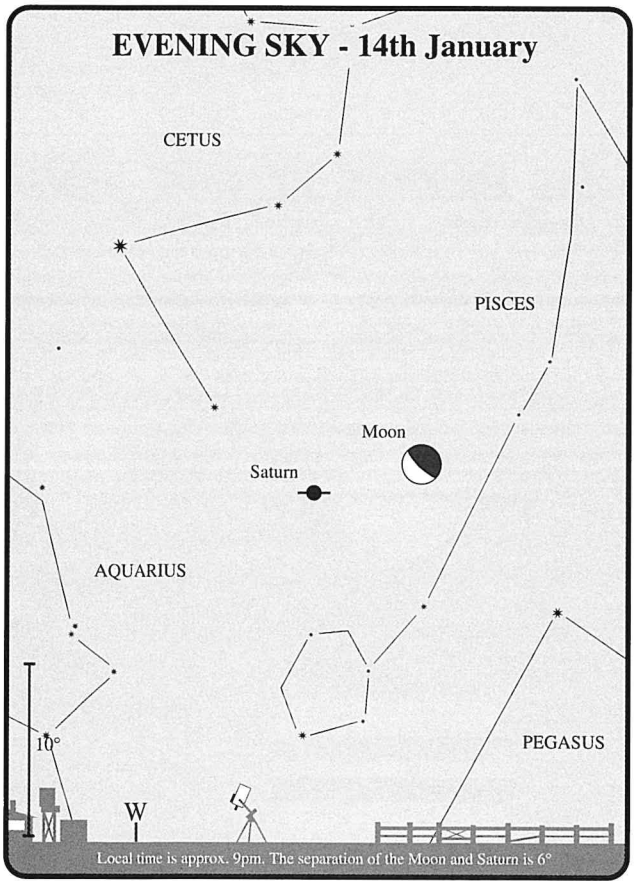
1st		m.p. 1 Ceres 0.8° East of NGC 7492 (GC) in Aquarius.
1st	Noon	Mars 3° North of the Moon.
2nd	8 AM	Earth at perihelion.
2nd	9 AM	Mercury in inferior conjunction.
2nd	9:45 AM	Last quarter Moon.
7th		Mars 0.5° South of NGC 4123 (G) in Virgo.
8th	1 AM	Venus 5° South of the Moon.
8th		Mercury at greatest latitude North (Heliocentric).
9th	12:26 PM	New Moon.
10th		Comet 46P/Wirtanen 1° NW of NGC 7492 (G) in Aquarius.
10th	5 PM	Moon at perigee.
11th	2 AM	Venus 0.2° West of M20 (Trifid Neb.) in Sagittarius.
12th		Mars 0.4° North of NGC 4179 (G) in Virgo.
12th	10 PM	Mercury 3° North of Venus.
13th	5 AM	Mercury stationary.
14th	1 PM	Saturn 2° South of the Moon.
14th	3 PM	Ceres in conjunction with the Sun.
16th	4:02 AM	First quarter Moon.
17th	9 PM	Neptune in conjunction with the Sun.
19th		Venus at descending node.
19th	2 PM	Aldebaran 0.7° South of the Moon; Occn.
19th	9 PM	Jupiter in conjunction with the Sun.
23rd		m.p. 1 Ceres 0.7° NW of NGC 7727 (G) in Aquarius.
23rd	11:11 PM	Full Moon.
24th	1 PM	Mercury greatest elongation West (25°).
24th	10 PM	Uranus in conjunction with the Sun.
26th	1 AM	Moon at apogee.
29th	7 AM	Mars 3° North of the Moon.
29th		Mars at aphelion.
31st		Mercury at descending node.

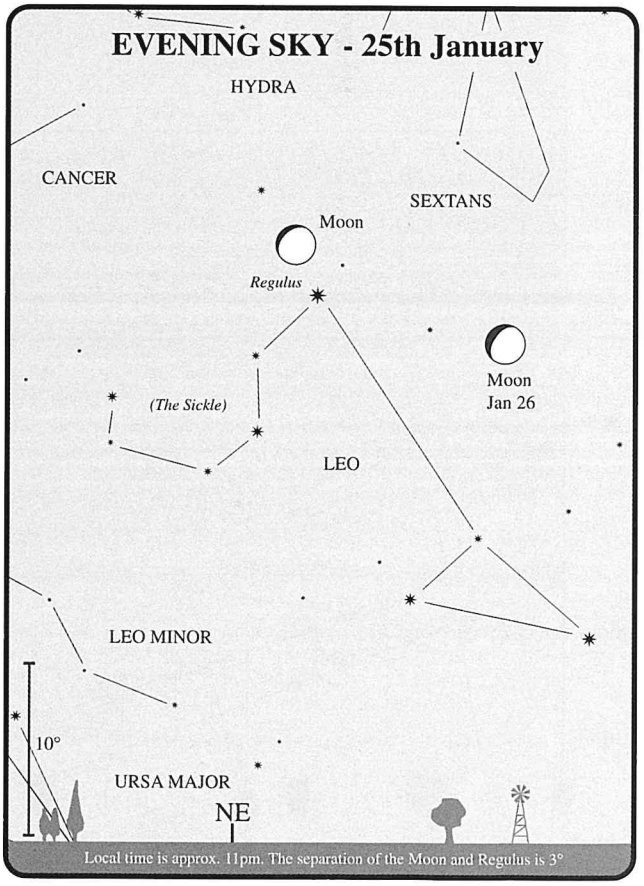





DAWN SKY - 13th January
LIBRA
LUPUS
N6067
NORMA
M4
Antares
N6231
ARA
N6281
SCORPIUS
OPHIUCHUS
M6
M7
TELESCOPIUM
SAGITTARIUS
N6530
CORONA AUSTRALIS
Mercury
Venus
10°
M25
M22
SE
Time is approx. 1 hour before sunrise. Mercury makes closest approach to Venus; only 3° apart.

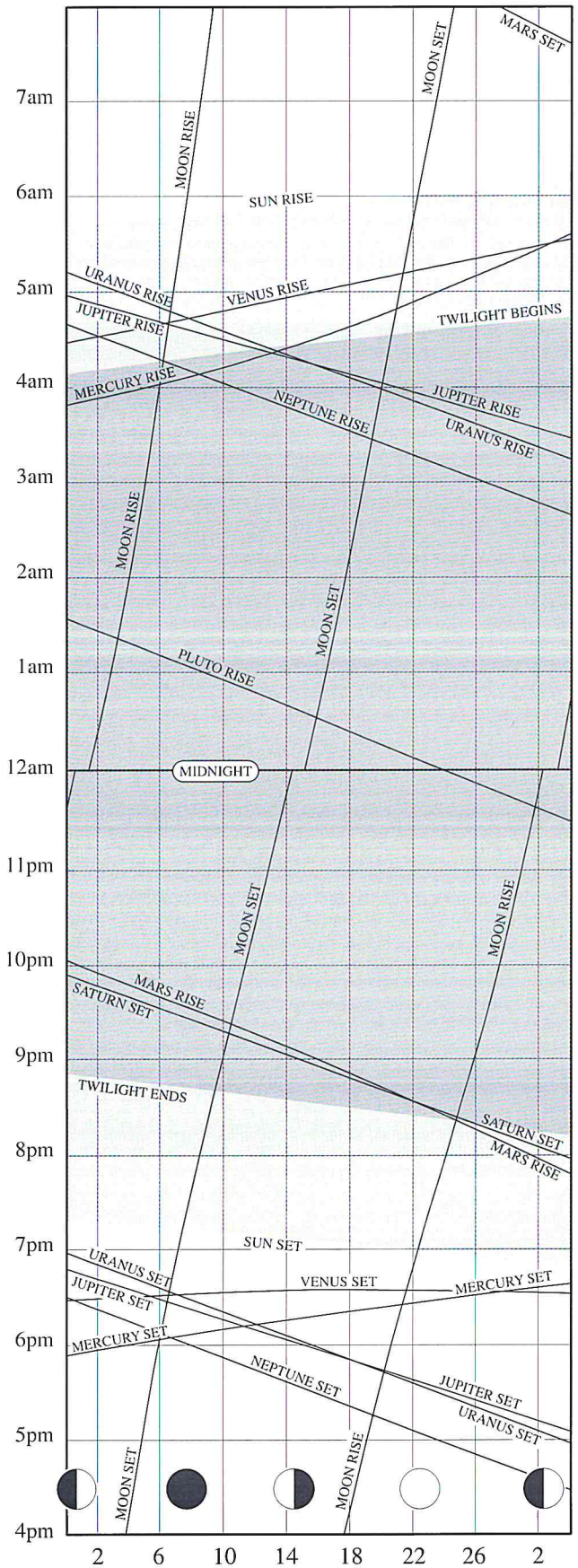

EVENING SKY - 19th January
Pleiades (M45)
"The Seven Sisters"
Betelgeuse
ORION
Aldebaran
Moon
Jan. 18
Hyades
Moon
TAURUS
Pleiades
(see insert)
M37
AURIGA
10°
PERSEUS
Algol
N
Capella
Time is approx. 9pm.
The separation of the Moon and Aldebaran is 4.5°


EVENING SKY - 14th January
CETUS
PISCES
Moon
Saturn
AQUARIUS
10°
PEGASUS
W
Local time is approx. 9pm. The separation of the Moon and Saturn is 6°


EVENING SKY - 25th January
HYDRA
CANCER
SEXTANS
Moon
Regulus
Moon
Jan 26
(The Sickle)
LEO
LEO MINOR
10°
URSA MAJOR
NE
Local time is approx. 11pm. The separation of the Moon and Regulus is 3°

FEBRUARY

RISE/SET CHART



FEBRUARY HIGHLIGHTS

- For the naked eye, the first half of February will have some close approaches involving Jupiter, Venus, and Mercury in the dawn sky. If you use a telescope or even binoculars, Uranus and Neptune also get into the act.
- Mercury is well placed in the morning sky for the first 2 weeks of the month.
- Jupiter, Uranus and Neptune move into morning sky.
- Early in the month is the last chance to observe Saturn in the evening sky, until the second half of the year.

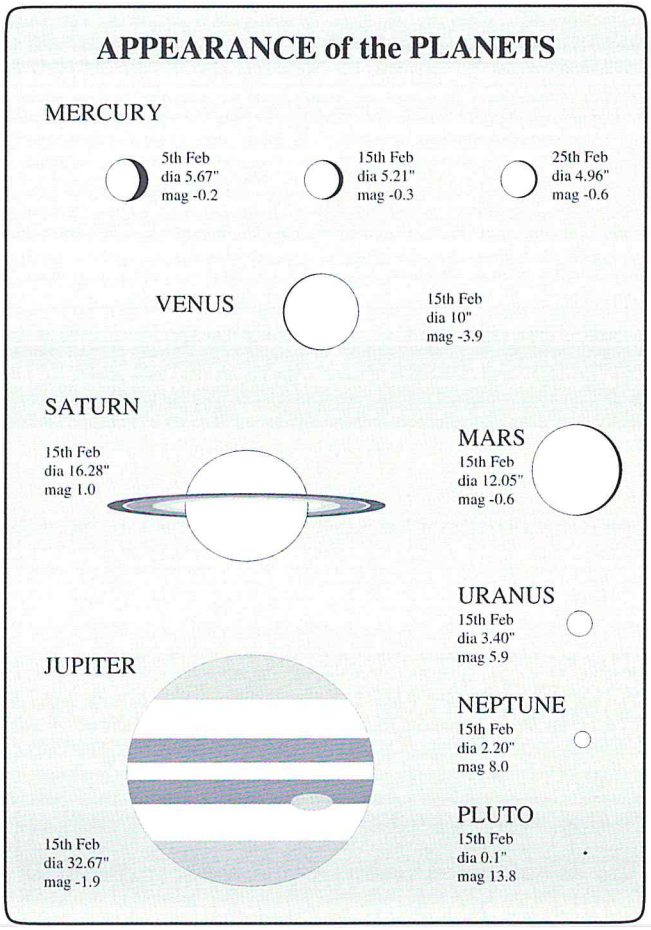
THE MOON

1st	Last Quarter.
8th	New Moon.
8th	Moon at perigee (closest to Earth - 356,847 km distant, angular size 33.6').
14th	First Quarter.
15th	Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach from our latitudes of 1.3° is seen around 10pm (see sky view).
22nd	Full Moon.
22nd	Moon at apogee (furthest from Earth - 406,395 km distant, angular size 29.6').

THE PLANETS

MERCURY travels from Sagittarius into Capricornus early in February, then onto Aquarius late in the month. With greatest western elongation in late January, the first half of this month provides a good opportunity to observe Mercury and some interesting conjunctions. On the 6th, the 27 day

APPEARANCE of the PLANETS



old very thin crescent Moon will be 7° north of the planet. On the 8th, Mercury and Neptune are less than 1.5° apart. A final event on the 13th sees Mercury, Jupiter and Uranus forming a triangle. Mercury will be 1° from both Jupiter and Uranus (Jupiter and Uranus less than 0.5° apart). With their unequal magnitudes, the trio should make an impressive sight in a low power telescope field (see also the sky views for the 7th and 13th, these however do not show Uranus).

VENUS, like Mercury, moves from Sagittarius into Capricornus, and then onto Aquarius during the month. Early February is certainly the time for the early morning planetary observer, with some excellent conjunctions and configurations. We begin with Venus and Neptune being 1° apart on the 2nd (about 1.5° on the 1st and 3rd). The two brightest planets, Venus and Jupiter, are extremely close at 0.5° on the 6th (see sky view on 7th). Finally, Venus and Uranus are within 0.5° of each other on the 8th. Your timing and a low horizon are important, otherwise twilight will interfere. It is not often that the planets Mercury, Neptune, Venus, Jupiter and Uranus are within 10° of each other and the 27 day old thin crescent Moon as well (6th February)!

MARS rises early evening in the constellation of Virgo. With opposition next month the planet is now quite brilliant (reaching mag. -1.0 by the 28th). Although this opposition is only slightly more favourable than the poor 1995 apparition, when the red planet was at aphelion (the point in its orbit furthest from the Sun), it still deserves some telescope time. If seeing and weather permits, telescope users may see a polar cap and some surface markings under high magnification. By mid month the disc diameter will be a little over 12 arc seconds in diameter. This is only half the size when Mars is at a favourable opposition (see Mars section in part II for more detail). On the 24th, the Moon, a few days past full can be seen 5° from Mars, and on the following evening 9° away (see sky view, 24th). The planet appears stationary on the 7th, and thereafter begins its western motion across the sky, continuing until the end of April. It then returns to its west-to-east track (see discussion on retrograde motion and the Mars finder chart in part II).

JUPITER, now past conjunction, rises in the early morning sky in the constellation of Capricornus. Playing a prominent role in the planetary shuffle mentioned in the Venus section, Jupiter also has its share of conjunctions. On the 6th Jupiter will be less than 0.5° from Venus, a spectacular naked eye sight with Jupiter at -1.9 magnitude and Venus at -3.9! The following day the pair can still be seen 0.7° apart (see sky view). Between the 13th and 19th Jupiter and Uranus will be less than 0.5° from each other, with closest approach on the 16th at a very close 11 arc minutes. Particular note should be made of the 13th when Jupiter, Mercury and Uranus share a small region of sky together (see Mercury for more detail).

SATURN sets in the western evening sky around the time astronomical twilight ends. With the planet in conjunction with the Sun (on the opposite side of the Sun to the Earth) next month, it is effectively lost from view until mid April when it appears in the dawn sky. Saturn moves from Pisces into Cetus around the 25th. On the 10th, the 3 day old thin crescent Moon will be seen 4° below Saturn (see sky view).

URANUS, moving into the morning sky since being in conjunction with the Sun, now interacts with Mercury, Venus and Jupiter. Uranus and Venus are within 1° of each other on the 8th. On the 13th Uranus and Jupiter are 0.5° apart with Mercury forming a triangle 1° from the other two planets. Uranus and Jupiter are close (less than 0.5°) from the 13th to the 19th; but on the 16th only 11 arc minutes!

NEPTUNE, like Uranus, moves into the morning sky after conjunction. It has a close approach with Mercury on the 8th (1.5° separation), and with Venus on the 2nd (1°).

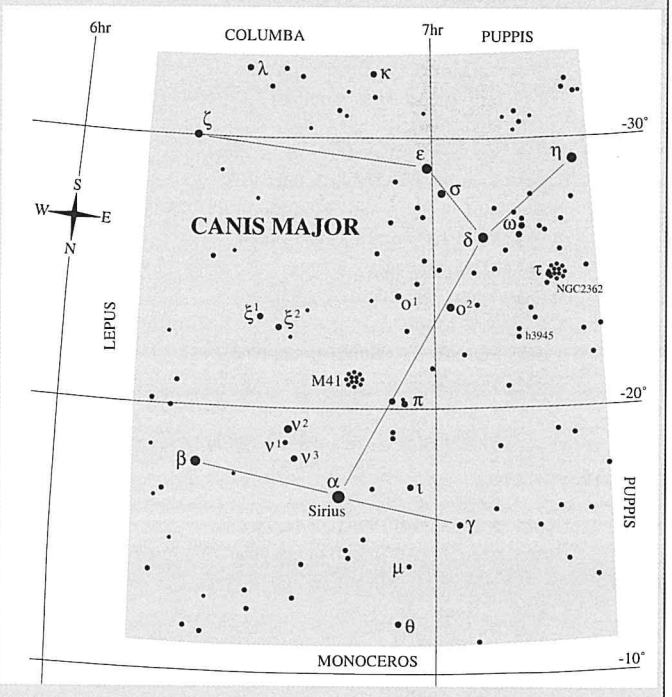
PLUTO on the 4th and 5th of this month will be 1 arc minute from a 7th magnitude star SAO141122. Using this star as a reference, and the pointer and finder charts (see pp 92 - 93), locating Pluto should be easy. This assumes you have a good dark sky and a telescope capable of seeing down to 14th magnitude! If you are not positive which faint pinpoint is actually Pluto, try sketching (or photographing) the field twice, about 2 weeks apart, and see which one has moved.

CONSTELLATION OF THE MONTH — CANIS MAJOR (CMa)

Canis Major, the Greater Dog, is one of two hunting dogs associated with Orion. The other canine is Canis Minor, the Lesser Dog. Both constellations were originally side by side, but were divided when the constellation of Monoceros was created in the year 1613. Canis Major was known to the ancient Greeks as "Seirios aster", the scorching star. This name didn't refer to the constellation as a whole, but to its brightest star Sirius. The name not only related to the brightness of this star, but also to Canis Major being near the Sun during the hottest time of the year. Later the Romans called the scorching midsummer days 'caniculares dies' or dog days, a term that has been carried down through history to become common usage in the English language. To the ancient Egyptians, its appearance in the eastern morning sky heralded the new year and the annual flooding of the Nile. The Australian aborigines knew it as an Eagle.

The brightest member of Canis Major is Sirius, the Dog Star. At -1.5 magnitude, this dazzling blue-white star, is the brightest star in the sky (except for the Sun of course). Sirius is about 36 times more luminous than our Sun, and its distance of 8.6 light years makes it the sixth closest star to our own system. Sirius is a double star. Its companion, Sirius B, was the first white dwarf star discovered and is also appropriately known as 'The Pup'. After a ten year study of the motion of Sirius, Bessel in 1844 announced his belief that there was a companion to the Dog Star. In 1862, a visual confirmation was made by the American astronomer Alvan Clark, when he was testing a new 46cm objective lens. The Pup has an orbital period of about 50 years and the distance from its primary varies from 2.5 to 11.4 arc seconds. At discovery it was about 10 arc seconds away. While not beyond the capability of a good amateur telescope, it is a difficult pair due to the overwhelming brilliance and closeness. Sirius B is ten magnitudes fainter than its companion. As the last close approach occurred in 1993, it may pay to wait a few years for the separation to increase, before trying to glimpse the 'Pup'. Maximum distance will be reached again in 2022.

The constellation contains many other double stars, most of which are easier than Sirius. Of particular note is a star designated as "h3945". The primary is 4.8 magnitude and the 6.8 magnitude companion is a wide 27 arc seconds away, ie. a typical double star. The remarkable thing about h3945 is the colour. One star is gold and the other blue - a truly exquisite sight.



Of the many deep sky objects, two of the open clusters are real gems. M41 (NGC2287) is visible to the unaided eye as a 5th magnitude "hazy" star, 4° south of Sirius. Low power is best for this scattered cluster of about 100 stars, many of its members forming arcs. A conspicuous reddish star, near the centre of the cluster, makes a fine sight amongst the many blue giants. The second open cluster of note is NGC2362, which surrounds the 4th magnitude triple star Tau Canis Majoris. The 40 members of this stunning cluster are packed into a 6 arc minute circle. The companions of "Tau" are not difficult to see in moderate sized telescopes. They are 10th and 11th magnitude, separated from the primary by 8 &14 arc seconds respectively.

FEBRUARY

COMETS

Wirtanen: Comet Wirtanen begins February low in the western evening sky, at magnitude 11.5, moving into Cetus, not far from Saturn. At this time, it sets around 9.30pm. During the month, it moves into Pisces and by the end of February it is setting at 8.30pm, having brightened to magnitude 10.5.

Wild 2: This comet is in Cancer at the beginning of the month, at magnitude 10.5, and visible for the whole night. By month's end, it has moved into Gemini, at around 10th magnitude, and is setting shortly after 2am.

Tabur: Beginning February at 11th magnitude, and rising around 2am in Hercules, Tabur quickly moves into Serpens. It ends the month near Alpha Serpentis. Now at only 12th magnitude it is rising around 11.30pm.

Hale-Bopp: During February, Hale-Bopp will be too far north of the Sun to be visible from Australia.

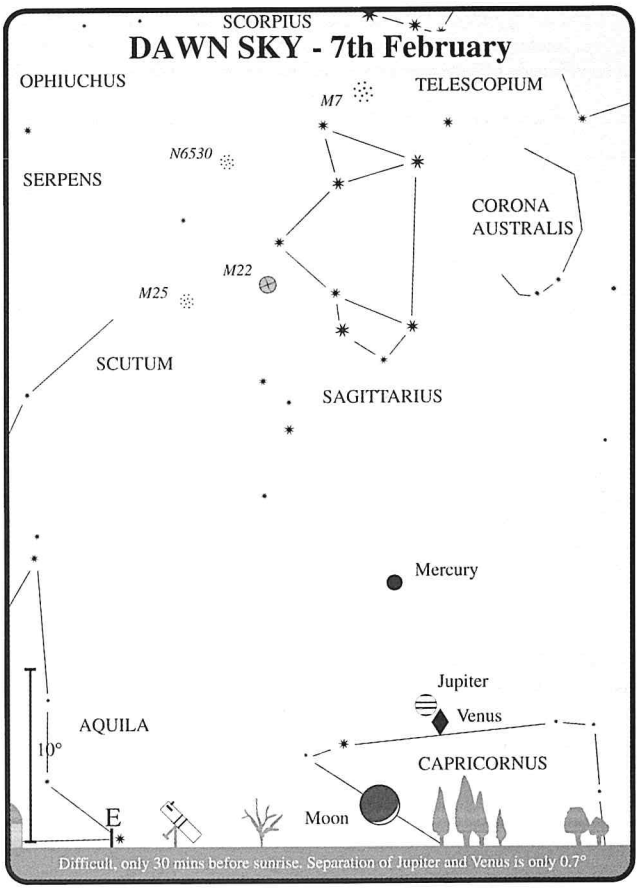
METEOR SHOWERS

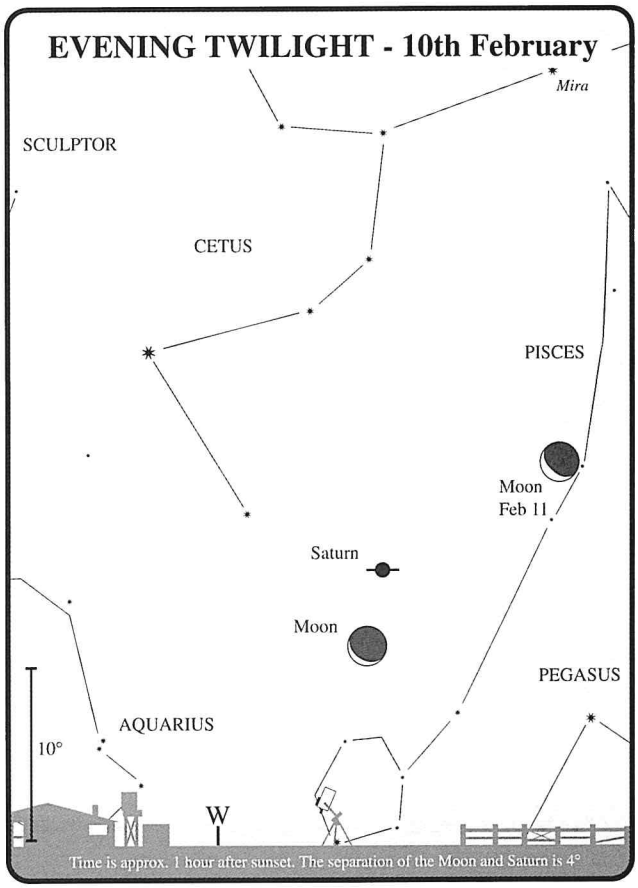
The **Alpha Centaurids** are active from 28th January through to 21st February, with maximum on the 7th of this month. Their zenith hourly rate (ZHR) is unpredictable, around 8 per hour at best, but high rates sometimes occur every 4 to 6 years. Most recently, in 1974 and 1980 the rate was 20 - 30 per hour. This increase is always temporary, lasting no more than 2-3 hours. The shower is noted for its brightly coloured fireballs that frequently reach negative magnitudes. They are predominantly yellow or blue, but their range can cover the entire spectrum. The Alpha Centaurids are also well known for their long lasting trains (about 25 to 30 percent of the meteors) which may last from a few seconds to several minutes. Being circumpolar, the shower is visible throughout the night.

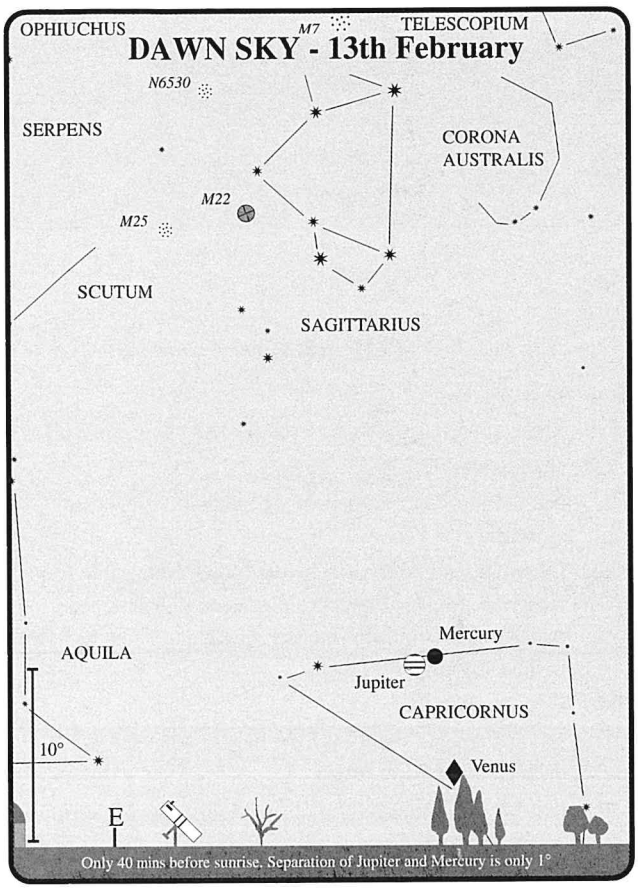
The **Gamma Normids** are active between 25th February and 22nd March. For most of the period the rate is low and members are difficult to sort out from the background sporadic activity. The peak occurs on March 13, when rates can reach 3 to 8 per hour. Generally, the Gamma Normids are bright and chiefly yellow, white or orange with about 15% leaving trains.

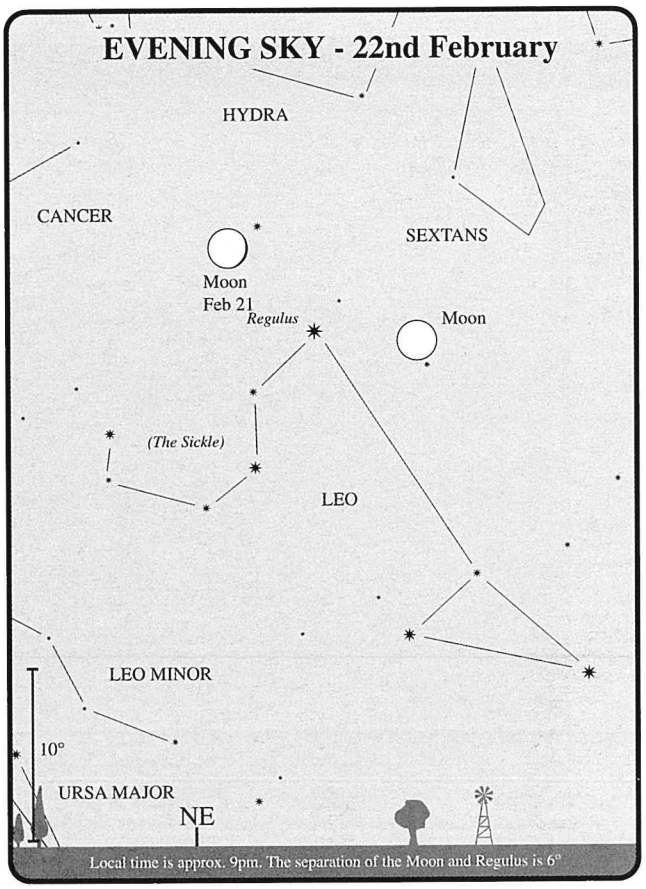
DIARY

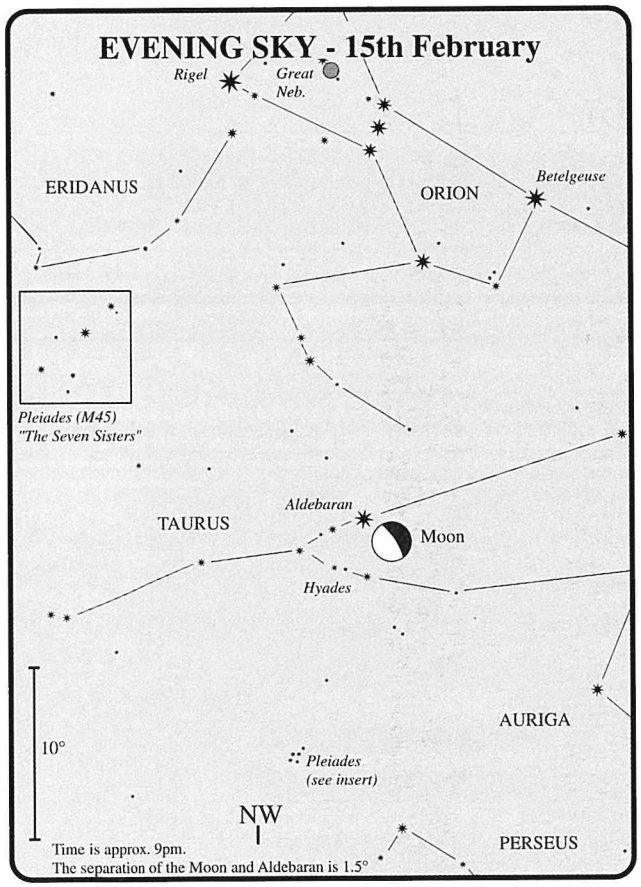
1st	3:40 AM	Last quarter Moon.
1st		m.p. 15 Eunomia 0.8° South of M62 (GC) in Ophiuchus.
1st	7 PM	Venus 1.0° South of Neptune.
3rd		m.p. 14 Irene 0.2° South of NGC 6342 (GC) in Ophiuchus.
3rd	2 PM	Vesta in conjunction with the Sun.
6th	8 AM	Venus 0.3° South of Jupiter.
6th	Noon	Mercury 5° South of the Moon.
6th	4 PM	Neptune 4° South of the Moon.
7th	2 AM	Mars stationary.
7th	8 PM	Venus 0.2° South of Uranus.
7th	11:06 PM	New Moon.
8th	4 AM	Mercury 1.4° South of Neptune.
8th	5 AM	Moon at perigee.
9th		Saturn 3.3° NW of Comet 46P/ Wirtanen.
9th		Mercury 0.7 North of M75 (GC) in Sagittarius.
11th	1 AM	Saturn 1.8° South of the Moon.
11th		Mercury at aphelion.
12th	10 PM	Mercury 1.0° South of Jupiter.
13th	8 AM	Mercury 0.9° South of Uranus.
14th		Neptune 0.2° North of m.p. 8 Flora.
14th	4:57 PM	First quarter Moon.
15th	7 PM	Aldebaran 0.6° South of the Moon; Occn.
16th		m.p. 532 Herculina 0.1° East of the Omega Neb. (M17) in Sagittarius.
16th	4 PM	Jupiter 0.2° North of Uranus.
18th		m.p. 14 Irene 0.2° SW of NGC 6440 (GC) in Sagittarius.
20th		Comet 46P/Wirtanen 0.5° North of IC 1613 (G) in Cetus.
22nd	1 AM	Moon at apogee.
22nd	6:27 PM	Full Moon.
23rd		Venus at aphelion.
25th		Comet 46P/Wirtanen 0.1° South of NGC 488 (G) in Pisces.
25th	9 AM	Mars 3° North of the Moon.

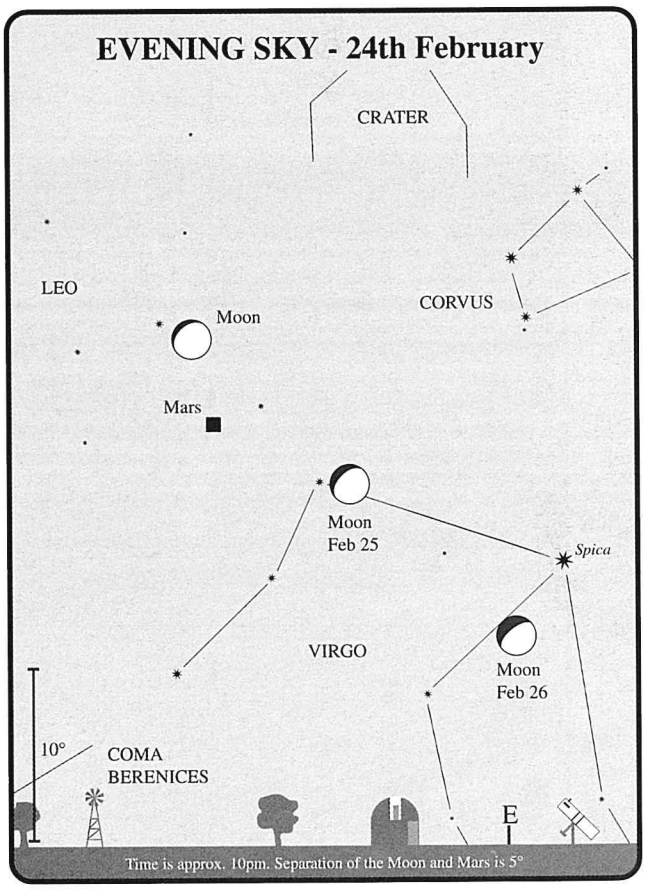





DAWN SKY - 13th February
OPHIUCHUS
M7
TELESCOPIUM
N6530
SERPENS
CORONA AUSTRALIS
M22
M25
SCUTUM
SAGITTARIUS
AQUILA
Mercury
Jupiter
CAPRICORNUS
10°
Venus
E
Only 40 mins before sunrise. Separation of Jupiter and Mercury is only 1°

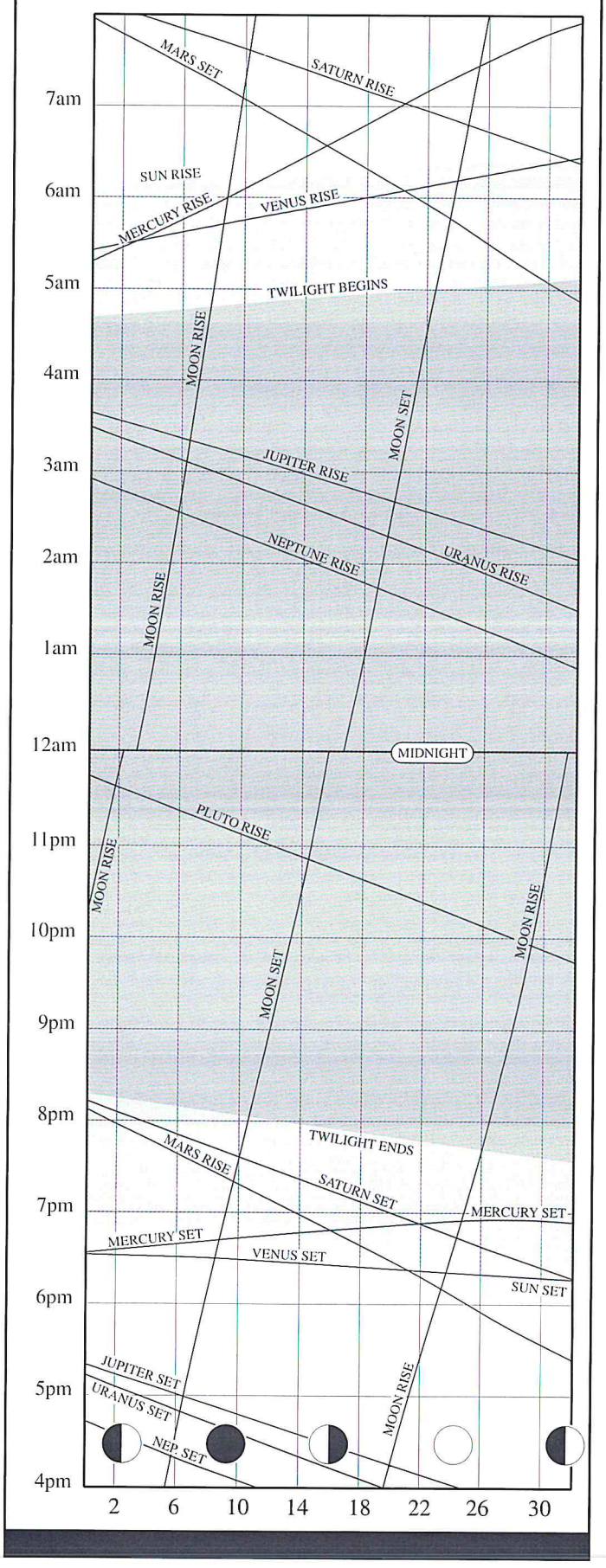

EVENING SKY - 22nd February
HYDRA
CANCER
SEXTANS
Moon
Feb 21
Regulus
Moon
(The Sickle)
LEO
LEO MINOR
10°
URSA MAJOR
NE
Local time is approx. 9pm. The separation of the Moon and Regulus is 6°


EVENING SKY - 15th February
Rigel
Great Neb.
ERIDANUS
ORION
Betelgeuse
Pleiades (M45)
"The Seven Sisters"
Aldebaran
TAURUS
Moon
Hyades
AURIGA
10°
Pleiades
(see insert)
NW
PERSEUS
Time is approx. 9pm.
The separation of the Moon and Aldebaran is 1.5°


EVENING SKY - 24th February
CRATER
LEO
CORVUS
Moon
Mars
Moon
Feb 25
Spica
VIRGO
Moon
Feb 26
10°
COMA
BERENICES
E
Time is approx. 10pm. Separation of the Moon and Mars is 5°

MARCH

RISE/SET CHART



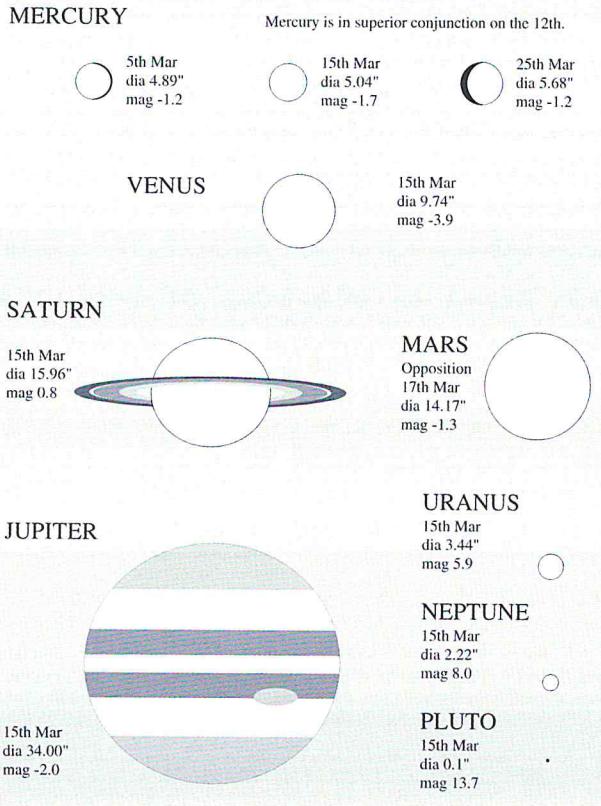
MARCH HIGHLIGHTS

- Mercury and Venus are not visible during March (too close to the Sun).
- Mars rises around sunset and is visible the whole night.
- Jupiter is in the eastern morning sky, rising around 3am.

THE MOON

2nd	Last Quarter.
8th	Moon at perigee (closest to Earth - 357,758 km distant, angular size 33.2').
9th	New Moon. Total eclipse of the Sun, not visible from Australia
15th	Occultation of Aldebaran by the Moon. Not visible from Australia, from our latitudes the Moon will be 4° from Aldebaran on the 14th (see sky view), and 9° on the 15th in the early evening skies.
16th	First Quarter.
21st	Moon at apogee (furthest from Earth - 405,958 km distant, angular size 29.0').
24th	Full Moon. Partial eclipse of the Moon, not visible from Australia.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY moves from the morning to the evening sky, after superior conjunction on the 12th (opposite side of the Sun to the Earth). The planet's next greatest elongation occurs early in April, but it is not a favourable one. Observations of Mercury in the evening sky will be better in July or August. The planet commences March in Aquarius and about mid-month moves into Pisces.

VENUS rises only a short time before the Sun as it moves toward superior conjunction (opposite side of the Sun to the Earth) in early April. The planet will be lost in the Sun's glare for several months, and then reappears in the evening twilight in late May. During the month Venus moves from Aquarius into Pisces and then onto Cetus.

MARS spends most of the month in Virgo, crossing into Leo during the last few days. It is at opposition on the 17th. At -1.3 magnitude, the planet is at its brightest since the last close approach in 1995. The 1995 opposition was a poor one with the Earth/Mars distance being 0.68au (astronomical units).The current apparition fares little better with the distance only marginally improved at 0.66au. With a disk diameter of only 14.2 arc seconds, compared with 25 arc seconds at a favourable opposition it is easy to see why there is not much interest generated in this event. Although conditions may not be ideal, the planet still deserves some telescope time. With good seeing and high magnification, observers should see a polar cap and some surface markings. On the 23rd, the Full Moon will be 3° from the red planet (see sky view). See also the Mars section on page 78 for details on future oppositions.

JUPITER can now be seen in the early morning sky, in the constellation of Capricornus. After a busy February, with Jupiter being visited by numerous planets, things settle down this month. Venus and Mercury have disappeared into the glare of the Sun, and Jupiter is left alone to dominate the eastern morning sky shining at -2.0 magnitude. On the 7th, the 27 day old thin crescent Moon will be 7.5° below Jupiter (see sky view).

SATURN in Cetus, is lost in the evening twilight this month as it moves closer to conjunction with the Sun on the 30th. By mid April Saturn will be visible in the eastern morning sky as twilight begins.

PLUTO is stationary on the 10th, and thereafter begins its western motion across the sky until August. It then returns to its west-to-east track. See discussion on retrograde motion and the Pluto finder chart in part II.

MINOR PLANETS. At opposition this month is 6 Hebe at mag. 9.6 in Leo.

COMETS

Wirtanen: Beginning the month at magnitude 10.5 in Pisces and setting at 8.30pm, Wirtanen moves into Taurus by month's end, setting just before 8pm. On 14th March, the comet is at perihelion.

Wild 2: Comet Wild 2 begins March in Gemini, setting shortly after 2am. Throughout the month, it is at its peak brightness of 10th magnitude. By months end it returns to Cancer, setting around 1am.

Tabur: This comet can be found near Alpha Serpentis at the beginning of March, rising around 11.30pm at 12th magnitude. During March it moves into Virgo. By month's end it rises around 8.30pm, visible until dawn, having faded to magnitude 12.5.

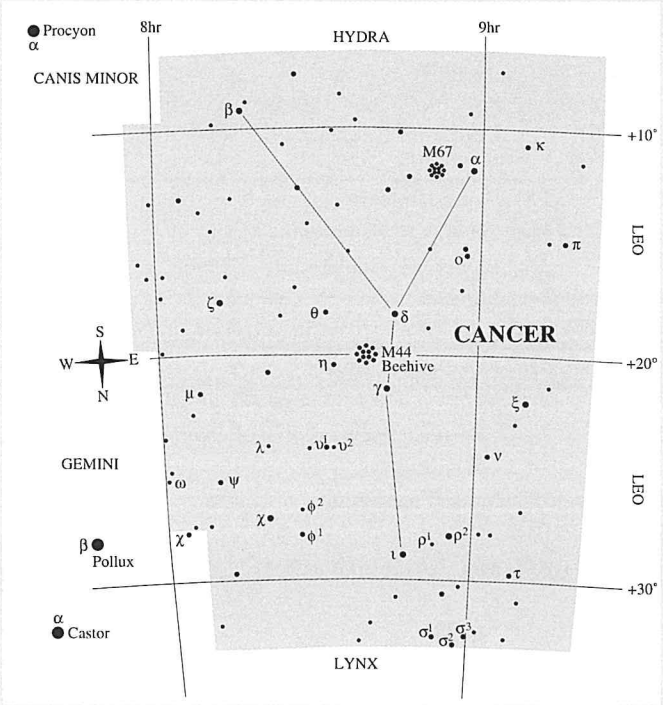
CONSTELLATION OF THE MONTH — CANCER (Cnc)

Cancer, the Crab, is a constellation of the Zodiac that is rather barren and lacking in bright stars. In fact, its main stars are only about 4th magnitude and are difficult to see from the suburbs without binoculars. Although faint, the location of the constellation is not hard to find. It lies within a triangle of bright stars formed by Castor and Pollux (the twins of Gemini), Regulus (in Leo) and Procyon (in Canis Minor). Of the zodiacal constellations "the Crab" is the most indistinct, but a number of fine objects, within its boundaries, make up for its lack lustre appearance. In March, the Crab is high in the north sky around 9pm.

From ancient mythology, Cancer was placed in the heavens by Juno after biting Hercules on the foot. Hercules at the time was wrestling with the serpent Hydra. As mentioned, Cancer is a rather inconspicuous constellation, but it was held in high regard in the early legends. Known as the "Gate of Men", it was the place where souls descended from heaven into their human form.

The showpiece of the constellation is the open star cluster named the Beehive (M44). At 500 light years away, the cluster is one of the nearest. In total about 300 stars combine to create a fuzzy, "cloudy" patch visible to the unaided eye. The Beehive is also known as Praesepe ie. the 'stall' or 'manger'. The cluster does not resemble a manger and the modern description of 'Beehive' is more apt. The two stars that flank the cluster, Gamma Cancri (Asellus Borealis) and Delta Cancri (Asellus Australis), are the northern and southern donkeys. The cluster was thought to be their home, hence a manger for the animals. The cluster, over one degree in diameter, is seen best in binoculars or in a low power telescope field. The stars form numerous triangles and many members are doubles. Two of the Solar System's inner most members, Mercury and Venus, visit the Beehive in July (see "July" for more detail).

For those using small telescopes, another fine galactic cluster known as M67 (NGC2682), can be found in this constellation.



Tighter and more compact than its larger more northern "Beehive" neighbour, M67 is estimated to be over 10 thousand million years old, making it one of the oldest clusters.

The constellation contains several double and multiple star systems. For small telescopes and for those who like colour contrast in double stars, the Iota Cancri pair are stunning. The stars are 4th and 6th magnitude, and are separated by a wide 30 arc seconds. The brighter is gold and its companion, light blue.

MARCH

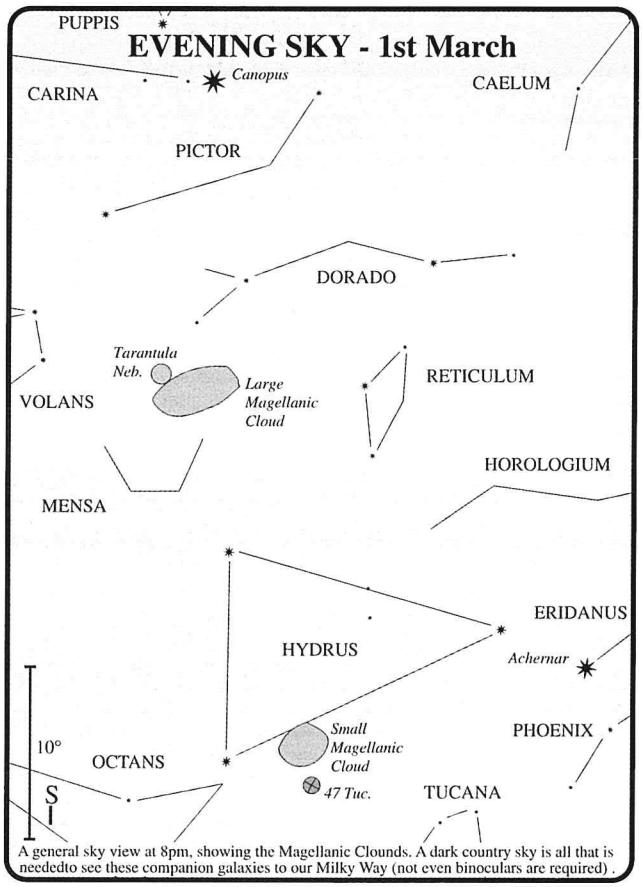
Hale-Bopp: The comet is too far north of the Sun to be visible from Australia. Northern hemisphere observers will be enjoying the comet at its brightest by the end of the month.

METEOR SHOWERS

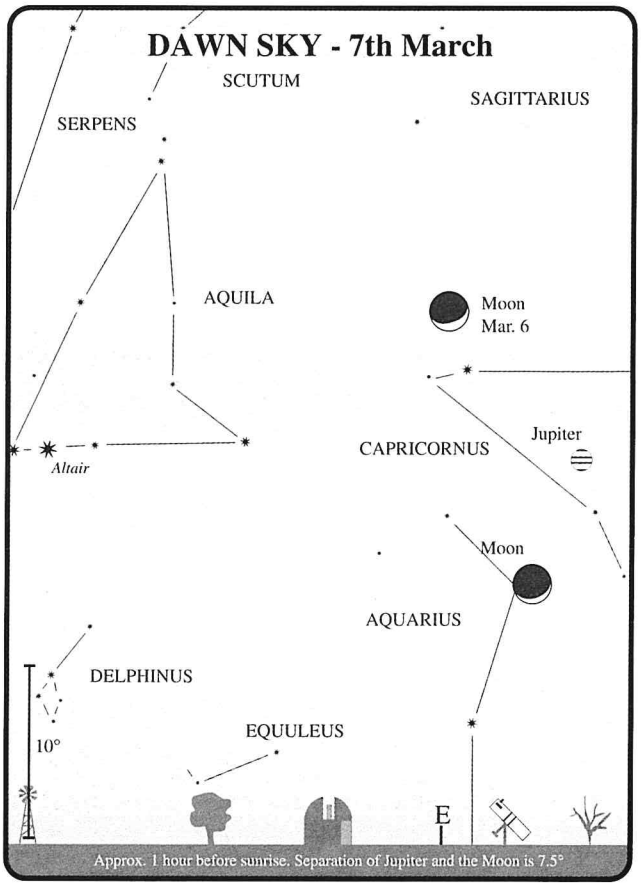
The Gamma Normids are active between 25th February and 22nd March. For most of the period the rate is low, and members are difficult to sort out from the background sporadic activity. The peak occurs on March 13, when rates can reach 3 to 8 per hour. Generally, the Gamma Normids are bright and chiefly yellow, white or orange with about 15% leaving trains.

DIARY

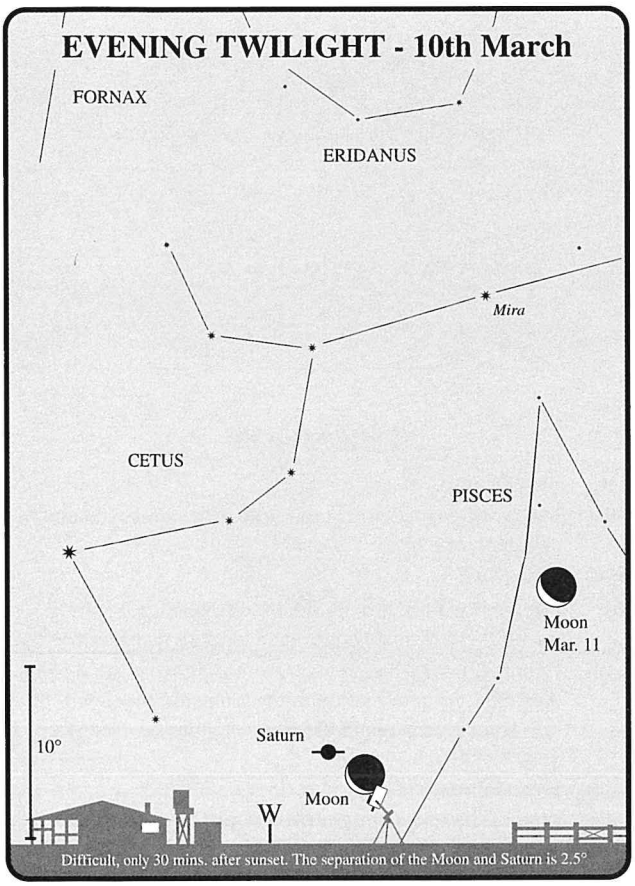
2nd	5:37 PM	Last quarter Moon.
3rd		Uranus 0.5° South of m.p. 8 Flora.
3rd		Neptune 0.7° South of m.p. 19 Fortuna.
3rd		Mercury at greatest latitude South (Heliocentric).
3rd		m.p. 15 Eunomia 0.4° North of NGC 6405 (OC) in Scorpius.
6th	4 AM	Neptune 4° South of the Moon.
6th		m.p. 15 Eunomia 0.5° North of NGC 6416 (OC) in Scorpius.
6th		Comet C/1996Q1 (Tabur) 0.3° North of Alpha Serpentis.
6th	5 PM	Uranus 5° South of the Moon.
6th	10 PM	Jupiter 5° South of the Moon.
7th		Mars 0.4° North of NGC 4123 (G) in Virgo.
8th		m.p. 8 Flora 1.2° NE of m.p. 40 Harmonia.
8th	5 PM	Moon at perigee.
9th		m.p. 15 Eunomia 0.4° South of NGC 6425 (OC) in Scorpius.
9th	9:15 AM	New Moon, total eclipse of the Sun
10th		Comet 46P/Wirtanen 0.7° North of NGC 821 (G) in Aries.
10th	2 PM	Pluto stationary.
10th	5 PM	Saturn 1.4° South of the Moon.
11th		Jupiter 0.1° South of m.p. 8 Flora.
11th	Midnight	Mercury in superior conjunction.
15th	3 AM	Aldebaran 0.5° South of the Moon; Occn.
16th	8:06 AM	First quarter Moon.
17th		Venus at greatest latitude South (Heliocentric).
17th		Comet C/1996Q1 (Tabur) 1° North of NGC 5921 (G) in Serpens.
17th	4 PM	Mars at opposition.
20th	10 PM	Equinox.
21st	1 AM	Mars closest approach.
21st		m.p. 2 Pallas 0.2° West of NGC 6803 (PN) in Aquila.
21st	8 AM	Moon at apogee.
22nd		Mercury at ascending node.
23rd		m.p. 7 Iris 0.1° North of NGC 5247 (G) in Virgo.
23rd	10 PM	Mars 4° North of the Moon.
24th	12:45 PM	Full Moon, partial eclipse of the Moon.
26th		m.p. 6 Hebe 0.5° South of NGC 3607 (G) in Leo.
27th		Mercury at perihelion.
31st	6 AM	Saturn in conjunction with the Sun.
31st		m.p. 7 Iris 0.8° NE of NGC 5170 (G) in Virgo.

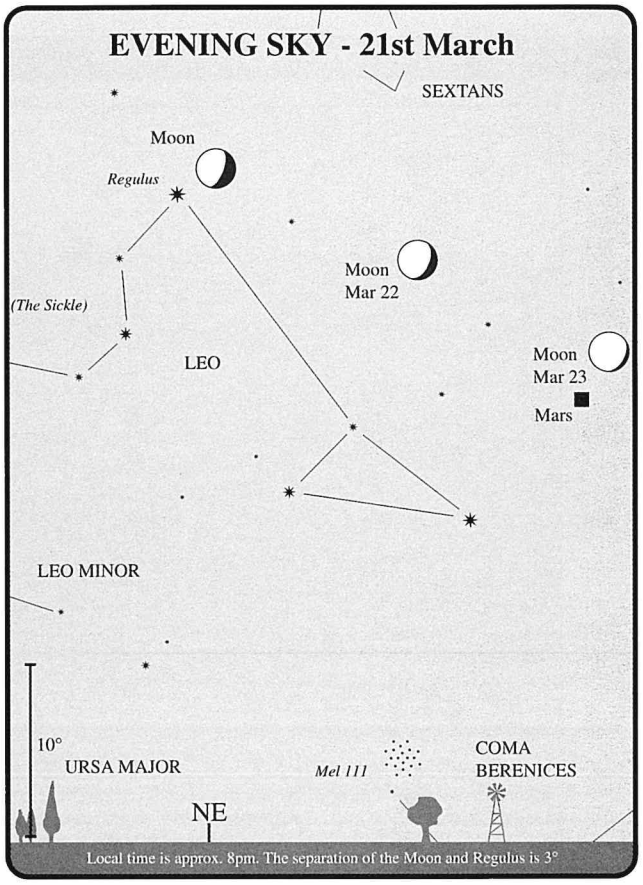


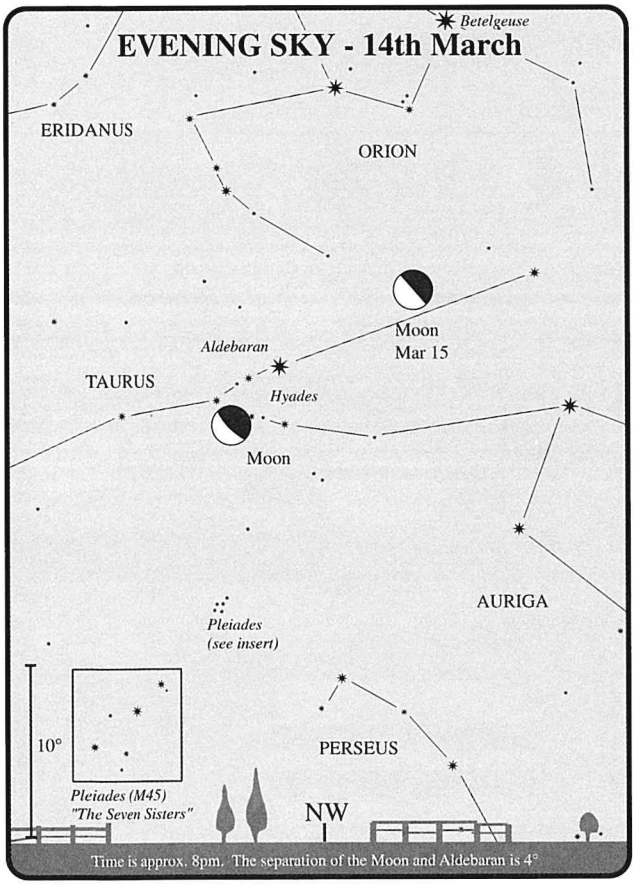
A general sky view at 8pm, showing the Magellanic Clounds. A dark country sky is all that is neededto see these companion galaxies to our Milky Way (not even binoculars are required).

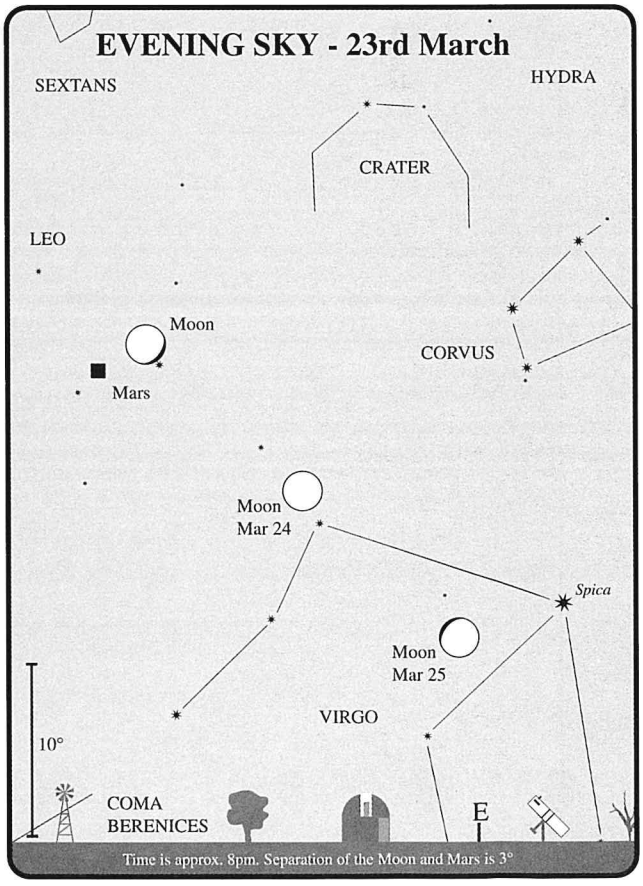


Approx. 1 hour before sunrise. Separation of Jupiter and the Moon is 7.5°


EVENING TWILIGHT - 10th March
FORNAX
ERIDANUS
Mira
CETUS
PISCES
Moon
Mar. 11
10°
Saturn
Moon
W
Difficult, only 30 mins. after sunset. The separation of the Moon and Saturn is 2.5°

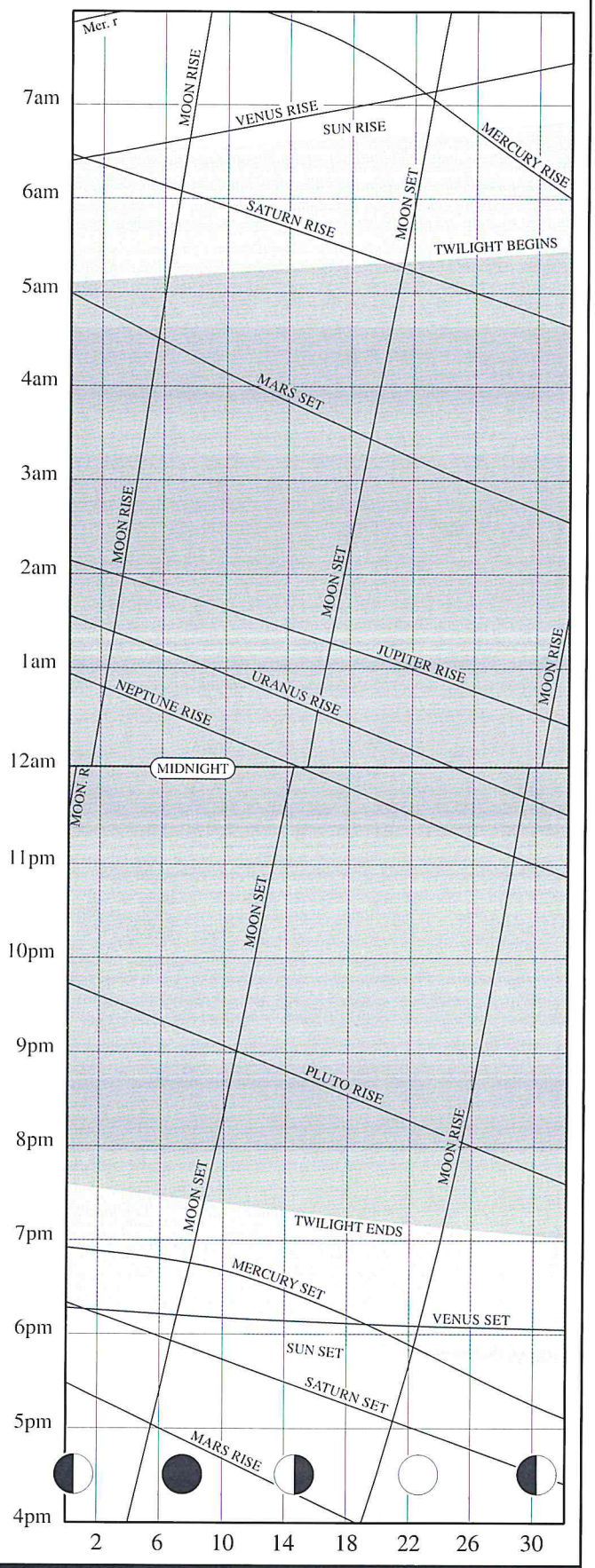

EVENING SKY - 21st March
SEXTANS
Moon
Regulus
Moon
Mar 22
(The Sickle)
LEO
Moon
Mar 23
Mars
LEO MINOR
10°
URSA MAJOR
Mel 111
COMA
BERENICES
NE
Local time is approx. 8pm. The separation of the Moon and Regulus is 3°


Betelgeuse
EVENING SKY - 14th March
ERIDANUS
ORION
Moon
Mar 15
Aldebaran
TAURUS
Hyades
Moon
AURIGA
Pleiades
(see insert)
10°
PERSEUS
Pleiades (M45)
"The Seven Sisters"
NW
Time is approx. 8pm. The separation of the Moon and Aldebaran is 4°


EVENING SKY - 23rd March
SEXTANS
HYDRA
CRATER
LEO
Moon
Mars
CORVUS
Moon
Mar 24
Spica
Moon
Mar 25
VIRGO
10°
COMA
BERENICES
E
Time is approx. 8pm. Separation of the Moon and Mars is 3°

APRIL

RISE/SET CHART



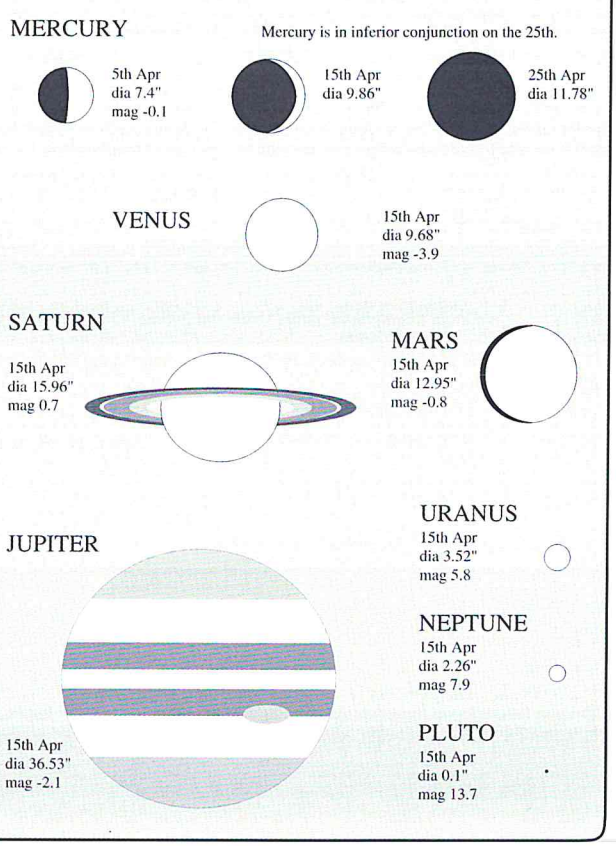
APRIL HIGHLIGHTS

- Mercury is not visible during April. The planet is in the evening twilight sky - moving into the morning sky in late April.
- Mars can be seen high in the northern evening sky.
- Jupiter is in the eastern morning sky.
- Saturn returns to the morning sky. It is visible in the later half of the month in the eastern sky, just before the start of dawn.

THE MOON

1st	Last Quarter.
6th	Moon at perigee (closest to Earth - 361,498 km distant, angular size 32.9').
7th	New Moon.
7th	Occultation of Saturn by the Moon. This is a daytime, far-northern hemisphere event and close to the Sun.
11th	Occultation of Aldebaran by the Moon. Not visible from Australia, from our latitudes the 4 day old Moon will be 3.5° from Aldebaran in the early evening sky (see sky view for 9th) .
15th	First Quarter.
18th	Moon at apogee (furthest from Earth - 405,003 km distant, angular size 29.6').
23rd	Full Moon.
30th	Last Quarter.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY remains in the constellation of Aries for the entire month. The planet is at its greatest elongation east of the Sun (19°) on the 6th. However, Mercury is still not in a favourable viewing position, as the planet sets less than three quarters of an hour after the Sun. After the 6th, the planet rapidly moves toward inferior conjunction (between the Earth and the Sun) on the 25th. Thereafter it returns to the eastern dawn sky. However, Mercury is better placed for viewing next month.

VENUS is at superior conjunction (on the opposite side of the Sun to the Earth) on the 2nd and is therefore too close to the Sun for viewing. The planet is still a couple of months away from being a dazzling, bright, western 'evening star'. At the end of March, Venus moved from Cetus into Pisces. Around mid-April, it changes constellations again, this time moving into Aries.

MARS, in Leo, can be seen high in the north evening sky, after twilight, and is visible until the early morning hours. With opposition now past, the planet's magnitude and diameter start to decrease, being -0.5 and 11.6 arc seconds respectively, by month's end. Compare this with -1.3 magnitude and 14.2 arc seconds during opposition on 17th March. The next opportunity to observe Mars with an enlarged disc will be at opposition in April 1999. That return will be slightly more favourable than this year. Mars has two close encounters with the Moon this month. On the 18th, the 11 day old Moon will be 9° away, and on the following evening 5° (see sky view for 17th) . The planet, in retrograde motion since early February, appears stationary on the 29th. Thereafter it resumes its west to east path across the sky. See discussion on retrograde motion and the Mars finder chart in part II.

JUPITER, in Capricornus, rises around 1am. With this gas giant at opposition in about four month's time, the planet begins to show a gradual increase in brightness and angular size. The Moon is in Jupiter's territory on two consecutive days this month. On the 3rd, the 24 day old Moon will be 7° away and on the following evening 10° (see sky view).

SATURN spends early April in Cetus before moving into Pisces. Having just been in conjunction with the Sun late last month (on the opposite side of the Sun to the Earth), the planet is still lost in the twilight. In late April, Saturn is visible in the eastern morning sky just prior to twilight. If Saturn and the Moon were not so close to the Sun on the 7th, northern hemisphere observers would see an occultation. This is the first in a series of fourteen occultations between Saturn and the Moon that begins this month and finishes in March next year. The next series starts in the year 2001.

NEPTUNE, in Sagittarius, moves into Capricornus in the first week of April. This is only a temporary visit with the planet returning to Sagittarius at the end of May.

PLUTO, in Ophiuchus, briefly visits Scorpius in the first week of April. The planet then returns to Ophiuchus after only three weeks.

MINOR PLANETS. At opposition this month is 7 Iris (mag. 9.5) and 29 Amphitrite (mag. 9.4) Both are in the constellation of Virgo.

CONSTELLATION OF THE MONTH — LEO (Leo)

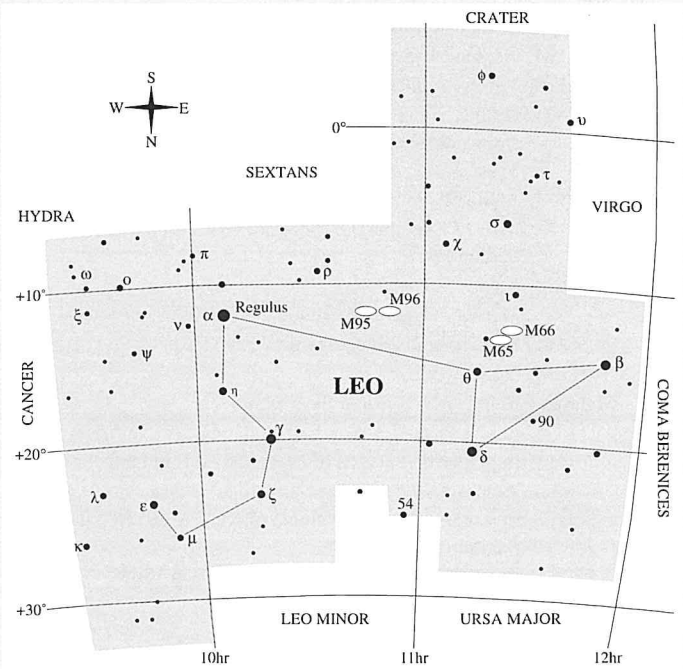
Leo, the Lion, a zodiacal constellation of great antiquity, lies on the ecliptic between Cancer and Virgo. It was recognised as a lion almost universally. The Greeks, Romans, Persians, Syrians, Babylonians and Hebrews, to name a few, all had names that translated into this majestic "king of the beasts". The outline of the brighter stars of the constellation indeed gives the impression of a crouching lion or sphinx, at least if you live in the northern hemisphere, where it is the right way up. The constellation contains the asterism, or pattern of stars, known as the "Sickle". Regulus is at the handle end and the stars Eta, Gamma, Zeta, Mu and Epsilon, making the curved arc of the blade.

The constellation is well placed to see in April, being highest in the northern sky, at 9pm, mid month. Its brightest member, 1st magnitude Regulus (the heart of the Lion), is located close to the plane of the ecliptic. Objects in the Solar System follow the ecliptic plane. Therefore occultations of Regulus by the Sun and Moon are fairly common. This includes close approaches (conjunctions) with the planets; this year Mercury comes within 1° of Regulus (July). Another visitor to Leo is Mars.

Leo has many fine double stars within its boundaries. Of note is 2nd magnitude Gamma Leonis (Algeiba). Being one of the "Sickle" stars, it is easy to find and excellent in small telescopes. The pair consists of two golden yellow suns of 2nd and 3rd magnitude, separated by 4 arc seconds. Two other gems are worthy of mention: 54 Leonis, a dainty pair of 4th and 6th magnitude stars, separated by 6.5 arc seconds, and 90 Leonis, another good duo of 6th and 7th yellow stars, 3.5 arc seconds apart. Regulus is also a double star, with an 8th magnitude orange companion, separated by a wide 3 arc minutes.

Leo also contains the star Wolf 359. It is nothing to look at, but worth mentioning. At 13.5 magnitude, this extremely faint, Jupiter sized, red dwarf is situated 7.7 light years from Earth. Only the Alpha Centauri system, and Barnard's Star (in Ophiuchus) lie closer to our Solar System.

The constellation contains many galaxies. Five of the brighter ones were observed by Charles Messier in the 18th century and these are relatively easy targets for amateur telescopes under dark skies. M65 (NGC3623) and M66 (NGC3627) lie in the same low power field 20 arc seconds apart (galaxy NGC3628 is in the same field). The galaxies, M95 (NGC3351), M96 (NGC3368) and M105 (NGC3379) also form a close trio.



Leo is also home to the famous Leonids.This meteor shower can reach an intensity of tens of thousands of meteors per hour! These are active between the 14th and 21st of November, each year. Moderate "falls" are normally expected with a peak, every 33 years. The next heavy fall is expected in the years 1998/9, with a build up in the preceding years.

APRIL

COMETS

Wirtanen spends most of the month in Taurus, beginning at about magnitude 10.5 and setting just before 8pm. It passes 1.3° north of the Pleiades on 3rd April, and 0.2° north of Beta Tauri on 24th April. By the end of the month, it will have crossed into Auriga, having faded to magnitude 11.5, but still setting around 8pm.

Wild 2: Setting around 1am, Wild 2 will be at 10th magnitude in Cancer. It remains in this constellation throughout April, at a fairly constant brightness, setting around 11.30pm by the end of the month. On 15th April, it passes just 0.7° north of the Beehive Cluster.

Tabur: During April, Tabur fades from magnitude 12.5 to 13.5, remaining in Virgo. At the beginning of the month, it is rising around 8.30pm, but becomes an all-night comet by month's end.

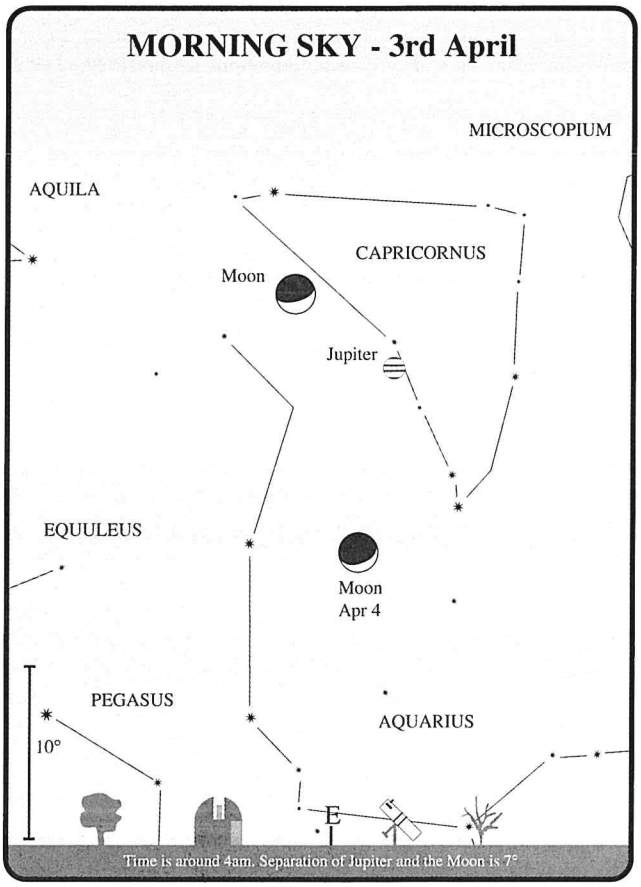
Hale-Bopp: Comet Hale-Bopp reaches perihelion on 1st April, and it is hoped that it will be very bright during this month. There is a chance that it will be visible from Australia by the end of the month. At that time it will be located in Taurus, setting around 6.45pm, and perhaps brighter than magnitude 2. An unobstructed western horizon, away from urban areas, is highly recommended.

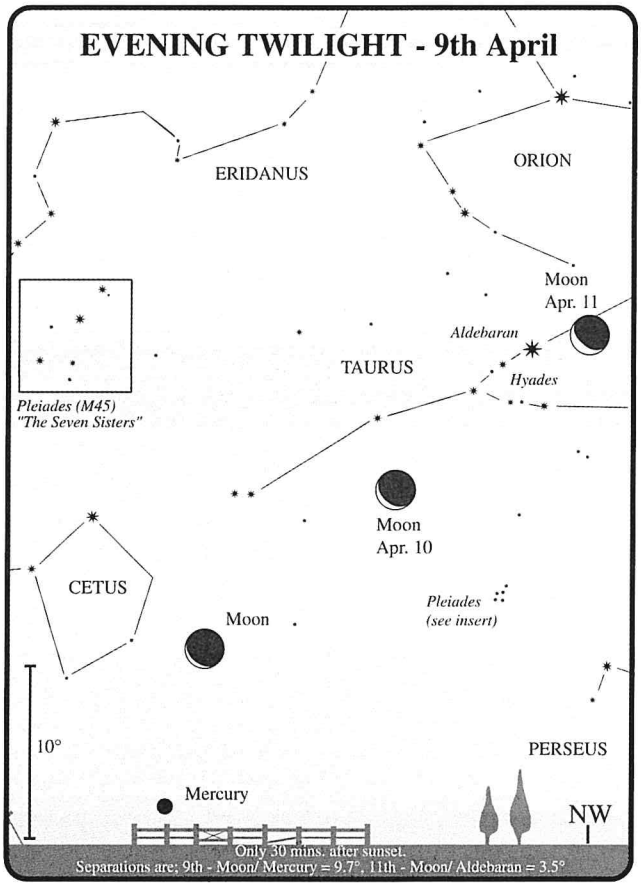
METEOR SHOWERS

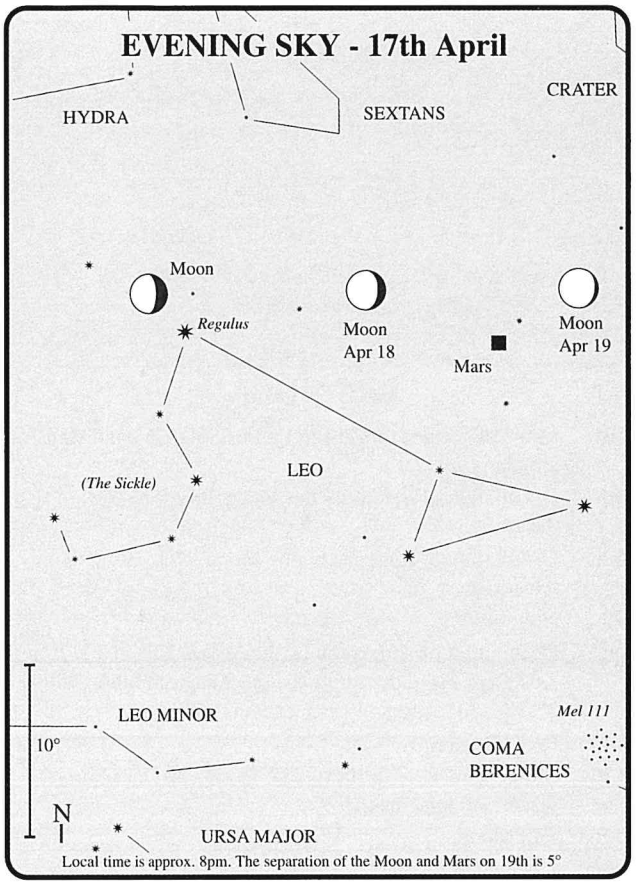
The **Eta Aquarids** are linked with Halley's Comet and rank as one of the most popular of the southern hemisphere showers. They are visible for a few hours before dawn from 19th April to 28th May. They peak next month on the 6th, but the rate is generally around 30 for the entire first week of May. The zenith hourly rate will often reach 50 or more meteors per hour (95 in 1975 and 110 in 1980). The Eta Aquarids are characterised by their high percentage of persistent trains (up to 25% of the meteors). They are very swift and are a striking yellow colour.

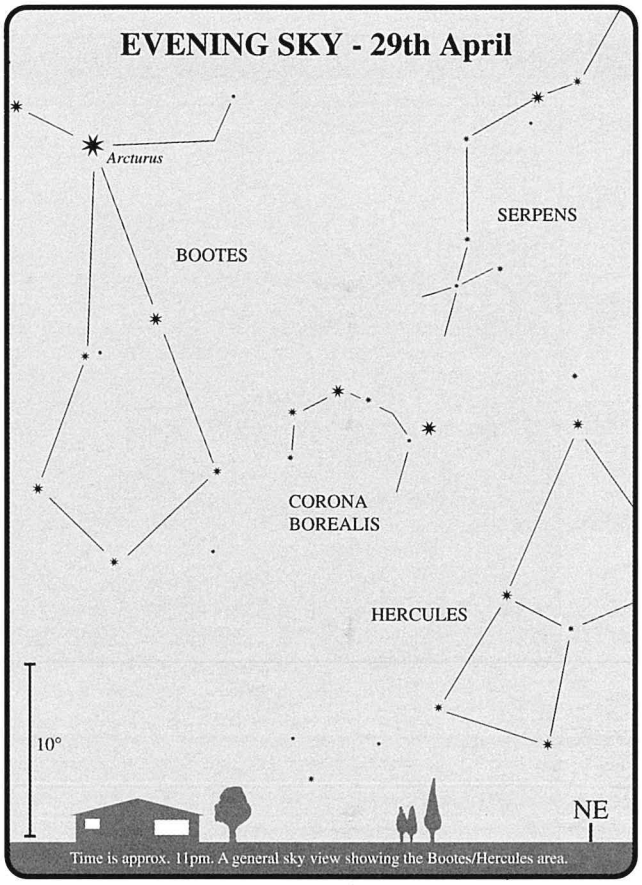
DIARY

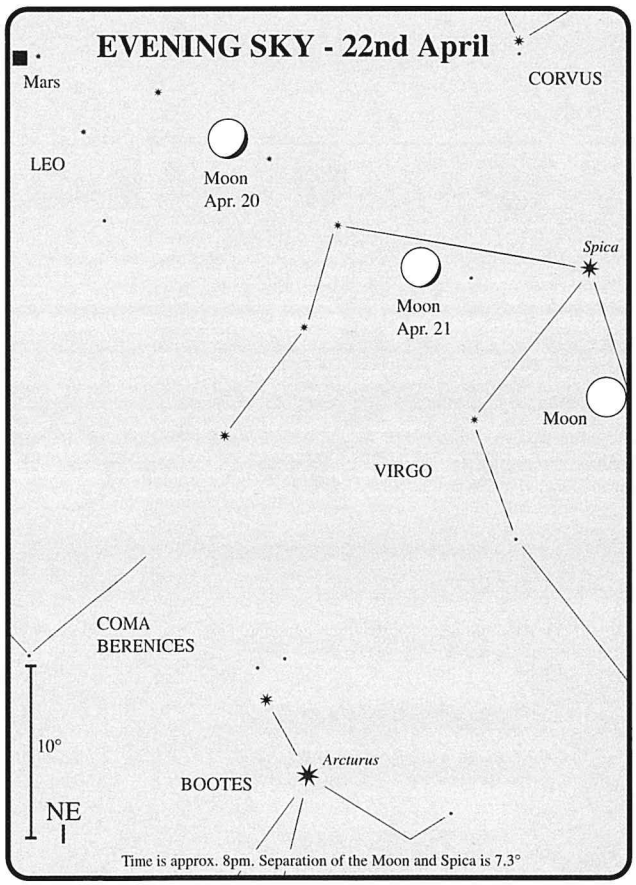
1st	3:38 AM	Last quarter Moon.
2nd	1 PM	Neptune 4° South of the Moon.
2nd	10 PM	Venus in superior conjunction.
3rd	3 AM	Uranus 5° South of the Moon.
3rd		Comet 46P/Wirtanen 1.3° North of the Pleiades in Taurus.
3rd	4 PM	Jupiter 4° South of the Moon.
5th		m.p. 15 Eunomia 0.6° South of NGC 6558 (GC) in Sagittarius.
6th	1 AM	Moon at perigee.
6th		Mercury at greatest latitude North (Heliocentric).
6th	9 AM	Mercury greatest elongation East (19°).
7th	7:02 PM	New Moon.
8th	Midnight	Mercury 6° North of the Moon.
10th		m.p. 4 Vesta 0.3° South of NGC 7606 (G) in Aquarius.
11th		m.p. 6 Hebe 0.9° NE of NGC 3507 (G) in Leo.
11th	Noon	Aldebaran 0.5° South of the Moon; Occn.
12th		m.p. 15 Eunomia 0.6° South of NGC 6569 (GC) in Sagittarius.
14th		m.p. 7 Iris 0.8° NE of NGC 5054 (G) in Virgo.
15th	1:00 AM	First quarter Moon.
15th		Comet 81P/Wild-2 0.7° North of the Beehive Cluster (M44) in Cancer.
15th	1 PM	Mercury stationary.
17th	11 PM	Moon at apogee.
19th	2 PM	Mars 4° North of the Moon.
23rd	4:33 AM	Full Moon.
23rd		m.p. 7 Iris 0.7° NE of NGC 4984 (G) in Virgo.
24th		Comet 46P/Wirtanen 0.2° North of Beta Tauri.
25th	7 PM	Mercury in inferior conjunction.
29th		Mercury at descending node.
29th	2 PM	Mars stationary.
29th	7 PM	Neptune 4° South of the Moon.
30th	10:37 AM	Last quarter Moon.
30th	11 AM	Uranus 5° South of the Moon.

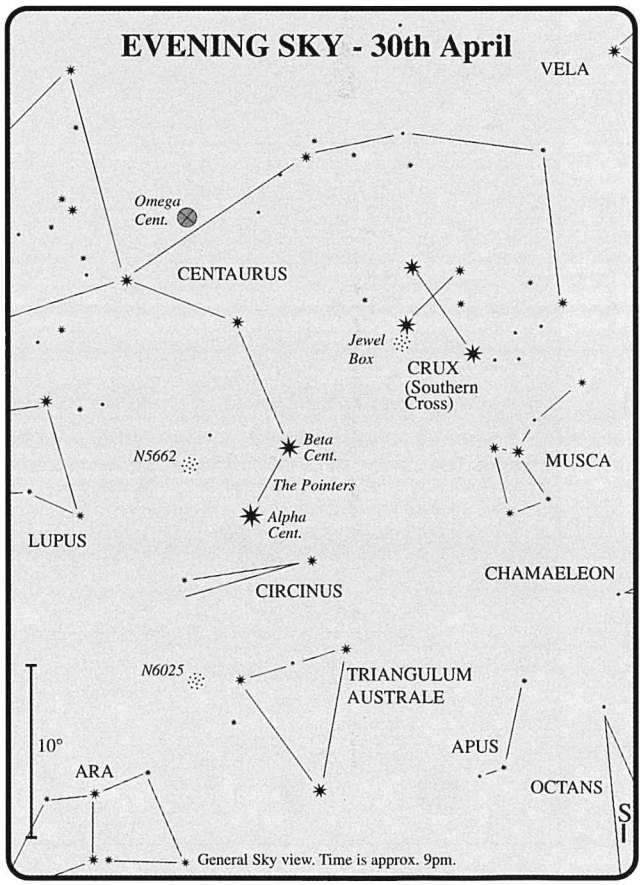





EVENING SKY - 17th April
HYDRA
SEXTANS
CRATER
Moon
Regulus
Moon
Apr 18
Mars
Moon
Apr 19
(The Sickle)
LEO
LEO MINOR
Mel 111
10°
COMA
BERENICES
N
URSA MAJOR
Local time is approx. 8pm. The separation of the Moon and Mars on 19th is 5°

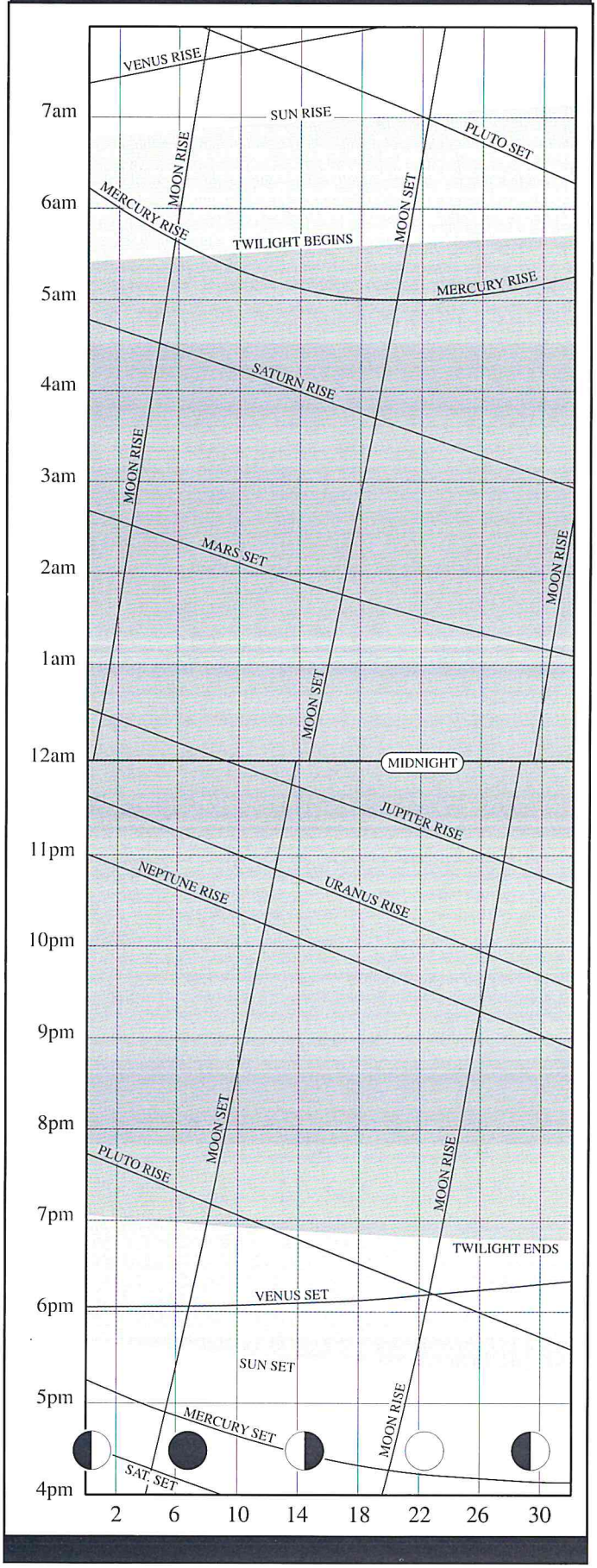

EVENING SKY - 29th April
Arcturus
SERPENS
BOOTES
CORONA
BOREALIS
HERCULES
10°
NE
Time is approx. 11pm. A general sky view showing the Bootes/Hercules area.


EVENING SKY - 22nd April
Mars
CORVUS
LEO
Moon
Apr. 20
Spica
Moon
Apr. 21
Moon
VIRGO
COMA
BERENICES
10°
Arcturus
BOOTES
NE
Time is approx. 8pm. Separation of the Moon and Spica is 7.3°


EVENING SKY - 30th April
VELA
Omega
Cent.
CENTAURUS
Jewel
Box
CRUX
(Southern
Cross)
Beta
Cent.
N5662
The Pointers
MUSCA
Alpha
Cent.
LUPUS
CHAMAELEON
CIRCINUS
N6025
TRIANGULUM
AUSTRALE
10°
APUS
ARA
OCTANS
S
General Sky view. Time is approx. 9pm.

MAY

RISE/SET CHART



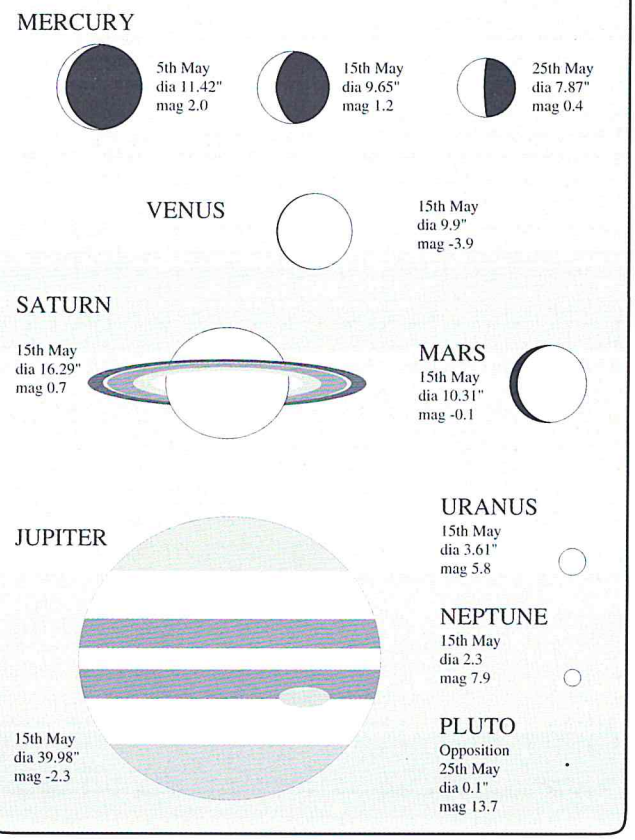
MAY HIGHLIGHTS

- Early in May, Comet Hale-Bopp becomes visible from Australia; low in NW evening twilight sky.
- Mercury is well placed in the western morning sky.
- Mars is high in the northern evening sky.
- Jupiter is visible in the early morning eastern sky.
- Saturn is in the pre-dawn eastern morning sky.
- Venus is low in the western evening twilight and difficult to see.

THE MOON

3rd	Moon at perigee (closest to Earth - 366,626 km distant, angular size 32.1').
5th	Occultation of Saturn by the Moon. Not visible from Australia.
6th	Occultation of Mercury by the Moon. Not visible from Australia.
7th	New Moon.
9th	Occultation of Aldebaran by the Moon. Not visible from Australia. From our latitudes, the 2 day old Moon will be 3° from Aldebaran in early evening twilight sky on 8th.
14th	First Quarter.
15th	Moon at apogee (furthest from Earth - 404,211 km distant, angular size 29.9').
22nd	Full Moon.
29th	Last Quarter.
29th	Moon at perigee (closest to Earth - 369,788 km distant, angular size 31.9').

APPEARANCE of the PLANETS



THE PLANETS

MERCURY offers one of its best observing periods, in the morning sky for the year, this month. This is the second (and last) such favourable morning appearance; the first occurred in January/February. The planet, just past inferior conjunction, moves rapidly to its greatest elongation (25°) west of the Sun on the 23rd. From about May 8 to June 9, Mercury rises at least 1.5 hours before the Sun. This provides an excellent opportunity to see the planet before the morning twilight. Typically, Mercury moves rapidly through the constellations. This month it begins in Aries, then passes into Pisces followed by Cetus and finally back into Aries. On the 6th there is an occultation of Mercury by the Moon, visible only from parts of Antarctica and South America. From Australia, the closet approach of 4° will be difficult to see due to twilight.

VENUS spends the first week of May in Aries, then moves onto Taurus. While in the constellation of the bull, it passes between the famous star clusters the Pleiades and the Hyades. The planet is still too close to the Sun for observation this month, and is best left until June when it will be easier to glimpse in the western evening twilight.

MARS transits the meridian around 8pm, providing comfortable evening viewing of the red planet while it is high in the northern sky. On two concurrent evenings the Moon will be close to the red planet. On the 16th the 9 day old Moon will be 2° away, and on the following evening 10° (see sky view on 14th). Observers with telescopes may have detected a slight gibbous (egg shaped) look about the planet recently. This phase grows until June when Mars reaches a point in its orbit known as its quadrature (see orbit aspects diagram page 6). At this point the Martian disc will be 88% illuminated by the Sun.

JUPITER rises just before midnight in the constellation of Capricornus, hence it remains an early morning object for observers. The planet does not cross the meridian until about the start of twilight. On the 1st May, the 23 day old Moon will be 4° from Jupiter (see sky view). On two occasions, later in the month, the Moon again will be near the planet. On the mornings of 28th and 29th, the Moon will be 7° and 9° away respectively.

SATURN, in Pisces, is visible in the eastern morning sky before the beginning of twilight. On the 5th, in the eastern dawn sky, the rising 27 day old thin crescent Moon will be 5° directly below Saturn (see sky view) . Some parts of the northern hemisphere will see Saturn occulted (covered) by the Moon. This is the second in a series of fourteen occultations between Saturn and the Moon that began in April and finishes in March next year, the next series starts in the year 2001.

URANUS appears stationary on the 13th and thereafter begins its western motion across the sky, continuing until mid October. It then returns to its west-to-east track (see discussion on retrograde motion and the Uranus finder chart in part II).

NEPTUNE appears stationary on the 2nd. Like Uranus, it then begins its western motion across the sky, continuing until early October. It then it returns to its west-to-east track (see discussion on

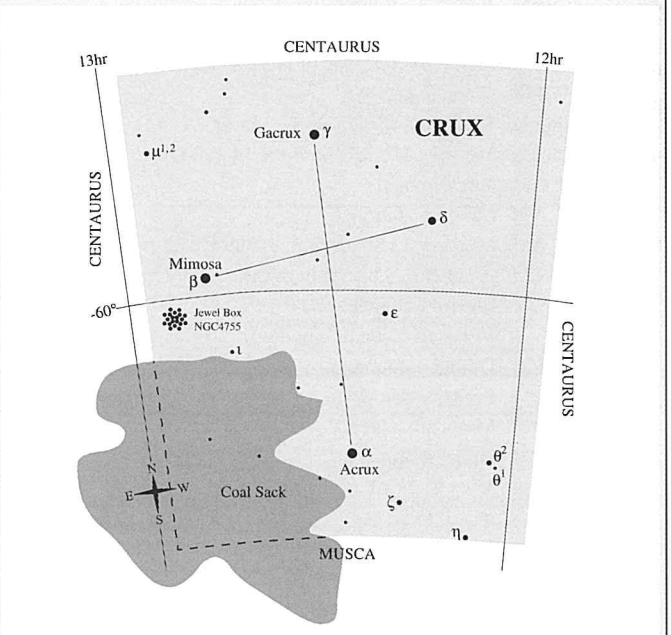
CONSTELLATION OF THE MONTH — CRUX (Cru)

Crux, the Southern Cross, had since the time of Plolemy been part of Centaurus. It was visible to the ancient Greek navigators, but can no longer be seen from latitudes north of 25 degrees due to the effects of precession. It is uncertain when it became a constellation in its own right, but writers in the 15th and 16th century make mention of it. Crux is the southern hemisphere's most famous and easily recognisable constellation. It forms part of the flags of Australia and New Zealand. Also a glimpse in any telephone directory will show how popular the name, 'Southern Cross', is in the business community. The outline of the constellation has even been adopted by an Australian bank (which bank?).

It seems ironic that the smallest of the 88 constellations (68 square degrees or less than 0.17% of the sky) should be so prominent and easily distinguishable. Its four main stars Alpha (Acrux), Beta (Mimosa), Gamma (Gacrux) and Delta form the arms of the cross. The first three of these can be found in lists of the 25 brightest stars (see page 102). Bounded on three sides by Centaurus (north, east & west) and to the south by Musca, the Cross, standing vertical, can be found high in the southern sky around 9pm this month.

Perhaps the most common object that people associate with Crux is the Jewel Box or Kappa Crucis cluster (NGC4755). The name, Jewel Box, came from Sir John Herschel who compared the cluster to a casket of multicoloured precious jewels. The cluster, consisting of over 100 stars, surrounds the 6th magnitude star, Kappa Crucis. Small telescopes show many stars, the brightest members forming an 'A' shape. Dark skies and moderately large apertures are recommended to view this splendid field of yellow, white and blue stars.

To the east of Acrux lies the Coal Sack, a massive cloud of interstellar dust and gas, that extends beyond the borders of the Cross into Centaurus and Musca. This "cloud" is very dense and obscures most of the background Milky Way stars. The Coal Sack is the largest of the dark nebulae visible to the unaided eye, covering



some 30 square degrees. Irregular in shape the cloud lies about 550 light years distant. It is best seen with the unaided eye under country skies (ie. somewhere you can see the Milky Way). Binoculars reveal that it is not totally devoid of stars.

By far the best double star in Crux (and one of the finest in the sky) is Acrux; two close brilliant bluish stars and a fainter companion. The main pair are of magnitude 1.4 and 1.9, separated by 4.4 seconds of arc. They are not always easy to split in small apertures unless the seeing is good. The third component is 5th magnitude, and is a distant 90 seconds of arc from the primary pair.

MAY

retrograde motion and the Neptune finder chart in part II). Neptune moves from Capricornus back into Sagittarius at the end of May, where it remains for the rest of the year.

PLUTO is at opposition on the 25th. Unlike some of the closer planets, opposition means little to this tiny distant member of the Solar System. Any difference in angular size or magnitude going from conjunction to opposition is insignificant.

COMETS

Wild 2: Reaching perihelion early this month, comet Wild 2 fades from 10th to 11th magnitude during May. At the beginning of the month, in Cancer, it is setting around 11.30pm, likewise at the end of the month when it has moved into Leo.

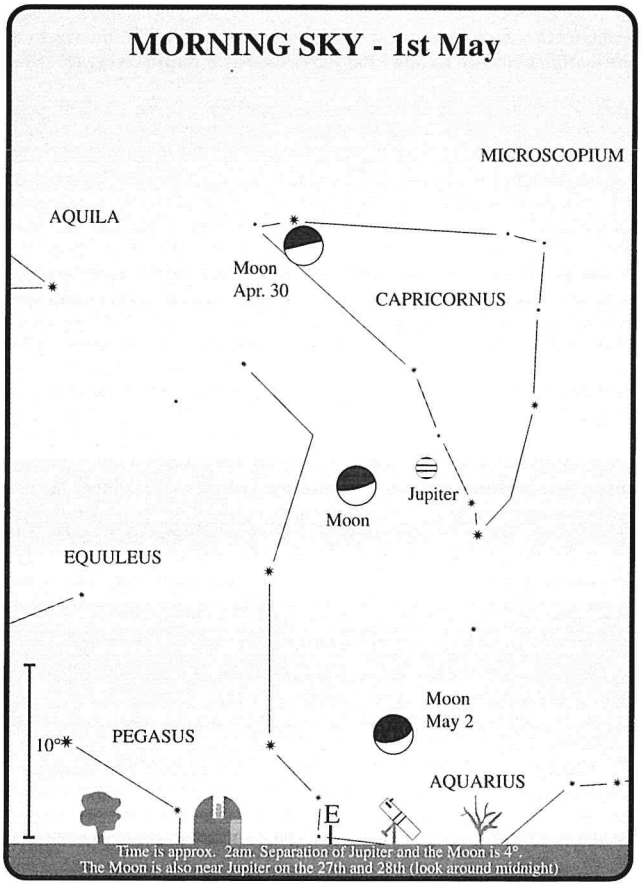
Hale-Bopp: Comet Hale-Bopp will not be an easy comet to observe during May, with it setting at around 6.45pm and low in the twilight sky. It begins the month in Taurus, hopefully brighter than magnitude 2, and by month's end it has moved into Orion and has faded to 3rd magnitude.

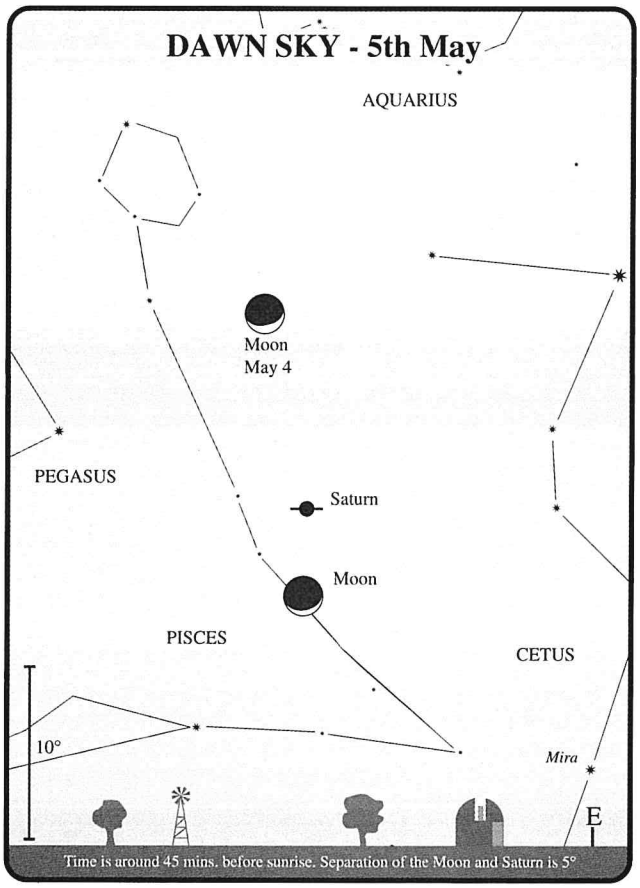
METEOR SHOWERS

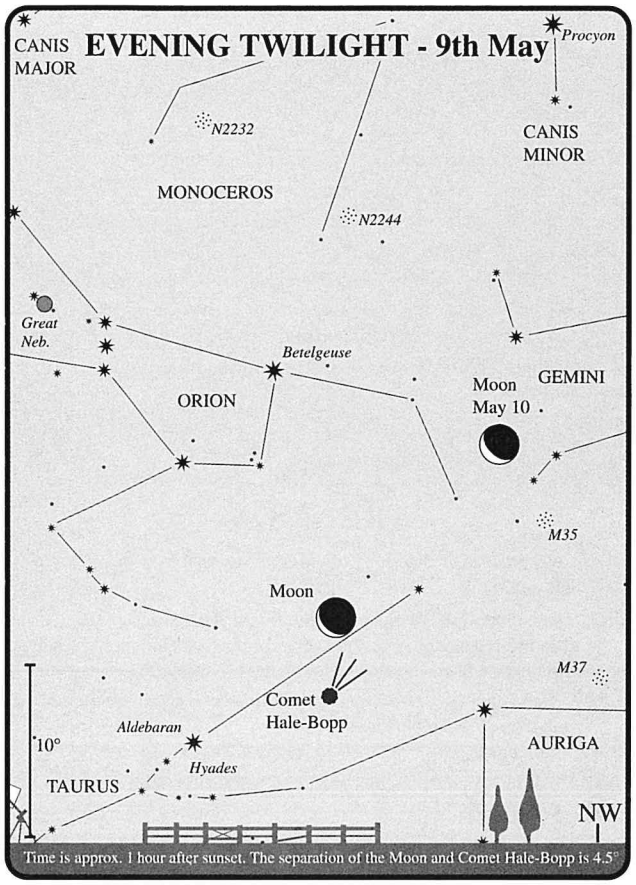
The **Eta Aquarids** are linked with Halley's Comet and rank as one of the most popular of the southern hemisphere showers. They are visible for a few hours before dawn, from 19th April to 28th May. They peak this month on the 6th, but the rate is generally around 30 for the entire first week of the month. The zenith hourly rate will often reach 50 or more meteors per hour (95 in 1975 and 110 in 1980). The Eta Aquarids are characterised by their high percentage of persistent trains (up to 25% of the meteors). They are very swift and are a striking yellow colour.

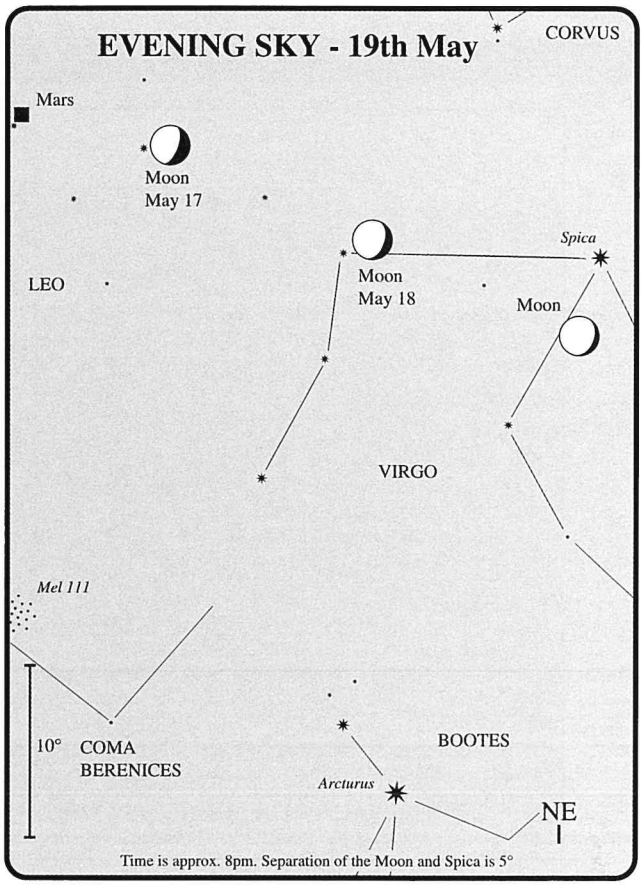
DIARY

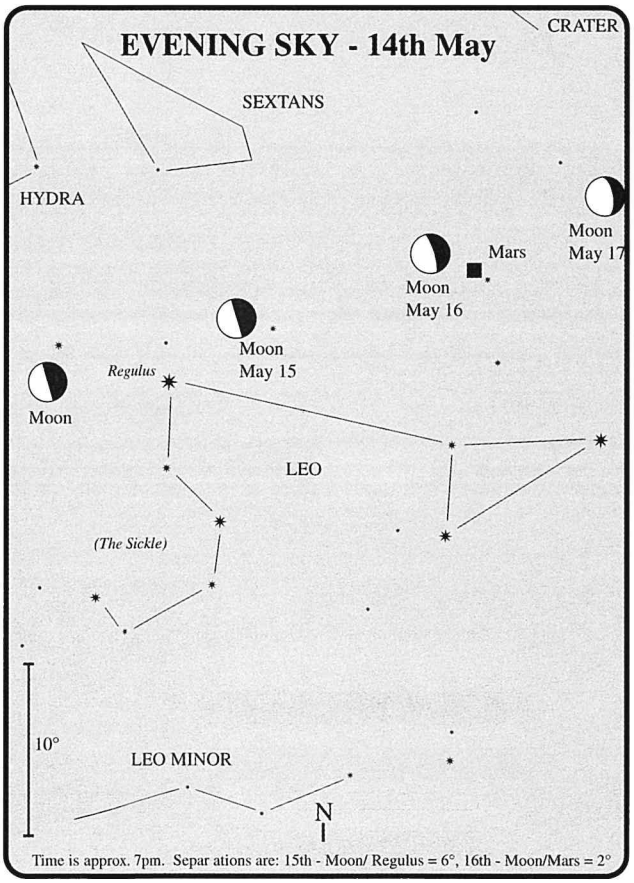
1st	5 AM	Jupiter 4° South of the Moon.
2nd	7 AM	Neptune stationary.
2nd		m.p. 7 Iris 0.8° NE of NGC 4902 (G) in Virgo.
3rd	7 PM	Moon at perigee.
4th	Midnight	Saturn 0.8° South of the Moon; Occn.
5th	Midnight	Mercury 1.2° North of the Moon; Occn.
7th	4:46 AM	New Moon.
8th	2 AM	Mercury stationary.
8th	3 AM	Mercury 1° South of m.p. 349 Dembowska.
8th	10 PM	Aldebaran 0.6° South of the Moon; Occn.
10th		Mercury at aphelion.
12th		Venus at ascending node.
13th	5 PM	Uranus stationary.
14th	6:55 PM	First quarter Moon.
15th	6 PM	Moon at apogee.
16th	8 PM	Pallas stationary.
16th	Midnight	Mars 2° North of the Moon.
17th		m.p. 6 Hebe 0.4° NE of NGC 3507 (G) in Leo.
19th	4 PM	Venus 6° North of Aldebaran.
21st		m.p. 9 Metis 0.3° West of IC 1613 (G) in Cetus.
22nd	5:13 PM	Full Moon.
23rd	7 AM	Mercury greatest elongation West (25°).
24th		m.p. 1 Ceres 1° South of Delta Aquarii.
25th		m.p. 2 Pallas 0.9° East of M71 (GC) in Sagitta.
25th		Comet 46P/Wirtanen 1.4° North of Pollux.
25th	6 PM	Pluto at opposition.
26th	Midnight	Neptune 4° South of the Moon.
27th		m.p. 8 Flora 1° NW of NGC 7606 (G) in Aquarius.
27th	4 PM	Uranus 4° South of the Moon.
28th	2 PM	Jupiter 4° South of the Moon.
29th	3 PM	Moon at perigee.
29th	3:51 PM	Last quarter Moon.
30th		Mercury at greatest latitude South (Heliocentric).

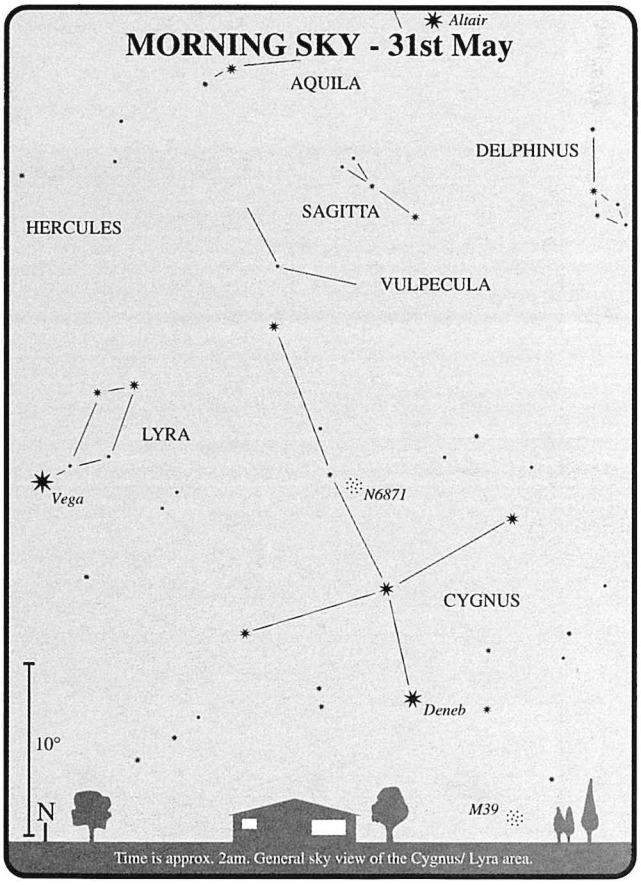





EVENING TWILIGHT - 9th May
CANIS MAJOR
Procyon
N2232
CANIS MINOR
MONOCEROS
N2244
Great Neb.
Betelgeuse
ORION
Moon May 10
GEMINI
M35
Moon
M37
Comet Hale-Bopp
Aldebaran
10°
AURIGA
Hyades
TAURUS
NW
Time is approx. 1 hour after sunset. The separation of the Moon and Comet Hale-Bopp is 4.5°

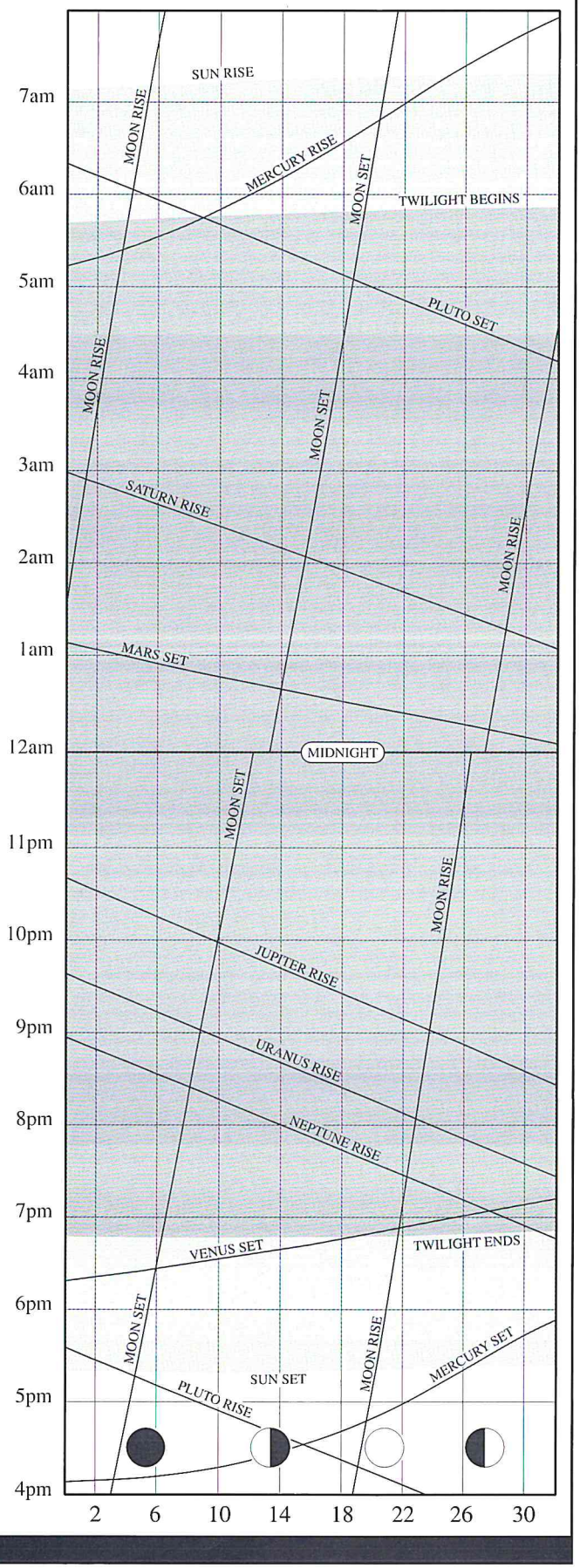

EVENING SKY - 19th May
CORVUS
Mars
Moon May 17
Spica
Moon May 18
LEO
Moon
VIRGO
Mel 111
10°
COMA BERENICES
BOOTES
Arcturus
NE
Time is approx. 8pm. Separation of the Moon and Spica is 5°


EVENING SKY - 14th May
CRATER
SEXTANS
HYDRA
Moon May 17
Mars
Moon May 16
Moon May 15
Regulus
Moon
LEO
(The Sickle)
10°
LEO MINOR
N
Time is approx. 7pm. Separ ations are: 15th - Moon/ Regulus = 6°, 16th - Moon/Mars = 2°


MORNING SKY - 31st May
Altair
AQUILA
DELPHINUS
SAGITTA
HERCULES
VULPECULA
LYRA
Vega
N6871
CYGNUS
Deneb
10°
N
M39
Time is approx. 2am. General sky view of the Cygnus/ Lyra area.

JUNE

RISE/SET CHART



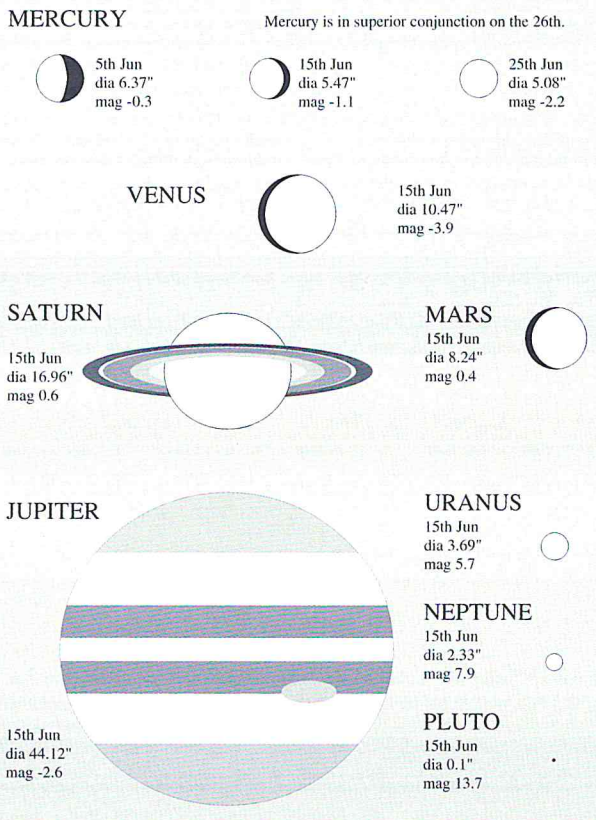
JUNE HIGHLIGHTS

- Comets Hale-Bopp and Encke can be seen low in the western evening twilight sky. On 15th they are only 3.5° apart.
- End of June is the last chance to see comet Hale-Bopp in the evening sky until October.
- Comet Encke is at its brightest, at the end of the month, in the early western evening sky.
- Early June is the last chance to get a good look at Mercury, in the morning sky, for 1997.
- Mars well placed in the early north west evening sky.
- Jupiter visible in the late eastern evening sky.
- Saturn can be seen in the eastern morning sky.
- Venus becomes easier to see as it moves away from the Sun in the western evening twilight sky.

THE MOON

1st	Occultation of Saturn by the Moon. Not visible from Australia.
5th	New Moon.
5th	Occultation of Aldebaran by the Moon. This is a daytime, northern hemisphere event (very close to the Sun) and is not visible.
12th	Moon at apogee (furthest from Earth - 404,185 km distant, angular size 29.9').
13th	First Quarter.
14th	Occultation of Mars by the Moon. Not visible from Australia.
21st	Full Moon.
24th	Moon at perigee (closest to Earth - 366,494 km distant, angular size 32.2').
27th	Last Quarter.
28th	Occultation of Saturn by the Moon. Not visible from Australia.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is moving back toward the Sun in the morning sky and remains observable only for the first half of June. The planet reaches superior conjunction (opposite side of the Sun to the Earth) on the 26th, then moves east of the Sun becoming an evening object. The Moon can be observed near Mercury on two consecutive mornings this month. On the 3rd, the 27 day old thin crescent Moon will be 7° above the planet (see sky view for 1st), and on the following morning 5° below (more difficult to see). Mercury spends the first week of the month in Aries before moving into Taurus. The last week of June sees the planet in Gemini.

VENUS, for the first time this year, can easily be seen in the evening sky; setting over an hour after the Sun. On the 7th, the 2 day old thin crescent Moon will be 9° above Venus, with comets Hale-Bopp and Encke nearby (see sky view). The planet spends the first few days of June in Taurus before moving into Gemini. At month's end it moves into Cancer.

MARS is now three months past opposition and is at the point in its orbit known as quadrature (see diagram page 6). The disc is distinctly gibbous (egg-shaped) with the Sun illuminating only 88% of the visible surface. On the 12th, Mars will be very close (approximately 0.1°) to the 4th magnitude star Beta Virginis (Zavijava), which should prove a pretty sight in a telescope. Mars, at 0.5 magnitude, commences June in Leo, soon crossing the border into Virgo. The first quarter Moon occults Mars on the 14th, this event can only be seen from Africa and Madagascar. From Australia, the Moon will be 2.5° from Mars high in the early evening NW sky on the 13th (see sky view for 11th). They close to 1° before both set around midnight.

JUPITER dominates the late evening sky in Capricornus. With opposition now just two months away the planet is bright at mag. -2.6. The planet's disc is also noticeably larger at 44 arc seconds in diameter. Compare the appearance diagram for this month with January. On the 24th, the 19 day old gibbous Moon will be 5° from Jupiter (see sky view). The planet appears stationary on the 10th, then it begins its western motion across the sky. At the beginning of October, it returns to its west-to-east track (see discussion on retrograde motion and the Jupiter finder chart in part II).

SATURN observers still need to be early risers, with the planet high in the northeast sky, just before the beginning of twilight. On three occasions the Moon will be near Saturn this month. On the 1st, the 25 day old Moon will be 2° away. Also approaches are seen on 28th (8°) and the 29th (5°) (see the sky view diagrams for the 1st and 29th). On the 1st and 28th the planet will be occulted by the Moon but these events are not visible to observers "down under". This is the 3rd and 4th in a series of fourteen occultations between Saturn and the Moon. These began in April and finish in March next year; the next series begins in the year 2001.

MINOR PLANET at opposition this month is 15 Eunomia at mag. 9.2 in Scorpius.

COMETS

Wild 2 begins June in Leo, at about 11th magnitude, setting before 11.30pm. Moving into Virgo, the comet fades half a magnitude, setting before 11pm.

Hale-Bopp: At the beginning of the month, residing in Orion, the comet could be 3rd magnitude, but will be setting around 6.45pm. By the end of June, it will be around magnitude 3.8 and setting about 6pm, having moved into Monoceros. At this time it will be rising around 6am and our attention will now turn to the morning sky for viewing the comet.

Encke: This famous comet should first become visible during June. It begins the month in Orion at about 7th magnitude, setting around 6.30pm. On the 15th June, having moved into Monoceros, it will only be 3.5 degrees northeast of Hale-Bopp. At this time, Encke will be around magnitude 6.5,

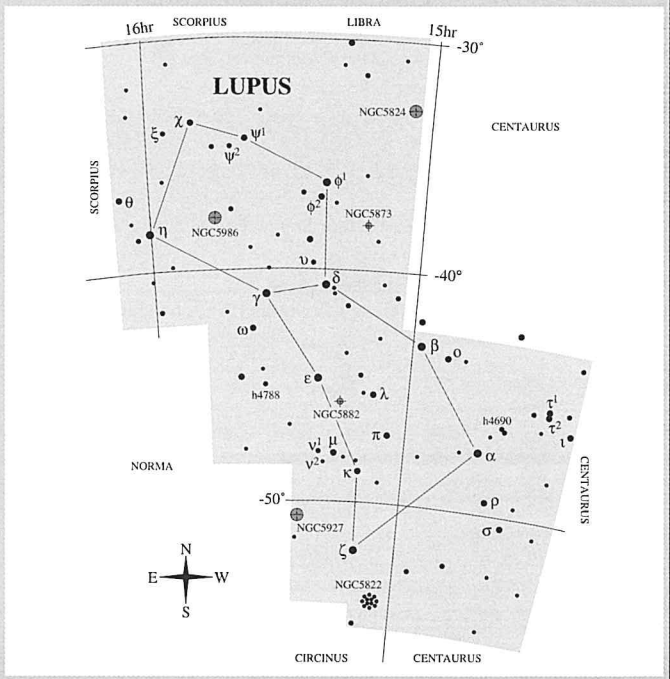
CONSTELLATION OF THE MONTH — LUPUS (Lup)

Lupus, the Wolf, is a constellation bounded in part by Centaurus and Scorpius. This ancient constellation has always been described as a wild beast. The Romans and Greeks considered it just as a wild animal, while the Arabs likened it to a lion, naming the constellation 'Al Asadah' (the lioness). The Latin name, however, translates as the Wolf. It was considered that Lupus was in the hands of the Centaur (Centaurus), perhaps as an offering to the gods. Some held the belief that it was a wine-skin, held by the Centaur, about to pour a drink. Others thought he held both the beast and the wine-skin, one in each hand.

With its main stars at 3rd and 4th magnitude, the constellation is not as prominent as some of its neighbours. Its fortuitous position near the Milky Way has provided Lupus with some interesting deep sky objects and multiple stars. Of historic interest was a supernova that occurred near Beta Lupi in the year 1006AD. Astronomers believe that the brightness of the exploding star was in the order of magnitude -8 to -10. For a time it outshone every star and planet in the heavens! All that remains today is a radio source, discovered by the Parkes radio telescope in 1964, and some very faint nebulous filaments, found in 1976, by the 4 meter telescope at Cerro Tololo in Chile.

Lupus boasts three globular clusters, all of which suffer from some degree of absorption from interstellar dust in the Milky Way. This is a bit like trying to look at something through a dark veil. Dark silhouettes of this dust can be easily seen on the Milky Way. Just drive out into the country and look up; this is a good time of the year to look at our home galaxy. Going back to the globular clusters, NGC5824 is small, bright and condensed lying very close to the Centaurus border. Near the border with Norma is NGC5927, which is in a good field of stars. If it wasn't for the heavy absorption in this area, NGC5927 would be visible to the unaided eye. NGC5986, like the other globulars in Lupus is small and compact.

There are some other interesting deep sky objects in Lupus. NGC5822 is one of four open star clusters in Lupus, and the only one suitable for small telescopes. The cluster is about 40 minutes of arc across and requires a low power field to be seen at its best. The population of about 100 stars, tend to be grouped in lines and arcs. With regards to planetary nebulae, two are worth a look. NGC5873 is very small and



has a bright bluish disk and NGC5882 is a tiny bright blue disk in a busy field of stars.

There are also about 70 double stars. Some of the better ones are:

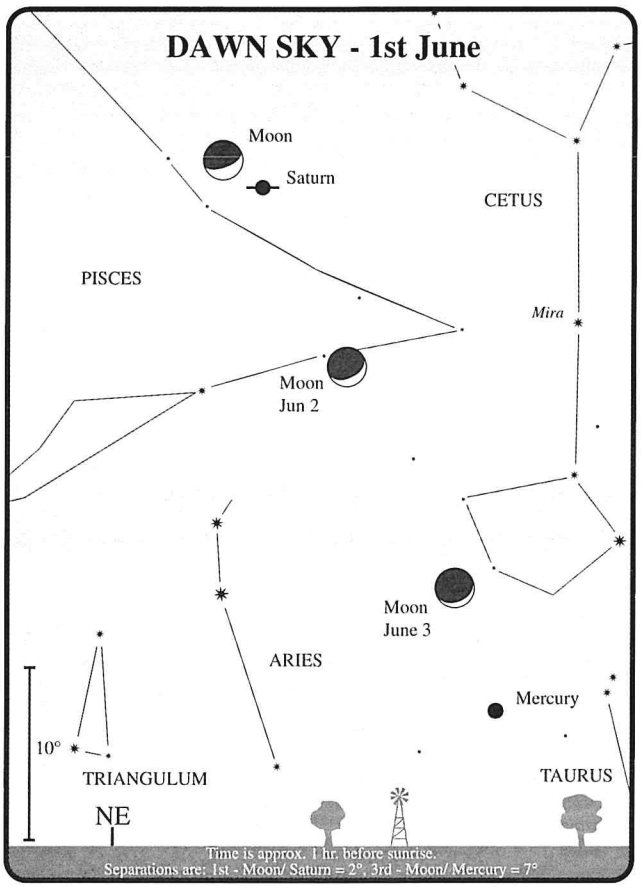
- h4788, a close pair of yellow suns, at 5th & 7th mag in a fine field.
- Eta Lupi, which is a white pair, at 3.5 & 8th mag., in a good field
- Kappa Lupi (Dunlop 177), at 4th & 6th mag., is a wide pair of yellow suns.
- h4690, an orange and white pair at 5.5 & 9th mag.
- Xi Lupi, two yellow stars of almost equal brightness at 5th magnitude.

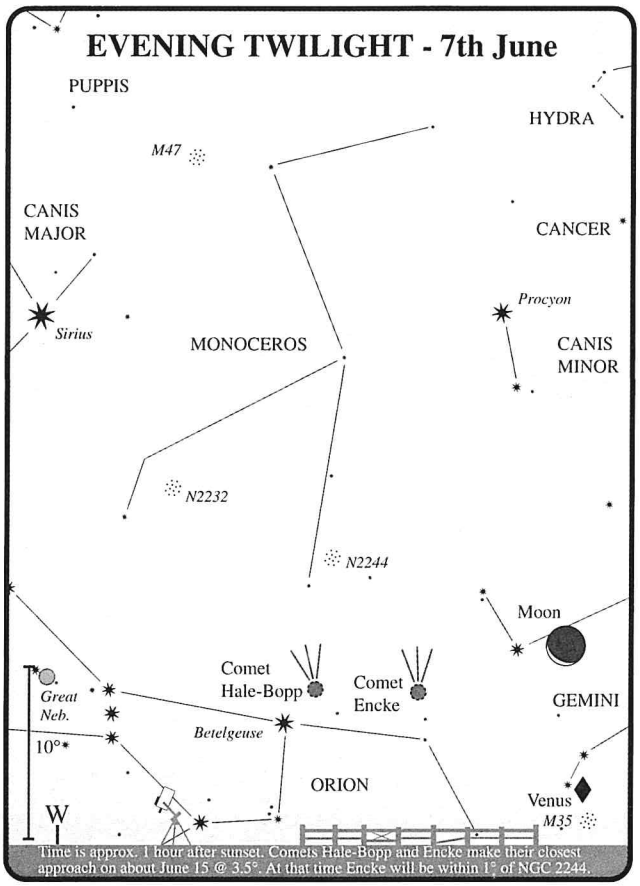
JUNE

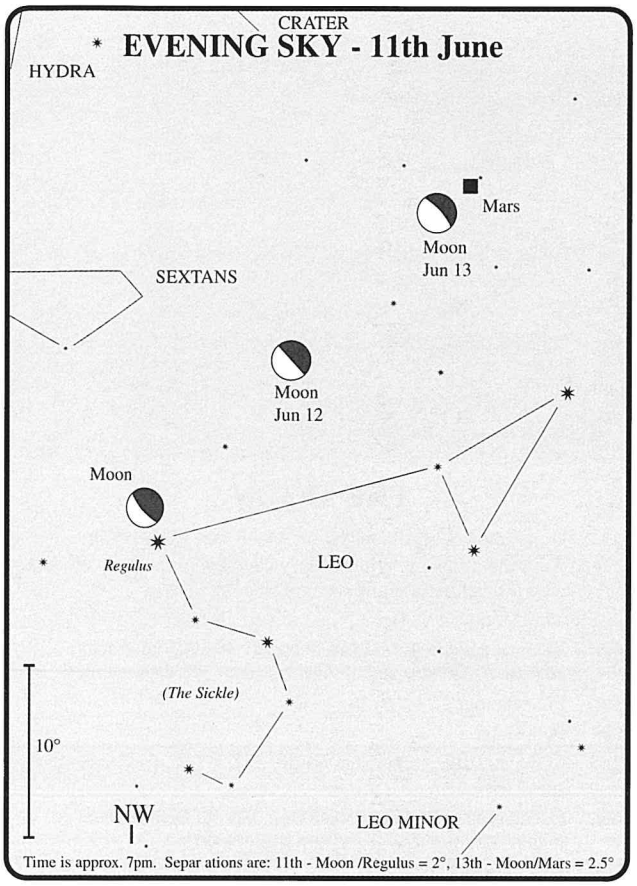
compared to 3rd magnitude for Hale-Bopp. By the end of the month, it will have brightened to 6th magnitude. Moving swiftly across the sky into Puppis (5° east of Sirius on 25th), it will be setting before 9pm, rising at 5.30am.

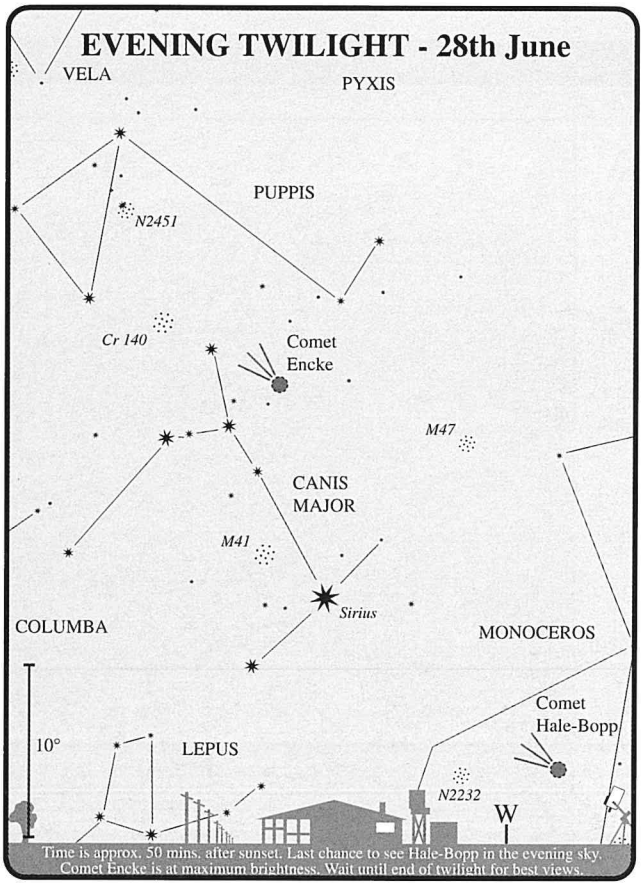
DIARY

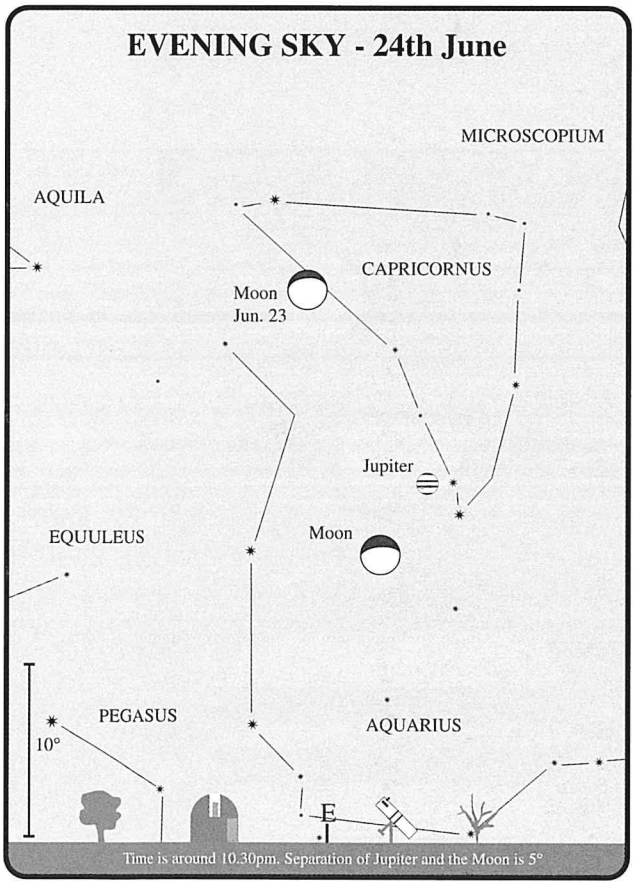
1st	11 AM	Saturn 0.5° South of the Moon; Occn.
2nd		m.p. 68 Leto 0.9° South of IC1613 (G) in Cetus.
3rd	9 PM	Mercury 1.6° North of the Moon.
5th		m.p. 68 Leto 1° NW of NGC 428 (G) in Cetus.
5th		m.p. 27 Euterpe 0.6° North of NGC 821 (G) in Aries.
5th		Comet 2P/Encke 1° NE of NGC 2169 (OC) in Orion.
5th	3:03 PM	New Moon.
6th		m.p. 40 Harmonia 0.4° North of NGC 7606 (G) in Aquarius.
6th		Comet 81P/Wild-2 0.1° South of M95 (G) in Leo.
7th	1 AM	Venus 6° North of the Moon.
7th		Saturn 0.7° North of m.p. 11 Parthenope.
7th		Comet 81P/Wild-2 0.5° South of M96 (G) in Leo.
7th		Comet 2P/Encke 1° NE of NGC 2169 (OC) in Orion.
9th		m.p. 1 Ceres 1° South of NGC 7492 (GC) in Aquarius.
10th	7 PM	Jupiter stationary.
11th		Comet C/1995 O1 (Hale-Bopp) 0.2° North of NGC 2186 (OC) in Orion.
12th	1 PM	Moon at apogee.
13th		m.p. 15 Eunomia 0.5° South of NGC 6425 (OC) in Scorpius.
13th	12:51 PM	First quarter Moon.
13th	Midnight	Mars 0.3° North of the Moon; Occn.
14th		m.p. 9 Metis 0.8° NW of NGC 676 (G) in Pisces.
14th		m.p. 11 Parthenope 0.1° South of NGC 488 (G) in Pisces.
14th	10 PM	Mercury 5° North of Aldebaran.
15th		Venus at perihelion.
15th		m.p. 15 Eunomia 0.4° North of NGC 6416 (OC) in Scorpius.
15th		Comet 2P/Encke 3.5° NE of Comet C/1995 O1 (Hale-Bopp).
15th	4 PM	Comet 2P/Encke 0.5° South of NGC 2244 (OC) in Monoceros.
18th		Mercury at ascending node.
19th		m.p. 15 Eunomia 0.5° North of NGC 6405 (OC) in Scorpius.
20th		m.p. 4 Vesta 0.1° SE of NGC 428 (G) in Cetus.
20th		m.p. 14 Irene 0.8° NW of Sigma Sagittarii.
20th		Comet 2P/Encke 0.7° SW of NGC 2286 (OC) in Monoceros.
21st	3:09 AM	Full Moon.
21st		m.p. 7 Iris 0.3° South of NGC 4781 (G) in Virgo.
21st	4 PM	Solstice.
22nd		Comet 2P/Encke 0.7° South of NGC 2302 (OC) in Monoceros.
23rd	6 AM	Neptune 4° South of the Moon.
23rd		Mercury at perihelion.
23rd	9 PM	Uranus 4° South of the Moon.
24th	7 AM	Venus 5° South of Pollux.
24th	1 PM	Moon at perigee.
24th	8 PM	Jupiter 4° South of the Moon.
25th		Comet 2P/Encke 5° East of Sirius.
26th	3 AM	Mercury in superior conjunction.
27th		Comet 2P/Encke 0.7° West of NGC 2367 (OC) in Canis Major.
27th	8:42 PM	Last quarter Moon.
28th		Comet 2P/Encke 1.3° East of NGC 2362 (OC) in Canis Major.
28th	8 PM	Saturn 0.2° South of the Moon; Occn.
29th		Comet 2P/Encke 1.7° East of Eta Canis Majoris.
30th		m.p. 68 Leto 0.2° SE of NGC 676 (G) in Cetus.

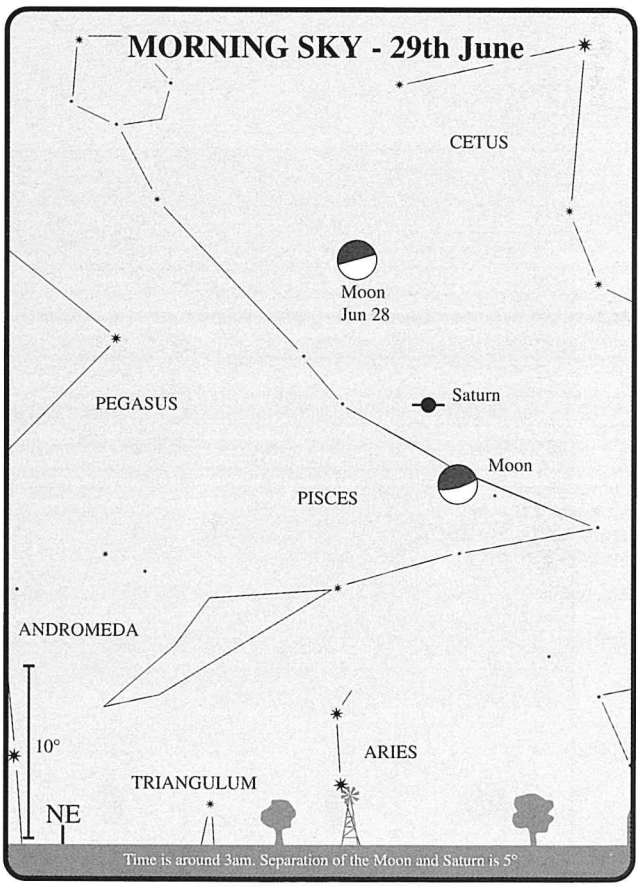





EVENING SKY - 11th June
CRATER
HYDRA
Mars
Moon
Jun 13
SEXTANS
Moon
Jun 12
Moon
Regulus
LEO
(The Sickle)
10°
NW
LEO MINOR
Time is approx. 7pm. Separ ations are: 11th - Moon /Regulus = 2°, 13th - Moon/Mars = 2.5°

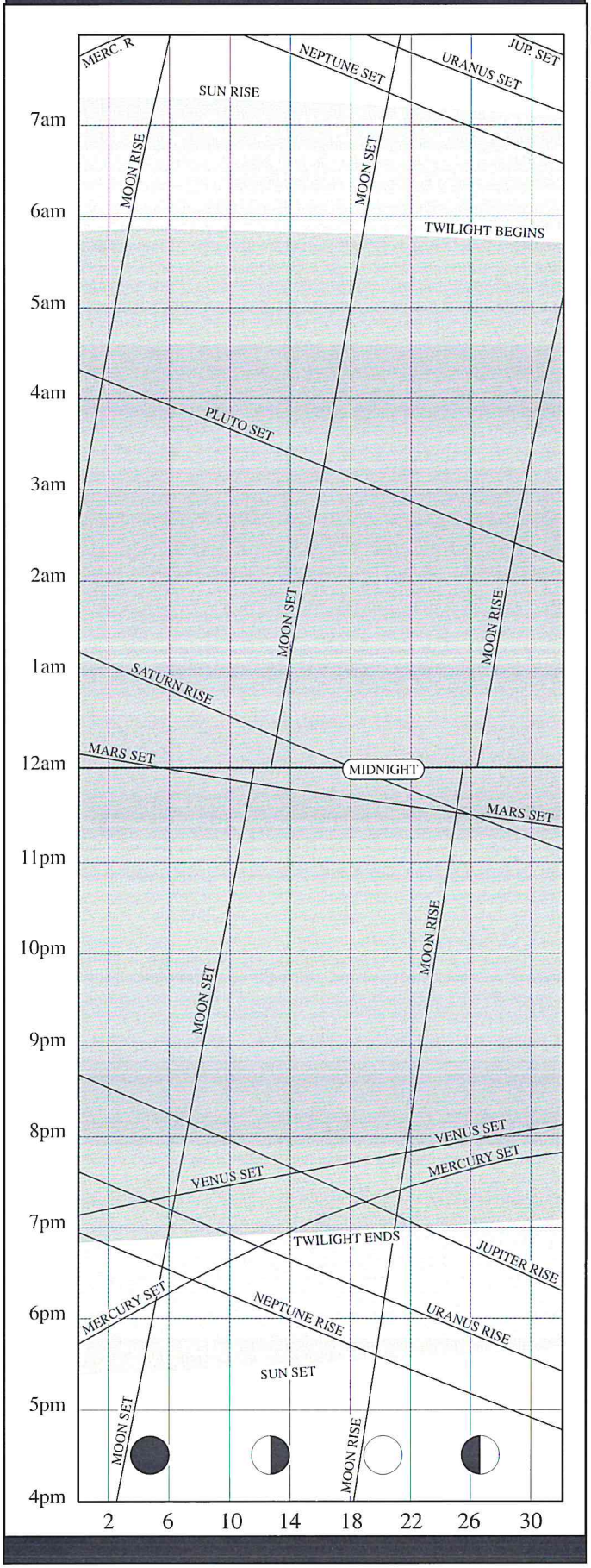

EVENING TWILIGHT - 28th June
VELA
PYXIS
PUPPIS
N2451
Cr 140
Comet
Encke
M47
CANIS
MAJOR
M41
Sirius
COLUMBA
MONOCEROS
Comet
Hale-Bopp
10°
LEPUS
N2232
W
Time is approx. 50 mins. after sunset. Last chance to see Hale-Bopp in the evening sky.
Comet Encke is at maximum brightness. Wait until end of twilight for best views.


EVENING SKY - 24th June
MICROSCOPIUM
AQUILA
CAPRICORNUS
Moon
Jun. 23
Jupiter
EQUULEUS
Moon
PEGASUS
AQUARIUS
10°
E
Time is around 10.30pm. Separation of Jupiter and the Moon is 5°


MORNING SKY - 29th June
CETUS
Moon
Jun 28
PEGASUS
Saturn
Moon
PISCES
ANDROMEDA
10°
ARIES
TRIANGULUM
NE
Time is around 3am. Separation of the Moon and Saturn is 5°

JULY

RISE/SET CHART



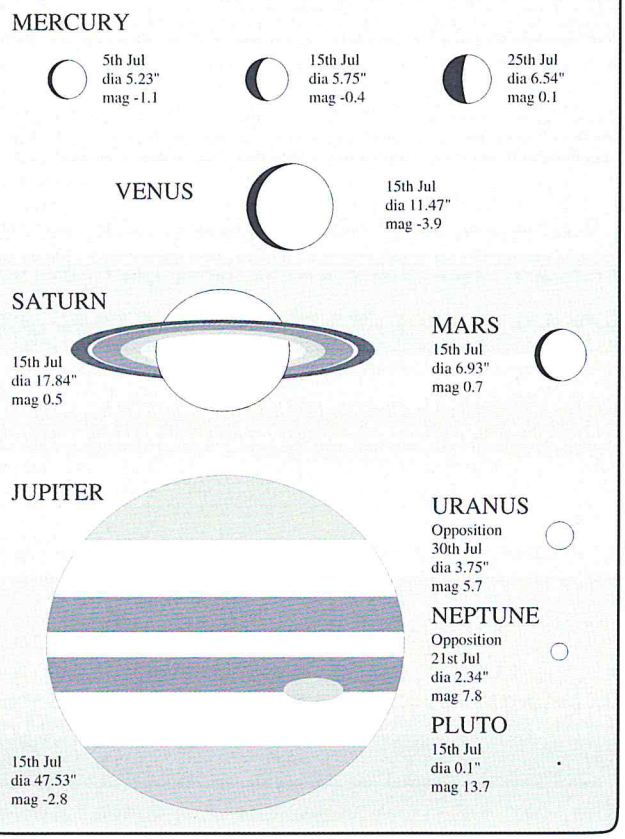
JULY HIGHLIGHTS

- Comet Hale-Bopp moves into the eastern dawn sky.
- Comet Encke is high in southwest evening sky, passing the Southern Cross/Pointers mid month.
- Mercury returns to the western evening sky, best seen in the later half of July.
- Venus in western evening sky, now setting after the end of twilight.
- Mars in NW evening sky, setting around 11pm.
- Jupiter rising in the early evening and is visible most of the night.
- Saturn, rising around midnight, is a morning object. Also occulted by the Moon on 26th.

THE MOON

2nd	Occultation of Aldebaran by the Moon. Not visible from Australia, from our latitudes the closest approach of 3° can be seen just before morning twilight (see sky view).
5th	New Moon.
10th	Moon at apogee (furthest from Earth - 404,945 km distant, angular size 29.4').
13th	First Quarter.
20th	Full Moon.
22nd	Moon at perigee (closest to Earth - 361,581km distant, angular size 32.9').
26th	Occultation of Saturn by the Moon. Visible from northern regions of Australia (see Saturn text below).
27th	Last Quarter.
29th	Occultation of Aldebaran by the Moon. Not visible from Australia, closest approach for W.A. is 5.8° on the 30th.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY, after moving to the east of the Sun late last month, returns to the evening sky in July. Typically, fast-paced Mercury moves through several constellations each month. July is no exception with Gemini, Cancer and Leo all visited. As the planet rises out of the western evening twilight, it moves towards the brilliant Venus (see sky view on 6th). On the 12th, Mercury moves into the midst of the Beehive cluster or Praesepe (M44). The Beehive is a large open star cluster about 1° across and visible to the unaided eye as a hazy patch. To get the best view of Mercury and M44, binoculars should be used. Even Galileo (in 1610) was able to resolve the cluster into more than 40 stars with his tiny telescope. From the 22nd July to the 2nd of August, Mercury and Venus will be within 5° of each other. Closest approach is from the 26th to 28th with a separation of 4.5° (see sky view for 26th). At the end of the month, Mercury and 1st magnitude Regulus (Alpha Leonis) will be within 2° of each other (from the 25th to 28th). The closest approach of less than 1° will be on the 26th and 27th.

VENUS spends the first half of July in Cancer and then moves into Leo for the rest of the month. On the 4th and 5th, Venus will be amid the stars of the Beehive cluster or Praesepe (M44); see sky view for 6th. Mercury visits the Beehive 8 days after Venus, but the Venus event occurs when the planet is higher up and consequently in a darker sky. For three days, Venus will be within 2° of 1st magnitude Regulus (Alpha Leonis), the closest the pair get is 1° on the 23rd. From 22nd July to 2nd August, Venus and Mercury are within 5° of each other. Closest approach is from the 26th to 28th at 4.5° (see sky view for 26th). Besides the close approaches of the two planets, the most aesthetically pleasing view would be on the 25th when Mercury, Regulus and Venus appear in almost a straight line, about 2° between each other.

MARS is in the northwest evening sky and sets around 11pm. Throughout July the planet and the 1st magnitude star Spica (Alpha Virginis) move closer together (see sky view on 12th). By the end of the month they will be 2.5° apart. Both Mars and Spica will be of the same brightness at this time, the orange "star" being Mars. On the 11th, the 6 day old Moon will be 7° below Mars. On the following evening, the first quarter Moon will be 5° above and slightly north (see sky view on 12th).

JUPITER, in Capricornus, rises in the early eastern sky and is visible for the entire night. With opposition in early August the planet reaches its maximum brightness of -2.8 by mid July. On the 21st the 16 day old waning gibbous Moon will be 4.5° from the planet (see sky view).

SATURN, in Pisces is still a morning object. The Moon occults Saturn on the 26th, but the event is only visible from the northern regions of Australia. From Darwin, Saturn disappears behind the bright limb of the 21 day old Moon around 3am, and reappears from the dark limb about 4.30am (ACST). From Alice Springs, Perth or Townsville the planet just misses the lunar limb by a few arc minutes. From all areas further south, Saturn will be within 0.5° to the limb. Closest approach for Perth is around 1.50am (WAST). See also the sky view for 26th. This is the 5th in a series of fourteen occultations between Saturn and the Moon that began in April and finishes in March next year; the next series begins in the year 2001.

URANUS and **NEPTUNE** are at opposition this month and are visible the whole night.

MINOR PLANETS at opposition this month are 14 Irene at mag. 9.5 in Sagittarius, 2 Pallas at mag. 9.6 in Vulpecula and 532 Herculina at mag. 9.4 in Sagittarius.

COMETS

Hale-Bopp: The comet begins the month at magnitude 3.9 in Monoceros, rising around 6am. Hale-Bopp will be much easier to see by the middle of the month when it will be rising at 5am. On 19th July, it is 0.3 degrees northeast of M50. By the end of July it has faded to magnitude 4.3, though it is now rising shortly after 4am, in Canis Major.

Encke: In early July, comet Encke passes Earth at a distance of around 0.19 AU, its closest approach ever to Earth since its discovery. At this time (5th) it is 2 degrees north of IC 2391. Beginning the month in Puppis, it is setting before 9pm and rising again around 5.30am. Encke moves rapidly through the southern sky, being circumpolar for much of the month, though it fades from 6th to 10th magnitude. On 8th July, it is only 0.8 degrees southeast of the "Southern Pleiades". By the end of July, the comet will be found in Scorpius, setting around 5am.

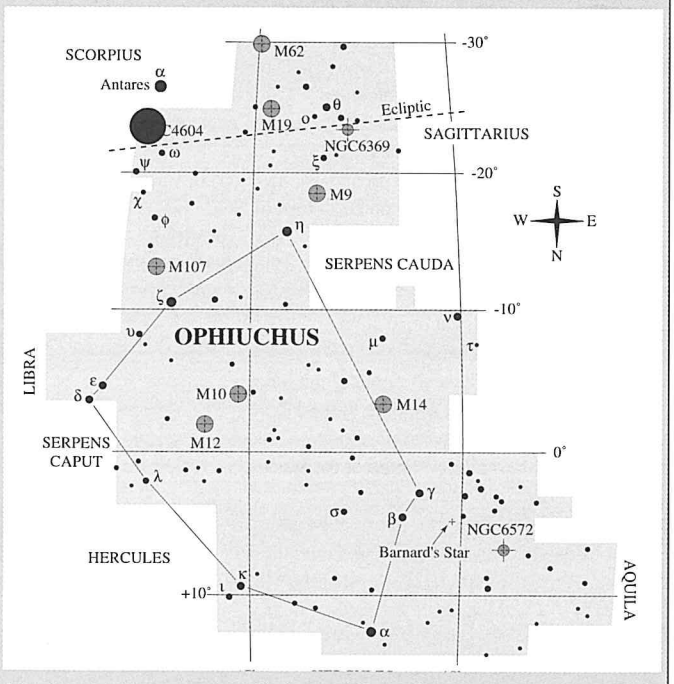
CONSTELLATION OF THE MONTH — OPHIUCHUS (Oph)

Ophiuchus, the Serpent Bearer or Serpent Holder, is the 11th largest constellation, by area. The constellation is high, in the northern sky, in the early evening this month. Its southern extremities cross the ecliptic between Scorpius and Sagittarius and its northern regions are bounded by Hercules.

The constellation's origins go back to antiquity. The name comes from the Greek, 'Ophioukhos', and it is the Greek god of medicine, 'Asclepius', that the figure represents. Asclepius was the ship's surgeon on the Argo and according to legend, was able to bring the dead back to life. He was so skilled as a surgeon, that when Hippolytus was quartered by four horses, he was able to glue him back together and revive him. The symbol of Ophiuchus was adopted by the western medical profession, ie. the staff he carried with the snake, Serpens, entwined around it. The mythical figure, traced out by the ancients, shows a man with this serpent coiled around his waist. The serpent is represented by a constellation appropriately named 'Serpens'. Divided by Ophiuchus, Serpens exists as two separate halves; Serpens Caput, 'the serpent's head' lying to the west, and Serpens Cauda, 'the serpent's tail' to the east.

The constellation is made up of many stars dispersed over its large area, the brightest being only 2nd magnitude. The southern portions intrude upon the Milky Way, and it is here that the remarkable region of dust and gas known as IC4604 surrounds the star Rho Ophiuchi. Ophiuchus has the distinction of being the home to more globular clusters than any other constellation. It also contains many planetary nebulae, an abundance of multiple stars, and a one or two unusual objects. One of the unusual objects is Barnard's 'Runaway Star', a 9.5 magnitude red dwarf. At only six light-years away, the star is our closest stellar neighbour after the Alpha Centauri system. It has the largest proper motion of any star; moving at 10.29 arc seconds per year it will cover one degree in just 350 years. Although Barnard discovered the large motion of this star in 1916, it was Edmund Halley (of Halley's Comet fame) who is credited with the discovery of proper motions amongst the 'fixed stars' in the year 1718.

Of the 20 globulars on offer, the best are probably those that Charles Messier observed in the 18th century. Of the eight 'Messier' objects in Ophiuchus, 7 of them are globulars and 1 is an open star cluster. The



Messier globulars near the ecliptic are: M9 small and compressed, M19 looking like a miniature Omega Centauri, M62 bright and large and M107 small and compact. M107 was not actually discovered by Messier, but by his friend P. Mechain. The remaining globulars are: M10 bright well resolved and large, M12 same as M10 and M14 which is compact and rich.

Many of the planetary nebulae in Ophiuchus are suitable for medium sized telescopes. Close to Barnard's Star is NGC6572, a planetary with a small elliptical blue-green disc, it is the brightest in the constellation. Almost lying on the ecliptic is NGC6369, a miniature of the Ring Nebula in Lyra.

JULY

METEOR SHOWERS

The **Pegasids** are a short lived shower, lasting only from the 7th to 13th, with maximum on the 10th. The shower is best viewed during the second half of the night, ie. after the Moon has set, and produces faint, swift meteors. The ZHR is low, about 3 can be expected. The radiant is on the west side of the Great Square of Pegasus, near 3rd mag. Alpha Pegasi.

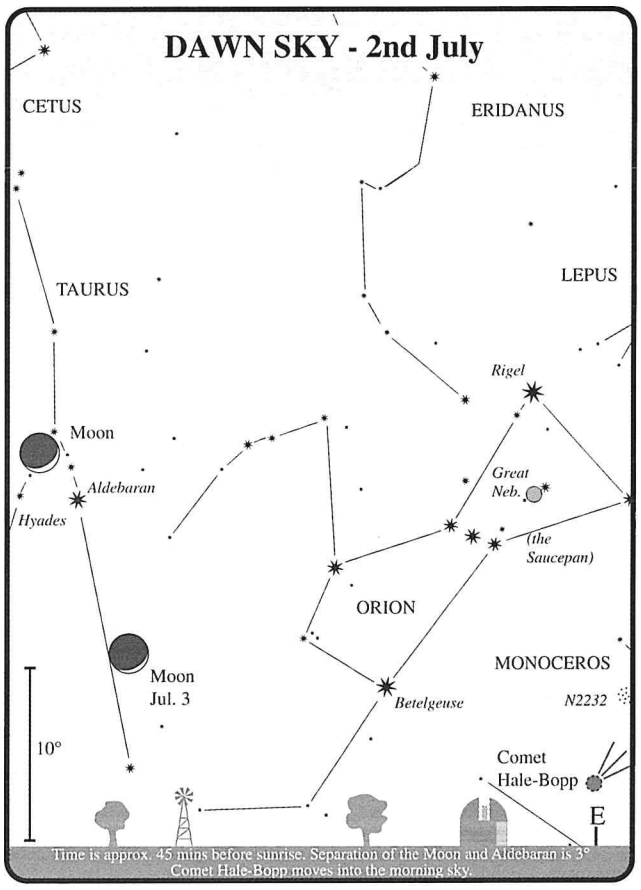
The **Phoenicids** are a southern hemisphere shower and are best seen after midnight, when the radiant is at its highest altitude. They are active from the 10th to 16th, with maximum on the 14th. Activity is variable and can reach rates of 3 to 10, but recently the ZHR has been as low as 2 per hour.

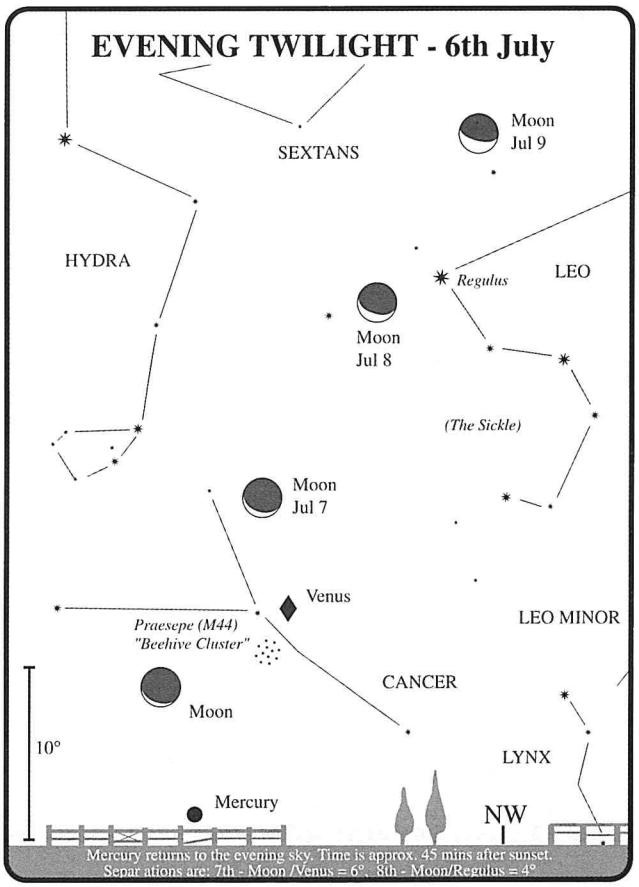
The **Piscis Austrinids** and **Aquarid/Capricornid** Complex are a conglomerate of five individual meteor showers. See August for description.

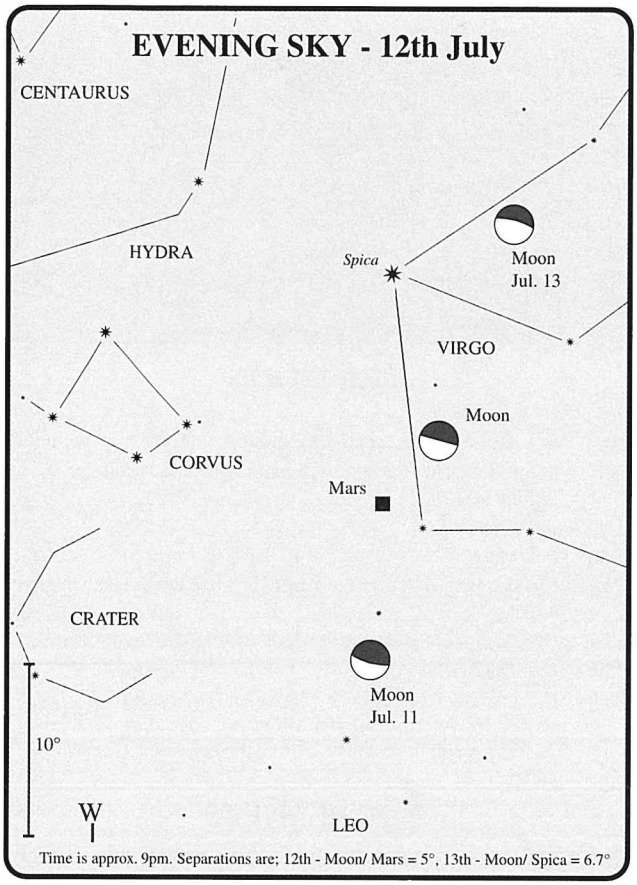
The **Perseids** duration is from 17th July through to 24th August, with maximum next month. See August for description.

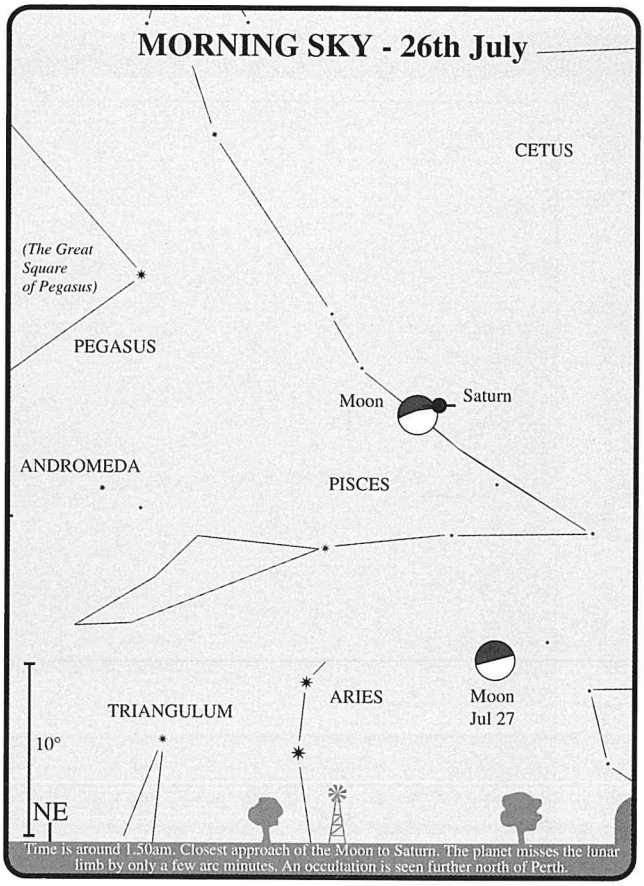
DIARY

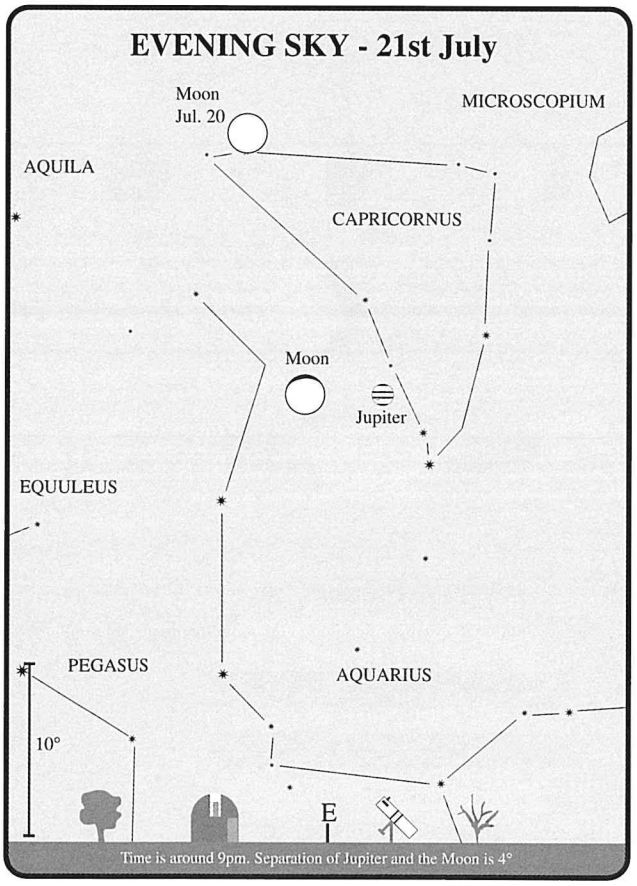
1st		Comet 2P/Encke 1.5° East of NGC 2451 (OC) in Puppis.
2nd	1 PM	Aldebaran 0.6° South of the Moon; Occn.
3rd		Mercury at greatest latitude North (Heliocentric).
3rd		Comet 2P/Encke 2.2° NE of Gamma Velorum.
4th		Comet 2P/Encke 2° North of IC 2391 (OC) in Vela.
4th	4 PM	Venus 0.4° West of the Beehive Cluster (M44) in Can.
5th	2:40 AM	New Moon.
5th	3 AM	Earth at aphelion.
5th	Noon	Mercury 5° South of Pollux.
6th		Venus at greatest latitude North (Heliocentric).
7th	10 AM	Venus 5° North of the Moon.
8th		Mars at descending node.
8th	5 PM	Comet 2P/Encke 0.8° SE of Mel 101 (OC) in Carina.
9th		Mars 0.1° South of NGC 4546 (G) in Virgo.
9th		Comet 81P/Wild-2 0.4° West of NGC 4123 (G) in Vir.
10th	7 AM	Moon at apogee.
11th		m.p. 2 Pallas 0.3° North of NGC 6802 (OC) in Vul.
12th		Mars 0.9° NE of NGC 4593 (G) in Virgo.
12th		Comet 81P/Wild-2 0.7° North of NGC 4179 (G) in Vir.
12th	9 AM	Mars 1.8° South of the Moon.
12th	4 PM	Mercury 0.4 East of M44 (Beehive OC) in Cancer.
13th	5:44 AM	First quarter Moon.
14th		Comet 2P/Encke 0.5° North of Alpha Circini.
15th	1 AM	Ceres stationary.
16th		Mars 0.4° North of NGC 4697 (G) in Virgo.
17th		m.p. 15 Eunomia 0.1° East of NGC 6304 (GC) in Oph.
18th		Mars 0.7° NE of NGC 4731 (G) in Virgo.
19th		Comet C/1995 O1 (Hale-Bopp) 0.3° NE of M50 (OC).
19th		Comet 81P/Wild-2 0.4° West of NGC 4517 (G) in Vir.
19th	6 PM	Pallas at opposition.
20th	11:20 AM	Full Moon.
20th	2 PM	Neptune 4° South of the Moon.
21st	5 AM	Uranus 4° South of the Moon.
21st	3 PM	Neptune at opposition.
22nd	1 AM	Jupiter 4° South of the Moon.
22nd	7 AM	Moon at perigee.
23rd	9 AM	Venus 1.2° North of Regulus.
24th	Midnight	Juno in conjunction with the Sun.
26th	3 AM	Saturn 0.02° North of the Moon; Occn.
26th		Mercury at descending node.
26th		Mars 0.2° North of NGC 4995 (G) in Virgo.
26th		Comet C/1995 O1 (Hale-Bopp) 0.6° NE of NGC 2353 (OC) in Monoceros.
27th	2:28 AM	Last quarter Moon.
27th	8 AM	Mercury 0.5° South of Regulus.
29th		m.p. 68 Leto 0.5° East of m.p. 11 Parthenope.
29th	7 PM	Aldebaran 0.4° South of the Moon; Occn.
30th	3 AM	Uranus at opposition.
31st		m.p. 7 Iris 1.2° SW of Spica.
31st		m.p. 6 Hebe 1° SW of NGC 4178 (G) in Virgo.

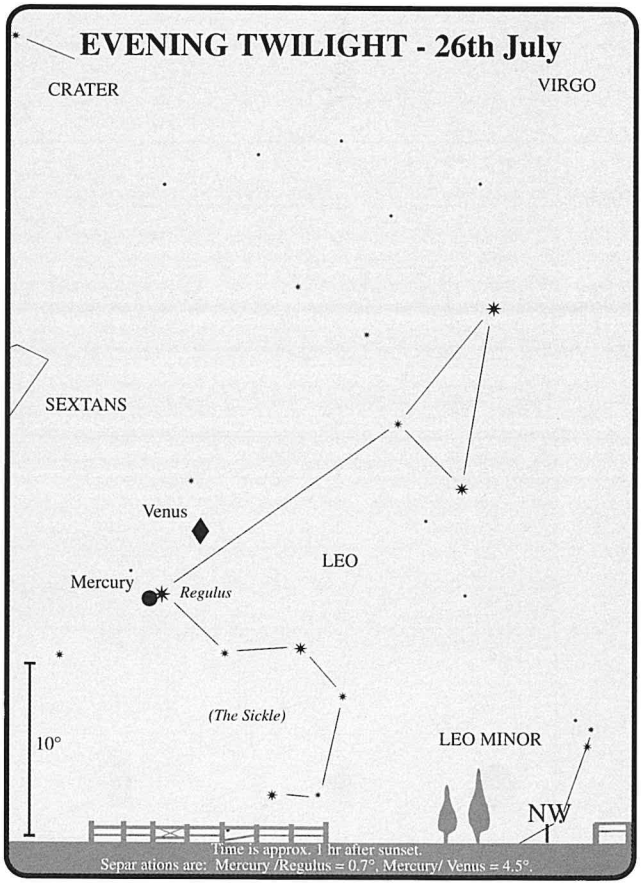





EVENING SKY - 12th July
CENTAURUS
HYDRA
Spica
Moon
Jul. 13
VIRGO
Moon
CORVUS
Mars
CRATER
Moon
Jul. 11
10°
W
LEO
Time is approx. 9pm. Separations are; 12th - Moon/ Mars = 5°, 13th - Moon/ Spica = 6.7°

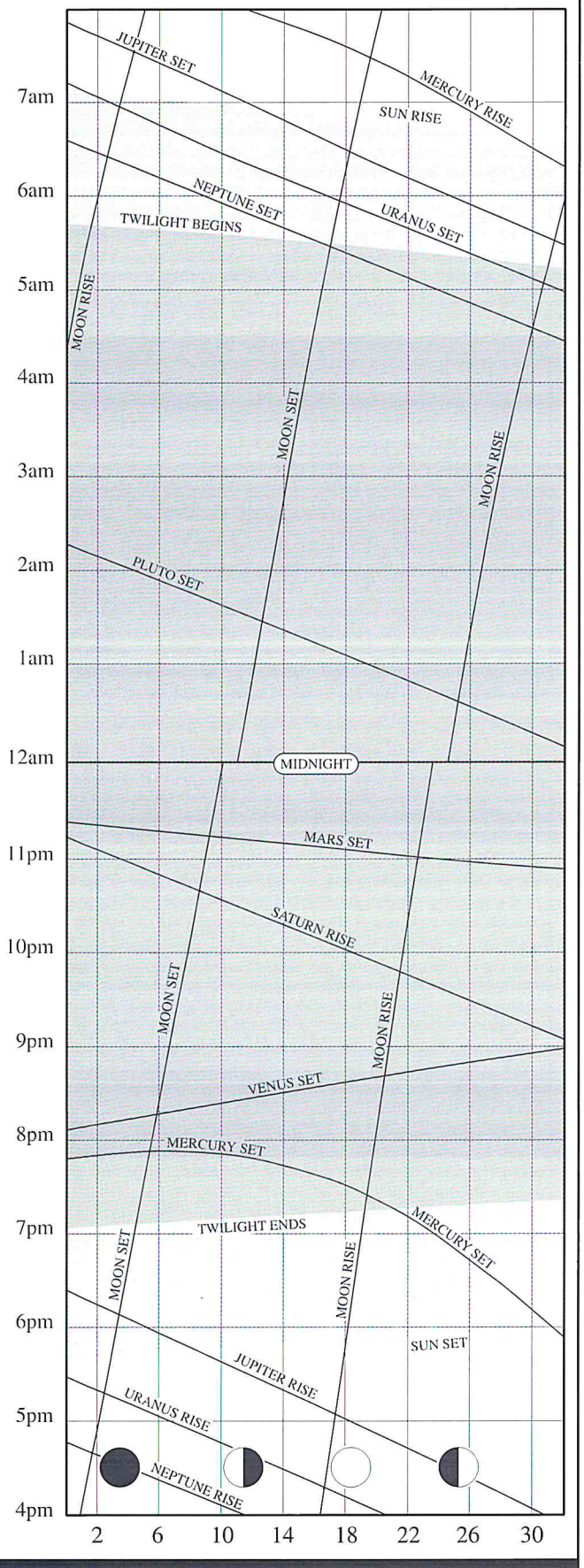

MORNING SKY - 26th July
CETUS
(The Great
Square
of Pegasus)
PEGASUS
Moon
Saturn
ANDROMEDA
PISCES
TRIANGULUM
ARIES
Moon
Jul 27
10°
NE
Time is around 1.50am. Closest approach of the Moon to Saturn. The planet misses the lunar limb by only a few arc minutes. An occultation is seen further north of Perth.


EVENING SKY - 21st July
Moon
Jul. 20
MICROSCOPIUM
AQUILA
CAPRICORNUS
Moon
Jupiter
EQUULEUS
PEGASUS
AQUARIUS
10°
E
Time is around 9pm. Separation of Jupiter and the Moon is 4°


EVENING TWILIGHT - 26th July
CRATER
VIRGO
SEXTANS
Venus
LEO
Mercury
Regulus
(The Sickle)
10°
LEO MINOR
NW
Time is approx. 1 hr after sunset.
Separations are: Mercury /Regulus = 0.7°, Mercury/ Venus = 4.5°.

AUGUST

RISE/SET CHART



AUGUST HIGHLIGHTS

- Comet Hale-Bopp is well placed in the eastern pre-dawn sky.
- Mercury, for the first half of the month, displays its best view in the evening sky for 1997.
- Venus is brilliant in the early western evening sky.
- Mars is in the NW evening sky, setting around 11pm.
- Jupiter is visible the whole night.
- Saturn can be seen in the late eastern evening sky, rising around 10pm.

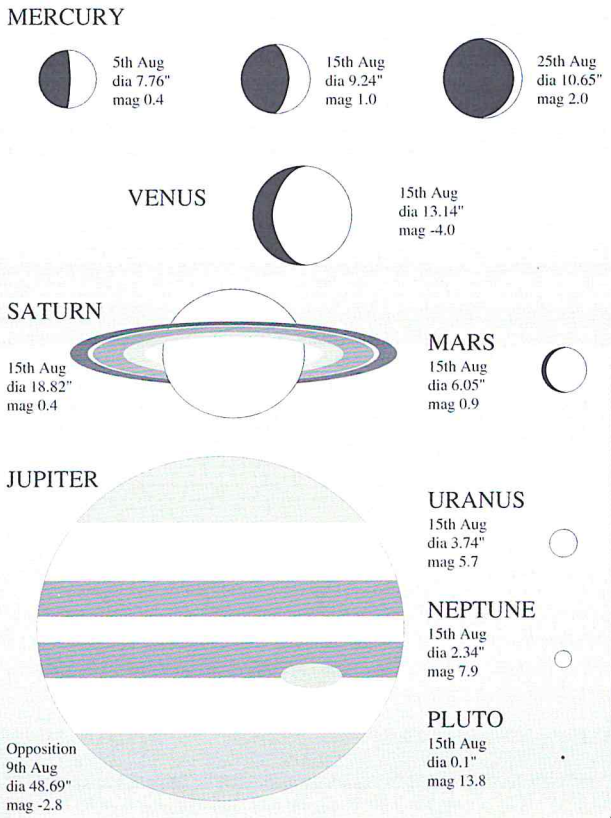
THE MOON

3rd	New Moon.
6th	Occultation of Mercury by the Moon. Not visible from Australia.
7th	Moon at apogee (furthest from Earth - 405,936 km distant, angular size 29.1').
11th	First Quarter.
18th	Full Moon.
19th	Moon at perigee (closest to Earth - 358,020 km distant, angular size 33.0').
22nd	Occultation of Saturn by the Moon. Not visible from Australia.
25th	Last Quarter.
26th	Occultation of Aldebaran by the Moon. The closest approach seen from Western Australia will be just after moonrise when Aldebaran will be less than 2° from the lunar limb (see also sky view).

THE PLANETS

MERCURY reaches its greatest elongation east (27°) of the Sun on the 4th, and is at its best for viewing in the western evening sky until mid month. The planet then swings rapidly back toward the Sun (getting lower in the western sky) and reaches inferior conjunction (between the Earth and the

APPEARANCE of the PLANETS



Sun) on the 1st of September. The first week of the month is the most interesting. Mercury is 6° above Regulus and 5° below Venus on the 1st. On the 5th, the 2 day old thin crescent Moon will be 5° below Mercury. On the following evening, Mercury will be 6° below the Moon. They will make a beautiful sight with brilliant Venus next to the Moon. These displays on the 5th/6th are shown well in the sky view for 5th. Mercury resides in only two constellations this month, Leo and Sextans, but manages to visit both, twice, in its travels. On the 6th, when Mercury is within 6° of the Moon, there is an occultation visible from the Arctic regions.

VENUS, setting about 2 hours after the Sun and at -3.9 magnitude, appears dazzling in the western evening sky (which no doubt will create some UFO reports). Venus moves from Leo into Virgo early in August, all the time nearing the 1st magnitude star Spica (Alpha Virginis). By the end of the month, the planet (named after the goddess of Love) and the star will be 8° apart. On the 6th, the 3 day old thin crescent Moon will be about 1° from Venus (see sky view for 5th).

MARS can be seen high in the north western evening sky after dark, setting in the west around 11pm. This "God of War" and the 1st magnitude star Spica (Alpha Virginis) remain companions early in the month. Their separation is 2° or less from the 1st to the 6th, being closest on the 4th. Do not confuse Mars with Spica during the month as they are close to the same brightness, Mars naturally has the orange hue. On the 9th, the 6 day old Moon forms a triangle with Mars and Spica, appearing approximately 5° from both (see sky view). The following evening the Moon is 10° from Mars, with Spica, Mars and the Moon forming a straight line. In Virgo for most of the month, Mars moves into Libra on the 27th.

JUPITER is at opposition on the 10th, and presents a good sized disc for those lucky enough to have a telescope. The size of Jupiter at opposition varies and depends on how close the Earth is at the time. Presently the Earth-Jupiter distance is 606 million kilometres. Next year when the distance is around 593 million kilometres, the disc will be slightly larger (about 49.7 arc seconds), which is about as large as it gets. The smallest Jupiter's equatorial diameter, at opposition, is slightly over 44 arc seconds. This will next occur in the year 2005, when the Earth-Jupiter distance will be 667 million kilometres (see further discussion in "Astronomy 2005"). Returning to 1997, on the 17th of this month, the Full Moon will be 6.4° from Jupiter (see sky view). On rare occasions it is possible to see Jupiter without any moons in the sky near the planet. This will be the case on the morning of the 28th. Most of this event is visible from Western Australia. The absence of the moons from the sky is the result of a number of factors: Callisto is in eclipse, Ganymede is in occultation, Europa is in transit and Io is in occultation. The first three of these are visible from Perth (see pages 82, 84).

SATURN is prominent in the late eastern evening sky. Residing in Pisces near the Cetus border, Saturn, at magnitude 0.5, is not difficult to pick out in this region lacking bright stars. On the 21st, the 18 day old Moon will be seen rising 5.6° above Saturn in the eastern evening sky (see sky view). On the following evening the Moon will be 9° below Saturn. During its closest approach on 22nd, South America, Africa and Asia will see an occultation. This is the 6th in a series of fourteen occultations between Saturn and the Moon. These began in April and finish in March next year; the next series starts in the year 2001. The planet appears stationary on the 3rd. Thereafter it begins its western motion across the sky, continuing until mid December. It then returns to its west-to-east track (see discussion on retrograde motion and the Saturn finder chart in part II).

PLUTO appears stationary on the 16th, having been in retrograde motion since March. It now returns to its west-to-east track. See the discussion on retrograde motion and the Pluto finder chart in part II. In mid August, Pluto travels from Ophiuchus into Scorpius.

MINOR PLANET. At opposition this month is 19 Fortuna at mag. 9.5 in Aquarius.

COMETS

Wild 2: Observers will most likely get their last views of Wild 2 during August. It begins the month at 12th magnitude, setting around 10.30pm. The comet remains in Virgo throughout the month, ending not too far from Mars. By month's end it is setting around 10pm and faded to 13th magnitude.

Hale-Bopp: Beginning August at magnitude 4.5, the comet rises around 4am in Canis Major. Hale-Bopp moves into Puppis, ending the month at magnitude 4.9, rising around 2am. On 29th it is 0.7° northeast of M93.

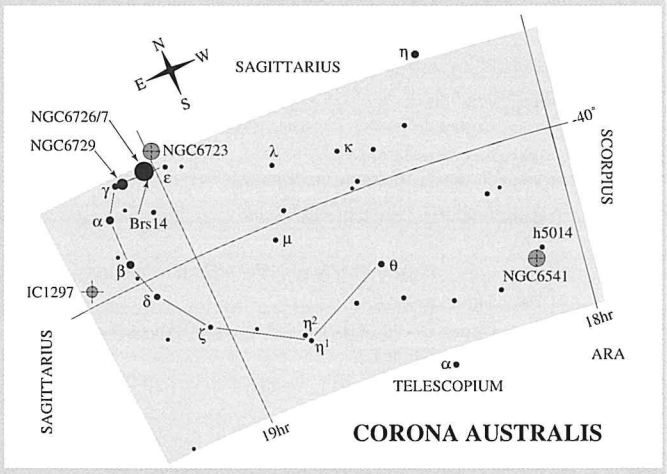
Encke begins August in Scorpius at 10th magnitude, visible throughout the night until it sets around 5am. Moving into Sagittarius the comet ends the month being fainter than 14th magnitude, setting around 3am.

CONSTELLATION OF THE MONTH — CORONA AUSTRALIS (CrA)

Corona Australis, the Southern Crown, is the counterpart to Corona Borealis or the Northern Crown. Covering only 128 square degrees of sky, the constellation is not large and ranks as number eighty in order of size. Culminating at 9pm mid month, the distinct group of stars forms a semicircle, and is easily found just south of Sagittarius and east of the tail of Scorpius. For those who recognise Sagittarius by the "teapot" shape formed by eight of its brightest stars, Corona Australis can be though of as a slice of lemon beside the teapot. Who the crown originally belonged to is unknown, but in some legends say it belonged to the centaur, Sagittarius. The Arabs pictured the constellation as a tortoise (Al Kubbah) and sometimes as a tent (Al Hiba). The Chinese also saw a tortoise while others, like the Greeks, saw it as a wreath.

The constellation lies just on the Milky Way fringes, in a region of interstellar dust and gas that make this area stunningly beautiful in colour photographs. The brighter of these complex regions of dark and light nebulosity are known as NGC6726 and NGC6727. This is a double reflection nebula, that surrounds the variable star TY Corona Australis. As the star changes in brightness, so do the nebulae. Nearby is the reflection nebula NGC6729. It also contains a variable star, R Corona Australis and, like NGC 6726/27, this nebula also changes in brightness synchronised with the star. These types of stars are known as nebula variables and appear to be young protostars, in their final stages of development. They are also found in the Orion Nebula.

Set in a brilliant starry field is the globular star cluster NGC6541. At 6.6 magnitude this tightly compressed blaze of stars is well suited to small telescopes, although a 15cm instrument is required to resolve it. Just across the border in Sagittarius (close to the nebula variables mentioned above) is another fine globular, NGC6723, which is slightly smaller than NGC6541



but similar in appearance. Near the eastern border lies a small (about 10 arc minutes across) bright bluish planetary nebula known as IC1297.

The constellation boasts four fine double star systems, two of which are close and a test for small apertures, the other two wide and easy. The beauty of the four pairs is enhanced by the fact that each has components with almost matching magnitudes. They are:

- h5014, at mag 5.7 & 5.7, separated by 1.8 arc seconds and in a good field.
- Kappa, at mag 5.9 & 6.6, separated by 21 arc seconds also in a good field.
- Brs14, mag 6.6 & 6.8, separated by 13 arc seconds.
- Gamma, mag 4.8 & 5.1, separated by 2.7 arc seconds.

AUGUST

METEOR SHOWERS

The **Piscis Austrinids** and **Aquarid/Capricornid Complex** are a conglomerate of five individual meteor showers summarised below.

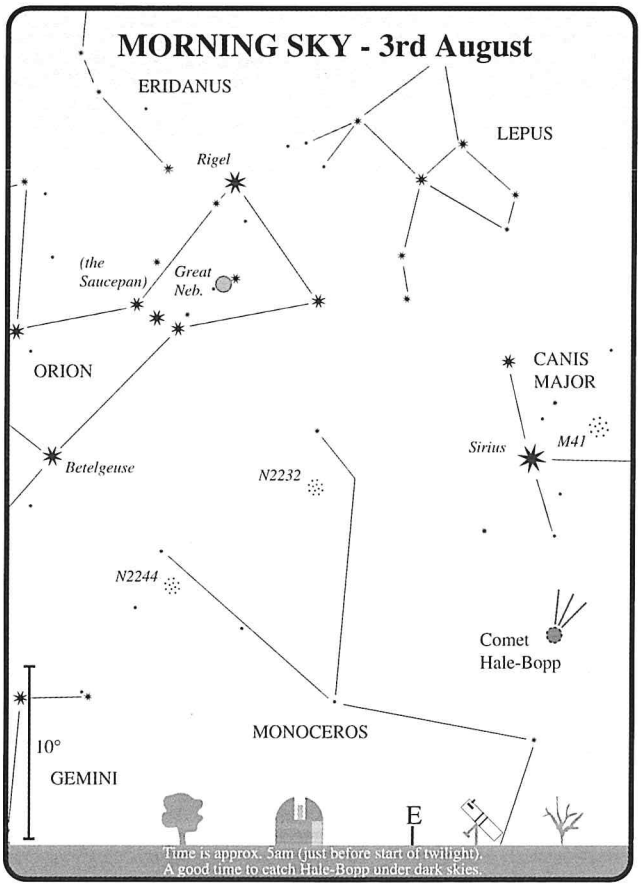
Piscis Austrinids, Active 15th Jul to 10th Aug. Max is 28th Jul. ZHR = 5.
Southern Delta-Aquarids, Active 12th Jul to 19th Aug. Max 28th Jul. ZHR = 20.
Alpha-Capricornids, Active 3rd Jul. to 15th Aug. Max 30th Jul. ZHR = 4.
Southern Iota-Aquarids, Active 25th Jul to 15th Aug. Max 4th Aug. ZHR = 2.
Northern Delta-Aquarids, Active 15th Jul to 25th Aug. Max 8th Aug. ZHR = 4.

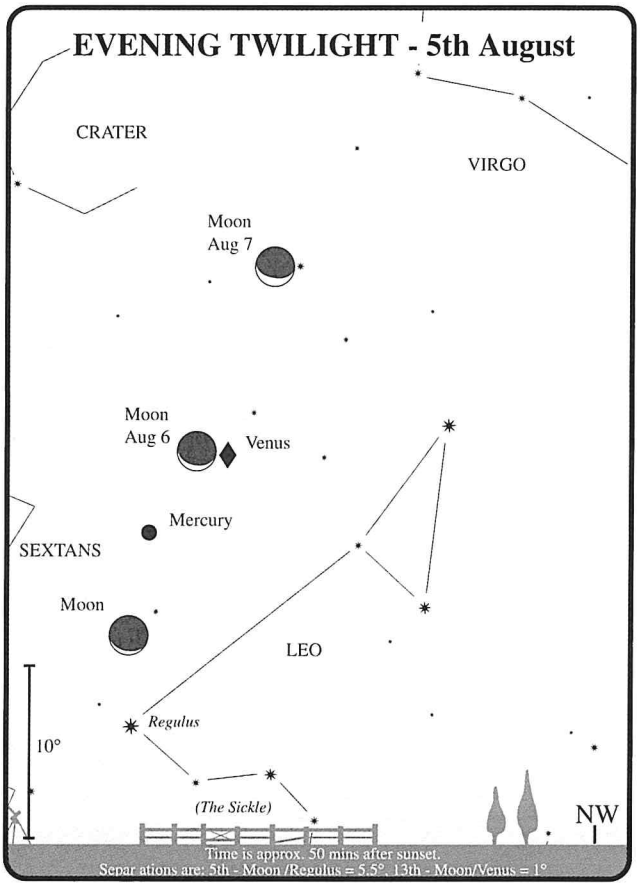
The Piscis Austrinids are often overlooked by southern observers, with the more popular Delta Aquarids active at the same time. They are generally blue, white or yellow in colour with a few leaving trains. The Southern Delta Aquarids are one of the strongest and consistent of the southern showers. They are generally faint (bright meteors are the exception), typically white, with some blue members, and an occasional train may be seen. The Alpha Capricornids are noted for their spectacular nature; bright slow meteors with long paths and frequent fireballs. The Southern Iota Aquarids are faint medium speed meteors. The Northern Delta Aquarids are faint, tend to be faster and have shorter trails than their southern counterpart.

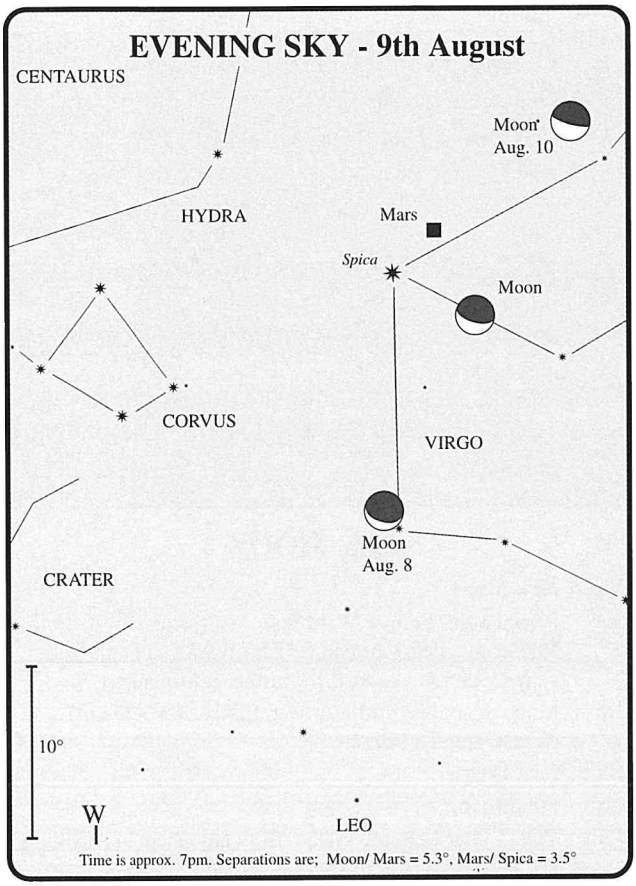
The **Perseids,** with their radiant below the northern horizon, are unfortunately not easily observed from "down under". The Perseids are probably the most dependable of meteor showers, with records of their activity going back over one thousand years. The duration is from 17th July through to 24th August, with maximum this month on 12th. The zenith hourly rate is variable and has in the past being exceptional: 1991 and 1992 saw over 400, in 1993 around 300, 1994 about 220 and 1995 around 160.

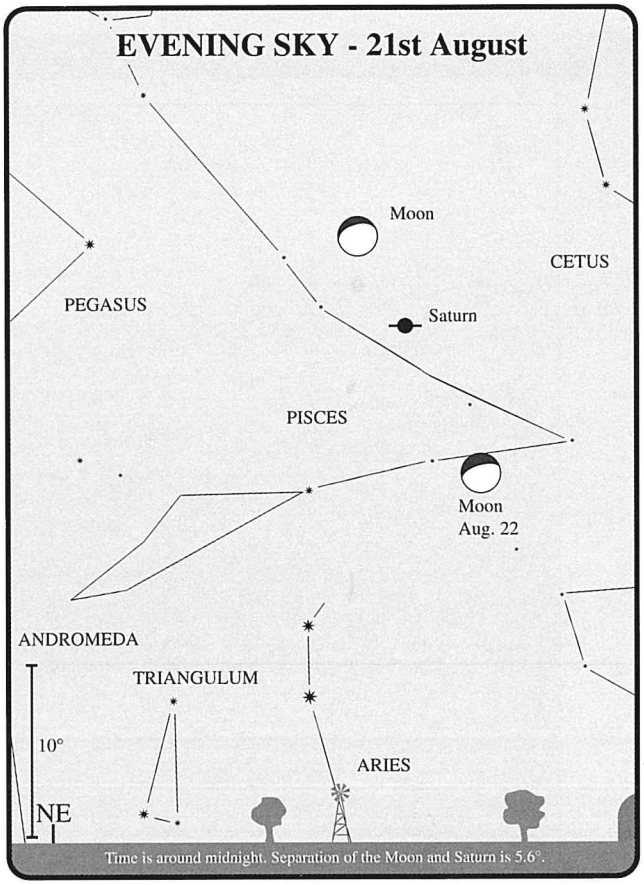
DIARY

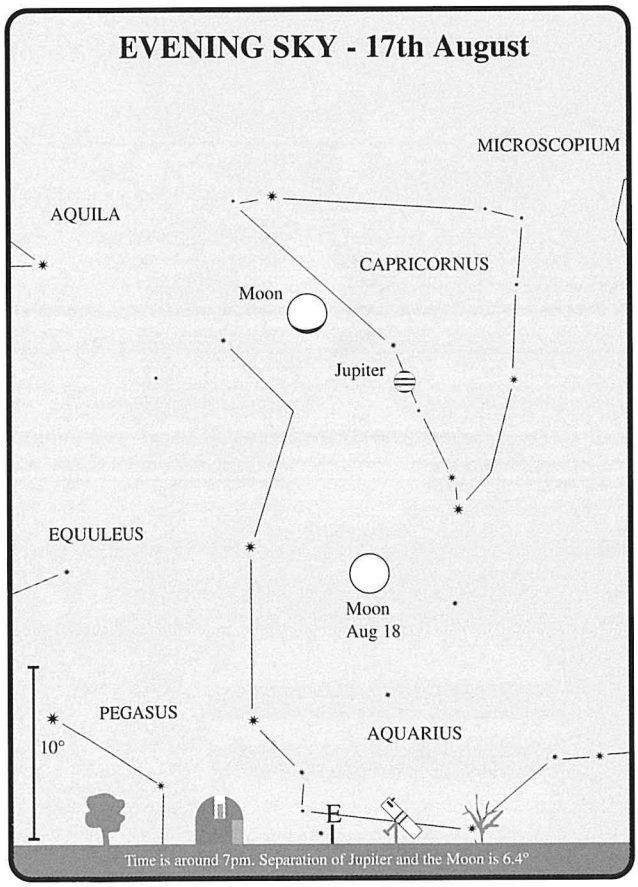
1st		Saturn 0.7° NW of NGC 488 (G) in Pisces.
3rd	3 AM	Saturn stationary.
3rd	7 AM	Mars 1.7° North of Spica.
3rd	4:14 PM	New Moon.
4th	8 AM	Mercury greatest elongation East (27°).
6th	3 AM	Mercury 1.0° South of the Moon; Occn.
6th		Mercury at aphelion.
6th	5 PM	Venus 1.6° North of the Moon.
6th	10 PM	Moon at apogee.
9th	10 PM	Jupiter at opposition.
9th	11 PM	Mars 4° South of the Moon.
11th	8:42 PM	First quarter Moon.
14th		m.p. 532 Herculina 0.5° NW of Sigma Sagittarii.
16th		m.p. 6 Hebe 0.3° SW of M49 (G) in Virgo.
16th	1 PM	Pluto stationary.
16th	Midnight	Neptune 4° South of the Moon.
17th		Comet 2P/Encke 1° East of NGC 6441 (GC) in Scorpius.
17th	11 AM	Mercury stationary.
17th	1 PM	Uranus 4° South of the Moon.
18th	6 AM	Jupiter 4° South of the Moon.
18th	6:55 PM	Full Moon.
19th		m.p. 6 Hebe 0.4° SW of NGC 4526 (G) in Virgo.
19th	1 PM	Moon at perigee.
20th		Comet C/1995 O1 (Hale-Bopp) 0.8° NE of NGC 2421 (OC) in Puppis.
21st		m.p. 15 Eunomia 0.1° South of NGC 6293 (GC) in Ophiuchus.
22nd	10 AM	Saturn 0.008° North of the Moon; Occn.
24th		Comet 2P/Encke 0.5° SE of M7 (OC) in Scorpius.
25th	10:23 AM	Last quarter Moon.
25th	5 PM	Venus 0.5° North of NGC 4546 (G) in Virgo.
26th	1 AM	Aldebaran 0.3° South of the Moon; Occn.
26th		Mercury at greatest latitude South (Heliocentric).
29th		Comet C/1995 O1 (Hale-Bopp) 0.7° NE of M93 (OC) in Puppis.
29th	5 PM	Venus 0.9° NE of NGC 4697 (G) in Virgo.
30th	11 AM	Ceres at opposition.
31st		Venus at descending node.
31st	10 PM	Mercury in inferior conjunction.

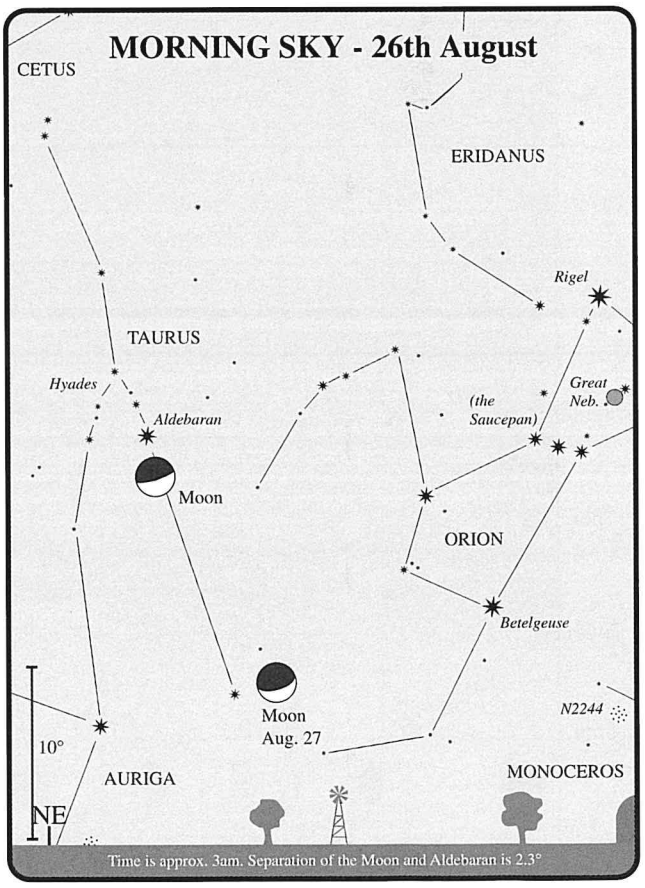





EVENING SKY - 9th August
CENTAURUS
Moon
Aug. 10
HYDRA
Mars
Spica
Moon
CORVUS
VIRGO
Moon
Aug. 8
CRATER
10°
W
LEO
Time is approx. 7pm. Separations are; Moon/ Mars = 5.3°, Mars/ Spica = 3.5°

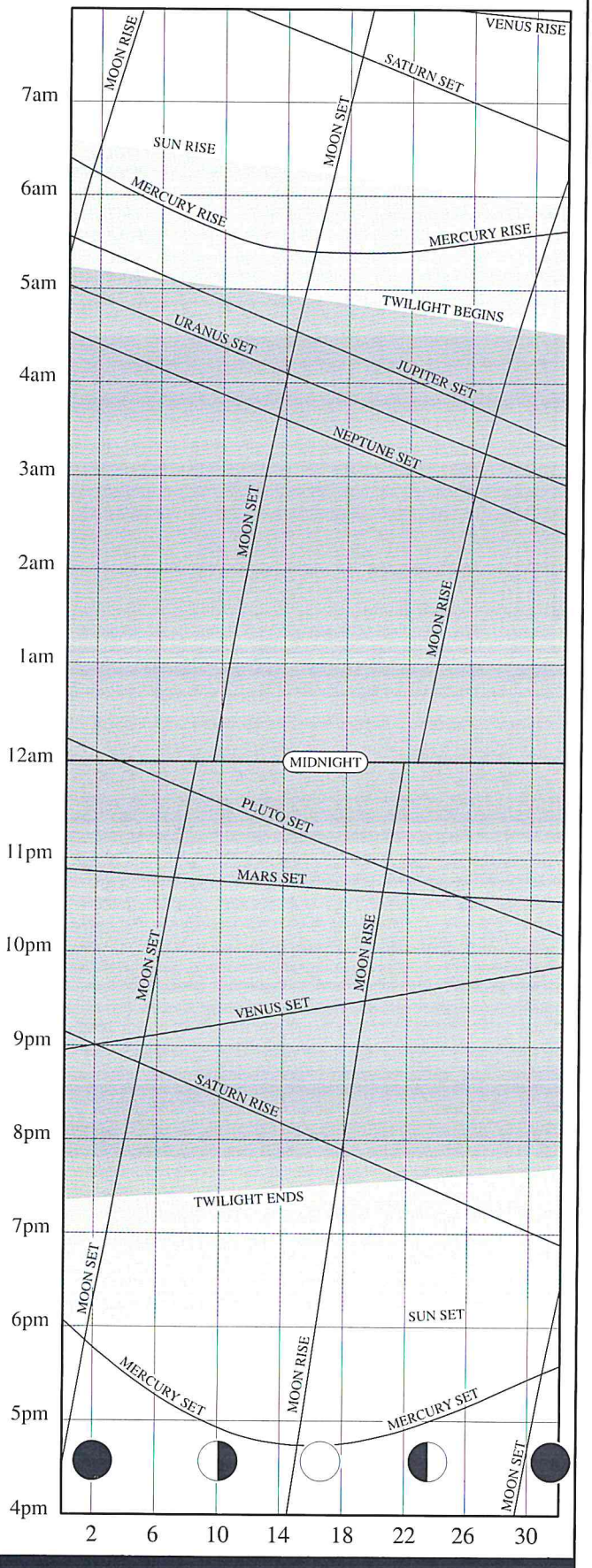

EVENING SKY - 21st August
Moon
CETUS
PEGASUS
Saturn
PISCES
Moon
Aug. 22
ANDROMEDA
TRIANGULUM
10°
ARIES
NE
Time is around midnight. Separation of the Moon and Saturn is 5.6°.


EVENING SKY - 17th August
MICROSCOPIUM
AQUILA
CAPRICORNUS
Moon
Jupiter
EQUULEUS
Moon
Aug 18
PEGASUS
10°
AQUARIUS
E
Time is around 7pm. Separation of Jupiter and the Moon is 6.4°


MORNING SKY - 26th August
CETUS
ERIDANUS
Rigel
TAURUS
Hyades
Great
Neb.
(the
Saucepan)
Aldebaran
Moon
ORION
Betelgeuse
N2244
Moon
Aug. 27
10°
AURIGA
MONOCEROS
NE
Time is approx. 3am. Separation of the Moon and Aldebaran is 2.3°

SEPTEMBER

RISE/SET CHART



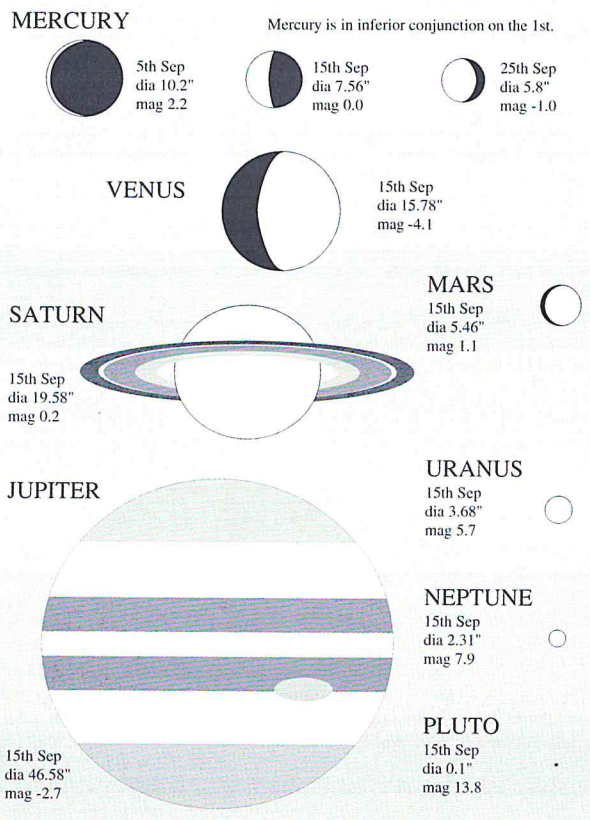
SEPTEMBER HIGHLIGHTS

- Partial Solar Eclipse on 2nd.
- Total Lunar Eclipse on the morning of 17th.
- Comet Hale-Bopp is in the eastern pre-dawn sky.
- Mercury returns to the morning sky, but is difficult to observe.
- Venus glows like a beacon in the early western evening sky.
- Mars is in the western evening sky, setting around 10.30pm.
- Jupiter is high in the northern sky in the early evening.
- Saturn rises in the early evening and is visible most of the night.

THE MOON

2nd	New Moon.
2nd	Partial Solar Eclipse. Visible from anywhere in Australia. Mid event occurs around 6.55am WAST in Perth (see eclipse section in part II for further information)
3rd	Moon at apogee (furthest from Earth - 406,479 km distant, angular size 29.4').
10th	First Quarter.
17th	Full Moon.
17th	Total Lunar Eclipse. Visible from anywhere in Australia. For WA, totality is reached at 2.46am. See the eclipse section in part II for further explanation (also the sky view).

APPEARANCE of the PLANETS



17th Moon at perigee (closest to Earth - 356,966 km distant, angular size 34.0').

18th Occultation of Saturn by the Moon. Not visible from Australia.

22nd Occultation of Aldebaran by the Moon. Not visible from Australia, a close approach of 3° is the best seen from W.A. (see sky view).

23rd Last Quarter.

30th Moon at apogee (furthest from Earth - 406,330 km distant, angular size 29.7').

THE PLANETS

MERCURY returns to the morning sky after inferior conjunction (between the Earth and the Sun) on the 1st. This "Messenger" planet reaches its greatest elongation west of the Sun (18°) on the 17th. This morning apparition of Mercury is poor and difficult to see, as it will be in twilight, rising just before the Sun. Occasionally during inferior conjunctions, Mercury will transit the Sun. These occurrences, when the tiny disc of Mercury is silhouetted against the solar surface, are rare and happen only about 13 times each century. The last transit was in 1993 and the next will be in 1999.

VENUS begins the month, in the western evening sky, 6.5° below the 1st magnitude star Spica (Alpha Virginis). On the 5th, Venus, Spica and the 3 day old thin crescent Moon appear in a line, Venus will be just over 2° from Spica and 4° from the Moon (see sky view). On the following evening Venus and Spica will be closer, ie. only 1.9°, with the Moon 9° from the pair. Venus travels from Virgo into Libra on the 19th. At this time, Spica, Venus and Mars form a vertical line above the early evening western horizon, each is separated by about 15°. By month's end, Venus and Mars will be 10° apart.

MARS, setting around 10.30pm, is situated in Libra, at the end of September it moves into Scorpius. On the 7th, the 5 day old Moon will be 6° from the red planet (see sky view for 5th). Mars moves into Scorpius at the end of the month. It will then be in the head of the Scorpion, near the 2nd magnitude stars Delta and Beta 1 Scorpii. This also places Mars 8° below its rival, the star Antares (see next month's description).

JUPITER, now past opposition, presents a 47 arc second diameter globe that is shinning at -2.7 magnitude. Jupiter is in an ideal position for observing this month. This gas giant's southerly declination (-18°) places it high in the sky as it transits the meridian around 9pm. On the 13th, the 11 day old Moon will be 9° from this "king of planets" and on the following evening 8° (see sky view for 14th).

SATURN rises in the eastern sky in the early evening, and transits the meridian about 1am. There is an occultation of Saturn by the Moon on the 18th, but this will only be visible from North and Central America. From Australia, we will see Saturn rising about 3° above the Moon on the 18th at 8pm (see sky view), the separation of the two bodies will then increase during the night. This is the 7th in a series of fourteen occultations between Saturn and the Moon that began in April and finishes in March next year; the next series begins in the year 2001.

MINOR PLANETS at opposition this month are 1 Ceres at mag. 7.7 in Aquarius and 40 Harmonia at mag. 9.3 in Aquarius.

COMETS

Hale-Bopp: Comet Hale-Bopp begins September in Puppis, rising around 2am at magnitude 5.0. It remains in Puppis throughout September. It will fade to magnitude 5.2 by month's end, when it is rising around 11.30pm, thus visible throughout the morning sky.

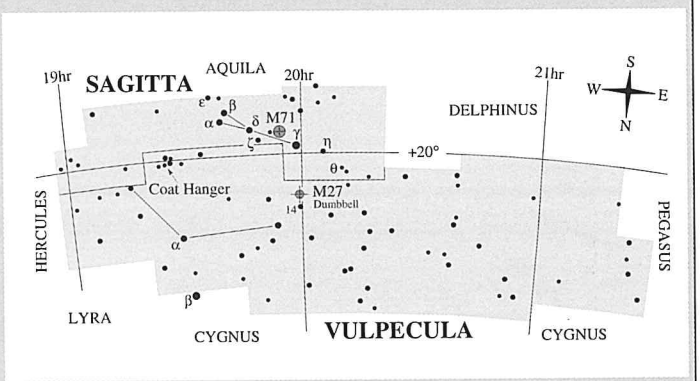
Hartley 2: This relatively new periodic comet should first become visible during September. At the beginning of the month, it is magnitude 13.5 in Serpens, setting around 2am. During the month, it should brighten to 12th magnitude, moving into Scutum and setting around midnight.

CONSTELLATIONS OF THE MONTH — SAGITTA (Sge) and VULPECULA (Vul)

Sagitta and Vulpecula are small neighbouring constellations in the northern sky above (south of) Cygnus. The Milky Way traverses both constellations, and although lacking in bright stars there are several interesting objects within the groups. Sagitta, the Arrow, is either the arrow that Hercules shot, or it may have belonged to the Centaur, Sagittarius. In different cultures it has had various names along a similar theme ie. the Pole, Obelisk, Spear, and the Nail (of the crucifixion). The more modern name, Vulpecula, the Fox, was introduced by Hevelius in the 17th century. Originally it was named 'The Little Fox with the Goose', but the goose has since been dropped and only the Fox remains.

Sagitta's main showpiece is the globular cluster known as M71 (NGC6838). Although in Messier's catalogue, it was discovered by his friend Pierre Mechain in 1780. This 8th magnitude globular, with its loose structured appearance, was originally thought to be an open star cluster. It is now realised that the interstellar gas in the area effectively blocks the light from the fainter members of the cluster. Several of Sagitta's double stars are worth looking for, particularly Zeta (yellow and red) and Theta (both yellow in a good field).

Vulpecula is the home to the first pulsar ever discovered. Known simply as PSR 1919+21, it was discovered by Jocelyn Bell in 1967. Within the constellation is an asterism of ten 6 to 8th magnitude stars, in the shape of a coat-hanger. In fact it is known as 'The Coat Hanger', or "Brocchi's Cluster' after the amateur who discovered it early this century. The Coat Hanger is just visible to the unaided eye as a small fuzzy patch, binoculars and small telescopes will instantly reveal its distinctive shape.

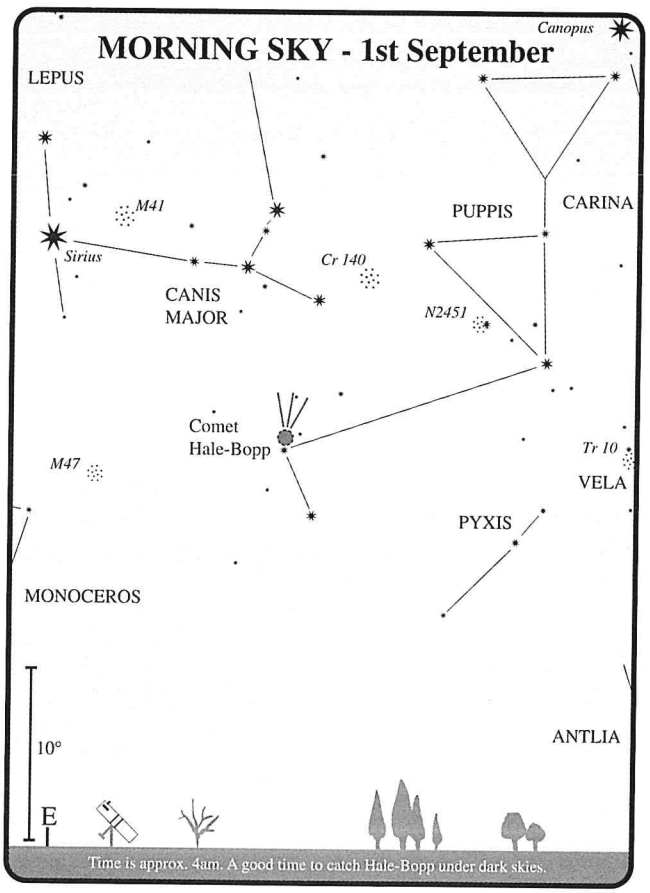


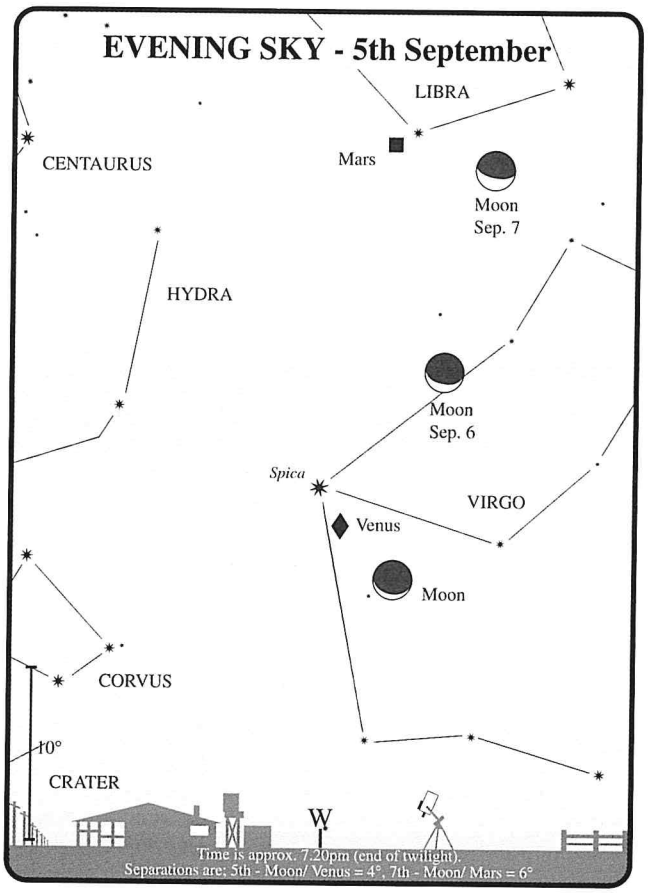
Vulpecula's showpiece is undoubtedly M27 (NGC6853) or the Dumbbell Nebula; a planetary well suited to both small and large apertures. M27 is below naked eye visibility but is easily found using binoculars. An easy way to locate the Dumbbell is to 'sweep' south 3 degrees from 3rd magnitude Gamma Sagittae. The nebula will look like a hazy star close to the 5th magnitude star 14 Vulpeculae. The hourglass or dumbbell shape is easily recognised in most small telescopes, using low to medium magnification. Vulpecula boasts about thirty planetary nebulae; aside from M27, all the others are faint and difficult.

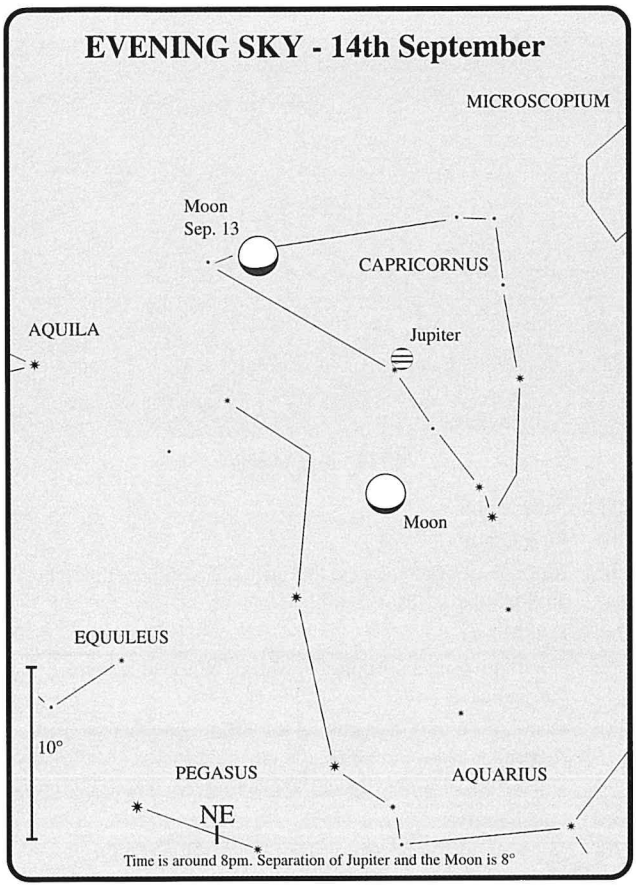
SEPTEMBER

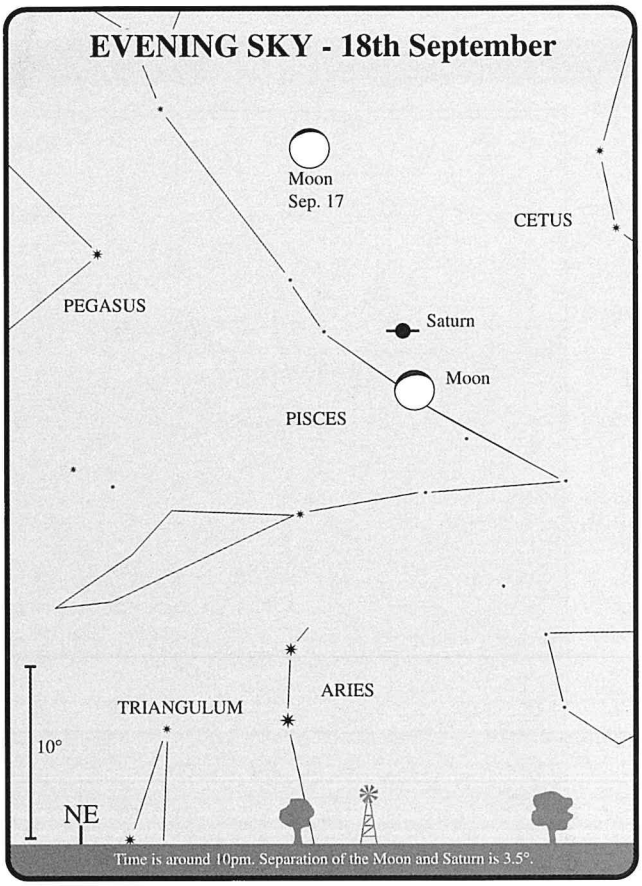
DIARY

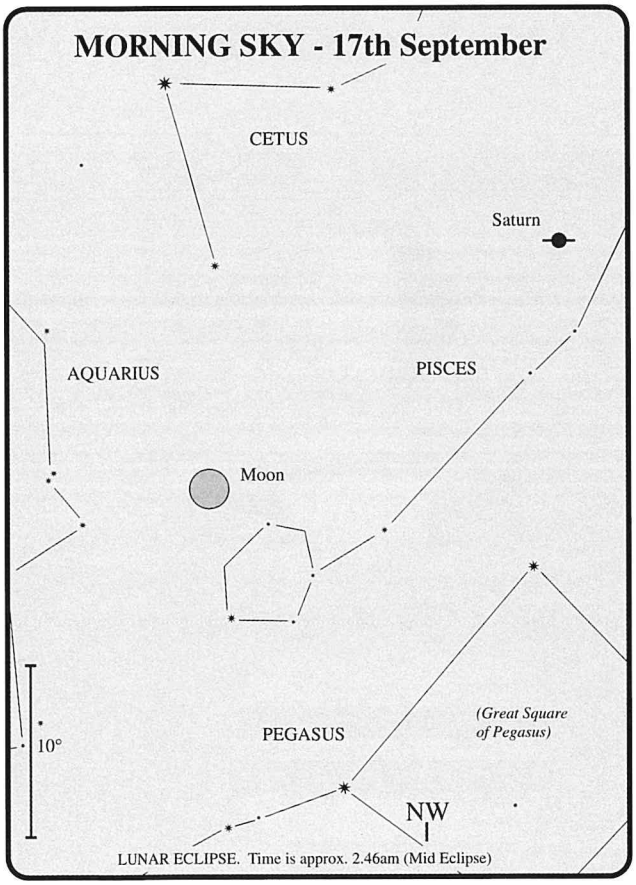
1st		m.p. 23 Thalia 0.5° SE of NGC 1647 (OC) in Taurus.
1st	3 PM	Vesta stationary.
2nd	7:52 AM	New Moon, partial eclipse of the Sun.
2nd	5 PM	Venus 0.5° North of NGC 4995 (G) in Virgo.
3rd	5 AM	Moon at apogee.
4th		Comet C/1995 O1 (Hale-Bopp) 0.2° North of NGC 2467 (OC) in Puppis.
5th	8 PM	Venus 3° South of the Moon.
6th	1 PM	Venus 1.9° North of Spica.
7th	5 PM	Mars 5° South of the Moon.
8th	9 AM	Pallas stationary.
9th	2 PM	Mercury stationary.
10th	9:31 AM	First quarter Moon.
12th		m.p. 14 Irene 1° North of Delta Sagittarii.
13th		Comet C/1995 O1 (Hale-Bopp) 0.6° East of NGC 2489 (OC) in Puppis.
13th	9 AM	Neptune 4° South of the Moon.
13th	10 PM	Uranus 4° South of the Moon.
14th		Mercury at ascending node.
14th	Noon	Jupiter 4° South of the Moon.
16th	11 PM	Moon at perigee.
17th	2:50 AM	Full Moon, total eclipse of the Moon.
17th	6 AM	Mercury greatest elongation West (18°).
18th	6 PM	Saturn 0.2° South of the Moon; Occn.
19th		Mercury at perihelion.
19th	6 PM	Venus 1° North of m.p. 7 Iris.
22nd	8 AM	Aldebaran 0.3° South of the Moon; Occn.
23rd	8 AM	Equinox.
23rd	9:35 PM	Last quarter Moon.
24th		m.p. 8 Flora 0.8° SE of NGC 157 (G) in Cetus.
24th		m.p. 27 Euterpe 0.1° West of the Crab Neb. (M1) in Taurus.
29th		Mercury at greatest latitude North (Heliocentric).
30th	7 AM	Moon at apogee.

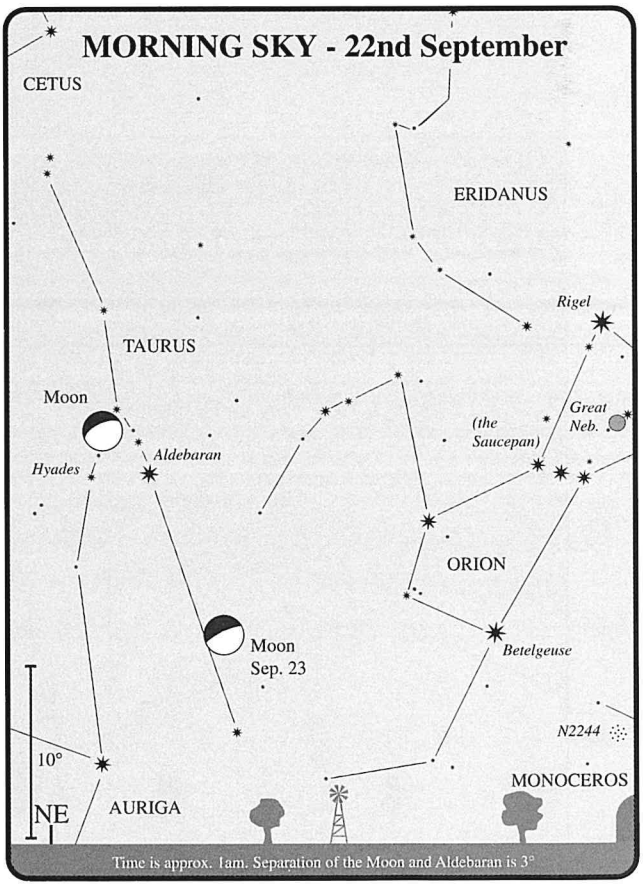





EVENING SKY - 14th September
MICROSCOPIUM
Moon
Sep. 13
CAPRICORNUS
AQUILA
Jupiter
Moon
EQUULEUS
10°
PEGASUS
AQUARIUS
NE
Time is around 8pm. Separation of Jupiter and the Moon is 8°

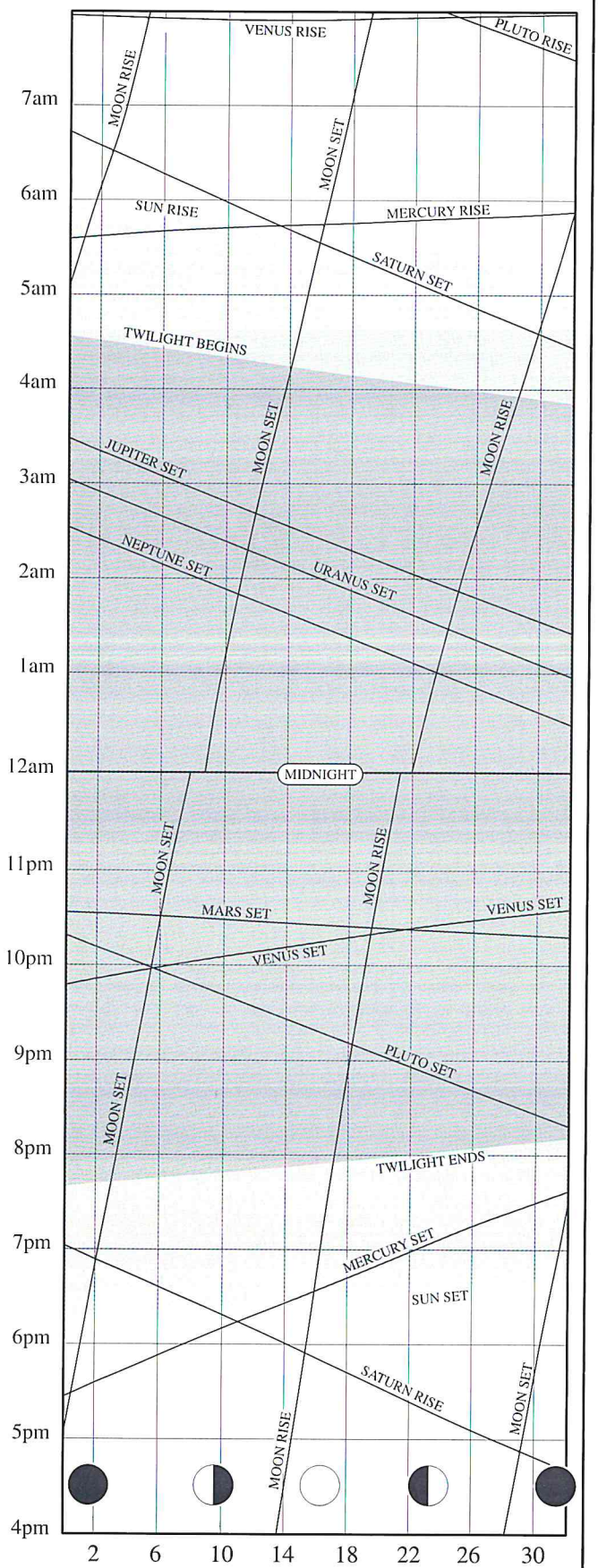

EVENING SKY - 18th September
Moon
Sep. 17
CETUS
PEGASUS
Saturn
Moon
PISCES
ARIES
TRIANGULUM
10°
NE
Time is around 10pm. Separation of the Moon and Saturn is 3.5°.


MORNING SKY - 17th September
CETUS
Saturn
AQUARIUS
PISCES
Moon
10°
PEGASUS
(Great Square
of Pegasus)
NW
LUNAR ECLIPSE. Time is approx. 2.46am (Mid Eclipse)


MORNING SKY - 22nd September
CETUS
ERIDANUS
Rigel
TAURUS
Moon
Great
Neb.
(the
Saucepan)
Hyades
Aldebaran
ORION
Moon
Sep. 23
Betelgeuse
N2244
10°
MONOCEROS
NE
AURIGA
Time is approx. 1am. Separation of the Moon and Aldebaran is 3°

OCTOBER

RISE/SET CHART



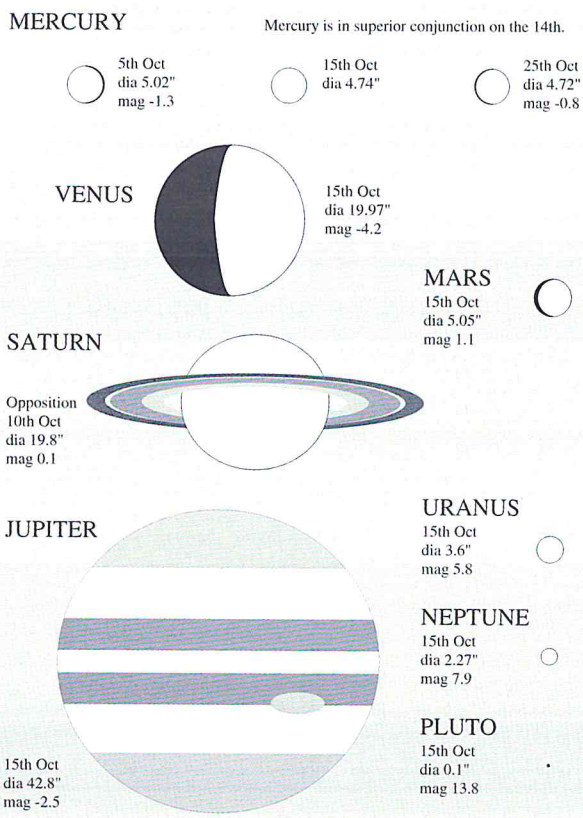
OCTOBER HIGHLIGHTS

- Comet Hale-Bopp moves into the evening sky, rising around 10pm by mid month.
- Mercury moves into the evening sky, but is too close to the Sun to see during October.
- Venus continues to be a beacon in the early western evening sky.
- Mars, Venus and Antares are close together in the early western evening sky.
- Jupiter is high in the NW sky in the early evening.
- Saturn rises on sunset and is visible the whole night.

THE MOON

2nd	New Moon.
9th	First Quarter.
15th	Moon at perigee (closest to Earth - 358,860 km distant, angular size 32.8').
16th	Full Moon.
16th	Occultation of Saturn by the Moon. Not visible from Australia.
19th	Occultation of Aldebaran by the Moon. Not visible from Australia. From our skies, the closest approach is about 4° at the time of moonrise in the evening sky (see sky view).
23rd	Last Quarter.
27th	Moon at apogee (furthest from Earth - 405,603 km distant, angular size 29.1').
31st	New Moon.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is in superior conjunction with the Sun on the 14th (on the opposite side of the Sun to the Earth). At this time, the planet moves from the morning into the evening sky. However, during October it is totally lost in the glare of the Sun. Mercury will be in a better position to see in the evening sky in November and early December.

VENUS has a very busy month, interacting with a number of celestial objects in the western evening sky. On the 5th, the 3 day old thin crescent Moon will be 8° from Venus, and a triangle is formed with Mars, 8° from Venus (see sky view). The trio form another triangle on the following evening, this time the Moon is closer to Mars. On the 10th, Venus having just crossed from Libra into Scorpius, can be seen 0.5° from the 2nd magnitude star Delta Scorpii. Moving through Scorpius, Venus nears Antares (Alpha Scorpii). On the 15th, Venus, Mars and Antares are all within 4° of each other. On the 17th, Venus will be at its closest to Antares at 1.7° (see sky view). Antares may be the rival to Mars (see Mars section) but it is certainly no match for the nearby brilliant Venus. On the 19th, a line will be formed with Venus in the middle and Antares and Mars 3° away on either side. Venus moves into Ophiuchus in the last week of the month, and can be seen around 2° from Mars. Venus also comes into contact with several globular clusters when near Mars. On the 24th Venus will be 0.5° from M19 (NGC6273), 0.4° from NGC6293 on the 25th, and 0.2° from NGC6355 on the 28th.

MARS moves from the head of the Scorpion (less than 1° from 2nd magnitude Delta Scorpii) towards its heart (Antares) early in the month. 1st magnitude Antares (Alpha Scorpii) was known by the Arabs as the 'heart of the scorpion'. Referring to its red colour, the Greek's thought that 'rival to Mars' was more fitting. This is especially the case when Mars and Antares are close in the sky. Mars comes within 3° of Antares on the 12th, an interesting sight with the colour and brightness of both very similar. On the 6th, the 4 day old crescent Moon will be 6.5° from Mars with Venus lower in the sky completing a triangle (see sky view for 5th). On the 15th, Mars, Venus and Antares are all within 4° of each other. Like Venus, Mars also has its share of encounters with globular star clusters. On the 7th and 8th, Mars will be 0.7° from M80 in Scorpius. On the 23rd, 0.9° from NGC6284 and on the 27th, 0.5° from NGC6325. Both of these clusters are in Ophiuchus.

JUPITER transits the meridian at 7pm mid month, so observations should commence as early as possible, before the planet gets too low in the west. Jupiter still presents an equatorial disc diameter of over 40 arc seconds; by December this will shrink down to 35 arc seconds. On the 11th, the 9 day old Moon will be 4.5° from Jupiter (see sky view). In retrograde motion since early June, Jupiter appears stationary on the 8th, and thereafter returns to its west-to-east path across the sky. See the discussion on retrograde motion and the Jupiter finder chart in part II.

SATURN is at opposition on the 10th, rising in the east as the Sun sets, it is visible all night. Not only is the planet at its brightest (0.1 magnitude), but it presents its largest equatorial diameter; 20 arc seconds, compared with 16 arc seconds at conjunction. This is an ideal time to observe the planet. Saturn is occulted by the Moon on the 16th, but the event is not visible from Australia. The closest that we see the two bodies are on the night of the 15th. In the early evening, the Full Moon is 3° above Saturn (see sky view). Throughout the night, the distance between them decreases. Closest approach is about 1° at 2am. This is the 8th in a series of fourteen occultations between Saturn and the Moon that began in April and finishes in March next year; the next series begins in the year 2001.

URANUS has been in retrograde motion since May. The planet appears stationary on the 15th and then returns to its normal west-to-east path across the sky.

NEPTUNE has been in retrograde motion since early August. It appears stationary on the 9th, thereafter returning to its eastern path across the sky.

MINOR PLANETS at opposition this month are 8 Flora at mag. 8.1 in Cetus and 4 Vesta at mag. 6.4 in Cetus.

COMETS

Hale-Bopp: Hopefully still visible to the naked-eye, Hale-Bopp begins October in Puppis at 5th magnitude, rising around 11.30pm. Moving into Vela, by the end of the month, it should have only faded to around magnitude 5.5. By now it is rising around 8pm, visible most of the night.

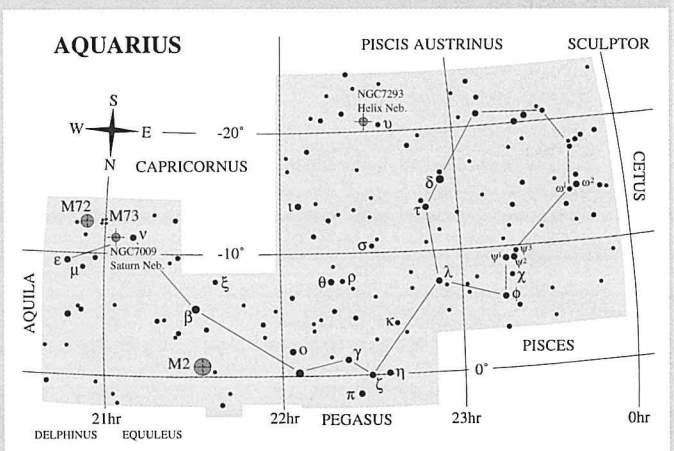
Hartley 2: An evening comet only, Hartley 2 begins the month at 12th magnitude in Scutum, setting around midnight. On 8th October, it is 1.2 degrees north of M11. By the end of October, in Aquila, it should have brightened to magnitude 10.5, setting around 11pm.

CONSTELLATION OF THE MONTH — AQUARIUS (Aqr)

Aquarius, the Water Carrier (or Water Bearer), is one of the constellations of the Zodiac. This area of sky includes a number of other constellations associated with water, Capricornus (the Sea Goat), Cetus (the Whale), Pisces (the Fishes) and Delphinus (the Dolphin). Aquarius covers a large portion of the sky (980 square degrees in area) and is the 10th largest constellation. However, it only has three stars as bright as 3rd magnitude, so it isn't very conspicuous. The figure of a man pouring water from a bucket or urn is not easy to imagine. However, the 2° diameter 'water jar', made up from the stars Zeta, Pi, Eta and Gamma, is not hard to find. It makes a great starting point to 'star hop' to other parts of the constellation. In 1846, Neptune was discovered in Aquarius by the German astronomer Galle, from positions predicted by Leverier. Interestingly, Neptune was originally observed by Galileo while observing Jupiter. He even made a comment that the 'star' had moved over the several nights of observation, but did not take the matter any further.

Messier catalogued three objects in Aquarius. The beautiful globular M2 (NGC7089) lies in a sparse field, and at 6th magnitude may be glimpsed with the unaided eye under dark sky. Medium sized telescopes show a compressed centre with outlying rays of stars. Not as impressive as M2 is Messier's other Globular in Aquarius, M72 (NGC6981). It appears loose in comparison to M2 and is much fainter and smaller. It also does resolve easily into stars. The third object Messier listed in Aquarius is something of a mystery. Apparently Messier included this 'object' in his catalogue because he thought it resembled a nebula. Known as M73 (NGC6994), it really consists of four insignificant and unrelated 10th magnitude stars in a uninteresting field.

Within the borders of Aquarius, are two of the best known and interesting planetary nebulae, the Saturn (NGC7009) and the Helix (NGC7293). The Saturn Nebula has filaments that project from each side, resembling a ringed planet. At 8th magnitude, the blue-green planetary appears stellar in small telescopes. High magnification will show the 25 arc second disc to be slightly oval. A dark sky and a large telescope, with a nebula filter, is recommended to glimpse the filaments. The Helix Nebula is the largest, and possibly the nearest of the planetaries. The total integrated magnitude of 6.5 is deceiving; due to its large quarter degree size its surface brightness is very low. Binoculars giving 10x to 20x magnification, under a dark sky, will easily show the Helix as a large circular hazy patch. A small telescope at low power is suitable, the use of a nebula filter will enhance the image.



The 'Age of Aquarius', popular with astrologers and 'new age' enthusiasts, is still a long way off. This 'Age' occurs around the year 2600, when the first point of Aries moves from its present position, in Pisces, into Aquarius. The movement is caused by the gyratory motion of the Earth's axis and is known as 'precession of the equinoxes'.

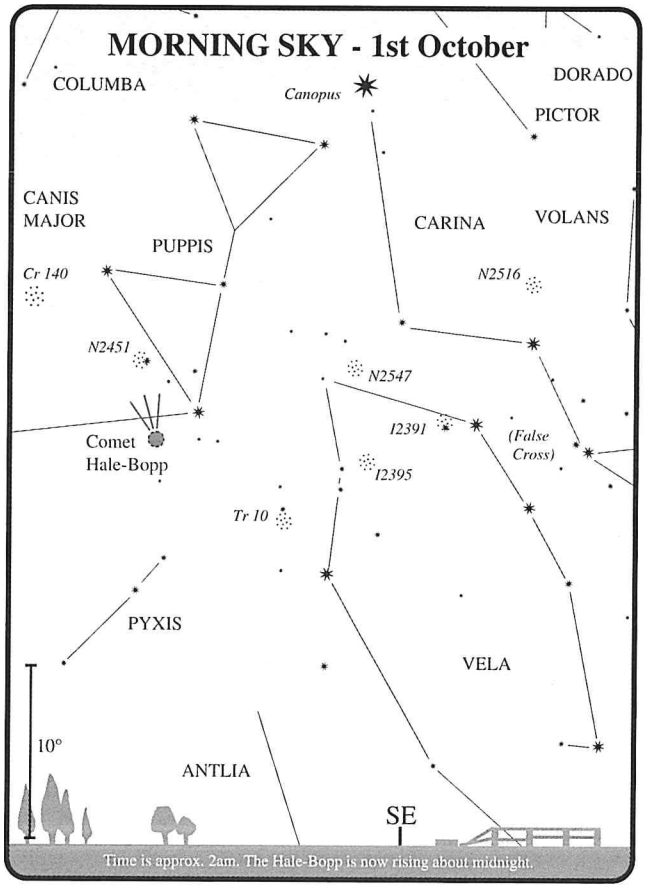
OCTOBER

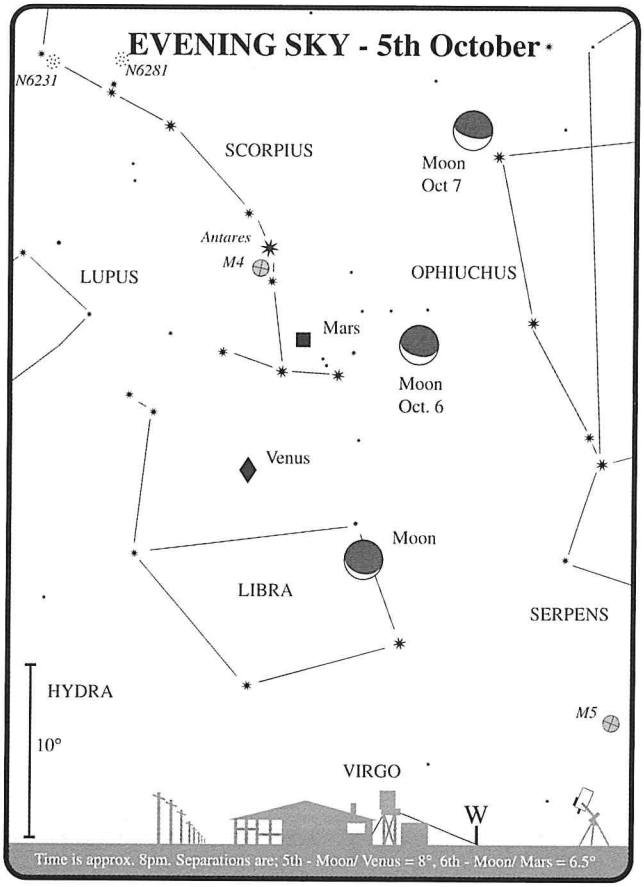
METEOR SHOWERS

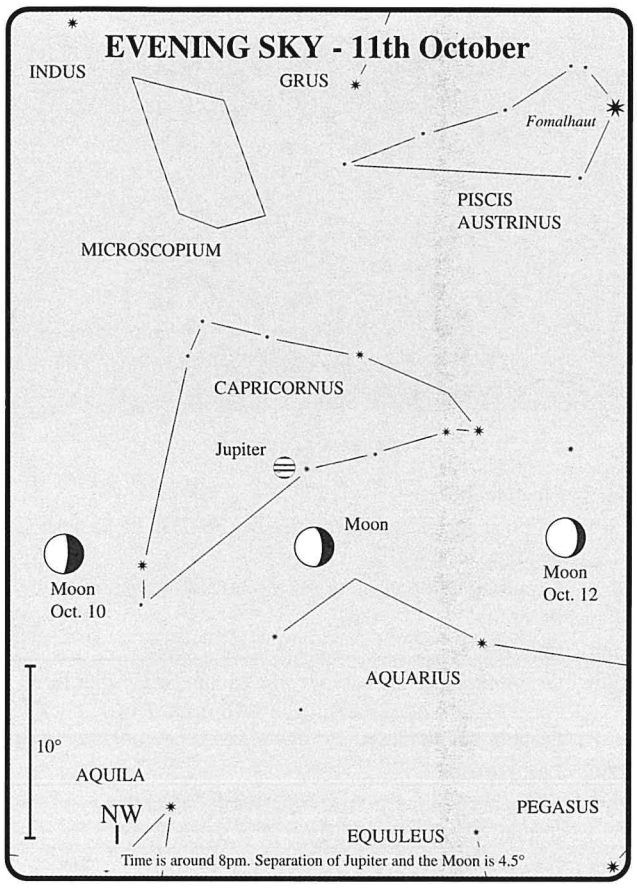
The **Taurids** (North and South) are associated with the short period comet Encke, and can be seen from around midnight to dawn. The shower has a double radiant ie. North and South. They are visible from 1st October through to 25th November. The Taurids do not have a well-defined sharp peak in activity, but rather plateau for about ten days in early November. Maxima occurs on the 5th November for the Taurids South (ZHR of 5) and on the 12th November for the Taurids North (ZHR of 5). Both maxima last for about a week and provide nearly constant ZHRs. The Taurids are frequently bright, slow moving, and noted for producing colourful fireballs. The International Meteor Organisation recommends the Taurids to newcomers. This allows them to practice their visual meteor plotting techniques, because of their slow speed and steady activity. Their brightness also makes them an ideal target for astrophotography.

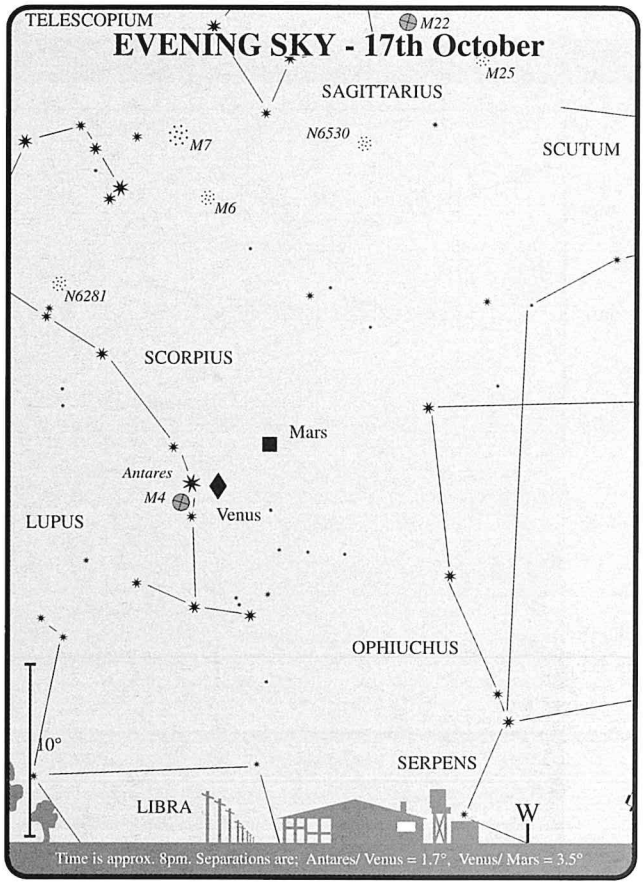
DIARY

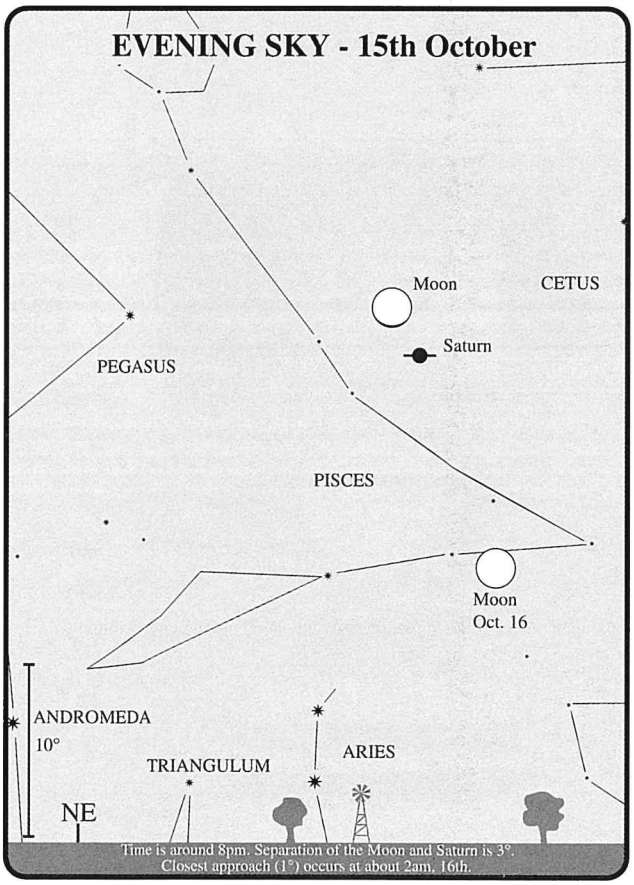
1st		Comet C/1995 O1 (Hale-Bopp) 0.9° West of NGC 2546 (OC) in Puppis.
1st	6 PM	Venus 0.8° North of NGC 5897 (GC) in Libra.
2nd	12:51 AM	New Moon.
2nd		Mars 0.9° North of Delta Scorpii.
5th		Venus at aphelion.
5th		m.p. 532 Herculina 0.1° South of Tau Sagittarii.
5th	9 PM	Venus 7° South of the Moon.
6th	2 PM	Mars 6° South of the Moon.
8th		Mars 0.7° NE of M80 (GC) in Scorpius.
8th		Comet 103P/Hartley 1.2° North of M11 (OC) in Scutum.
8th	3 PM	Jupiter stationary.
9th	6 AM	Neptune stationary.
9th	8:22 PM	First quarter Moon.
10th	Noon	Saturn at opposition.
10th	5 PM	Neptune 4° South of the Moon.
10th	6 PM	Venus 0.5° SW of Delta Scorpii.
11th	6 AM	Uranus 4° South of the Moon.
11th	7 PM	Jupiter 4° South of the Moon.
12th	6 AM	Mars 3° North of Antares.
14th	5 AM	Mercury in superior conjunction.
14th	10 PM	Uranus stationary.
15th	10 AM	Moon at perigee.
16th	2 AM	Saturn 0.4° South of the Moon; Occn.
16th	11:46 AM	Full Moon.
17th	6 AM	Venus 1°7 North of Antares.
17th	1 PM	Vesta at opposition.
19th	5 PM	Aldebaran 0.3° South of the Moon; Occn.
22nd		Mercury at descending node.
23rd		Mars 0.9° North of NGC 6284 (GC) in Ophiuchus.
23rd	12:48 PM	Last quarter Moon.
24th	6 PM	Venus 0.5° NE of M19 (GC) in Ophiuchus.
25th	5 AM	Ceres stationary.
25th	6 PM	Venus 0.4° North of NGC 6293 (GC) in Ophiuchus.
26th		m.p. 23 Thalia 0.5° NW of the Crab Neb. (M1) in Taurus.
27th	7 AM	Venus 2° South of Mars.
27th		Venus at greatest latitude South (Heliocentric).
27th		Mars 0.5° South of NGC 6325 (GC) in Ophiuchus.
27th	5 PM	Moon at apogee.
28th		Comet C/1995 O1 (Hale-Bopp) 0.6° NW of NGC 2547 (OC) in Puppis.
28th	6 PM	Venus 0.2° South of NGC 6355 (GC) in Ophiuchus.
31st	6:01 PM	New Moon.

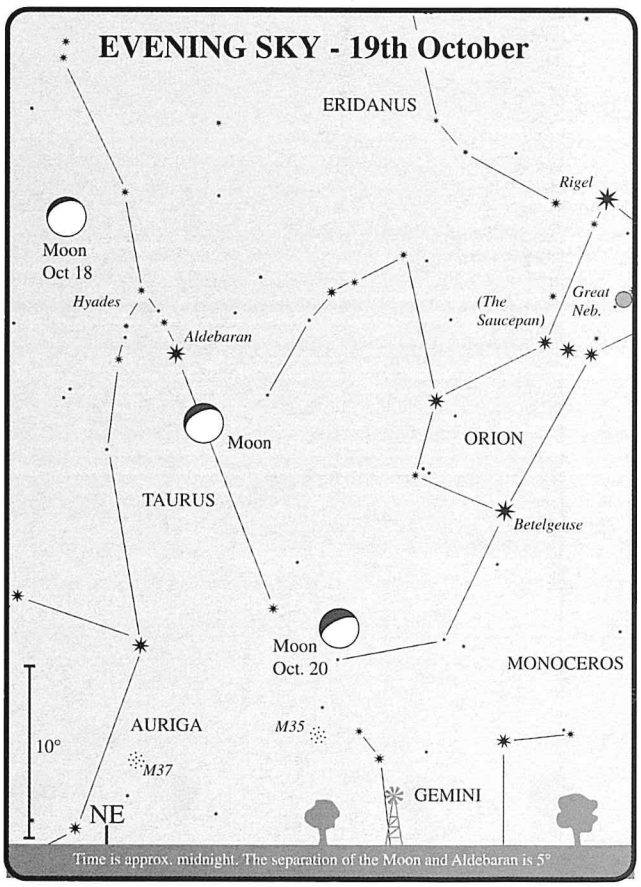





EVENING SKY - 11th October
INDUS
GRUS
Fomalhaut
PISCIS AUSTRINUS
MICROSCOPIUM
CAPRICORNUS
Jupiter
Moon
Moon Oct. 10
Moon Oct. 12
AQUARIUS
10°
AQUILA
NW
PEGASUS
EQUULEUS
Time is around 8pm. Separation of Jupiter and the Moon is 4.5°

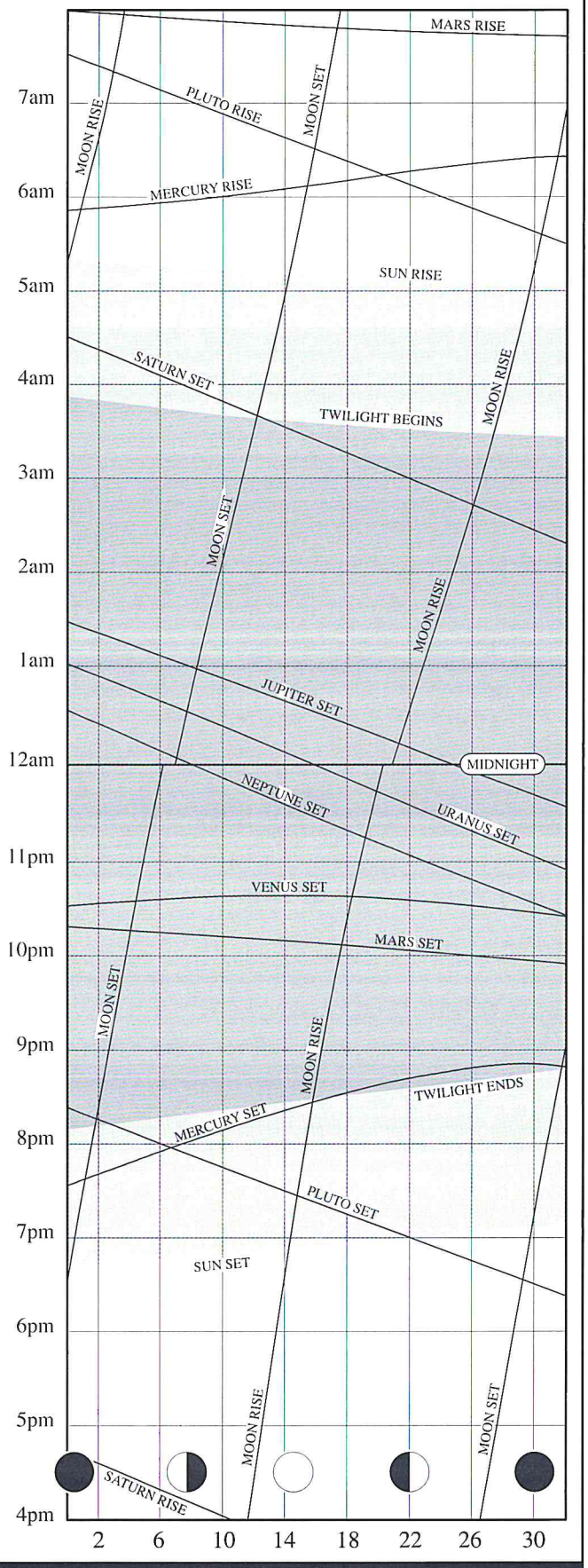

TELESCOPIUM
M22
EVENING SKY - 17th October
M25
SAGITTARIUS
M7
N6530
SCUTUM
M6
N6281
SCORPIUS
Mars
Antares
M4
Venus
LUPUS
OPHIUCHUS
10°
SERPENS
LIBRA
W
Time is approx. 8pm. Separations are; Antares/ Venus = 1.7°, Venus/ Mars = 3.5°


EVENING SKY - 15th October
Moon
CETUS
Saturn
PEGASUS
PISCES
Moon Oct. 16
ANDROMEDA
10°
TRIANGULUM
ARIES
NE
Time is around 8pm. Separation of the Moon and Saturn is 3°.
Closest approach (1°) occurs at about 2am, 16th.


EVENING SKY - 19th October
ERIDANUS
Rigel
Moon Oct 18
Hyades
(The Saucepan)
Great Neb.
Aldebaran
Moon
ORION
TAURUS
Betelgeuse
Moon Oct. 20
MONOCEROS
AURIGA
M35
10°
M37
GEMINI
NE
Time is approx. midnight. The separation of the Moon and Aldebaran is 5°

NOVEMBER

RISE/SET CHART



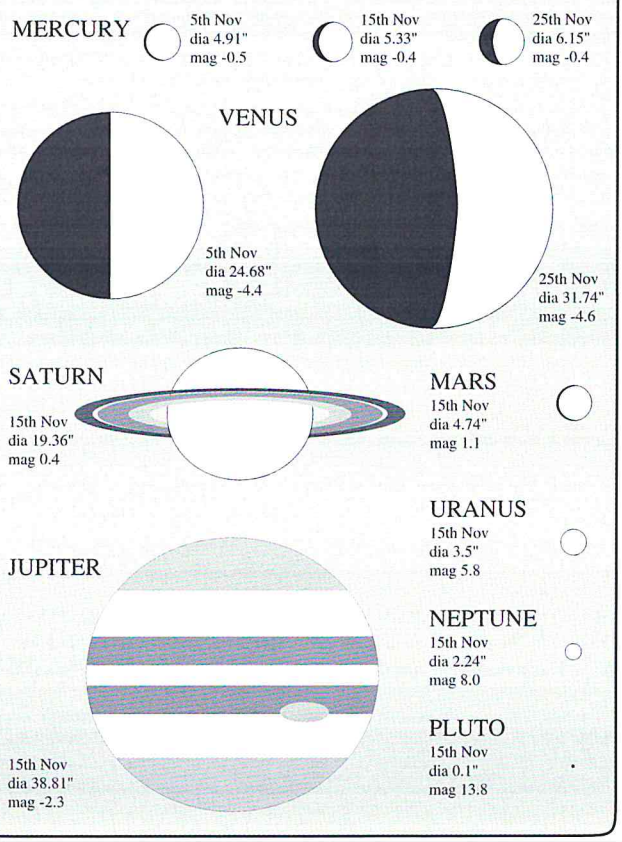
NOVEMBER HIGHLIGHTS

- Mercury, in the evening sky, is best observed in the later half of the month.
- Venus is still prominent in the early western evening sky.
- Mars is in the western evening sky within a few degrees from Venus.
- Jupiter is located high in the western sky at the end of twilight.
- Saturn is visible most of the night, setting around dawn.

THE MOON

8th	First Quarter.
12th	Moon at perigee (closest to Earth - 363,380 km distant, angular size 33.1').
12th	Occultation of Saturn by the Moon. Not visible from Australia.
15th	Full Moon.
16th	Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach seen from "down under" is about 1.3° at dawn.
22nd	Last Quarter.
24th	Moon at apogee (furthest from Earth - 404,695 km distant, angular size 29.7').
30th	New Moon.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is in the evening sky, reaching its greatest elongation east of the Sun (22°) on the 29th. Early in the month is not a good time to locate the planet, for it is near the western horizon during twilight. On the 9th, Mercury, having just crossed from Libra into Scorpius, can be seen very close (0.2°) to the 2nd magnitude star Delta Scorpii. On the 14th, Mercury moves into Ophiuchus and will be 2.5° from 1st magnitude Antares (Alpha Scorpii). The path of Mercury follows closely in the footsteps of Venus and Mars over the past few months, especially the near approaches to Delta and Alpha Scorpii. Mercury finally ends up in Sagittarius at the end of the month, together with Venus, Mars and Neptune.

VENUS, in the western evening sky, reaches its greatest elongation east of the Sun (47°) on the 6th. With the planet being a -4.5 magnitude beacon, it is bright enough to cast a perceptible shadow. You can see your own shadow cast by Venus. However, you will need to be under dark country skies and away from any stray light. Venus and Mars keep each other company for the next two months, never more than about 7° apart. Venus begins the month in Ophiuchus, 3° above Mars in the evening sky. On the 2nd, Venus moves into Sagittarius, where it remains for the rest of the month. On the 4th, the 4 day old crescent Moon will be 10° from Venus with Mars closer (see sky view on 2nd). On the 18th, Venus will be very close to the 2nd magnitude star Nunki (Sigma Sagittarii), one of the 'Teapot' stars (see sky view).

MARS, in the early western evening sky, follows Venus from Ophiuchus into Sagittarius early in the month. The red planet is now about 4 arc seconds in diameter, a stark contrast to its opposition diameter of 14 arc seconds in March this year. On the 4th, the 4 day old crescent Moon will be 7° from Mars (see sky view on 2nd). Mars again encounters several globular star clusters this month, all of them in Sagittarius. On the 11th the planet will be 0.3° from NGC6544. On the 16th, it will be 0.3° from a little gem of a globular known as M28 and on 20th, 0.6° from the stunning M22.

JUPITER can be seen high in the north western evening sky, as the sky begins to darken. On the 7th, the 7 day old moon will be 6° below Jupiter and on the following evening 10° away (see sky view). It is always interesting when a star is in the plane of Jupiter's moons. On the 12th and 13th, a star of 6th magnitude (designated as HR8083) can be seen as a fifth moon. Being a similar brightness to the Galilean moons, it will be difficult to pick.

SATURN, now one month past opposition, is high in the northern sky around 9pm. On the 11th, the 11 day old moon is 8° from Saturn, and on the following evening a similar distance at 7.7° (see sky view). This close approach on the 12th will be seen as an occultation in some parts of the northern hemisphere. This is the 9th in a series of fourteen occultations between Saturn and the Moon. These began in April and finish in March next year; the next series begins in the year 2001.

PLUTO is in conjunction with the Sun on the 28th, and will not be observable until it returns to the morning sky next year.

MINOR PLANETS at opposition this month are 68 Leto at mag. 9.6 in Aries, 11 Parthenope at mag. 9.5 in Cetus, 9 Metis at mag. 8.4 in Taurus and 37 Fides at mag. 9.6 in Aries.

COMETS

Hale-Bopp: Beginning the month in Vela at magnitude 5.6, Hale-Bopp is rising around 8pm and is visible for the rest of the night. During November, it moves into Carina, fading to 6th magnitude, but being visible all night.

Hartley 2: November sees Hartley 2 initially at magnitude 10.5 in Aquila, setting around 11pm. During the month, it moves into Aquarius, finishing November at 9th magnitude and setting around 11pm. Not far from Hartley 2 at this time is Jupiter.

CONSTELLATION OF THE MONTH — PISCES (Psc)

Pisces, the Fishes, is an ancient zodiacal constellation that was known as a fish or fishes in several different cultures. It is another of the constellations that are associated with water in this region of the sky. The others are, Capricornus (the Sea Goat), Cetus (the Whale) and Piscis Australis (the Southern Fish). To escape the monster Typhon, Aphrodite and her son Eros (known as Venus and Cupid in Roman mythology) jumped into the Euphrates river, where they transformed themselves in fishes. The two fish are depicted in drawings tied together by the their tails; the knot being the star Al Rischa (Alpha Piscium). This is an appropriate name, for in Arabic it means 'the cord'.

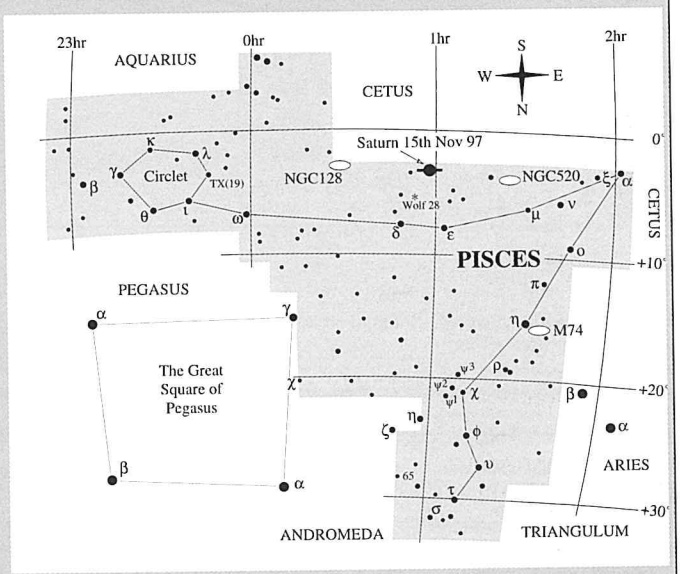
Being located high in the northern sky this month (around 9pm), Pisces is a large constellation that is not easily to see because there are no bright stars. However, identifying the faint members of the group by 'star hopping' from nearby familiar stars is relatively easy. Directly above the Great Square of Pegasus is the pattern known as the Circlet. This is an elliptical group (about 7° by 5° in size) of 4th magnitude stars representing the western fish. From the Circlet, the cord or rope can be traced eastward to Alpha Piscium. It then heads north, down to the right hand side of the Great Square to the other fish.

Apart from a number of galaxies, Pisces has no other deep sky objects. The brightest of the galaxies was discovered by Mechain in 1780 and appears on Messier's list as M74 (NGC628). M74 is a "face on" spiral galaxy about 8 minutes of arc in diameter. Like most galaxies of this type, the outer regions are quite faint, having a very low surface brightness. Most small telescopes will show the central condensation well but large instruments are required to glimpse the spiral arms. Other galaxies in Pisces are no better than M74, unless a large telescope is available. They may be faint, but a few are interesting because of their peculiar nature. NGC128 has a rectangular nucleus and NGC520 appears to be two galaxies in collision.

The best objects to observe in Pisces, particularly if you are city bound and using a small telescope, are the many easy double star systems. Some of the best are:

* 65 Piscium, a fine pair of equal 6th magnitude yellow suns separated by 4.5 arc seconds

* Zeta Piscium is a good wide pair separated by 23 arc seconds, at 5th and 6th magnitude and yellow and white in colour



* Alpha Piscium, a test for small apertures, is a close pair of 4th and 5th magnitude stars less than 2 arc seconds apart.

Pisces contains two unusual stars. One is a naked eye variable and the other, a faint white dwarf. The variable is known as TX Piscium (or 19 Pisium), and it is the easternmost star in the Circlet of Pisces. With a spectral class of "N0", TX is a deep red colour and is one of a few stars, in this class, bright enough to see with the unaided eye. Varying irregularly from 5.5 down to 6th magnitude, the red colour is easily visible in binoculars. The white dwarf is Van Maanen's Star or Wolf 28, and like Barnard's Star in Ophiuchus, has a large proper motion. At a distance of only 14 light years, the star shines at a weak 14th magnitude. It is one of the smallest stars known and one of the few white dwarfs observable with amateur instruments. It has a mass similar to the Sun, but is only the size of the Earth! Its density is about one million times that of water.

NOVEMBER

METEOR SHOWERS

The **Taurids** (North and South) are associated with the short period comet Encke, and can be seen from around midnight to dawn. The shower is composed of a main double radiant ie. North and South. They are visible from 1st October through to 25th November. The Taurids do not have a well-defined sharp peak in activity, but rather plateau for about ten days in early November. Maxima occurs on the 5th November for the Taurids South (ZHR of 5) and on the 12th November for the Taurids North (ZHR of 5). Both maxima last for about a week and provide nearly constant ZHRs. The Taurids are frequently bright, slow moving, and noted for producing colourful fireballs.

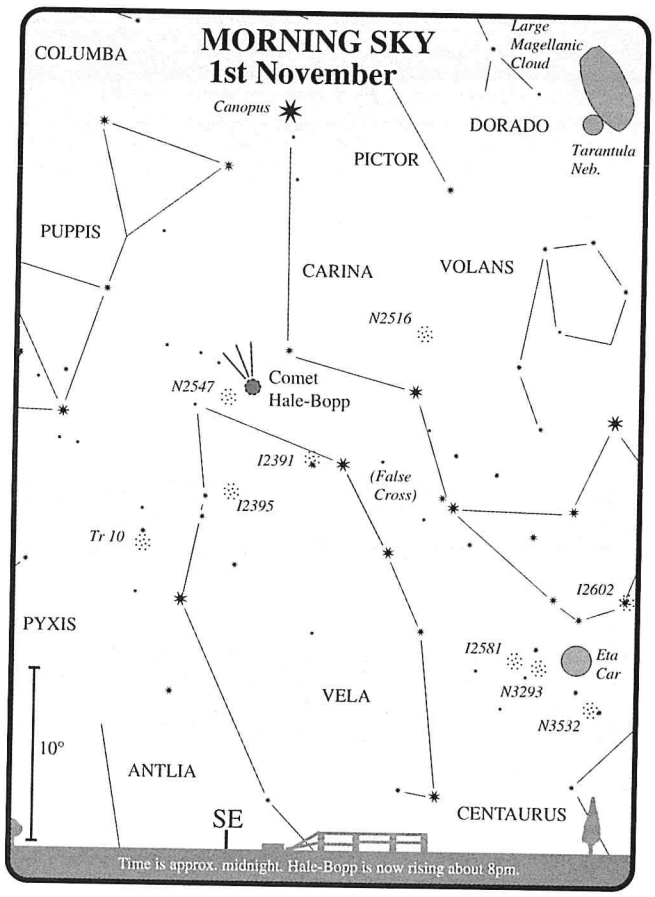
The **Chi-Orionids** are active from 26th November through to 15th December. Their peak is on December 2nd, with a low zenith hourly rate of 3. While generally a weak stream visually, a number of bright meteors have been recorded.

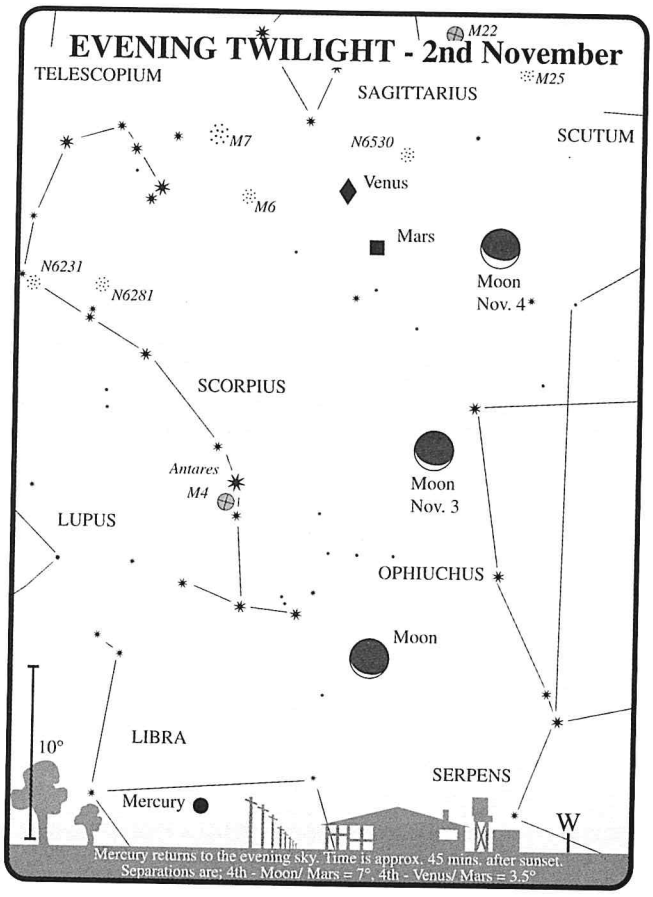
The **Leonids** are associated with comet Temple Tuttle and are best about every 33 years when the comet returns to the inner Solar System. Generally they provide showers of low to medium activity each year. The shower is active from 14th to 21st, peaking on the 17th. They are increasing in activity as the comet is due to return early 1998. Unfortunately this year the Moon will affect viewing.

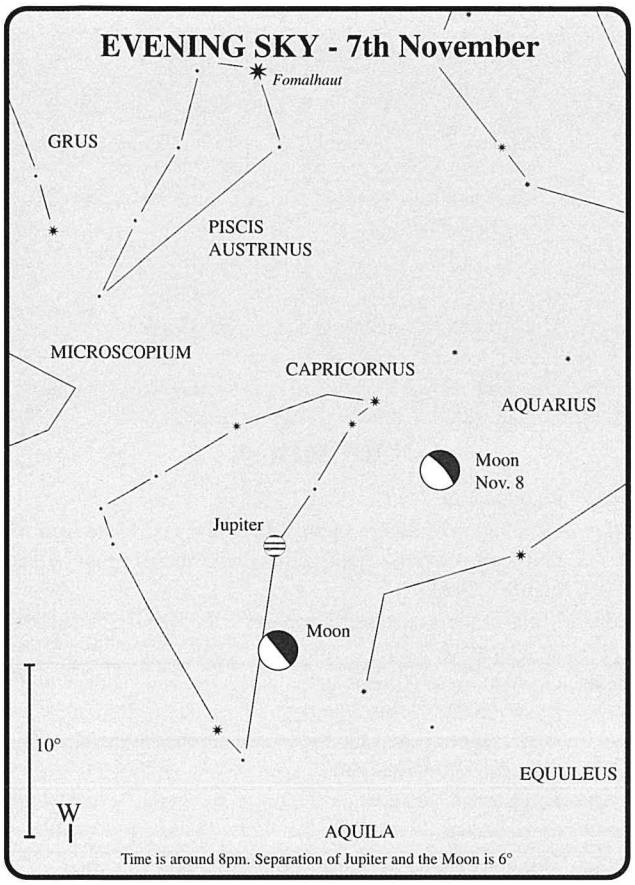
The **Phoenicids** are a southern shower that was discovered in 1956, when a zenith hourly rate of around 100 was observed. There have been three minor bursts in activity since 1956, but in recent years the shower seems nonexistent. There is a possibility that this may be a periodic shower, so observations should still be carried out in case of a return. The period of activity appears to be 28th November through 9th December, with 6th being the maximum.

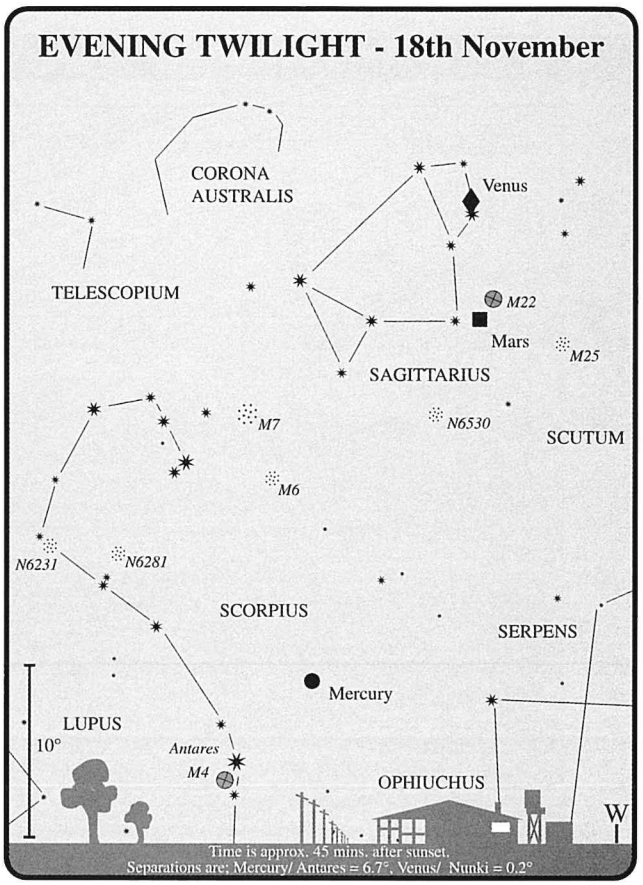
DIARY

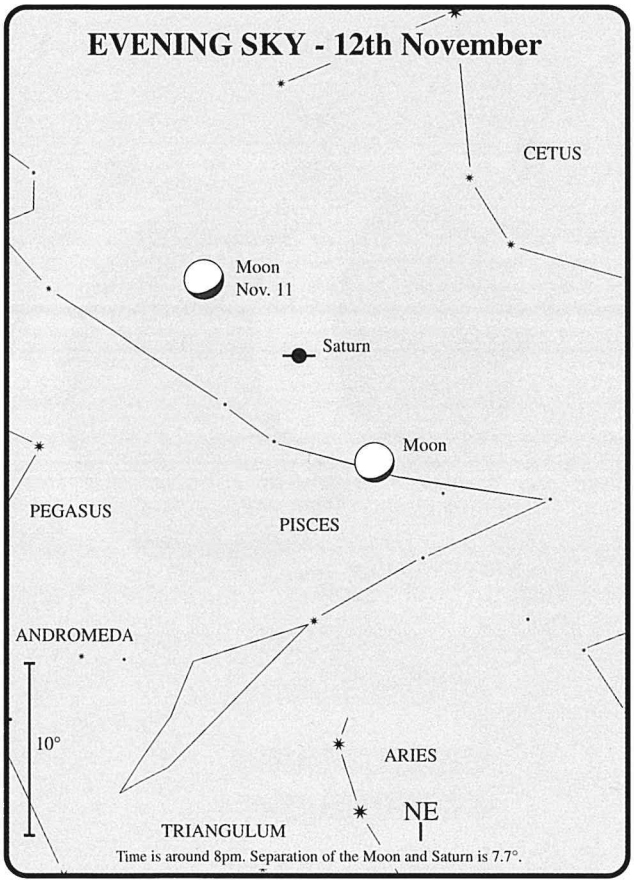
1st		m.p. 15 Eunomia 0.1° East of NGC 6629 (PN) in Sagittarius.
2nd		Mercury at aphelion.
2nd		Mars 0.6° South of NGC 6401 (GC) in Ophiuchus.
4th		m.p. 15 Eunomia 0.6° North of NGC 6642 (GC) in Sagittarius.
4th	1 PM	Mars 6° South of the Moon.
4th	7 PM	Venus 9° South of the Moon.
5th		m.p. 29 Amphitrite 1° North of Pi Scorpii.
6th	3 PM	Venus greatest elongation East (47°).
6th	11 PM	Neptune 4° South of the Moon.
7th	1 PM	Uranus 4° South of the Moon.
7th	6 PM	Venus 1° South of NGC 6553 (GC) in Ophiuchus.
8th	4 AM	Jupiter 4° South of the Moon.
8th	5:43 AM	First quarter Moon.
9th	5 PM	Mercury 0.2 North of Delta Scorpius.
11th		Mars 0.3° North of NGC 6544 (GC) in Sagittarius.
12th	9 AM	Saturn 0.4° South of the Moon; Occn.
12th	4 PM	Moon at perigee.
12th	5 PM	Mercury 0.7° SE of M80 (GC) in Scorpius.
14th	Noon	Mercury 2° North of Antares.
14th	10:12 PM	Full Moon.
16th	4 AM	Aldebaran 0.5° South of the Moon; Occn.
16th		Mars 0.3° North of M28 (GC) in Sagittarius.
16th		m.p. 11 Parthenope 0.5° South of NGC 864 (G) in Cetus.
18th	6 PM	Venus 0.2° East of Sigma Sagittarii.
20th		Mars 0.6° South of M22 (GC) in Sagittarius.
20th	6 PM	Mercury 0.8° SE of NGC 6284 (GC) in Ophiuchus.
22nd	7:58 AM	Last quarter Moon.
22nd		Mercury at greatest latitude South (Heliocentric).
23rd	6 PM	Mercury 0.7° North of NGC 6355 (GC) in Ophiuchus.
24th	10 AM	Moon at apogee.
28th	1 AM	Pluto in conjunction with the Sun.
28th	Midnight	Mercury greatest elongation East (22°).
30th	10:14 AM	New Moon.

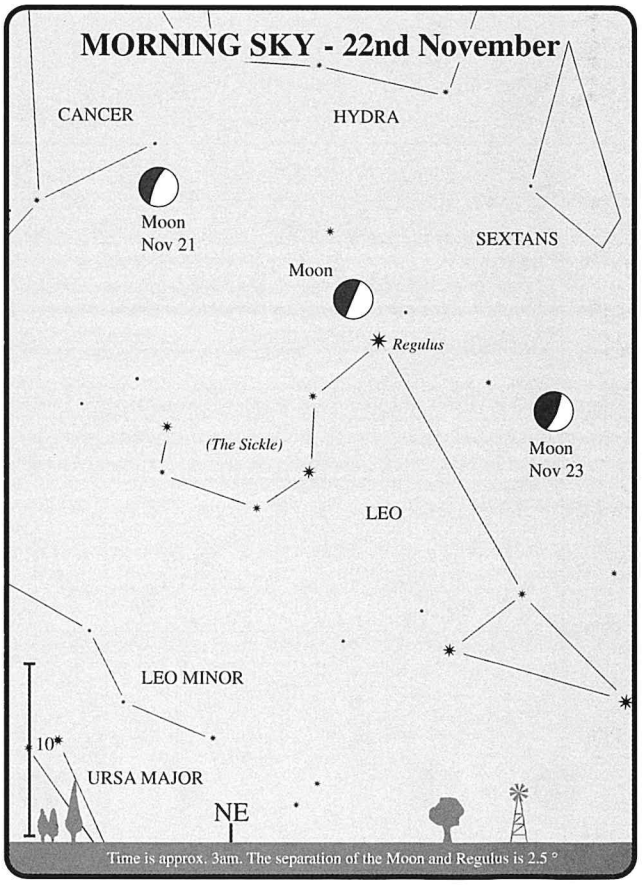





EVENING SKY - 7th November
Fomalhaut
GRUS
PISCIS AUSTRINUS
MICROSCOPIUM
CAPRICORNUS
AQUARIUS
Moon Nov. 8
Jupiter
Moon
10°
W
EQUULEUS
AQUILA
Time is around 8pm. Separation of Jupiter and the Moon is 6°

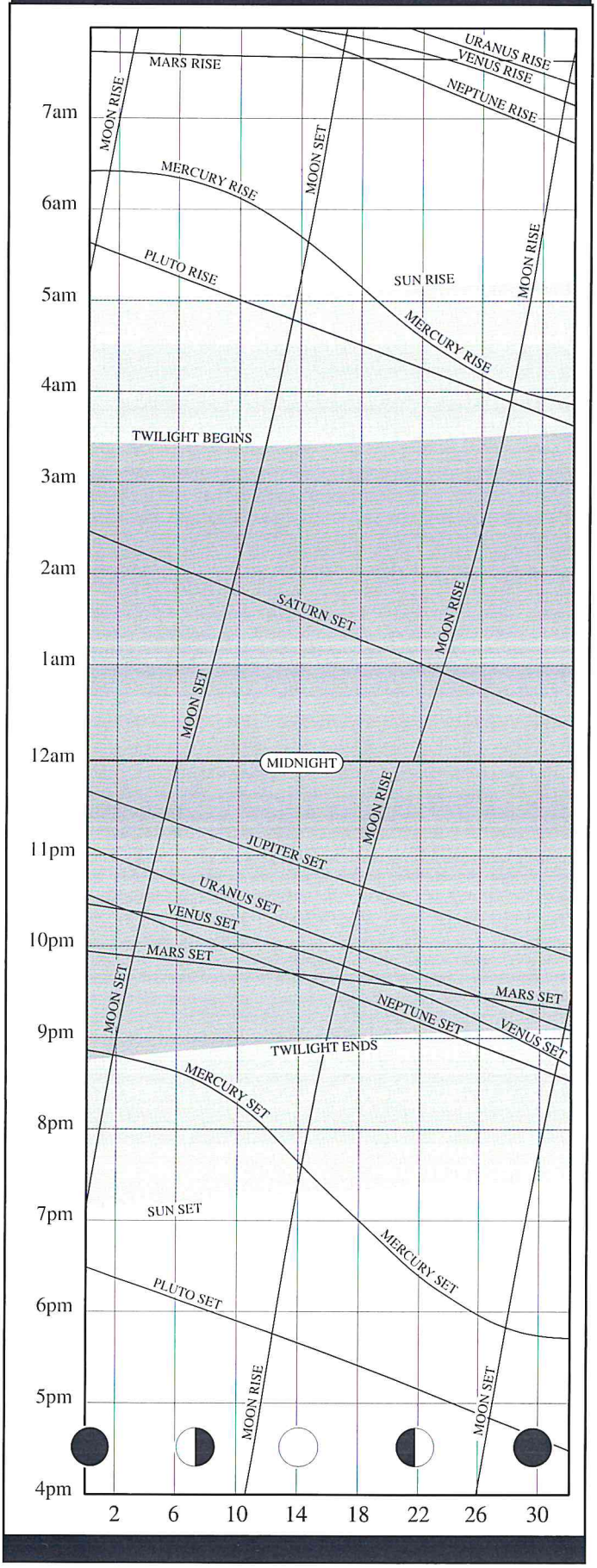

EVENING TWILIGHT - 18th November
CORONA AUSTRALIS
Venus
TELESCOPIUM
M22
Mars
M25
SAGITTARIUS
M7
N6530
SCUTUM
M6
N6231
N6281
SCORPIUS
SERPENS
Mercury
LUPUS
10°
Antares
M4
OPHIUCHUS
W
Time is approx. 45 mins. after sunset.
Separations are: Mercury/ Antares = 6.7°, Venus/ Nunki = 0.2°


EVENING SKY - 12th November
CETUS
Moon Nov. 11
Saturn
Moon
PEGASUS
PISCES
ANDROMEDA
10°
ARIES
NE
TRIANGULUM
Time is around 8pm. Separation of the Moon and Saturn is 7.7°.


MORNING SKY - 22nd November
CANCER
HYDRA
Moon Nov 21
SEXTANS
Moon
Regulus
(The Sickle)
Moon Nov 23
LEO
LEO MINOR
10°
URSA MAJOR
NE
Time is approx. 3am. The separation of the Moon and Regulus is 2.5 °

DECEMBER

RISE/SET CHART



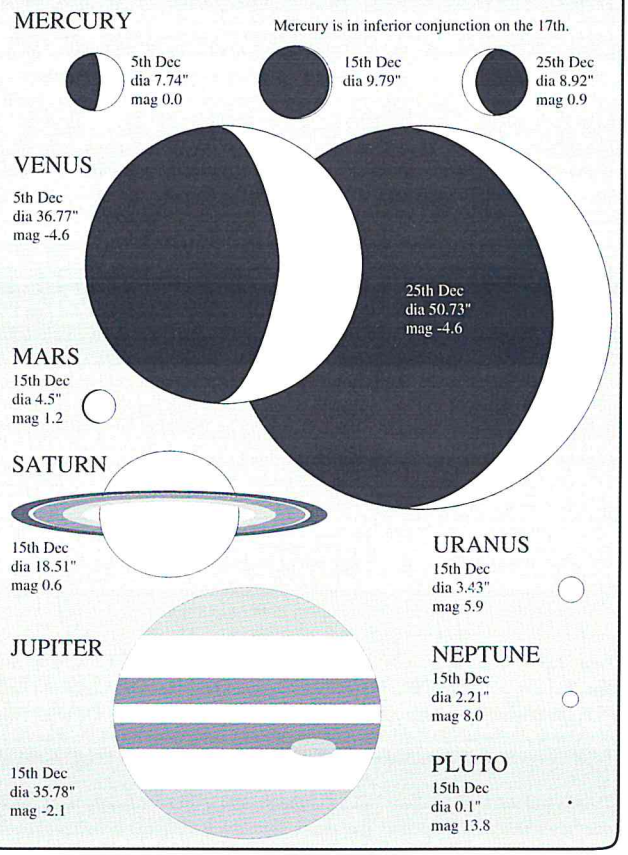
DECEMBER HIGHLIGHTS

- Mercury is visible in the western evening twilight sky for about the first week of December.
- Venus and Mars spend the month in the western evening twilight sky. On 3rd they form an impressive triangle with the Moon.
- Mars, Venus, Neptune and Uranus are involved in a series of close conjunctions this month.
- Jupiter can be seen in the early western evening sky, above Venus and Mars.
- Saturn is in the NW evening sky, at the end of twilight.

THE MOON

7th	First Quarter.
9th	Occultation of Saturn by the Moon. This is visible from northeast Australia and is a daytime event (see Saturn text on next page).
10th	Moon at perigee (closest to Earth - 368,874 km distant, angular size 32.2').
13th	Occultation of Aldebaran by the Moon. Not visible from Australia, the closest approach of around 4° from our skies can be seen as the Moon rises in the eastern sky during evening twilight.
14th	Full Moon.
22nd	Last Quarter.
22nd	Moon at apogee (furthest from Earth - 404,262 km distant, angular size 29.8').
30th	New Moon.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is in the evening twilight for the first two weeks of December. After inferior conjunction on the 17th, it swings west of the Sun to appear in the morning twilight sky. The planet is in Sagittarius until inferior conjunction, then it moves into Ophiuchus. Twice during the month the thin crescent Moon makes an appearance near Mercury. On the 2nd, the 2 day old Moon will be 11° towards the north in the western evening twilight sky (see sky view). On the 28th, the 28 day old Moon is 4° towards the north in the morning sky (see sky view).

VENUS, now past its greatest eastern elongation, begins to lose altitude as it moves back towards the Sun in the western evening twilight sky. In late January the planet will be seen as the Morning Star. On the 12th, Venus is at its brightest for this year, at magnitude -4.7. On the 3rd, the 3 day old crescent Moon will be 8° from Venus, and on the 31st the 2 day old Moon will be 2° directly below the planet. The sky view diagrams for 2nd and 31st illustrate these conjunctions. This "goddess of Love" will make a close approach (3°) to Neptune on the 8th. Venus moves from Sagittarius into Capricornus on the 10th, joining Jupiter and Uranus in that constellation. Mars also chimes in, crossing the border into Capricornus a week after Venus. Also on the 10th, Venus can be seen about 0.5° from the compact globular cluster M75. Venus and Mars, close companions over the past two months, approach within 2° this month. Their closest meeting is on 22nd at only 1.1° (see sky view).

If you know precisely where to look, Venus can be seen during daylight. You do not have to wait until it is at its brightest to try this. Sometimes, it can help to look on a day when the Moon is near the planet, December 3rd would be reasonable. Binoculars would also help to initially find Venus. The Moon, as well as being a sign post ,can also help you focus your eyes and the binoculars. Warning, choose a day when Venus is near a maximum elongation, ie. as far away from the Sun as possible. Permanent eye damage can result from looking at or close to the Sun, especially through binoculars.

MARS is 7° from the 3 day old Moon on the 3rd; the pair form a triangle with Venus in the western evening sky (see sky view for 2nd). On the 17th, just before Mars moves from Sagittarius into Capricornus, the planet comes within 0.5° of the globular star cluster M75. This is the same scenario as Venus one week before. Mars and Venus approach to within 2°, this month, and are at their closest (1.1°) on the 22nd (see sky view). Mars also comes close to two of the solar system's dimmer and distant worlds. On the 16th the red planet is 1.6° from Neptune and the 27th, 0.6° from Uranus.

JUPITER transits the meridian in the late afternoon, and can be seen low in the early western evening sky. December is almost the last chance to see the planet out of twilight, until late March next year when it appears in the morning sky. Jupiter is moving toward the Sun (lower in the western sky), with conjunction occurring in February next year. The planet is too close to the Sun to see for the next three months. On the 5th, the 5 day old Moon will be 5° from Jupiter (see sky view for the 2nd).

SATURN can be seen in the north western evening sky, immediately after the end of twilight. Saturn is occulted by the Moon on the 9th and is visible, during the day, from far north eastern Australia. Townsville will see the planet disappear behind the lunar limb just after moonrise, with reappearance at about 3pm (AEST). Elsewhere, in southeast Australia, closest approach will be around 2.45pm AEST (about 1 hour after moonrise). At the time of closest approach, the objects are below the horizon from Perth. This conjunction is best visible that evening, when the 10 day old Moon will be 4° from Saturn (see sky view). This is the 10th in a series of fourteen occultations between Saturn and the Moon that began in April and finishes in March next year; the next series begins in the year 2001. Saturn has been in retrograde motion since early August, Saturn appears stationary on the 17th, and thereafter it returns to its normal west-to-east path across the sky. See the discussion on retrograde motion and the Saturn finder chart in part II.

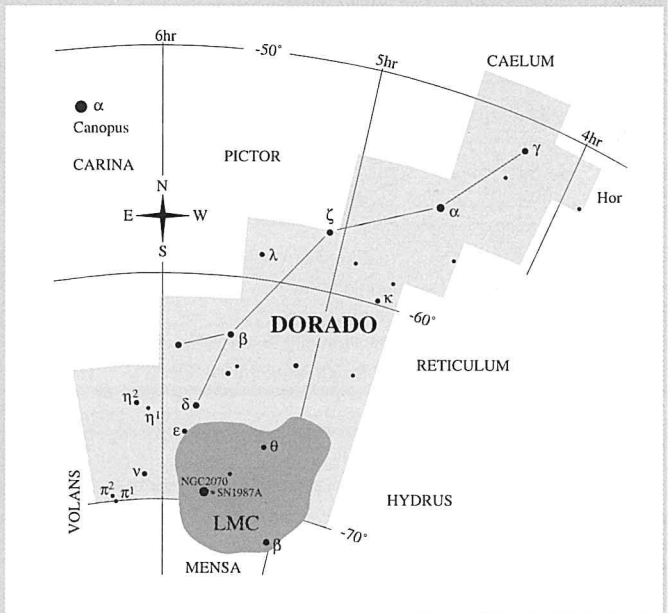
URANUS. On the 27th, Mars will be 0.6° from Uranus.

CONSTELLATION OF THE MONTH — DORADO (Dor)

Dorado, the Swordfish or Goldfish, was first published in Bayer's Uranometria in 1603. It is one of eleven southern constellations invented by Pieter Dirksz Keyser and Frederick de Houtman in the late 1590s. Without any stars brighter than about 3rd magnitude, Dorado is a rather barren constellation. However, its claim to fame is not in its stars, but in the remarkable Large Magellanic Cloud (which in part spills over into Mensa). Dorado is high in the southern sky, around midnight, during December. The best way to trace its straggling line of stars is to 'star hop' from Canopus in nearby Carina (Canopus is the second brightest star in the sky after Sirius). The stars of Dorado and the LMC are best seen under dark skies, away from the light pollution of the cities and suburbs.

The Large Magellanic Cloud (LMC), or Nebecula Major, is one of two satellite galaxies of our own galaxy, the Milky Way, both of which are visible to the unaided eye. The other is the Small Magellanic Cloud (SMC), located in Tucana. Both galaxies, resembling large detached portions of the Milky Way, were named in honour of the Portuguese explorer, Ferdinand Magellan. Sprawling across 6° of sky, the LMC is classified midway between an irregular and a barred spiral-type galaxy. Estimated at 50,000 light years across and 170,000 light years distant, the LMC's mass is about ten percent of own galaxy, or the equivalent of 25 million million suns. Abounding with globulars, nebulae, and clusters, the LMC is an excellent binocular or small telescope object. If the LMC is allowed to drift across a low power field, a panorama, with few celestial equals, will unfold. It is interesting that a 10cm telescope will show as much detail in the LMC as 100cm of aperture will reveal on the bright and relatively close Andromeda Galaxy.

Within the LMC is the Tarantula Nebula (NGC 2070). Surrounding the star 30 Doradus, it is the largest diffuse nebula known and so named because of its spidery shape. If the Great Nebula in Orion (1500 light years distant) were to be replaced by the Tarantula, it would extend a staggering 35 degrees across the sky, and glow at -5 magnitude! Everything about this nebula is astonishing. Its diameter is about 900 light years and this 'spider' has fainter extensions that cover several thousand light years. It is the most distant of the gaseous nebulae visible to the unaided eye and the only nebula within another galaxy visible in a small telescope. In the words of Sir John Herschel in the 1830s, 'This is one of the most singular and extraordinary objects which the heavens present'. Also known as the Great Looped Nebula, a small telescope will show bright luminous regions,



contrasted against dark lanes. Instruments in the 20 to 30cm range will reveal the extremely complex looped structure.

On 23rd February 1987, near the Tarantula Nebula, a supernova known as SN1987A became visible. The supernova had previously been an insignificant 12th magnitude star called Sanduleak -69° 202. This blue supergiant star ended its life in this cataclysmic explosion. This was the nearest and brightest supernova since Kepler's star in 1604 and it also had the distinction of being the closest and brightest since the start of the telescope age. Theory states that when a supernova occurs, most of the star's energy is released as neutrinos. SN1987A was the first supernova where neutrinos were discovered. Travelling at the speed of light, billions of these neutrinos made the long journey (170,000 years) towards the Earth. Only about ten of these neutrinos were observed by detectors, just prior to the visual appearance of the star.

DECEMBER

NEPTUNE will be 3° from Venus on the 8th, 1.6°from Mars on the 16th.

PLUTO moves from Scorpius to Ophiuchus in the first week of the month.

MINOR PLANETS at opposition this month are 23 Thalia at mag. 9.2 in Tau., 349 Dembowska at mag. 9.6 in Tau. and 27 Euterpe at mag. 8.5 in Tau.

COMETS

Hale-Bopp: Beginning December in Carina, Hale-Bopp is at 6th magnitude and visible throughout the night. It slowly moves through Carina, just crossing into Dorado at the end of the year. It could still be brighter than 7th magnitude, and not far from the LMC.

Hartley 2: During December, Hartley 2 will remain in Aquarius, setting around 11pm. It begins the month at 9th magnitude, but brightens by about a magnitude by New Year's Eve. Perihelion is on 21st December.

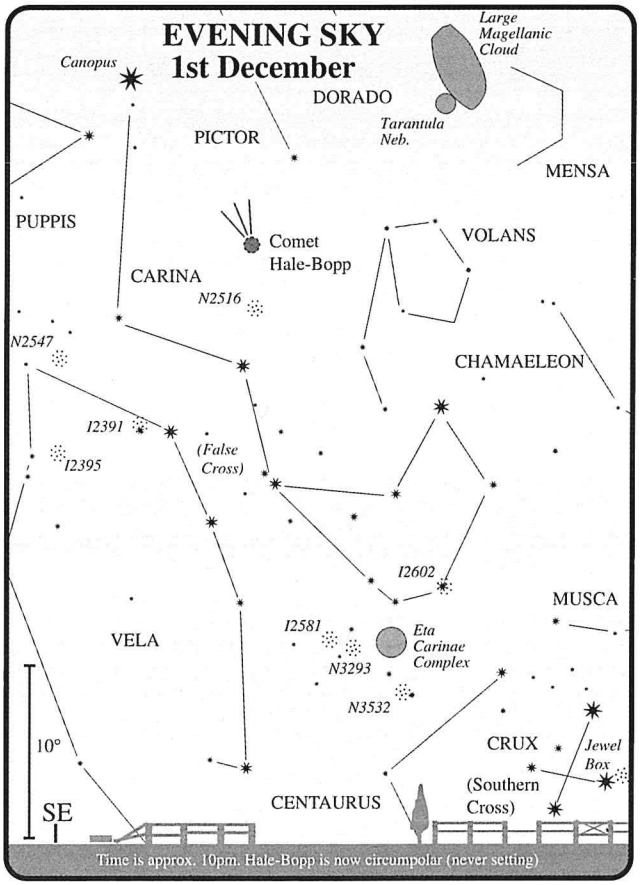
METEOR SHOWERS

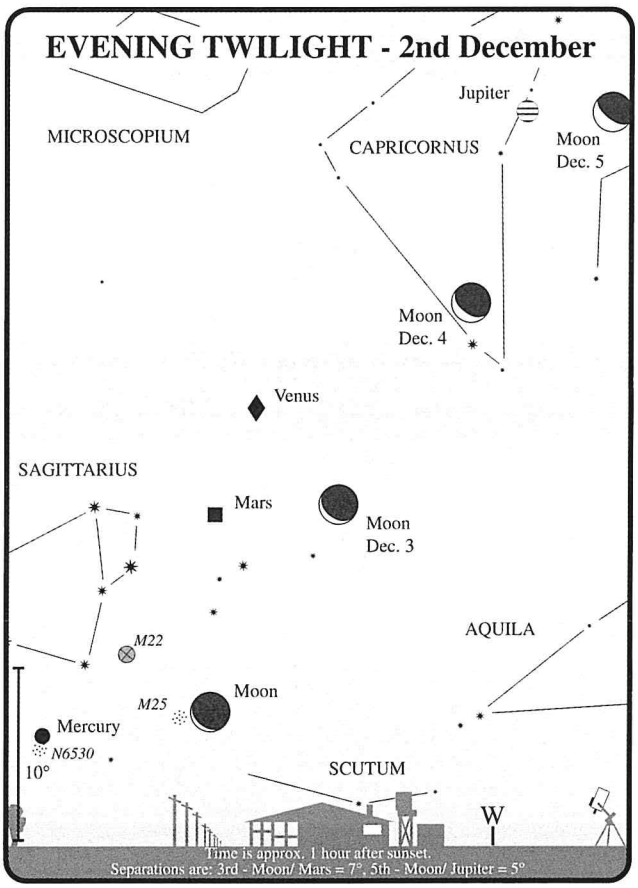
Chi-Orionids are active from 26th November through to 15th December, peaking on December 2nd, with a low zenith hourly rate of 3. Generally a weak stream visually, a number of bright meteors have been recorded.

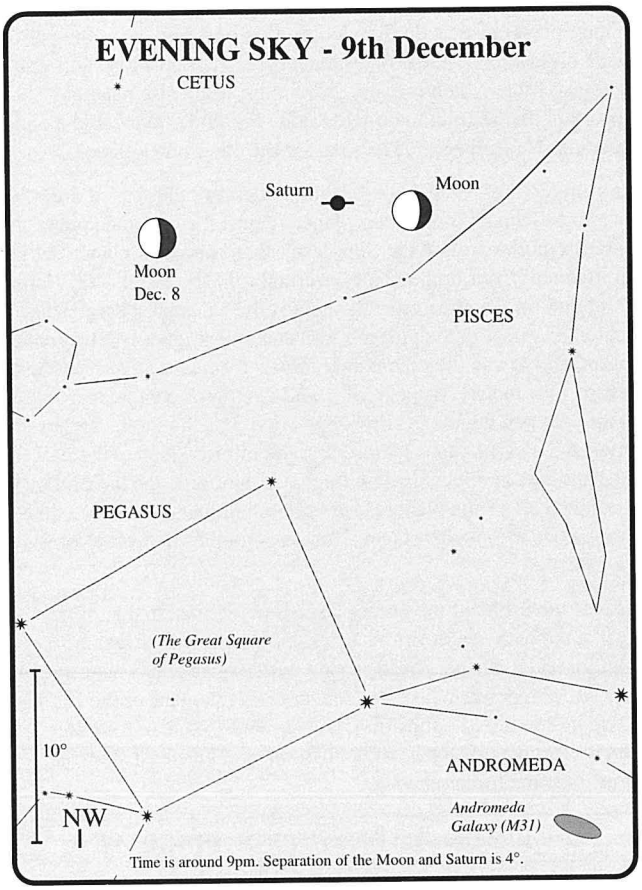
The **Phoenicids** are a southern shower that was discovered in 1956, when a zenith hourly rate of around 100 was observed. There have been three minor bursts in activity since 1956, but in recent years the shower seems nonexistent. This may be a periodic shower, so observations should still be carried out in case of a return. The period of activity appears to be 28th November through 9th December, with 6th being the maximum.

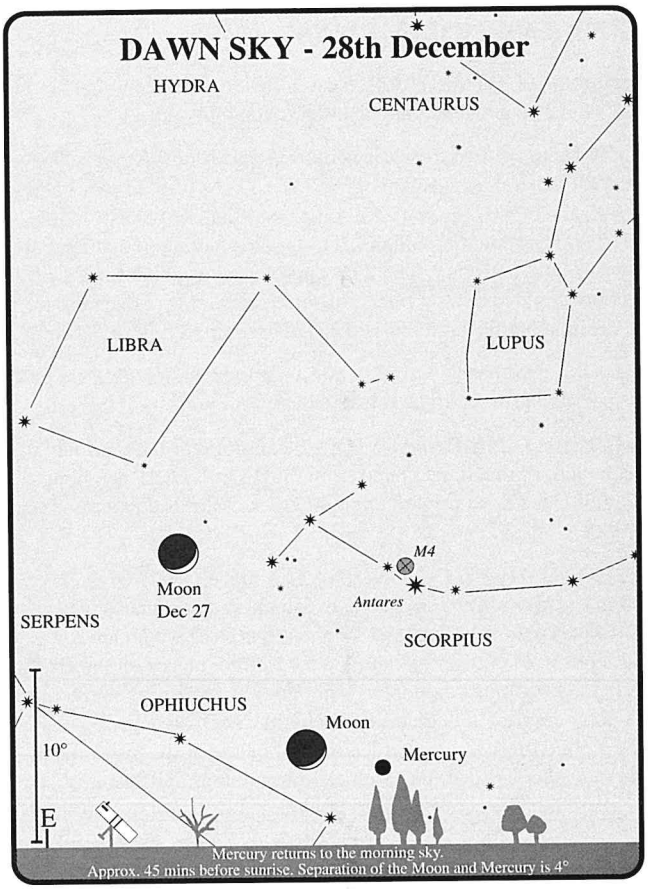
DIARY

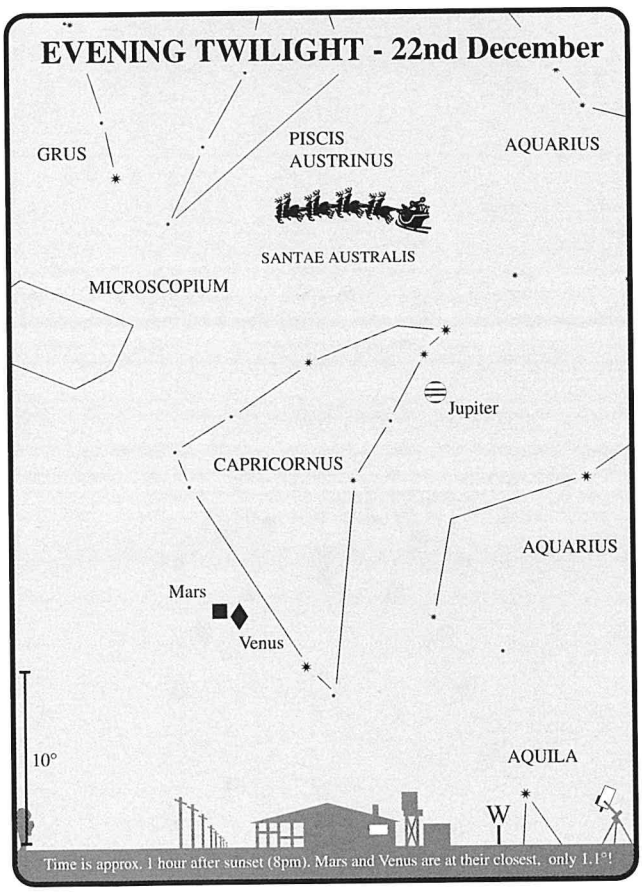
2nd	4 AM	Mercury 7° South of the Moon.
2nd	6 PM	Mercury 0.5° SW of NGC 6544 (GC) in Sagittarius.
3rd	1 PM	Mars 5° South of the Moon.
3rd	6 PM	Mercury 0.6° North of NGC 6553 (GC) in Sagittarius.
4th	1 AM	Venus 7° South of the Moon.
4th	6 AM	Neptune 3° South of the Moon.
4th	8 PM	Uranus 4° South of the Moon.
5th	4 PM	Jupiter 3° South of the Moon.
6th		m.p. 27 Euterpe 0.5° South of NGC 2129(OC) in Gem.
7th	2 AM	Vesta stationary.
7th	2:09 PM	First quarter Moon.
7th	Midnight	Mercury stationary.
8th	4 AM	Venus 3° South of Neptune.
9th	3 PM	Saturn 0.2° South of the Moon; Occn.
10th	1 AM	Moon at perigee.
10th	7 PM	Venus 0.5° South of M75 (GC) in Sagittarius.
11th		Mercury at ascending node.
12th	7 AM	Venus greatest brilliancy.
12th		Mars at greatest latitude South (Heliocentric).
13th	1 PM	Aldebaran 0.5° South of the Moon; Occn.
14th	10:37 AM	Full Moon.
16th	3 AM	Mars 1.6° South of Neptune.
16th		Mercury at perihelion.
17th		Mars 0.5° North of M75 (GC) in Sagittarius.
17th	4 PM	Mercury in inferior conjunction.
17th	7 PM	Saturn stationary.
22nd	4 AM	Solstice.
22nd	5:43 AM	Last quarter Moon.
22nd	7 AM	Moon at apogee.
22nd	7 PM	Venus 1.1° North of Mars.
23rd		Venus at ascending node.
25th	10 PM	Venus stationary.
26th		Mercury at greatest latitude North (Heliocentric).
27th	4 AM	Mars 0.6° South of Uranus.
27th	9 PM	Mercury stationary.
28th	11 AM	Mercury 2° South of the Moon.
29th		m.p. 1 Ceres 0.3° South of NGC 7492 (GC) in Aquarius.
29th		Comet 103P/Hartley 0.9° NW of NGC 7606 (G) in Aqr.
30th	12:56 AM	New Moon.
31st	2 PM	Neptune 3° South of the Moon.
31st	9 PM	Venus 1.3° South of the Moon.

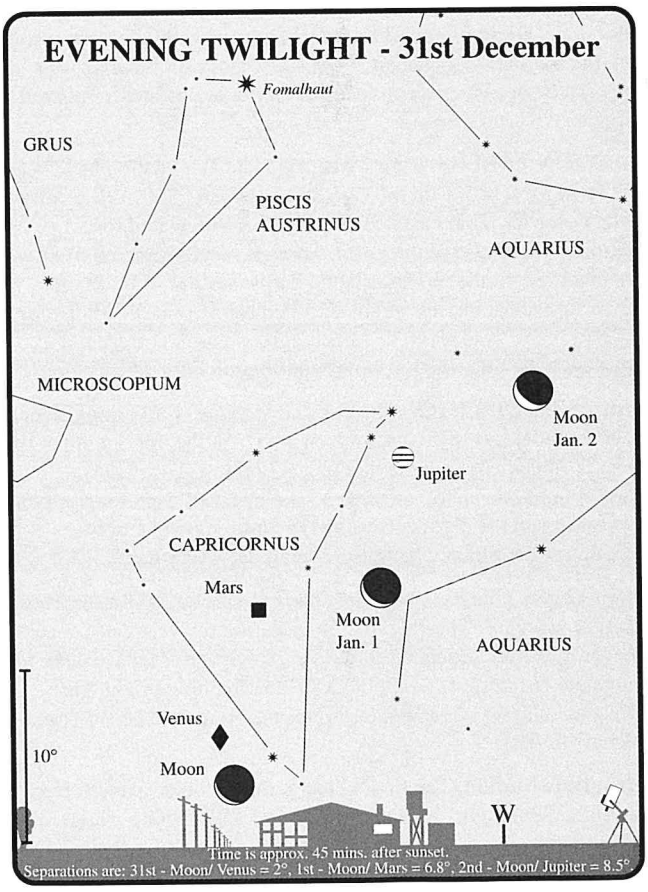





EVENING SKY - 9th December
CETUS
Saturn
Moon
Moon
Dec. 8
PISCES
PEGASUS
(The Great Square
of Pegasus)
10°
NW
ANDROMEDA
Andromeda
Galaxy (M31)
Time is around 9pm. Separation of the Moon and Saturn is 4°.


DAWN SKY - 28th December
HYDRA
CENTAURUS
LIBRA
LUPUS
M4
Moon
Dec 27
Antares
SERPENS
SCORPIUS
OPHIUCHUS
Moon
10°
Mercury
E
Mercury returns to the morning sky.
Approx. 45 mins before sunrise. Separation of the Moon and Mercury is 4°


EVENING TWILIGHT - 22nd December
GRUS
PISCIS
AUSTRINUS
AQUARIUS
SANTAE AUSTRALIS
MICROSCOPIUM
Jupiter
CAPRICORNUS
AQUARIUS
Mars
Venus
10°
AQUILA
W
Time is approx. 1 hour after sunset (8pm). Mars and Venus are at their closest, only 1.1°!


EVENING TWILIGHT - 31st December
Fomalhaut
GRUS
PISCIS
AUSTRINUS
AQUARIUS
MICROSCOPIUM
Moon
Jan. 2
Jupiter
CAPRICORNUS
Mars
Moon
Jan. 1
AQUARIUS
Venus
10°
Moon
W
Time is approx. 45 mins. after sunset.
Separations are: 31st - Moon/ Venus = 2°, 1st - Moon/ Mars = 6.8°, 2nd - Moon/ Jupiter = 8.5°

PART II - THE SOLAR SYSTEM

GENERAL COMMENTS

Astronomical Terms. Words, used in this introduction, that are in *italics* have an expanded explanation in the Glossary.

TIME There are two time zones used in part II of this book. They are West Australian Standard Time (WAST) as used in part I and Universal Time (UT). The 24 hr clock is often used in astronomy 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 II of this book, eg. for rise/set times. In some areas, it is convenient to use decimal hours. eg. 5.3hr is the same as 5hr 18 min or 5:18hr.

LOCATIONS. Rise/Set times and Lunar Occultation data are given for specific Perth, latitude 31° 57' South, longitude 115° 51' East.

UNIVERSAL TIME, or UT, is the mean time for the meridian of Greenwich, England, reckoned from midnight. WAST is 8 hours ahead of UT. For example, midnight UT, or 0 hr, is equal to 8:00hr or 8:00am WAST.

ASTRONOMICAL CO-ORDINATES OR POSITIONS. The astronomical positions are given as equatorial coordinates. These are Right Ascension (RA) and Declination (Dec) which are analogous to longitude and latitude for finding places on the Earth. RA is the longitude component but unlike its terrestrial counterpart it is not measured in degrees, but in hours. The 360 degrees, for once around the sky, are divided into 24 one hour divisions. Each hour is further divided, like a clock, into minutes and seconds. Declination is the counterpart to latitude but does not use north or south. Instead, objects north of the celestial equator have positive(+) declinations, south are negative(-).

The Earth's daily rotation on its polar axis causes the stars to appear to rotate around a point in the sky. From southern latitudes, including Australia, this point is called the 'South Celestial Pole' and is at declination -90°. The 'Northern Celestial Pole', not visible from the southern hemisphere, is at +90°. The celestial equator and poles can be described as projections on the sky of their terrestrial partners.

POSITION TABLES. Right Ascension and Declination have been calculated for 0 hr UT on the date listed (*Epoch* 2000). All positions are 'geocentric'. This means they have been calculated for a position at the centre of the Earth. There is no allowance for the parallax effect of the observer being on the surface of the Earth. Except for the Moon, this slight shift is insignificant. Positions for the outer planets are given in weekly intervals and correspond to Saturdays. The Sun, Moon, Venus and Mercury are daily.

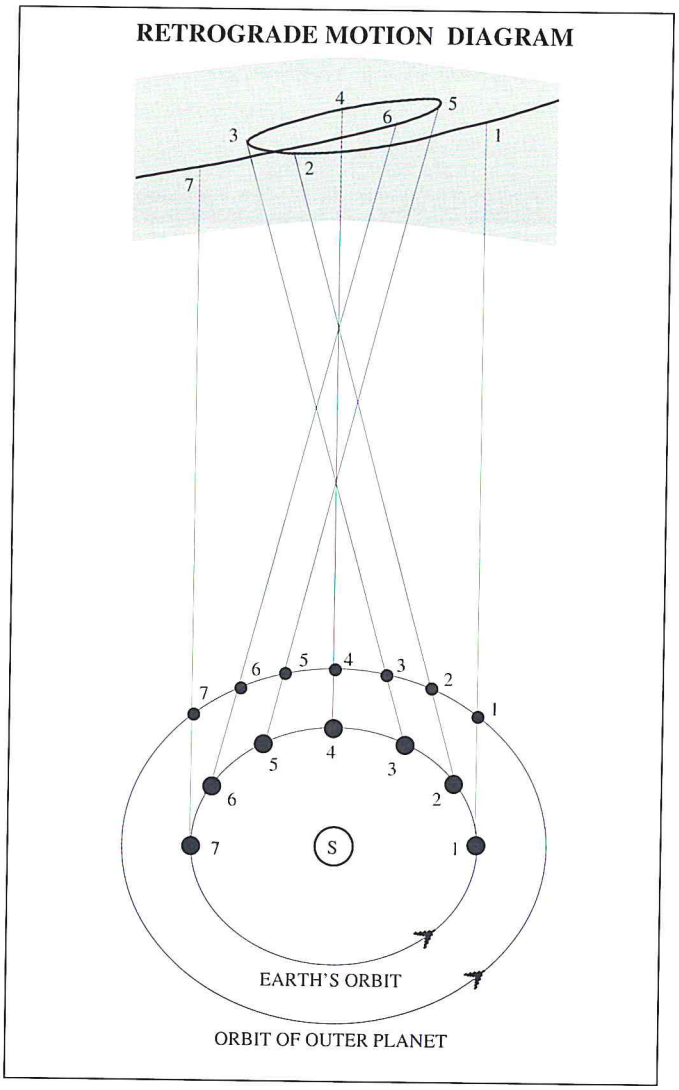
RISE AND SET TIMES. The rise and set times for various objects are given in WAST. The times given are when the upper limb of the object is coincident with the theoretical horizon. The data is adjusted for atmospheric refraction. The intervals used for rise/sets are weekly and the dates correspond to Saturdays. The only exception is the Moon which is presented for every day.

Planet Finder Charts. No finder charts are presented for the Moon, Venus or Mercury. Their rapid motion during the year causes them to cover a very large section of the sky which is difficult to cater for adequately in the space available. Considering how bright these objects are, the sky view diagrams (see part I) should be sufficient to act as 'finders'.

Retrograde Motion. The finder charts, for the outer planets, have one thing in common - an apparent motion with a 'loop' shape. This puzzled astronomers for centuries until it was finally recognised that the Earth orbited the Sun. This was just like any of the other 'wanderers' or planets. Unfortunately, the Earth could no longer be looked upon as the centre of the Universe. The diagram below illustrates the combined effects of the orbital motions of Earth and an outer planet to explain this 'loop'. This only applies to the period during opposition. All the outer planets reach opposition each year, except for Mars which is every 26 months. Mars also reaches opposition this year and you will notice the same 'loop' shape on its finder charts (see page 77) as seen for the other outer planets.

Returning to the 'Retrograde Motion Diagram', the shaded area represents the path of an outer planet against the celestial sphere. As the Earth moves around the Sun, faster than this outer planet (let's call it Uranus), our home planet overtakes it. The result is this loop or 'S-bend' in the apparent path against the celestial sphere. This apparent reversal in the planet's movement is known as retrograde motion, and at this time the planet moves from east to west instead of from west to east. At position 1 and 2, Uranus continues its west to east path and begins to slow to position 3 as the Earth catches up. Between 3 and 5 Uranus is in retrograde motion (ie. moving east to west) and it is at opposition (in line with the Earth and the Sun) at 4. At points 3 and 5 the planet is said to be stationary. After 5, as the Earth passes the slower planet, Uranus continues its west to east direction.

Because the orbits of the outer planets are inclined to that of the Earth's, the path can never be a straight line. It will always be a 'loop' or an 'S' shape. An 'S' shape will happen if it is near one of its *nodes* (the points where a planet crosses the plane of the Earth's orbit), at the time of opposition. During 1997, none of the outer planets cross a node, close to opposition, and hence all show a "loop" (see the finder charts).



USE OF STAR ATLASES. Over many years the stars appear to move in the sky relative to the celestial poles. This is called 'precession' and is caused by the Earth's axis slowly wobbling like a spinning top over thousands of years. 'Epoch 2000.0' refers to an object's position relative to where the celestial poles (+ /-90° in declination) will be in the year 2000. This epoch has now been adopted by all modern star atlases. 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 epoch 2000.0. The precession over this 50 year period can cause a shift of up to one degree in the apparent position of a Solar System object relative to the background stars. This may not be a problem when looking for the brighter planets, but high precision may be necessary to track down a 12th magnitude comet. The calculations to convert (or 'precess') positions from one epoch to another, are not complicated considering the power of today's calculators and computers. Suggested references are 'Practical Astronomy with a Calculator' (Duffett-Smith) or 'Astronomical Algorithms' (Meeus).

FIELD OF VIEW IN A TELESCOPE. All the satellite diagrams and finder charts in this book are drawn to correct or normal sky orientation, 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.

SECTION EXPLANATION

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

Declination of the Sun and Planets (p. 62) In general, the further south a planet is, the higher in the northern sky it is, as seen from Australia. This is another reason why the opposition of Mars, in March this year, is poor. Not only is the size small, but its declination of +5° places it lower in the sky. You have to look through more atmosphere, hence the image is more prone to turbulence.

Planetary Angular Size (p. 62) The 'Y' axis of this diagram is arc seconds. It is interesting that Venus, in late December, grows to an angular size exceeding 50 arc seconds. There have been rare reports of people having the ability to see the crescent of Venus, with the naked eye, when the planet is close to 1 arc minute in size. It is certainly worthwhile trying to observe Venus' crescent in binoculars (it helps to keep the binoculars steady by using a tripod). Looking during twilight can often help. There is less glare and the planet is higher in the sky. See part I for the expected crescent shape.

Meridian Passage of the Sun and Planets (p. 63). In this diagram, the 'Y' axis represents the local mean time. It shows the time the Sun and planets cross the meridian (or *culminates*) for the year. When a planet culminates around midnight (0 or 24 hours), it is at opposition and visible the whole night. Ideally, observations at night should be made as close as possible to the time of culmination. At that time it has reached its maximum altitude and the effect of atmospheric turbulence is minimised. Unfortunately this is not possible for Mercury or Venus.

MOON -Rise/Set Data (page 69). Looking at this data you will see there are some days where the Moon appears not to rise or set (represented by 'DNR' for Does Not Rise or 'DNS', Does Not Set). The reason for this lies in the Moon's rapid daily motion from west to east. Consecutive days show the Moon to rise (or set) more than 24 hours later. Hence, if the Moon rises just before midnight on the 1st of the month, it may not rise again until after midnight on the 2nd (making it an event for the 3rd).

JUPITER and SATURN

Jupiter's Moons (see pages 80 to 85). Jupiter is like a miniature solar system with 16 moons orbiting the planet. Also, like the planets, these moons all lie in a similar plane. This plane is also very close to the Earth's orbit. Therefore, seen from Earth, the Moons appear to move from side-to-side (east-west) of Jupiter, occasionally passing across (a *transit*) or behind (an *occultation*) the planet. The diagrams on pp. 83 to 85 show the patterns the four major moons of Jupiter make as they move from side-to-side. Each complete period represents one orbit of the satellite. The horizontal date line represents midnight WAST (16hr UT). The close pair of parallel vertical lines represents the disc of Jupiter. It is interesting to compare the times when each moon passes over these lines, with the satellite's transit times (see pages 81-82). The same can be done with the occultation times ie. when the line disappears behind Jupiter. These four moons (Io, Europa, Ganymede and Callisto) are bright enough to be seen in binoculars (7x power or greater is recommended). It may be necessary to mount the binoculars on a tripod to help keep them steady. Initially, try looking for Callisto when it is furthest from Jupiter (maximum elongation). This happens every 8 days approximately; an example would be the evening of 23rd August. To see the moons, with binoculars, may take a little practice. The power or magnification of the binoculars will determine how close to Jupiter you can follow a moon. Of course, with a small telescope you would have no problem following the moons and their shadows as they cross the disc of Jupiter. Watching a moon fade and disappear as it moves into Jupiter's shadow (an eclipse) is very impressive.

Eclipse Positions of Jupiter's Moons (bottom of p. 80) shows the positions of the *eclipse* events for each satellite for the month, relative to Jupiter. An eclipse is when the moon passes into (disappears or 'd') or out of (reappears or 'r') Jupiter's shadow.

Jupiter - Longitudes of Central Meridian. (page 86) Unlike Mars, Jupiter (and Saturn) are 'Gas Giants' and they only allow us to view their upper atmospheric features. Only a small telescope (even a 50mm instrument) is required to view the equatorial belts and the Great Red Spot. When seeing is good, numerous breaks can be glimpsed in the bands as well as many minor spots. There is no one correct rotation period for the features of Jupiter. The speed of movement of any feature on the "surface" depends on its latitude, hence the multiple rotation systems used. To monitor the movement and development of any feature, amateurs often measure the time a feature crosses the central meridian of the planet.

The longitude can be worked out from the 'Longitude of Central Meridian' tables (see p. 86). All the times on the main tables (ie. daily figures) are calculated for 0hrs UT (8:00am WAST) of date. You will need to add multiple hours/minutes from the small 'Increase in Longitude' tables. For example the longitude of central meridian for Jupiter (system I) for June 21 at 12:20am WAST would be calculated as follows:

The longitude on June 20 is 285.4°. To this add an adjustment for the 16 hours since 8am which is 225.3° and finally for the 20 mins add 12.2°. This equals 522.9°; subtracting 360° gives 162.9°.

Saturn's Rings. (p 88) The 'Appearance of the Planets' diagrams in part I show how 'open' the rings are for 1997. The plane of the rings is tilted, with respect to the plane of the ecliptic, by 28°. The planet's year is 29.5 (Earth) years. During this period the Earth can be up to 28° above or below the plane of the rings. Every 7 years, after each of these maximum ring 'openings', the Earth passes through the plane of the rings and they are seen as 'edge-on'. The rings were edge-on during 1995 and early in 1996. During 1997, the rings are in the process of opening up.

SOLAR SYSTEM DATA — THE PLANETS

NAME	MEAN DISTANCE FROM SUN ($\times 10^3$ km)	(Earth = 1)	MAG at OPP	EQUATORIAL DIAMETER (km).	FLATTENING [1]	No of MOONS	MASS ($\times 10^{24}$ kg)	(Earth = 1)
Sun	-		-26.8	1392530	0	-	1989085	332946
Moon	-		-12.74 [11]	3475	0	-	0.073483	0.0123
Mercury	57856	0.387	0.16 [12]	4879	0	0	0.33022	0.055
Venus	108132	0.723	-4.07 [12]	12104	0	0	4.8690	0.816
Earth	149492	1.000	-3.5 [13]	12756	0.00335364	1	5.9742	1.000
Mars	227780	1.524	-2.01	6794	0.006476	2	0.64191	0.107
Jupiter	777776	5.203	-2.70	142984	0.0648074	16	1898.8	317.900
Saturn	1425983	9.540	0.67	120536	0.097962	18	568.50	95.200
Uranus	2867760	19.180	5.52	51118	0.022927	15	86.625	14.500
Neptune	4492800	30.700	7.84	49528	0.017081	8	102.78	17.400
Pluto	5745000	39.670	13.7	2302	0	1	0.015	0.003

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

Notes:

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

PART II - THE SOLAR SYSTEM ...continued

Satellites of Saturn (pp. 88 and 89). To estimate the configuration or positions of the satellites, the 'Apparent Orbits' diagram (p. 88) and the times of 'Greatest Eastern Elongation' are needed. For each satellite, take the previous (most recent) date of greatest eastern elongation and work out the period that has elapsed (in days/hours) since this time. Locate this time on the relevant orbit on the diagram (p. 88) and that gives the moon's position directly.

URANUS / NEPTUNE / PLUTO

Satellites of Uranus (see p. 91).Titania (III) and Oberon (IV) are the easiest to observe visually. However, at least a 20cm telescope, under 'dark skies', is needed to glimpse these distant bodies. The inner satellites, Ariel and Umbriel, are harder to observe and they would be a real test for a 40cm telescope. The orbits of the satellites are half face-on as seen from Earth (see diagram p. 91). The orbits' apparent minor axis (running east/west) is 62% of the apparent major axis (north/south). For example, Oberon, at opposition, has a maximum elongation of 44' (see p. 61). Its minimum elongation would be 62% of this or 27'. To locate the approximate position angle (degrees east of north) for a satellite, at your time of observation:

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

Satellites of Neptune (see p. 91). With typical amateur telescopes, Triton (I) is the only observable moon. To find Triton, use the approach as described above for the satellites of Uranus. Note that in this case, the apparent major axis is in the east/west direction. Like Uranus, the orbits of the Neptunian satellites are currently relatively open (see diagram p. 91). In 1997, Triton's apparent orbit as seen from Earth is a ellipse with the minor axis being 78% of the major axis. Therefore Triton, at opposition, varies from 17' down to 13'. To find the approximate position angle of Triton, the same approach is used as above for Uranus. The sidereal orbital period for Triton is 5.88 days and after step 3 add 90° to get the position angle from north. If the answer is greater than 360°, subtract 360°.

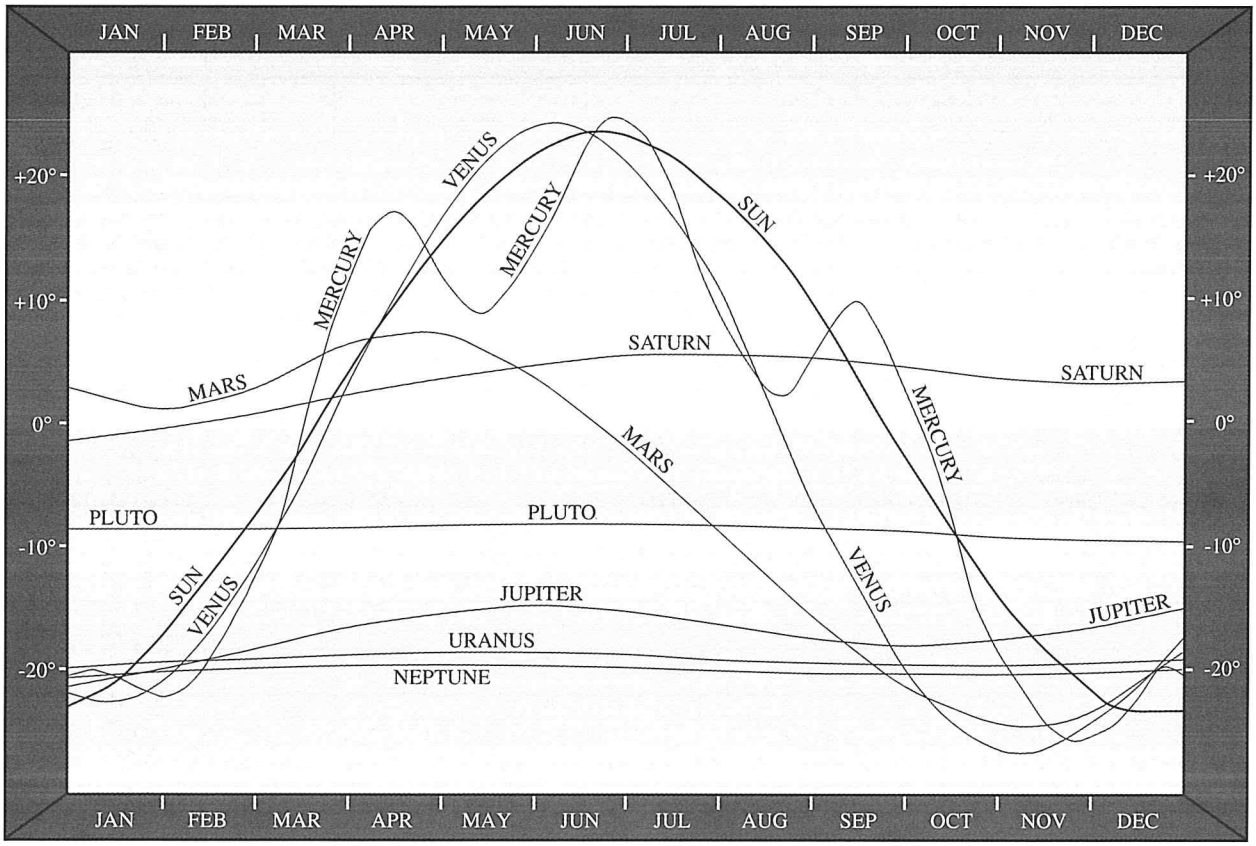
PLUTO (see pages 92 and 93). The pointer chart (p. 92) is designed to help people find the general area for Pluto. The main finder chart shows stars down to approximately magnitude 14.5. This is necessary to pick out the faint star-like image of Pluto (magnitude 13.7) from the other numerous faint stars in the field. The commonly available star atlases do not include stars down to anywhere near this magnitude limit (or faintness).

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 (kms)	SIDEREAL PERIOD OF ROTATION (days) [4]	MAGNITUDE AT OPPOSITION
Earth										
Moon		27.321661		384.400	0.054900489	18.28-28.58	0.01230002	1738	S	-12.74
Mars										
Phobos	I	0.31891023	25"	9.378	0.015	1.0	$1.5x10^{-8}$	13.5x10.8x9.4	S	11.3
Deimos	II	1.2624407	1' 02"	23.459	0.0005	0.9-2.7	$3x10^{-9}$	7.5x6.1x5.5	S	12.40
Jupiter										
Metis	XVI	0.294780	0' 42"	128			$0.5x10^{-10}$	20		17.5
Adrastea	XV	0.29826	0' 42"	129			$0.1x10^{-10}$	12.5x10x7.5		19.1
Amalthea	V	0.49817905	0' 59"	181	0.003	0.40	$38x10^{-10}$	135x83x75	S	14.1
Thebe	XIV	0.6745	1' 13"	222	0.015	0.8	$4x10^{-10}$	55x45	S	15.7
Io	I	1.769137786	2' 18"	422	0.004	0.04	$4.68x10^{-5}$	1815	S	5.02
Europa	II	3.551181041	3' 40"	671	0.009	0.47	$2.52x10^{-5}$	1569	S	5.29
Ganymede	III	7.15455296	5' 51"	1070	0.002	0.21	$7.80x10^{-5}$	2631	S	4.61
Callisto	IV	16.6890184	10' 18"	1883	0.007	0.51	$5.66x10^{-5}$	2400	S	5.65
Leda	XIII	238.72	1° 00' 39"	11094	0.14762	26.07	$0.03x10^{-10}$	8		20.2
Himalia	VI	250.5662	1° 02' 46"	11480	0.15798	27.63	$50x10^{-10}$	93	0.4	14.84
Lysithea	X	259.22	1° 04' 04"	11720	0.107	29.02	$0.4x10^{-10}$	18		18.4
Elara	VII	259.6528	1° 04' 10"	11737	0.20719	24.77	$4x10^{-10}$	38	0.5	16.77
Ananke	XII	631. R	1° 55' 52"	21200	0.16870	147	$0.2x10^{-10}$	15		18.9
Carme	XI	692. R	2° 03' 31"	22600	0.20678	164	$0.5x10^{-10}$	20		18.0
Pasiphae	VIII	735. R	2° 08' 26"	23500	0.378	145	$1x10^{-10}$	25		17.03
Sinope	IX	758. R	2° 09' 31"	23700	0.275	153	$0.4x10^{-10}$	18		18.3
Saturn										
Pan	XVIII	0.5750	0' 21"	133.583				10		
Atlas	XV	0.6019	0' 22"	137.670	0.000	0.3		20x10		18
Prometheus	XVI	0.6130	0' 23"	139.353	0.003	0.0		70x50x40		16
Pandora	XVII	0.6285	0' 23"	141.700	0.004	0.0		55x45x35		16
Epimetheus	XI	0.6942	0' 24"	151.422	0.009	0.34		70x60x50	S	15
Janus	X	0.6945	0' 24"	151.472	0.007	0.14		110x100x80	S	14
Mimas	I	0.942421813	0' 30"	185.52	0.0202	1.53	$8.0x10^{-8}$	196	S	12.9
Enceladus	II	1.370217855	0' 38"	238.02	0.00452	0.00	$1.3x10^{-7}$	250	S	11.7
Telesto	XIII	1.8878	0' 48"	294.66				17x14x13		18.5
Tethys	III	1.887802160	0' 48"	294.66	0.00000	1.86	$1.3x10^{-6}$	530	S	10.2
Calypso	XIV	1.8878	0' 48"	294.66				17x11x11		18.7
Helene	XII	2.7369	1' 01"	377.40	0.005	0.0		18x16x15		18
Dione	IV	2.736914742	1' 01"	377.40	0.002230	0.02	$1.85x10^{-6}$	560	S	10.4
Rhea	V	4.517500436	1' 25"	527.04	0.00100	0.35	$4.4x10^{-6}$	765	S	9.7
Titan	VI	15.94542068	3' 17"	1221.83	0.029192	0.33	$2.38x10^{-4}$	2575	S	8.28
Hyperion	VII	21.2766088	3' 59"	1481.1	0.104	0.43	$3x10^{-8}$	205x130x110		14.19
Iapetus	VIII	79.3301825	9' 35"	3561.3	0.02828	14.72	$3.3x10^{-6}$	730	S	11.1
Phoebe	IX	550.48 R	34' 51"	12952	0.16326	177 [2]	$7x10^{-10}$	110	0.4	16.45
Uranus										
Cordelia	VI	0.335033	0' 04"	49.77	<0.001	0.1		13		24.1
Ophelia	VII	0.376409	0' 04"	53.79	0.010	0.1		15		23.8
Bianca	VIII	0.434577	0' 04"	59.17	<0.001	0.2		21		23.0
Cressida	IX	0.463570	0' 05"	61.78	<0.001	0.0		31		22.2
Desdemona	X	0.473651	0' 05"	62.68	<0.001	0.2		27		22.5
Juliet	XI	0.493066	0' 05"	64.35	<0.001	0.1		42		21.5
Portia	XII	0.513196	0' 05"	66.09	<0.001	0.1		54		21.0
Rosalind	XIII	0.558459	0' 05"	69.94	<0.001	0.3		27		22.5
Belinda	XIV	0.623525	0' 06"	75.26	<0.001	0.0		33		22.1
Puck	XV	0.761832	0' 07"	86.01	<0.001	0.31		77		20.2
Miranda	V	1.41347925	0' 10"	129.39	0.0027	4.2	$0.08x10^{-5}$	240	S	16.3
Ariel	I	2.52037935	0' 14"	191.02	0.0034	0.3	$1.56x10^{-5}$	579	S	14.16
Umbriel	II	4.1441772	0' 20"	266.30	0.0050	0.36	$1.35x10^{-5}$	586	S	14.81
Titania	III	8.7058717	0' 33"	435.91	0.0022	0.14	$4.06x10^{-5}$	790	S	13.73
Oberon	IV	13.4632389	0' 44"	583.52	0.0008	0.10	$3.47x10^{-5}$	762	S	13.94
Neptune										
Naiad	III	0.294396	0' 02"	48.23	<0.001	4.74		29		24.7
Thalassa	IV	0.311485	0' 02"	50.07	<0.001	0.21		40		23.8
Despina	V	0.334655	0' 02"	52.53	<0.001	0.07		74		22.6
Galatea	VI	0.428745	0' 03"	61.95	<0.001	0.05		79		22.3
Larissa	VII	0.554654	0' 03"	73.55	0.0014	0.20		104x89		22.0
Proteus	VIII	1.122315	0' 06"	117.65	<0.001	0.55		218x208x201		20.3
Triton	I	5.8768541 R	0' 17"	354.76	0.000016	157.345	$2.09x10^{-4}$	1353	S	13.47
Nereid	II	360.13619	4' 21"	5513.4	0.7512	27.6 [3]	$2x10^{-7}$	170		18.7
Pluto										
Charon	I	6.38725	<1"	19.6	<0.001	99 [3]	0.22	593	S	16.8

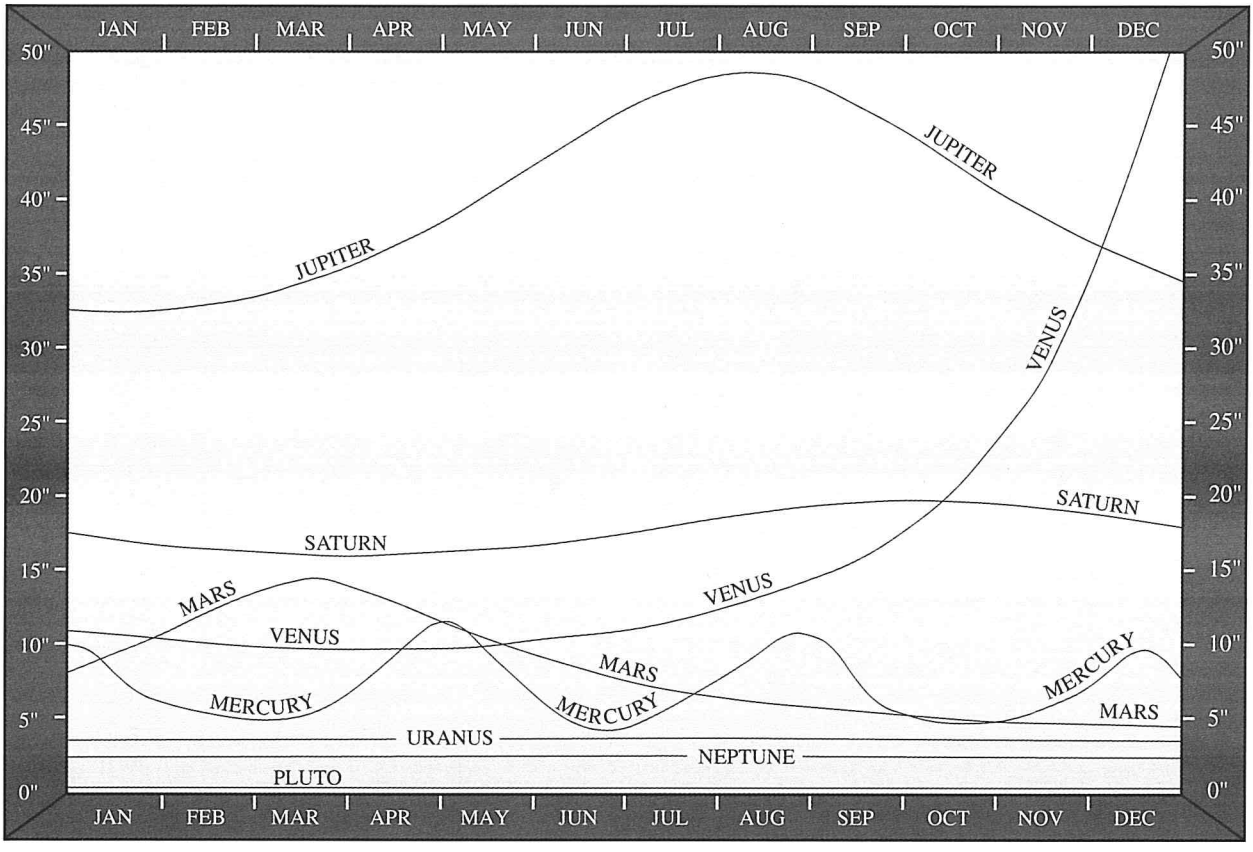
Notes: **1** - Sidereal periods, except tropical periods are given for Saturn. **2** - Relative to the ecliptic plane. **3** - Referred to the equator of 1950.0
4 - S = Synchronous, rotation period same as orbital period. ie. keeps the same section of its surface facing its planet.

DECLINATIONS of the SUN and PLANETS

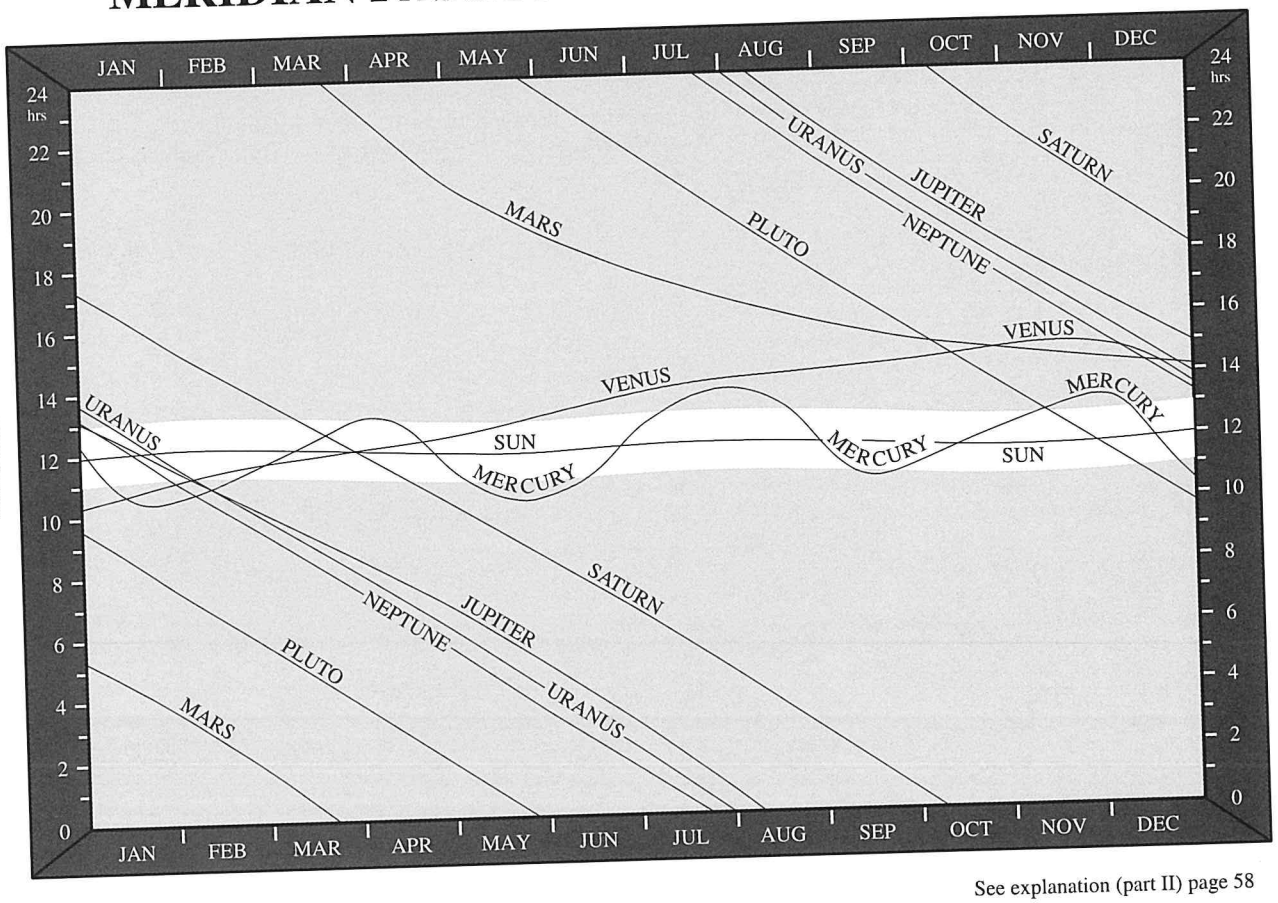


See explanation (part II) page 58

PLANETARY ANGULAR SIZE

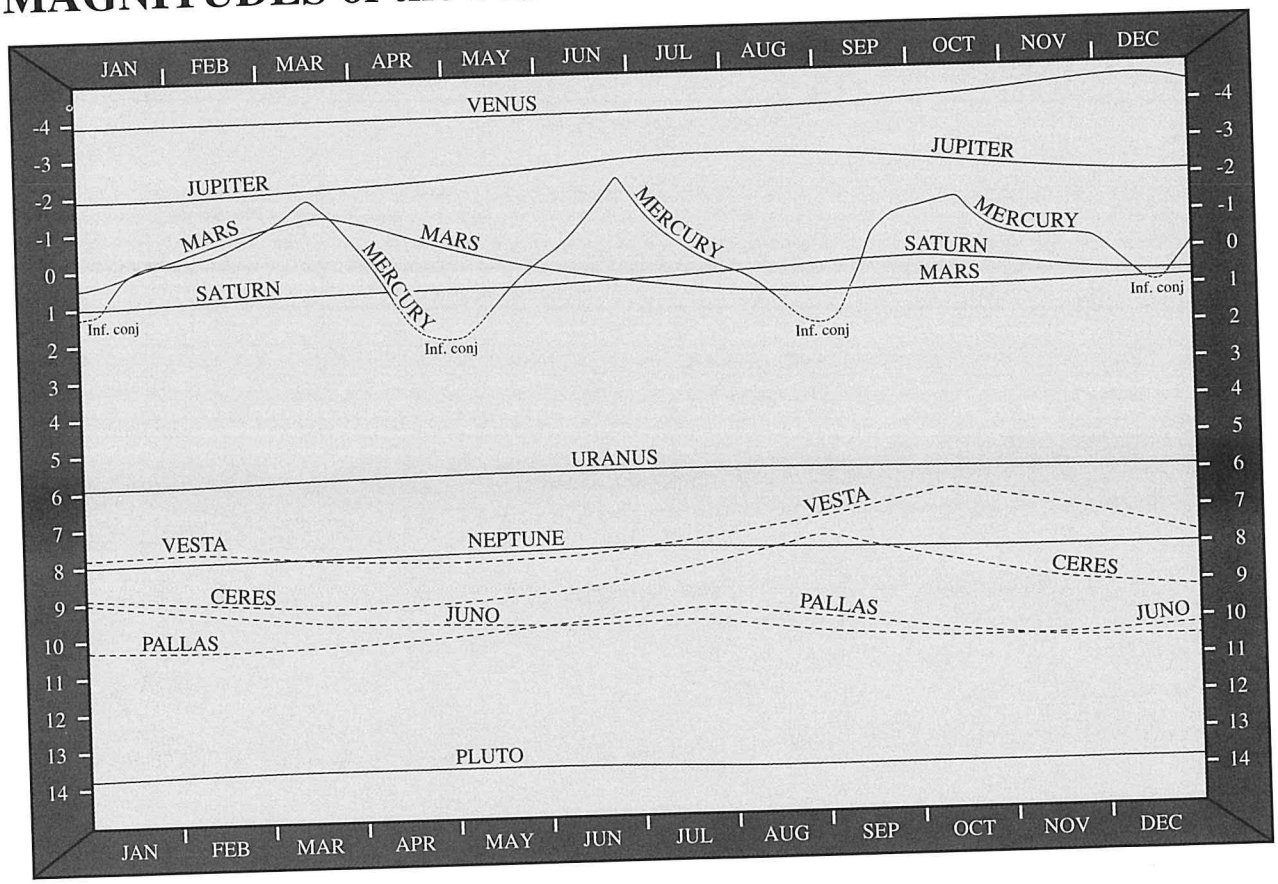


MERIDIAN PASSAGE of the SUN and PLANETS



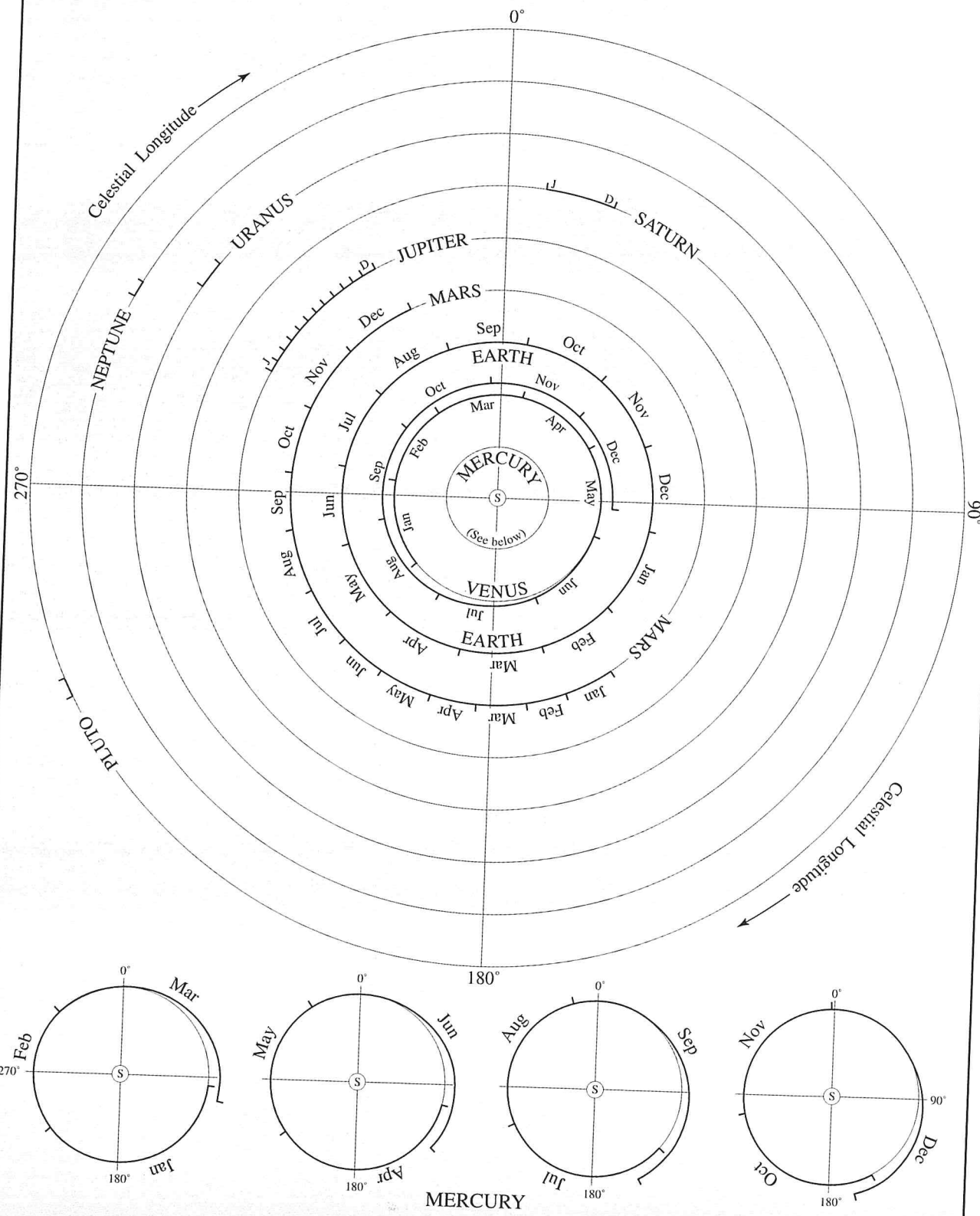
See explanation (part II) page 58

MAGNITUDES of the PLANETS and MAJOR ASTEROIDS



PLANET POSITIONS

This diagram illustrates the relative positions of the planets during the course of their orbits in 1997. The illustration clearly shows the relationship between the solar system bodies. For example note the Earth/Mars position in March, when Mars is at opposition. The diagram is drawn as viewed from below (South of) the solar system. The drawing has been simplified in that the orbits are not shown as ellipses and the sun/planet distances are not drawn to scale. It should also be noted that Pluto, with its highly elliptical orbit, is at present inside the orbit of Neptune. This situation continues until 1999.



SUN

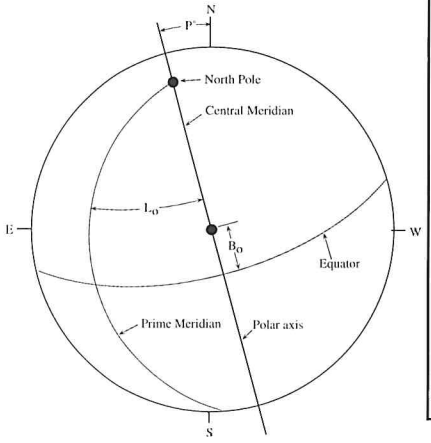
GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

SUN — RISE, SET (for Perth, W.A.S.T.) and ORIENTATION

SYNODIC ROTATION NUMBERS (UT)		
		d.dd
1918	Jan	5.61
1919	Feb	1.95
1920	Mar	1.29
1921	Mar	28.60
1922	Apr	24.87
1923	May	22.10
1924	Jun	18.31
1925	Jul	15.50
1926	Aug	11.72
1927	Sep	7.97
1928	Oct	5.24
1929	Nov	1.54
1930	Nov	28.84
1931	Dec	26.17



VARIATION OF L_o	
DAILY	
1	13.18
2	26.37
3	39.55
4	52.73
5	65.91
6	79.10
HOURLY	
1	0.55
2	1.10
3	1.65
4	2.20
5	2.75
6	3.30
7	3.84
8	4.39
9	4.94
10	5.49
11	6.04
12	6.59
13	7.14
14	7.69
15	8.24
16	8.79
17	9.34
18	9.89
19	10.43
20	10.98
21	11.53
22	12.08
23	12.63
24	13.18

DATE		TWI BEG	SUN RISE	SUN SET	TWI END	P°	B_o°	L_o°
		h m	h m	h m	h m	0hr UT		
Jan	4	3 37	5 16	19 27	21 05	+ 0.56	- 3.39	021.20
	11	3 44	5 22	19 27	21 04	- 2.81	- 4.16	289.02
	18	3 53	5 28	19 25	21 01	- 6.10	- 4.86	196.85
	25	4 01	5 35	19 23	20 56	- 9.24	- 5.49	104.68
Feb	1	4 10	5 41	19 18	20 50	- 12.20	- 6.04	012.52
	8	4 19	5 48	19 13	20 42	- 14.94	- 6.49	280.35
	15	4 27	5 54	19 07	20 34	- 17.43	- 6.84	188.19
	22	4 35	6 00	19 00	20 25	- 19.63	- 7.08	096.00
Mar	1	4 42	6 06	18 52	20 16	- 21.55	- 7.22	003.80
	8	4 48	6 11	18 43	20 06	- 23.16	- 7.25	271.58
	15	4 54	6 16	18 35	19 56	- 24.45	- 7.17	179.34
	22	5 00	6 21	18 26	19 47	- 25.40	- 6.98	087.06
	29	5 05	6 26	18 17	19 38	- 26.02	- 6.69	354.74
Apr	5	5 09	6 31	18 08	19 29	- 26.28	- 6.31	262.39
	12	5 14	6 35	17 59	19 21	- 26.20	- 5.83	170.00
	19	5 18	6 40	17 51	19 13	- 25.75	- 5.27	077.57
	26	5 22	6 45	17 44	19 06	- 24.94	- 4.65	345.10
May	3	5 26	6 50	17 37	19 00	- 23.78	- 3.96	252.60
	10	5 30	6 54	17 31	18 55	- 22.26	- 3.21	160.06
	17	5 34	6 59	17 27	18 51	- 20.41	- 2.43	067.48
	24	5 38	7 04	17 23	18 48	- 18.25	- 1.61	334.88
	31	5 41	7 08	17 20	18 47	- 15.81	- 0.77	242.25
Jun	7	5 45	7 12	17 19	18 46	- 13.11	+ 0.07	149.62
	14	5 47	7 15	17 19	18 46	- 10.22	+ 0.91	056.97
	21	5 49	7 17	17 20	18 47	- 7.18	+ 1.74	324.31
	28	5 50	7 18	17 22	18 49	- 4.05	+ 2.55	231.65
Jul	5	5 51	7 18	17 25	18 52	- 0.87	+ 3.32	138.99
	12	5 50	7 16	17 28	18 55	+ 2.29	+ 4.04	046.35
	19	5 48	7 14	17 32	18 58	+ 5.39	+ 4.72	313.72
	26	5 45	7 10	17 37	19 01	+ 8.38	+ 5.32	221.11
Aug	2	5 41	7 05	17 41	19 05	+ 11.22	+ 5.86	128.53
	9	5 36	6 59	17 46	19 09	+ 13.88	+ 6.32	035.96
	16	5 30	6 52	17 50	19 12	+ 16.34	+ 6.69	303.42
	23	5 23	6 45	17 54	19 16	+ 18.57	+ 6.98	210.91
	30	5 15	6 36	17 59	19 20	+ 20.56	+ 7.16	118.42
Sep	6	5 07	6 28	18 03	19 24	+ 22.27	+ 7.25	025.97
	13	4 57	6 18	18 07	19 28	+ 23.71	+ 7.23	293.53
	20	4 48	6 09	18 11	19 33	+ 24.84	+ 7.11	201.12
	27	4 38	6 00	18 16	19 38	+ 25.66	+ 6.89	108.73
Oct	4	4 28	5 51	18 20	19 43	+ 26.15	+ 6.57	016.36
	11	4 19	5 42	18 25	19 49	+ 26.29	+ 6.15	284.01
	18	4 09	5 34	18 30	19 56	+ 26.07	+ 5.64	191.67
	25	4 00	5 26	18 36	20 03	+ 25.48	+ 5.04	099.34
Nov	1	3 51	5 19	18 41	20 10	+ 24.51	+ 4.37	007.04
	8	3 43	5 14	18 48	20 18	+ 23.15	+ 3.63	274.74
	15	3 36	5 09	18 54	20 27	+ 21.41	+ 2.84	182.45
	22	3 31	5 06	19 00	20 35	+ 19.30	+ 2.00	090.18
	29	3 27	5 04	19 06	20 43	+ 16.85	+ 1.12	357.92
Dec	6	3 25	5 03	19 12	20 51	+ 14.10	+ 0.23	265.67
	13	3 25	5 04	19 17	20 57	+ 11.10	- 0.66	173.43
	20	3 27	5 07	19 21	21 02	+ 7.89	- 1.55	081.21
	27	3 30	5 10	19 25	21 05	+ 4.56	- 2.42	349.00

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

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

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

SOLAR AND LUNAR ECLIPSES

During 1997 there are four eclipses, two of the Sun and two of the Moon. One solar eclipse is total and the other partial. One lunar eclipse is total and the other partial. From Australia both the partial solar and the total lunar eclipses in September are visible.

9th March TOTAL ECLIPSE of the SUN

This eclipse is visible from parts of Asia, Japan, the Arctic regions, Alaska and the western area of Canada. The maximum duration of totality is 2 minutes and 50 seconds.

24th March PARTIAL ECLIPSE of the MOON

Visible from the Americas and west Africa.

2nd September PARTIAL ECLIPSE of the SUN

Visible from Australia, New Zealand and part of Antarctica. See next page for detail.

	UT	Longitude	Latitude
Eclipse begins	1d21h 44.1m	+127° 40.3'	-24° 47.5'
Greatest eclipse	2d00h 03.7m	+114° 21.3'	-71° 51.5'
Eclipse ends	2d02h 23.1m	-138° 20.4'	-57° 09.2'

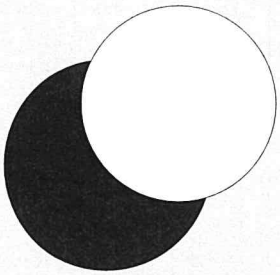
17th September TOTAL ECLIPSE of the MOON

This eclipse will be visible from Australia, although twilight interferes with the late stages of the eclipse from the eastern states. Observers in Western Australia will see the entire eclipse before the onset of dawn. See next page for detail.

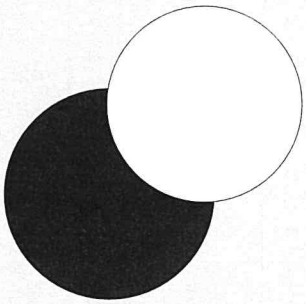
	Stage	WAST
Moon enters penumbra	P1	00h 11.0m
Moon enters umbra	U1	01h 08.0m
Moon enters totality	U2	02h 15.4m
Middle of eclipse	Mid	02h 46.6m
Moon leaves totality	U3	03h 17.9m
Moon leaves umbra	U4	04h 25.2m
Moon leaves penumbra	P4	05h 22.2m

PARTIAL SOLAR ECLIPSE of 2nd September 1997

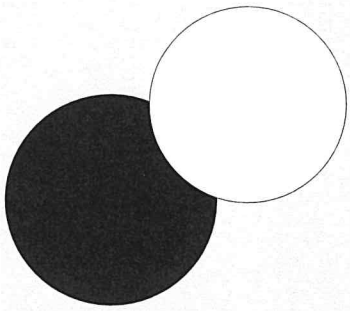
The diagrams show the appearance of the Sun at the approximate local time of mid eclipse.
Below each location is the beginning and end times. All times are correct to within about 5 minutes.



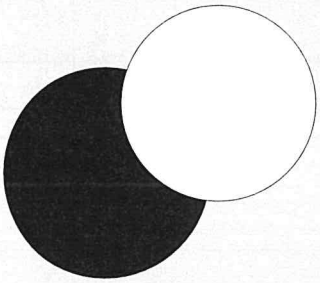
ALBANY 7.00am WAST, altitude 6°
Eclipse begins below horizon, ends 8.05am



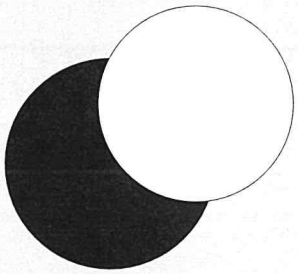
ALICE SPRINGS N.T. 8.20am CAST
altitude 20°
Eclipse begins 7.15am, ends 9.25am



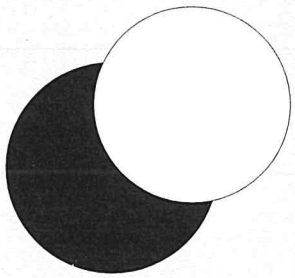
BROOME 6.30am WAST, altitude 7°
Eclipse begins below horizon, ends 7.20am



CARNARVON 6.45am WAST, altitude 1°
Eclipse begins below horizon, ends 7.35am



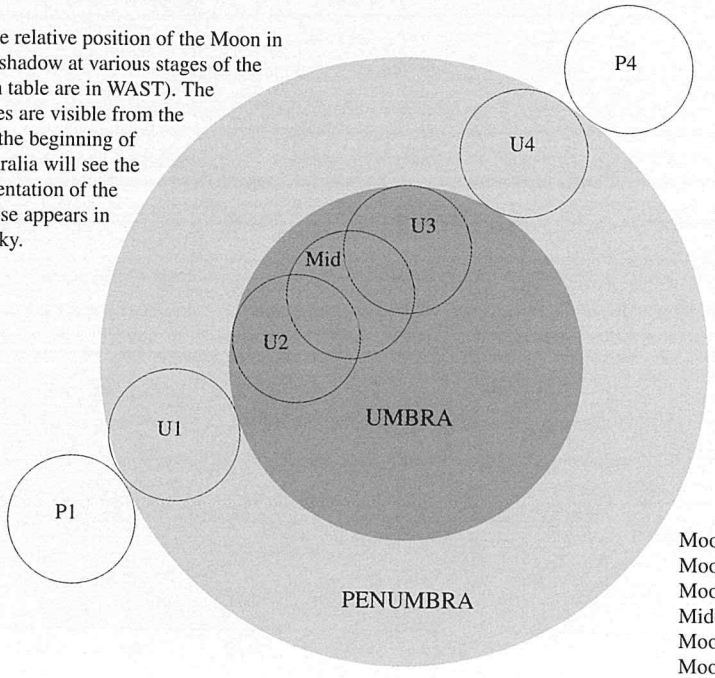
KALGOORLIE 7.00am WAST, altitude 10°
Eclipse begins below the horizon, ends 8.05am



PERTH 6.55am WAST, altitude 4°
Eclipse begins below horizon, ends 8.00am

TOTAL LUNAR ECLIPSE of 17th September 1997

The diagram shows the relative position of the Moon in relation to the Earth's shadow at various stages of the eclipse (times given in table are in WAST). The beginning to mid stages are visible from the eastern states prior to the beginning of twilight. Western Australia will see the entire eclipse. The orientation of the diagram is as the eclipse appears in the western morning sky.

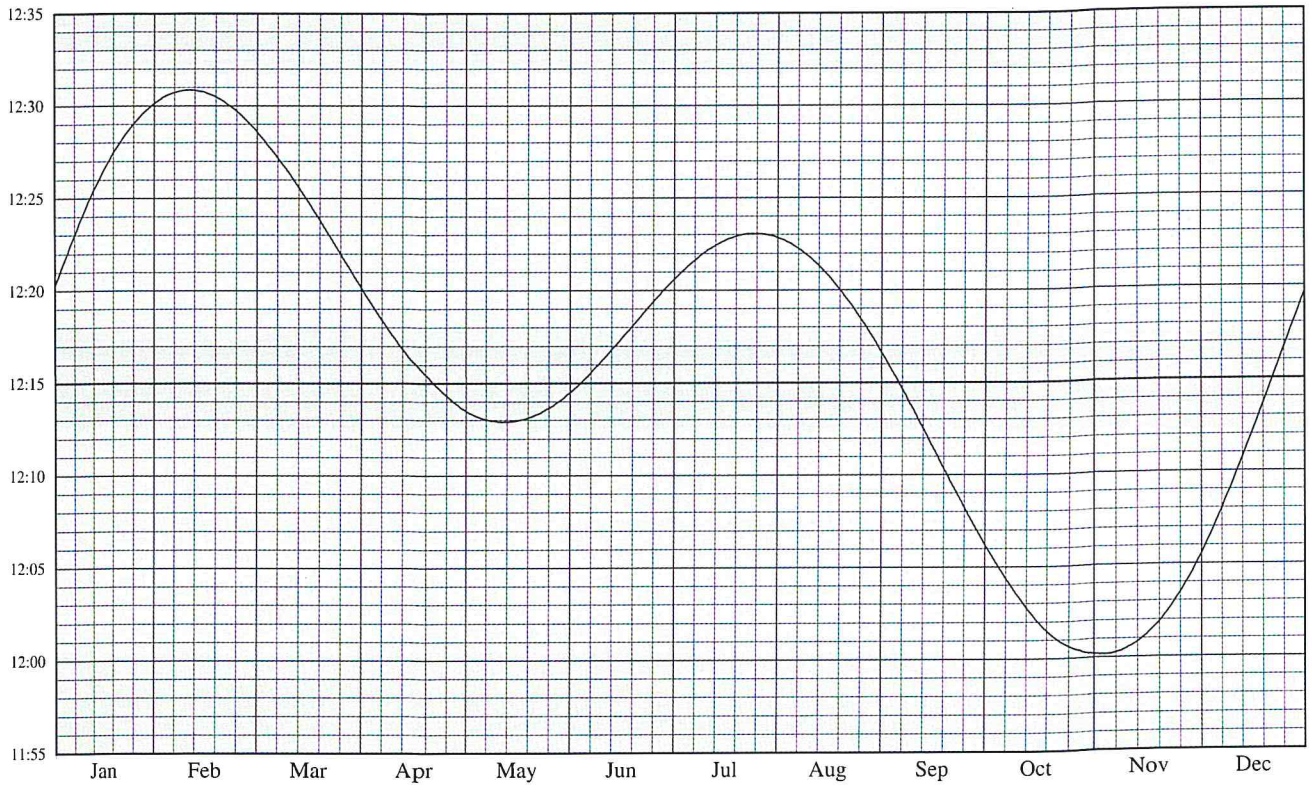


Moon enters penumbra (P1) 00h 11.0m
Moon enters umbra (U1) 01h 08.0m
Moon enters totality (U2) 02h 15.4m
Middle of eclipse (Mid) 02h 46.6m
Moon leaves totality (U3) 03h 17.9m
Moon leaves umbra (U4) 04h 25.2m
Moon leaves penumbra (P4) 05h 22.2m

SUN TRANSIT TIMES FOR PERTH (W.A.S.T.)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DATE
	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	hh mm ss	
1	12 20 14	12 30 13	12 28 56	12 20 27	12 13 39	12 14 23	12 20 25	12 22 52	12 16 32	12 06 13	12 00 11	12 05 39	1
2	12 20 42	12 30 20	12 28 44	12 20 09	12 13 33	12 14 33	12 20 36	12 22 48	12 16 13	12 05 54	12 00 10	12 06 02	2
3	12 21 10	12 30 27	12 28 31	12 19 51	12 13 26	12 14 42	12 20 47	12 22 44	12 15 54	12 05 35	12 00 10	12 06 26	3
4	12 21 37	12 30 33	12 28 18	12 19 34	12 13 21	12 14 53	12 20 58	12 22 38	12 15 34	12 05 17	12 00 10	12 06 50	4
5	12 22 04	12 30 38	12 28 05	12 19 17	12 13 15	12 15 03	12 21 09	12 22 33	12 15 14	12 04 59	12 00 12	12 07 15	5
6	12 22 31	12 30 42	12 27 51	12 19 00	12 13 11	12 15 14	12 21 19	12 22 26	12 14 54	12 04 41	12 00 14	12 07 40	6
7	12 22 57	12 30 45	12 27 37	12 18 43	12 13 07	12 15 25	12 21 29	12 22 19	12 14 34	12 04 24	12 00 17	12 08 05	7
8	12 23 23	12 30 48	12 27 23	12 18 26	12 13 03	12 15 37	12 21 38	12 22 11	12 14 13	12 04 07	12 00 21	12 08 32	8
9	12 23 48	12 30 50	12 27 08	12 18 10	12 13 01	12 15 49	12 21 47	12 22 03	12 13 52	12 03 50	12 00 26	12 08 58	9
10	12 24 12	12 30 51	12 26 52	12 17 54	12 12 58	12 16 00	12 21 56	12 21 54	12 13 32	12 03 34	12 00 32	12 09 25	10
11	12 24 36	12 30 51	12 26 37	12 17 38	12 12 57	12 16 13	12 22 04	12 21 45	12 13 10	12 03 19	12 00 38	12 09 53	11
12	12 24 59	12 30 51	12 26 21	12 17 22	12 12 55	12 16 25	12 22 12	12 21 35	12 12 49	12 03 04	12 00 45	12 10 21	12
13	12 25 22	12 30 50	12 26 05	12 17 07	12 12 55	12 16 37	12 22 19	12 21 24	12 12 28	12 02 49	12 00 53	12 10 49	13
14	12 25 44	12 30 47	12 25 48	12 16 52	12 12 55	12 16 50	12 22 26	12 21 13	12 12 07	12 02 35	12 01 02	12 11 17	14
15	12 26 05	12 30 45	12 25 31	12 16 37	12 12 55	12 17 03	12 22 32	12 21 01	12 11 45	12 02 21	12 01 12	12 11 46	15
16	12 26 26	12 30 41	12 25 14	12 16 23	12 12 56	12 17 16	12 22 38	12 20 49	12 11 24	12 02 08	12 01 23	12 12 15	16
17	12 26 46	12 30 37	12 24 57	12 16 09	12 12 58	12 17 28	12 22 43	12 20 36	12 11 02	12 01 56	12 01 34	12 12 44	17
18	12 27 05	12 30 32	12 24 40	12 15 55	12 13 00	12 17 41	12 22 47	12 20 23	12 10 41	12 01 44	12 01 46	12 13 13	18
19	12 27 24	12 30 26	12 24 22	12 15 42	12 13 02	12 17 54	12 22 51	12 20 09	12 10 19	12 01 33	12 02 00	12 13 43	19
20	12 27 41	12 30 20	12 24 04	12 15 29	12 13 05	12 18 07	12 22 55	12 19 55	12 09 58	12 01 22	12 02 14	12 14 13	20
21	12 27 58	12 30 13	12 23 46	12 15 17	12 13 09	12 18 20	12 22 58	12 19 40	12 09 37	12 01 12	12 02 28	12 14 42	21
22	12 28 14	12 30 05	12 23 28	12 15 05	12 13 13	12 18 33	12 23 00	12 19 25	12 09 16	12 01 03	12 02 44	12 15 12	22
23	12 28 30	12 29 57	12 23 10	12 14 53	12 13 18	12 18 46	12 23 02	12 19 10	12 08 54	12 00 54	12 03 00	12 15 42	23
24	12 28 44	12 29 48	12 22 52	12 14 42	12 13 23	12 18 59	12 23 03	12 18 54	12 08 34	12 00 47	12 03 18	12 16 12	24
25	12 28 58	12 29 39	12 22 34	12 14 32	12 13 29	12 19 12	12 23 04	12 18 37	12 08 13	12 00 39	12 03 36	12 16 42	25
26	12 29 11	12 29 29	12 22 15	12 14 22	12 13 35	12 19 24	12 23 04	12 18 20	12 07 52	12 00 33	12 03 55	12 17 12	26
27	12 29 24	12 29 18	12 21 57	12 14 12	12 13 42	12 19 37	12 23 03	12 18 03	12 07 32	12 00 27	12 04 14	12 17 41	27
28	12 29 35	12 29 07	12 21 39	12 14 03	12 13 49	12 19 49	12 23 02	12 17 46	12 07 12	12 00 23	12 04 34	12 18 11	28
29	12 29 46		12 21 21	12 13 55	12 13 57	12 20 01	12 23 01	12 17 28	12 06 52	12 00 18	12 04 55	12 18 40	29
30	12 29 55		12 21 03	12 13 47	12 14 05	12 20 13	12 22 58	12 17 10	12 06 32	12 00 15	12 05 17	12 19 09	30
31	12 30 04		12 20 45		12 14 14		12 22 56	12 16 51		12 00 13		12 19 38	31

TRANSIT TIME OF THE SUN AT PERTH (W.A.S.T.)



MOON RISE AND SET (for Perth)

(W.A.S.T.)

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
	h mm	h mm	h mm	h mm	h mm	h mm	h mm	h mm	h mm	h mm	h mm	h mm
1	23 51	11 35	DNR	13 07	23 01	11 56	DNR	13 33	0 29	13 54	2 37	14 37
2	DNR	12 29	0 20	14 05	23 48	12 53	0 31	14 24	1 33	14 36	3 41	15 19
3	0 25	13 24	1 06	15 04	DNR	13 50	1 34	15 12	2 38	15 18	4 43	16 02
4	1 02	14 22	1 58	16 04	0 42	14 46	2 40	15 57	3 43	15 59	5 45	16 47
5	1 42	15 21	2 56	17 01	1 41	15 41	3 46	16 41	4 48	16 40	6 45	17 36
6	2 28	16 22	4 00	17 56	2 44	16 33	4 54	17 23	5 53	17 23	7 41	18 27
7	3 18	17 23	5 07	18 48	3 51	17 21	6 01	18 06	6 57	18 09	8 34	19 20
8	4 16	18 23	6 17	19 35	5 00	18 07	7 07	18 49	7 59	18 56	9 22	20 14
9	5 18	19 20	7 26	20 20	6 09	18 51	8 13	19 33	8 58	19 47	10 05	21 08
10	6 25	20 13	8 34	21 02	7 17	19 34	9 16	20 20	9 52	20 39	10 45	22 01
11	7 33	21 01	9 41	21 43	8 24	20 16	10 16	21 08	10 43	21 32	11 21	22 54
12	8 41	21 46	10 45	22 24	9 30	21 00	11 11	21 59	11 28	22 25	11 56	23 46
13	9 48	22 27	11 47	23 06	10 32	21 44	12 03	22 50	12 09	23 18	12 29	DNS
14	10 52	23 07	12 46	23 50	11 32	22 30	12 50	23 42	12 47	DNS	13 01	0 39
15	11 55	23 46	13 43	DNS	12 29	23 18	13 33	DNS	13 22	0 11	13 35	1 32
16	12 56	DNS	14 36	0 35	13 21	DNS	14 12	0 35	13 56	1 03	14 10	2 26
17	13 55	0 26	15 26	1 23	14 10	0 08	14 48	1 27	14 29	1 56	14 48	3 21
18	14 53	1 08	16 13	2 12	14 54	0 58	15 23	2 20	15 02	2 49	15 30	4 19
19	15 48	1 51	16 56	3 03	15 35	1 50	15 56	3 12	15 37	3 42	16 16	5 17
20	16 40	2 37	17 36	3 55	16 13	2 42	16 30	4 05	16 14	4 38	17 09	6 17
21	17 29	3 25	18 13	4 47	16 49	3 34	17 03	4 58	16 53	5 34	18 06	7 15
22	18 15	4 15	18 48	5 39	17 23	4 26	17 39	5 52	17 37	6 32	19 08	8 11
23	18 57	5 07	19 22	6 32	17 56	5 19	18 17	6 48	18 26	7 31	20 12	9 04
24	19 36	5 59	19 55	7 24	18 29	6 12	18 58	7 45	19 20	8 29	21 18	9 52
25	20 12	6 52	20 28	8 17	19 04	7 05	19 43	8 42	20 18	9 26	22 23	10 37
26	20 47	7 44	21 02	9 10	19 39	8 00	20 32	9 40	21 19	10 19	23 27	11 19
27	21 20	8 37	21 38	10 04	20 18	8 55	21 26	10 36	22 22	11 08	DNR	11 59
28	21 52	9 29	22 17	10 59	20 59	9 51	22 25	11 30	23 26	11 54	0 31	12 39
29	22 26	10 22			21 45	10 48	23 26	12 21	DNR	12 37	1 34	13 19
30	23 01	11 15			22 36	11 44	DNR	13 09	0 30	13 18	2 36	14 00
31	23 38	12 10			23 31	12 39			1 34	13 58		

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
1	3 36	14 44	5 12	15 59	5 57	17 26	5 39	17 58	5 57	19 28	6 04	20 07
2	4 36	15 31	5 58	16 52	6 31	18 19	6 12	18 51	6 37	20 23	6 55	21 02
3	5 33	16 20	6 41	17 45	7 05	19 11	6 45	19 44	7 21	21 18	7 51	21 53
4	6 26	17 11	7 20	18 39	7 37	20 03	7 20	20 38	8 09	22 13	8 51	22 41
5	7 16	18 05	7 56	19 31	8 10	20 55	7 58	21 32	9 01	23 05	9 52	23 26
6	8 01	18 58	8 30	20 24	8 44	21 48	8 38	22 27	9 57	23 55	10 55	DNS
7	8 42	19 52	9 03	21 16	9 19	22 42	9 23	23 22	10 57	DNS	11 58	0 09
8	9 20	20 45	9 35	22 08	9 57	23 37	10 12	DNS	11 58	0 41	13 02	0 49
9	9 56	21 38	10 08	23 01	10 40	DNS	11 05	0 15	13 02	1 26	14 06	1 29
10	10 29	22 30	10 43	23 54	11 26	0 32	12 04	1 07	14 07	2 08	15 11	2 09
11	11 02	23 22	11 19	DNS	12 18	1 28	13 06	1 57	15 13	2 49	16 15	2 51
12	11 34	DNS	12 00	0 49	13 15	2 22	14 10	2 45	16 19	3 31	17 19	3 35
13	12 08	0 15	12 45	1 46	14 17	3 15	15 17	3 30	17 26	4 13	18 22	4 22
14	12 44	1 09	13 35	2 43	15 23	4 06	16 25	4 13	18 33	4 57	19 21	5 13
15	13 23	2 05	14 32	3 40	16 31	4 54	17 33	4 56	19 37	5 44	20 16	6 06
16	14 06	3 02	15 33	4 36	17 41	5 40	18 42	5 39	20 39	6 34	21 05	7 02
17	14 55	4 00	16 39	5 30	18 50	6 24	19 49	6 24	21 36	7 27	21 50	7 58
18	15 50	4 59	17 47	6 20	19 58	7 08	20 55	7 10	22 27	8 21	22 30	8 54
19	16 50	5 57	18 56	7 07	21 05	7 51	21 57	7 58	23 14	9 17	23 07	9 49
20	17 55	6 52	20 05	7 52	22 10	8 36	22 55	8 49	23 55	10 12	23 41	10 43
21	19 02	7 44	21 12	8 35	23 12	9 22	23 48	9 41	DNR	11 07	DNR	11 35
22	20 09	8 32	22 18	9 17	DNR	10 09	DNR	10 35	0 33	12 00	0 14	12 28
23	21 16	9 17	23 22	9 59	0 11	10 59	0 35	11 29	1 08	12 53	0 46	13 20
24	22 22	9 59	DNR	10 43	1 05	11 51	1 18	12 23	1 41	13 45	1 19	14 13
25	23 26	10 40	0 24	11 28	1 54	12 43	1 58	13 16	2 14	14 37	1 53	15 07
26	DNR	11 20	1 22	12 15	2 39	13 36	2 34	14 08	2 46	15 30	2 30	16 02
27	0 29	12 01	2 17	13 04	3 20	14 29	3 08	15 01	3 20	16 24	3 10	16 59
28	1 31	12 44	3 09	13 55	3 58	15 22	3 41	15 53	3 56	17 19	3 55	17 56
29	2 30	13 29	3 56	14 48	4 33	16 14	4 13	16 45	4 34	18 15	4 45	18 52
30	3 27	14 17	4 40	15 41	5 06	17 06	4 46	17 38	5 17	19 11	5 41	19 46
31	4 21	15 07	5 20	16 34			5 21	18 33			6 40	20 37

MOON PHASES (WAST)

Lunation	New Moon		First Quarter		Full Moon		Last Quarter	
	d	h m	d	h m	d	h m	d	h m
915							Jan 02	09:45
916	Jan 09	12:26	Jan 16	04:02	Jan 23	23:11	Feb 01	03:40
917	Feb 07	23:06	Feb 14	16:57	Feb 22	18:27	Mar 02	17:37
918	Mar 09	09:15	Mar 16	08:06	Mar 24	12:45	Apr 01	03:38
919	Apr 07	19:02	Apr 15	01:00	Apr 23	04:33	Apr 30	10:37
920	May 07	04:46	May 14	18:55	May 22	17:13	May 29	15:51
921	Jun 05	15:03	Jun 13	12:51	Jun 21	03:09	Jun 27	20:42
922	Jul 05	02:40	Jul 13	05:44	Jul 20	11:20	Jul 27	02:28
923	Aug 03	16:14	Aug 11	20:42	Aug 18	18:55	Aug 25	10:23
924	Sep 02	07:52	Sep 10	09:31	Sep 17	02:50	Sep 23	21:35
925	Oct 02	00:51	Oct 09	20:22	Oct 16	11:46	Oct 23	12:48
926	Oct 31	18:01	Nov 08	05:43	Nov 14	22:12	Nov 22	07:58
927	Nov 30	10:14	Dec 07	14:09	Dec 14	10:37	Dec 22	05:43
928	Dec 30	00:56						

MOON (WAST)

APOGEE		PERIGEE	
	d hh		d hh
Jan	26 01	Jan	10 17
Feb	22 01	Feb	8 05
Mar	21 08	Mar	8 17
Apr	17 23	Apr	6 01
May	15 18	May	3 19
Jun	12 13	May	29 15
Jul	10 07	Jun	24 13
Aug	6 22	Jul	22 07
Sep	3 05	Aug	19 13
Sep	30 07	Sep	16 23
Oct	27 17	Oct	15 10
Nov	24 10	Nov	12 16
Dec	22 07	Dec	10 01

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 monthly moves across the heavily star populated Milky Way. It also occasionally occults the Sun and the planets. An eclipse of the Sun is indeed the most spectacular lunar occultation!

From month to month the Moon does not occult the same stars. In fact over a number of years it drifts in declination between plus and minus 28 degrees. The brighter stars the Moon occults are listed in the Zodiacal Catalogue (ZC). There are about 3500 stars in the ZC.

The Moon moves from west to east, so it rises and sets later from day to day. From just after New Moon to just before Full Moon, stars being occulted will disappear behind part of the dark limb and reappear from the bright limb. The limb is another way of saying the edge of the Moon. After Full Moon a star will disappear on the bright limb and reappear on the dark limb. There is no dark limb at the time of Full Moon.

Dark limb events, in particular disappearances, are the easiest to observe. Following a star until it 'winks out' is much easier than scanning the lunar limb waiting for it to suddenly reappear. The brighter the star the more spectacular the event. The following tables present the easier to observe occultations for 1997 as predicted for Perth. 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, are required. For multiple events, the amateur may tape record simultaneously a shortwave radio time signal (eg. VNG) with his own voice calling out the events (eg. star gone ... now !). The tape would be later played back (often at a slower speed) and the precise times determined. An accuracy of within 0.2 seconds is not unusual for the experienced observer.

TELESCOPE REQUIREMENTS. These vary greatly with the brightness of the star being observed,the brightness of the Moon (how close to Full Moon) and whether the event is on a bright or dark limb. Disappearances of first magnitude stars on the dark limb c[illegible] observed with the naked eye!

[illegible]er information on timing methods for occultations it would [illegible]hile contacting your local astronomical society (see page

LUNAR OCCULTATION TABLES

The faintest stars, which have occultation predictions on the following pages, are approximately 8th magnitude. The criteria for selection are complex involving Sun and Moon altitude, star magnitude and whether it is a bright or dark limb event.

EXPLANATION

WAST Is the date and time of the occultation in WAST.

CATALOG is the ZC catalogue number.

PD This is the event which consists of two letters. The first letter is the type of Event ie. 'D' = Disappearance and 'R' = Reappearance. The second letter represents: 'D' = Dark limb, 'B' = a bright limb event.

Mag is the magnitude of the star.

Elg is the elongation or separation of the Moon from the Sun as measured in degrees.

Alt. Is the altitude of the Moon during the occultation.

P.A. Position Angle is the position the event occurs on the limb of the Moon (measured as degrees east of true north).

A Coefficient of Longitude (see below)

B Coefficient of Latitude (see below)

**** NB. For some stars, close to 'grazing', A and B values become useless, and no values are recorded.

CALCULATING EVENT TIME FOR OTHER LOCATIONS

Unless the event is close to a 'graze' (ie. PA is close to 0° or 180°) this calculation will give a good approximation for any location within about 500km from the city's table you are working from. The formula is:

Predicted Time at your location

= Time from Table - (A x n) + (B x p)

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

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

'p' is positive(+) if North, negative(-) if South.

The values for A and B are taken from the tables.

It is best to use data for the city which you are closest to.

WORKED EXAMPLE

An observer wishes to calculate a more accurate time for the reappearance of ZC 2969 on April 29 for their location in Wagin (117° 20' E, 33° 19' S, see page 103).

-The change in longitude from Perth (decimal degrees)

= 115°.85 - 117°.33 = -1°.48 — 'n'

-The change in latitude from Perth (decimal degrees)

= 31°.95 - 33°.32 = -1°.37 — 'p'

From the table, the time of the event is 23:35 WAST and the values of A and B are -0.2 and -0.8 respectively.

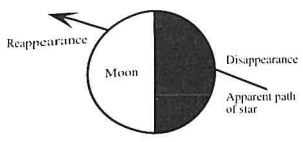
Therefore the equation becomes :-

23:35 - (-0.2 * -1.48) + (-0.8 * -1.37)

= 23:35 - (0.30) + (+1.1)

= 23:35 + 1 = 23:36

The event will be visible from Wagin approximately 1 min later than Perth, ie. about 11:36pm (WAST) on April 29th.



Lunar occultation predictions were calculated using Occult version 3.17 by D.Herald, PO Box 254 Woden ACT 2606. heraldd@canberra.DIALix.oz.au

LUNAR OCCULTATION TABLE

PERTH (31° 57' S, 115° 51'E)

ACST	CATALOG	PD	Mag	Elg	Alt	PA	A	B
Jan 05 03:42	2148	RD	7.8	57	24	305	0.3	-1.9
Jan 06 03:45	2285	RD	8.1	45	15	287	0.1	-1.4
Jan 12 20:31	3319	DD	7.9	46	15	133	0.9	-0.9
Jan 13 20:53	3474	DD	6.0	60	19	71	0.6	1.5
Jan 15 21:36	204	DD	7.3	86	25	109	1.3	0.4
Jan 16 21:43	331	DD	8.2	99	30	75	1.6	1.4
Jan 21 00:12	884	DD	7.8	146	31	59	2.4	2.0
Jan 27 02:27	1567	RD	6.3	146	52	238	4.5	2.5
Jan 27 03:41	1573	RD	7.0	146	49	277	2.6	0.2
Jan 28 04:04	1676	RD	6.7	135	54	252	3.6	1.6
Jan 29 01:39	1770	DB	5.9	124	44	81	2.3	-0.6
Jan 29 02:50	1770	RD	5.9	124	54	335	1.2	-3.1
Feb 03 01:59	2365	RD	7.1	66	10	304	-0.2	-1.7
Feb 03 02:30	2372	DB	4.4	66	16	135	-0.2	-2.1
Feb 03 03:22	2372	RD	4.4	65	27	253	0.9	-0.5
Feb 04 04:42	2527	RD	6.9	52	32	346	-0.7	-5.1
Feb 16 21:29	832	DD	4.7	115	35	142	2.0	-1.8
Feb 16 22:27	832	RB	4.7	115	29	222	2.5	3.1
Feb 16 22:37	836	DD	5.5	116	28	160	0.5	-3.6
Feb 16 23:10	836	RB	5.5	116	23	208	2.9	5.1
Feb 17 22:35	985	DD	6.9	127	34	100	2.2	0.3
Feb 19 23:22	1228	DD	8.4	149	40	65	3.2	1.7
Feb 24 03:08	1641	RD	7.9	166	46	241	3.5	3.1
Feb 25 21:19	1828	RD	6.6	145	10	271	0.3	-1.1
Feb 26 02:32	1849	DB	6.2	144	61	56	4.6	3.0
Feb 26 03:16	1849	RD	6.2	144	61	1	-0.1	-5.8
Feb 26 21:29	1941	RD	4.8	134	5	350	-0.3	-3.6
Mar 04 01:37	2603	RD	8.0	72	10	305	-0.3	-1.8
Mar 04 01:58	2606	RD	7.1	72	14	289	0.0	-1.4
Mar 05 03:58	2789	RD	7.3	58	27	239	0.9	0.1
Mar 06 04:16	2936	RD	6.8	44	17	314	-0.1	-2.7
Mar 13 20:02	494	DD	8.3	59	18	84	1.1	1.2
Mar 15 21:49	787	DD	7.5	84	16	92	1.1	1.0
Mar 18 20:50	1184	DD	7.8	118	41	103	2.6	-0.3
Mar 21 19:58	1497	DD	7.5	151	35	100	1.9	-1.3
Mar 22 23:51	1606	DD	8.1	163	52	86	3.0	0.4
Mar 25 23:44	1920	RD	6.7	163	55	225	5.2	4.3
Mar 26 20:50	2020	RD	6.6	153	14	303	0.1	-1.8
Mar 27 21:44	2135	RD	7.6	141	17	230	1.0	0.6
Mar 28 01:10	2148	RD	7.8	140	59	256	2.6	0.0
Mar 28 03:35	2158	RD	7.3	139	70	316	2.0	-2.1
Mar 28 22:55	2265	RD	8.4	129	23	292	0.3	-1.6
Mar 29 03:07	2285	RD	8.1	127	71	270	2.5	-0.3
Mar 31 00:21	2548	RD	7.5	104	20	253	0.6	-0.5
Apr 01 02:22	2722	RD	7.1	90	34	261	1.0	-0.7
Apr 02 01:46	2880	RD	5.1	77	14	270	0.2	-1.0
Apr 16 20:45	1367	DD	8.5	110	43	170	0.5	-3.7
Apr 18 21:41	1567	DD	6.3	132	51	174	0.4	-4.1
Apr 18 22:17	1573	DD	7.0	132	49	138	1.7	-1.6
Apr 18 22:35	1567	RB	6.3	132	47	244	3.7	2.6
Apr 19 22:59	1676	DD	6.7	143	53	179	0.1	-4.8
Apr 20 20:58	1770	DD	5.9	154	51	101	2.2	-1.2
Apr 20 22:25	1770	RB	5.9	154	59	317	1.8	-2.0
Apr 22 04:38	1903	DD	7.5	167	15	85	0.4	1.3
Apr 24 04:16	2123	RD	8.2	168	42	214	1.4	6.9
Apr 24 23:30	2231	RD	6.9	158	55	293	1.6	-1.7
Apr 25 03:05	2245	RD	6.4	157	66	260	2.4	1.0
Apr 25 21:04	2365	RD	7.1	147	15	296	0.0	-1.6
Apr 25 21:40	2372	DB	4.4	147	23	144	-0.1	-2.5
Apr 25 22:30	2372	RD	4.4	146	33	246	1.3	-0.2
Apr 26 02:41	2387	RD	8.3	145	75	280	2.4	-0.5
Apr 28 00:27	2674	RD	6.0	120	36	274	0.9	-1.1
Apr 29 23:35	2969	RD	3.2	95	1	265	-0.2	-0.8
May 01 03:25	3146	DB	6.5	80	35	119	1.0	-2.5
May 01 03:44	3145	RD	6.8	80	39	191	1.3	4.4
May 01 04:18	3146	RD	6.5	80	46	212	1.4	1.9
May 02 05:43	3294	RD	6.9	66	49	246	1.6	0.2
May 04 05:44	35	RD	6.4	39	24	276	1.0	-1.3
May 10 19:31	963	DD	8.4	45	12	89	0.9	1.1
May 12 18:18	1210	DD	5.9	67	38	173	0.1	-4.5
May 12 18:56	1210	RB	5.9	67	34	223	3.9	4.5
May 15 20:42	1538	DD	8.5	101	45	89	2.6	0.7
May 16 20:06	1626	DD	8.3	112	54	176	0.3	-4.5
May 17 00:18	1641	DD	7.9	113	19	169	0.1	-3.0
May 19 18:10	1941	RB	4.8	145	31	353	-0.1	-4.1
May 20 03:04	1969	DD	7.1	148	18	41	0.4	4.8
May 21 01:13	2080	DD	8.3	159	52	63	2.2	2.6
May 22 01:19	2200	DD	7.7	170	62	164	1.6	-4.6
May 23 19:31	2454	RD	7.2	165	12	225	0.7	0.7
May 23 21:25	2460	RD	6.1	164	35	247	1.3	-0.2
May 24 02:42	2485	RD	7.4	162	68	250	2.2	1.4
May 24 03:20	2495	DB	6.0	162	61	74	1.9	1.4
May 24 04:37	2495	RD	6.0	161	46	285	1.5	0.3
May 25 22:30	2789	RD	7.3	138	26	305	0.2	-2.2
May 26 02:52	2808	RD	7.4	136	74	266	2.4	0.0
May 27 04:50	2958	RD	7.8	122	71	278	2.5	-0.2
May 27 06:28	2969	DB	3.2	122	56	30	0.9	3.2
May 28 00:53	3088	RD	8.2	111	30	234	1.0	0.3
May 28 04:25	3103	RD	7.7	109	68	241	2.1	1.0
May 29 03:45	3249	RD	8.7	96	51	257	1.8	-0.2
May 30 01:56	3380	RD	6.2	84	17	299	0.5	-2.5
May 30 03:11	3385	RD	6.6	83	32	234	1.0	0.4
May 31 03:53	3530	RD	7.0	69	27	216	0.7	1.1
May 31 04:32	3533	RD	8.1	69	35	307	2.2	-3.9
Jun 09 19:38	1284	DD	6.3	49	16	85	1.1	1.3
Jun 11 20:46	1497	DD	7.5	71	24	131	0.8	-0.5
Jun 12 19:17	1589	RB	6.0	82	47	287	2.2	-0.1
Jun 13 18:22	1696	DD	7.0	92	56	138	1.8	-2.0
Jun 14 00:33	1712	DD	3.8	94	0	30	9.9	9.9
Jun 14 19:11	1791	DD	8.7	104	59	48	6.2	5.6
Jun 16 00:22	1920	DD	6.7	117	25	161	0.7	-2.5
Jun 16 20:21	2020	DD	6.6	127	66	60	3.9	2.1
Jun 16 20:56	2022	DD	5.5	127	67	144	1.7	-2.5
Jun 16 21:13	2020	RB	6.6	127	66	351	0.8	-4.7
Jun 16 22:15	2022	RB	5.5	127	59	264	2.5	1.0
Jun 17 01:19	2032	DD	7.3	128	24	165	1.0	-3.3
Jun 17 18:26	2128	DD	5.8	138	44	62	2.2	0.4
Jun 17 19:15	2128	RB	5.8	138	53	344	0.4	-4.0
Jun 17 20:46	2135	DD	7.6	139	68	106	2.3	-1.0
Jun 18 00:38	2148	DD	7.8	140	44	102	1.5	0.4
Jun 18 02:36	2158	DD	7.3	141	20	77	0.4	1.5
Jun 19 01:28	2285	DD	8.1	152	46	83	1.5	1.3
Jun 19 19:57	2410	DD	8.7	163	44	74	1.6	-0.3
Jun 20 04:47	2447	DD	7.7	166	17	87	0.2	1.1
Jun 22 06:06	2768	RD	8.4	165	24	273	0.5	0.9
Jun 23 21:19	3027	RD	7.0	142	13	255	0.3	-0.5
Jun 24 06:03	3070	RD	6.6	138	46	287	1.8	0.2
Jun 25 02:52	3208	RD	6.5	126	64	213	1.5	2.3
Jun 25 04:58	3213	RD	8.4	125	64	304	3.5	-2.0
Jun 29 04:55	235	RD	6.9	72	37	265	1.7	-0.6
Jun 29 05:20	238	RD	6.7	72	40	289	2.5	-1.8
Jul 10 18:55	1658	RB	6.4	63	40	266	2.2	1.2
Jul 10 20:23	1668	DD	7.9	63	25	55	1.9	4.0
Jul 12 19:20	1866	DD	5.9	85	56	109	2.2	-0.3
Jul 12 20:47	1866	RB	5.9	85	41	302	1.5	-0.4
Jul 13 22:25	1985	DD	7.1	97	33	84	1.2	1.4
Jul 17 01:34	2372	DD	4.4	134	29	112	0.9	0.3
Jul 17 02:34	2372	RB	4.4	134	16	251	0.1	1.6
Jul 17 20:12	2495	DD	6.0	145	63	101	1.9	-1.1
Jul 17 21:38	2495	RB	6.0	145	75	276	2.4	-0.4
Jul 19 01:40	2674	DD	6.0	160	51	23	0.5	4.6
Jul 19 22:02	2830	DD	6.9	171	61	66	2.0	0.5
Jul 21 02:26	2995	RD	6.2	171	63	207	1.0	3.3
Jul 21 23:29	3137	RD	6.7	158	53	246	1.7	0.3
Jul 23 22:15	3431	RD	6.6	131	11	244	0.3	-0.2
Jul 25 02:52	50	DB	6.0	115	49	4	0.2	3.9
Jul 25 03:35	50	RD	6.0	115	54	300	3.5	-2.6
Aug 09 19:05	1933	RB	7.0	66	46	299	1.7	-0.4
Aug 09 19:52	1941	DD	4.8	66	38	107	1.4	0.3
Aug 09 21:08	1941	RB	4.8	67	22	292	0.7	0.3
Aug 11 21:46	2167	DD	7.5	90	37	132	1.3	-0.8
Aug 12 23:23	2306	DD	8.7	102	28	91	0.8	1.0
Aug 13 23:44	2447	DD	7.7	115	35	125	1.4	-0.4
Aug 15 02:15	2606	DD	7.1	128	16	27	-0.6	3.3
Aug 16 00:47	2768	DD	8.4	141	46	72	1.1	1.5
Aug 17 23:41	3072	DD	6.6	168	72	103	2.6	-0.6
Aug 18 03:42	3088	DD	8.2	170	32	103	1.1	0.6
Aug 19 20:29	3357	RD	6.8	164	18	269	0.5	-1.0
Aug 19 22:52	3369	RD	8.6	163	46	247	1.5	0.1
Aug 20 02:33	3385	RD	6.6	161	59	289	2.8	-0.5
Aug 21 04:53	8	RD	8.2	146	43	229	1.2	1.9
Aug 22 01:44	133	RD	8.2	133	48	254	1.9	0.1
Aug 23 01:28	283	RD	7.0	120	35	297	2.4	-2.5
Aug 23 05:40	295	RD	8.7	118	44	230	1.8	1.7
Aug 24 04:23	428	RD	7.8	105	44	287	2.9	-1.0
Aug 25 03:20	558	RD	8.2	93	30	248	1.4	-0.1
Aug 26 02:42	711	RD	8.2	81	14	214	0.2	1.0
Sep 06 20:22	2020	DD	6.6	48	17	145	0.6	-1.2
Sep 07 20:14	2128	DD	5.8	60	30	108	1.0	0.4
Sep 10 21:30	2527	DD	6.9	95	47	32	0.8	4.3
Sep 11 20:02	2674	DD	6.0	108	73	51	2.2	2.4
Sep 11 21:13	2674	RB	6.0	108	61	299	2.4	-0.8
Sep 14 19:40	3137	DD	6.7	148	51	86	1.7	-0.6
Sep 14 21:00	3145	DD	6.8	149	64	7	0.9	5.4
Sep 15 03:29	3169	DD	6.2	151	17	23	-0.2	2.7
Sep 17 01:29	3473	DD	7.7	179	55	349	-1.5	7.4
Sep 17 01:49	3473	RD	7.7	179	52	318	4.7	-4.4
Sep 18 04:53	81	RD	6.6	165	26	307	1.4	-0.6
Sep 19 05:17	235	RD	6.9	151	29	274	1.3	0.8
Sep 19 23:30	354	RD	5.5	139	27	241	0.9	0.1
Sep 20 00:00	360	RD	6.8	139	31	175	-1.1	5.5
Sep 20 02:42	369	RD	8.5	138	47	205	1.2	2.3
Sep 21 00:41	496	RD	7.9	125	27	177	-1.4	5.8
Sep 22 01:47	650	RD	5.7	112	27	225	0.9	0.7
Sep 24 05:00	963	RD	8.4	86	35	251	2.2	0.1
Oct 09 20:43	2789	DD	7.3	90	53	19	0.3	4.9
Oct 11 20:26	3072	RB	6.6	116	70	237	1.9	1.6
Oct 11 23:31	3088	DD	8.2	117	39	85	1.2	1.1
Oct 12 20:45	3226	DD	8.0	130	68	103	2.7	-0.8
Oct 13 01:25	3249	DD	8.7	131	25	56	0.4	1.8
Oct 13 19:37	3369	DD	8.6	143	50	74	1.7	-0.1
Oct 13 23:37	3385	DD	6.6	145	53	40	1.2	2.2
Oct 14 22:21	3530	DD	7.0	158	58	19	0.9	2.8
Oct 15 01:53	8	DD	8.2	160	36	98	1.5	0.7
Oct 15 03:30	16	DD	7.6	161	17	41	0.4	2.1
Oct 15 22:04	133	DD	8.2	172	48	69	1.8	0.2
Oct 16 04:26	167	DD	5.7	175	14	23	0.6	2.8
Oct 16 21:52	283	RD	7.0	173	35	290	2.1	-1.9
Oct 17 22:35	428	RD	7.8	159	29	316	3.2	-4.7
Oct 21 04:21	904	RD	7.1	118	39	193	2.3	7.5
Nov 07 19:47	3027	DD	7.0	84	59	29	0.9	3.2
Nov 13 01:52	235	DD	6.9	154	27	50	1.1	1.9
Nov 13 02:30	238	DD	6.7	155	20	18	0.8	3.2
Nov 13 20:04	354	DD	5.5	166	28	103	1.6	-1.5
Nov 13 21:01	354	RB	5.5	166	37	208	0.8	1.6
Nov 14 02:05	376	DD	7.0	168	31	102	1.6	0.5
Nov 19 01:57	1114	RD	6.8	127	33	215	1.8	2.1
Dec 04 20:37	2995	RB	6.2	54	24	266	0.5	1.1
Dec 07 21:19	3431	DD	6.6	94	42	56	1.2	1.8
Dec 13 02:26	609	DD	7.5	162	21	119	1.0	0.0
Dec 14 03:05	764	DD	5.0	174	22	72	1.5	1.4
Dec 16 01:42	1060	RD	7.4	159	39	297	2.4	-0.9
Dec 19 02:37	1422	RD	6.8	124	41	242	2.9	0.7
Dec 20 02:09	1531	DB	5.9	113	33	63	2.2	0.2
Dec 20 03:07	1531	RD	5.9	113	42	340	1.4	-3.4
Dec 21 03:48	1628	RD	7.9	102	45	306	1.9	-2.0
Dec 23 01:26	1821	RD	2.9	81	8	245	0.3	-0.3
Dec 23 02:41	1825	RD	6.1	80	23	264	1.0	-1.0
Dec 25 03:11	2043	RD	6.6	58	16	273	0.4	-1.2
Dec 25 03:29	2047	RD	6.7	58	19	252	0.7	-0.6

MOON

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

MERCURY

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

MERCURY

RISE AND SET TIMES FOR PERTH (W.A.S.T.)

VENUS

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

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

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

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

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

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

VENUS

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

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

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

MARS

RISE, SET (for Perth, W.A.S.T.)

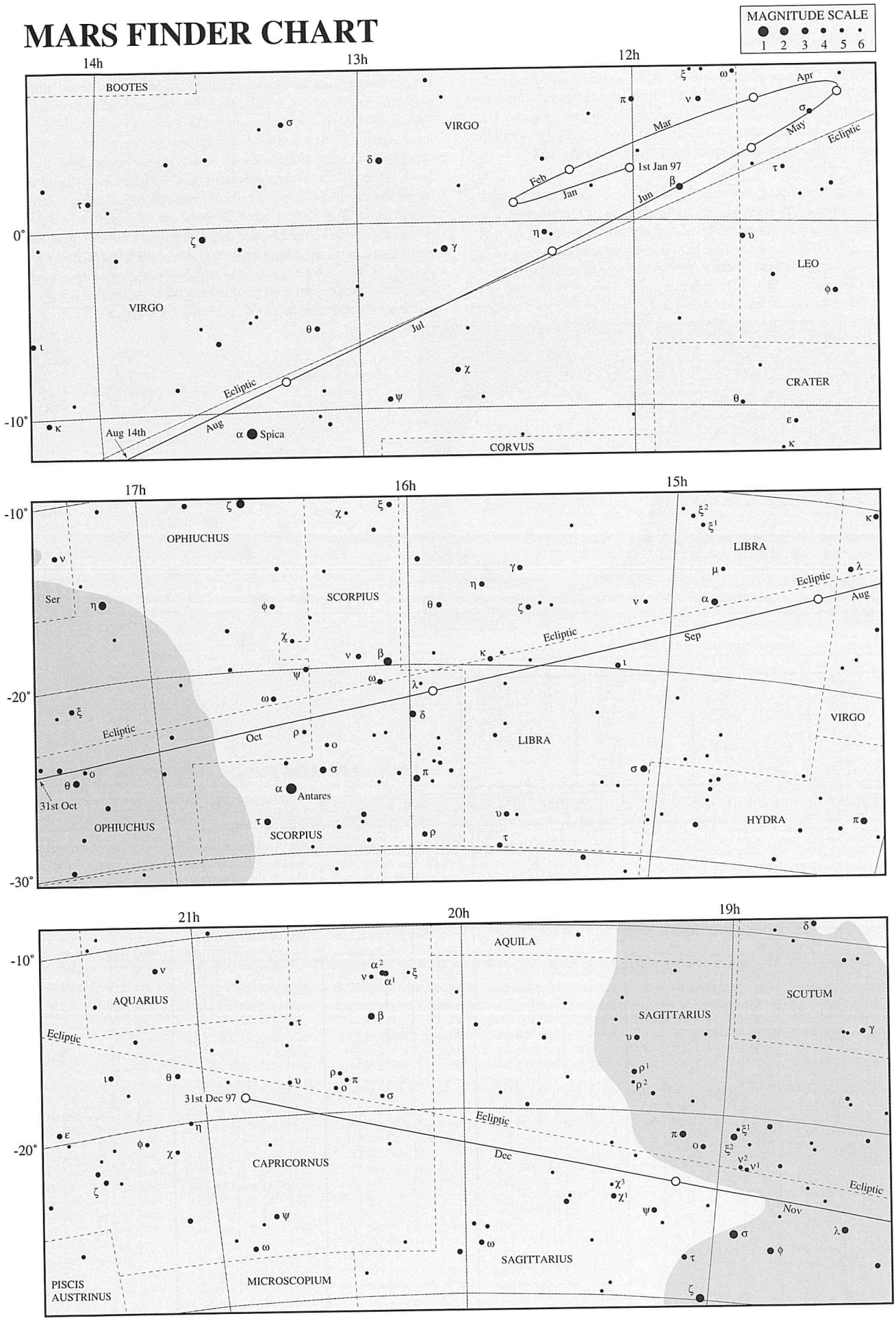
AND

GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

	RA h m s	DEC ° ' "	RISE h mm	SET h mm
Jan 4	12 05 13	+ 02 23 01	23 28	11 23
11	12 12 53	+ 01 43 05	23 07	11 05
18	12 19 08	+ 01 12 42	22 44	10 45
25	12 23 47	+ 00 53 01	22 20	10 23
Feb 1	12 26 36	+ 00 45 16	21 55	9 59
8	12 27 19	+ 00 50 39	21 28	9 31
15	12 25 44	+ 01 09 46	21 00	9 02
22	12 21 47	+ 01 42 23	20 30	8 29
Mar 1	12 15 32	+ 02 27 09	19 58	7 53
8	12 07 15	+ 03 21 14	19 24	7 15
15	11 57 33	+ 04 19 57	18 49	6 36
22	11 47 16	+ 05 17 24	18 14	5 56
29	11 37 20	+ 06 07 55	17 39	5 16
Apr 5	11 28 35	+ 06 46 59	17 04	4 38
12	11 21 42	+ 07 11 39	16 31	4 03
19	11 17 05	+ 07 20 50	15 59	3 30
26	11 14 52	+ 07 15 00	15 29	3 01
May 3	11 14 56	+ 06 55 20	15 01	2 34
10	11 17 09	+ 06 23 11	14 35	2 10
17	11 21 19	+ 05 39 58	14 10	1 48
24	11 27 09	+ 04 47 08	13 46	1 29
31	11 34 27	+ 03 45 58	13 23	1 11
Jun 7	11 43 01	+ 02 37 28	13 01	0 55
14	11 52 42	+ 01 22 33	12 40	0 40
21	12 03 22	+ 00 02 09	12 20	0 26
28	12 14 52	- 01 22 52	12 00	0 13

	RA h m s	DEC ° ' "	RISE h mm	SET h mm
Jul 5	12 27 09	- 02 51 47	11 41	0 02
12	12 40 09	- 04 23 54	11 23	23 50
19	12 53 50	- 05 58 25	11 05	23 40
26	13 08 08	- 07 34 31	10 48	23 31
Aug 2	13 23 03	- 09 11 28	10 31	23 22
9	13 38 36	- 10 48 32	10 15	23 14
16	13 54 45	- 12 24 48	9 59	23 07
23	14 11 31	- 13 59 22	9 44	23 01
30	14 28 55	- 15 31 19	9 30	22 55
Sep 6	14 46 56	- 16 59 42	9 16	22 49
13	15 05 37	- 18 23 30	9 03	22 44
20	15 24 55	- 19 41 37	8 51	22 40
27	15 44 51	- 20 52 57	8 40	22 36
Oct 4	16 05 25	- 21 56 28	8 30	22 32
11	16 26 35	- 22 51 04	8 21	22 28
18	16 48 17	- 23 35 41	8 12	22 25
25	17 10 29	- 24 09 21	8 05	22 21
Nov 1	17 33 07	- 24 31 16	7 59	22 17
8	17 56 05	- 24 40 43	7 54	22 13
15	18 19 18	- 24 37 11	7 50	22 08
22	18 42 39	- 24 20 23	7 46	22 03
29	19 06 04	- 23 50 12	7 44	21 57
Dec 6	19 29 25	- 23 06 50	7 42	21 51
13	19 52 38	- 22 10 40	7 40	21 44
20	20 15 37	- 21 02 17	7 39	21 35
27	20 38 20	- 19 42 27	7 38	21 27

MARS FINDER CHART



MARS AT OPPOSITION

On March 17th 1997 Mars comes to opposition (closest approach is on the 21st), providing the best opportunity to observe the red planet since February 1995. The period between successive oppositions (the synodic period) is 779.8 days, but because of the elliptical nature of the planet's orbit the Earth and Mars distance at each opposition varies greatly. This apparition is a poor one (with Mars 0.66 A.U. from Earth), but shouldn't be ignored by observers as six years must elapse until the next favourable opposition (see figure 1).

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 its 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. Perihelic oppositions happen around August, and fortunately for southern hemisphere observers, Mars is at its 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 a perihelic opposition (see figure 1). During the 1997 opposition, the disc steadily grows from 8" at the beginning of the year to 14" at opposition, it then decreases to 4" by year's end. 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 Earth's day, surface features cross the central meridian 40 minutes later each night. As the 40 minute delay equals about 9° of longitude per day, observations made at the same time each night will see all surface features cross the central meridian in under six weeks.

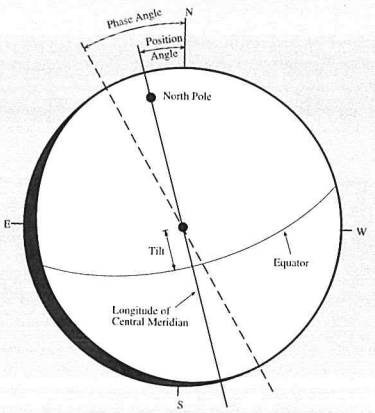
Phase: The fraction of the disc of Mars illuminated by the Sun. 1.0 would be the entire disc. At opposition the "phase " is at maximum.

Phase Angle: The number of degrees (east of north) the "Phase" is rotated.

Cent. Mer.: Longitude of central meridian is the longitude that is centred on the disc.

P.A.: The number of degrees (east of north) that Mars' north pole is rotated from north.

Tilt: (or Sub-Earth latitude) is the number of degrees that Mars' north pole is tilted towards (positive value) or away (negative value) as seen from the Earth. It is also equal to the latitude of the centre of the disc.

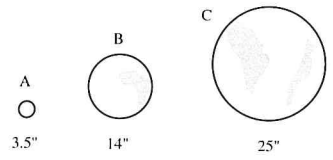


NOTE. Example diagram only, does not refer to any particular date

FIGURE 1

COMPARATIVE SIZES OF MARS AT:

A - Conjunction
B - Poor opposition
C - Perihelic opposition



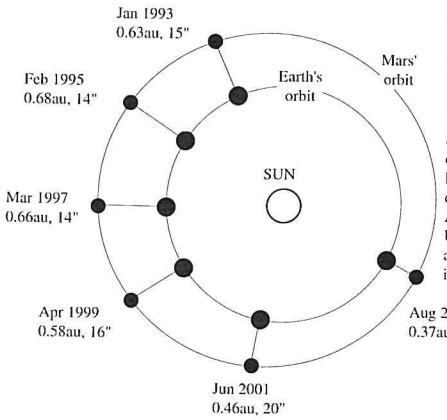


FIGURE 2

OPPOSITIONS FROM 1993 to 2003

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

Central Meridian — Increase in Longitude

hr	deg°	hr	deg°	hr	deg°	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		

EPHEMERIS FOR PHYSICAL OBSERVATIONS (0hr UT)

	JANUARY '97					FEBRUARY '97					MARCH '97					APRIL '97					MAY '97					JUNE '97					
	Cent Mer°	Tilt°	P.A.°	Phase	Phase Angle	Cent Mer°	Tilt°	P.A.°	Phase	Phase Angle	Cent Mer°	Tilt°	P.A.°	Phase	Phase Angle	Cent Mer°	Tilt°	P.A.°	Phase	Phase Angle	Cent Mer°	Tilt°	P.A.°	Phase	Phase Angle	Cent Mer°	Tilt°	P.A.°	Phase	Phase Angle	
1	294.8	24.2	26.6	0.907	35.5	006.0	23.0	29.6	0.940	28.5	114.8	22.8	28.1	0.987	13.1	204.7	23.7	22.5	0.989	12.1	296.2	24.8	20.0	0.933	30.1	006.6	26.1	23.3	0.892	38.4	1
2	285.3	24.1	26.8	0.908	35.3	356.8	22.9	29.6	0.941	28.1	106.1	22.8	28.0	0.988	12.4	196.0	23.7	22.4	0.987	12.9	287.0	24.9	20.0	0.931	30.5	357.1	26.2	23.5	0.891	38.5	2
3	275.9	24.1	26.9	0.908	35.2	347.7	22.9	29.6	0.943	27.7	097.3	22.8	27.9	0.990	11.7	187.2	23.8	22.2	0.986	13.6	277.8	24.9	20.0	0.929	30.9	347.6	26.2	23.7	0.890	38.7	3
4	266.5	24.1	27.1	0.909	35.1	338.6	22.9	29.6	0.944	27.3	088.5	22.9	27.7	0.991	11.0	178.4	23.8	22.0	0.984	14.4	268.6	25.0	20.1	0.927	31.3	338.1	26.2	23.9	0.890	38.8	4
5	257.0	24.0	27.2	0.910	35.0	329.5	22.8	29.6	0.946	26.9	079.8	22.9	27.6	0.992	10.2	169.6	23.8	21.9	0.983	15.1	259.4	25.0	20.1	0.926	31.6	328.6	26.2	24.1	0.889	38.9	5
6	247.6	24.0	27.4	0.910	34.8	320.4	22.8	29.6	0.948	26.4	071.0	22.9	27.4	0.993	09.5	160.8	23.9	21.7	0.981	15.8	250.2	25.1	20.2	0.924	32.0	319.1	26.3	24.3	0.888	39.0	6
7	238.2	23.9	27.5	0.911	34.7	311.3	22.8	29.6	0.949	26.0	062.3	22.9	27.3	0.994	08.7	152.0	23.9	21.6	0.979	16.5	241.0	25.1	20.2	0.922	32.4	309.6	26.3	24.5	0.888	39.2	7
8	228.8	23.9	27.6	0.912	34.6	302.2	22.8	29.6	0.951	25.6	053.6	23.0	27.1	0.995	08.0	143.2	23.9	21.4	0.978	17.2	231.7	25.2	20.3	0.921	32.7	300.0	26.3	24.6	0.887	39.3	8
9	219.4	23.9	27.8	0.913	34.4	293.2	22.8	29.6	0.953	25.1	044.9	23.0	26.9	0.996	07.2	134.3	24.0	21.3	0.976	17.9	222.5	25.2	20.3	0.919	33.1	290.5	26.3	24.8	0.887	39.4	9
10	210.0	23.8	27.9	0.913	34.2	284.1	22.8	29.6	0.955	24.6	036.1	23.0	26.8	0.997	06.4	125.5	24.0	21.1	0.974	18.6	213.2	25.3	20.4	0.918	33.4	280.9	26.3	25.0	0.886	39.5	10
11	200.7	23.8	28.0	0.914	34.1	275.1	22.7	29.6	0.956	24.1	027.4	23.0	26.6	0.998	05.7	116.6	24.1	21.0	0.972	19.3	203.9	25.3	20.5	0.916	33.7	271.4	26.3	25.2	0.885	39.6	11
12	191.3	23.7	28.1	0.915	33.9	266.1	22.7	29.5	0.958	23.6	018.7	23.1	26.4	0.998	04.9	107.7	24.1	20.9	0.970	19.9	194.6	25.3	20.6	0.915	34.0	261.8	26.4	25.5	0.885	39.7	12
13	181.9	23.7	28.2	0.916	33.7	257.1	22.7	29.5	0.960	23.1	010.0	23.1	26.2	0.999	04.2	098.8	24.1	20.8	0.968	20.6	185.3	25.4	20.7	0.913	34.3	252.3	26.4	25.7	0.885	39.7	13
14	172.6	23.6	28.3	0.917	33.5	248.1	22.7	29.4	0.962	22.6	001.4	23.1	26.0	0.999	03.6	089.9	24.2	20.7	0.966	21.2	176.0	25.4	20.8	0.912	34.6	242.7	26.4	25.9	0.884	39.8	14
15	163.2	23.6	28.5	0.918	33.3	239.1	22.7	29.4	0.964	22.0	352.7	23.2	25.8	0.999	03.0	081.0	24.2	20.6	0.964	21.8	166.7	25.5	20.9	0.910	34.9	233.1	26.4	26.1	0.884	39.9	15
16	153.9	23.6	28.6	0.919	33.1	230.1	22.7	29.3	0.965	21.5	344.0	23.2	25.6	1.000	02.5	072.0	24.2	20.5	0.962	22.4	157.3	25.5	21.0	0.909	35.1	223.5	26.4	26.3	0.883	40.0	16
17	144.6	23.5	28.7	0.920	32.9	221.2	22.7	29.3	0.967	20.9	335.3	23.2	25.5	1.000	02.2	063.1	24.3	20.4	0.960	23.0	148.0	25.6	21.1	0.908	35.4	213.9	26.4	26.5	0.883	40.0	17
18	135.3	23.5	28.7	0.921	32.7	212.3	22.7	29.2	0.969	20.3	326.6	23.3	25.3	1.000	02.3	054.1	24.3	20.3	0.958	23.6	138.6	25.6	21.2	0.906	35.6	204.3	26.4	26.7	0.883	40.1	18
19	126.0	23.4	28.8	0.922	32.4	203.3	22.7	29.2	0.971	19.7	317.9	23.3	25.1	0.999	02.6	045.1	24.3	20.3	0.956	24.2	129.3	25.6	21.3	0.905	35.9	194.7	26.4	26.9	0.882	40.1	19
20	116.7	23.4	28.9	0.923	32.2	194.4	22.7	29.1	0.972	19.1	309.3	23.3	24.9	0.999	03.1	036.1	24.4	20.2	0.954	24.7	119.9	25.7	21.5	0.904	36.1	185.1	26.4	27.1	0.882	40.2	20
21	107.4	23.3	29.0	0.924	31.9	185.5	22.7	29.0	0.974	18.5	300.6	23.4	24.7	0.999	03.8	027.1	24.4	20.1	0.952	25.3	110.5	25.7	21.6	0.903	36.4	175.5	26.4	27.4	0.882	40.2	21
22	098.1	23.3	29.1	0.926	31.7	176.7	22.7	28.9	0.976	17.9	291.9	23.4	24.5	0.998	04.5	018.1	24.5	20.1	0.950	25.8	101.1	25.8	21.7	0.902	36.6	165.9	26.4	27.6	0.881	40.3	22
23	088.9	23.3	29.1	0.927	31.4	167.8	22.7	28.8	0.978	17.2	283.2	23.4	24.3	0.998	05.2	009.0	24.5	20.0	0.948	26.3	091.7	25.8	21.9	0.900	36.8	156.3	26.4	27.8	0.881	40.3	23
24	079.6	23.2	29.2	0.928	31.1	158.9	22.7	28.7	0.979	16.6	274.5	23.5	24.1	0.997	05.9	360.0	24.6	20.0	0.946	26.8	082.3	25.8	22.0	0.899	37.0	146.6	26.4	28.0	0.881	40.4	24
25	070.4	23.2	29.3	0.929	30.8	150.1	22.7	28.6	0.981	15.9	265.8	23.5	23.9	0.997	06.7	350.9	24.6	20.0	0.944	27.3	072.8	25.9	22.2	0.898	37.2	137.0	26.3	28.2	0.881	40.4	25
26	061.1	23.2	29.3	0.931	30.5	141.3	22.7	28.5	0.982	15.2	257.1	23.5	23.7	0.996	07.5	341.8	24.6	20.0	0.942	27.8	063.4	25.9	22.3	0.897	37.4	127.4	26.3	28.5	0.881	40.4	26
27	051.9	23.1	29.4	0.932	30.2	132.4	22.8	28.4	0.984	14.6	248.4	23.5	23.5	0.995	08.3	332.7	24.7	20.0	0.940	28.3	054.0	26.0	22.5	0.896	37.6	117.7	26.3	28.7	0.880	40.5	27
28	042.7	23.1	29.4	0.934	29.9	123.6	22.8	28.3	0.985	13.9	239.7	23.6	23.3	0.994	09.0	323.6	24.7	19.9	0.938	28.7	044.5	26.0	22.7	0.895	37.7	108.1	26.3	28.9	0.880	40.5	28
29	033.5	23.0	29.5	0.935	29.5						230.9	23.6	23.1	0.993	09.8	314.5	24.8	19.9	0.936	29.2	035.1	26.0	22.8	0.894	37.9	098.4	26.3	29.1	0.880	40.5	29
30	024.3	23.0	29.5	0.937	29.2						222.2	23.6	22.9	0.991	10.6	305.3	24.8	20.0	0.935	29.6	025.6	26.1	23.0	0.894	38.1	088.8	26.2	29.3	0.880	40.5	30
31	015.2	23.0	29.5	0.938	28.8						213.5	23.7	22.7	0.990	11.4						016.1	26.1	23.2	0.893	38.2						31

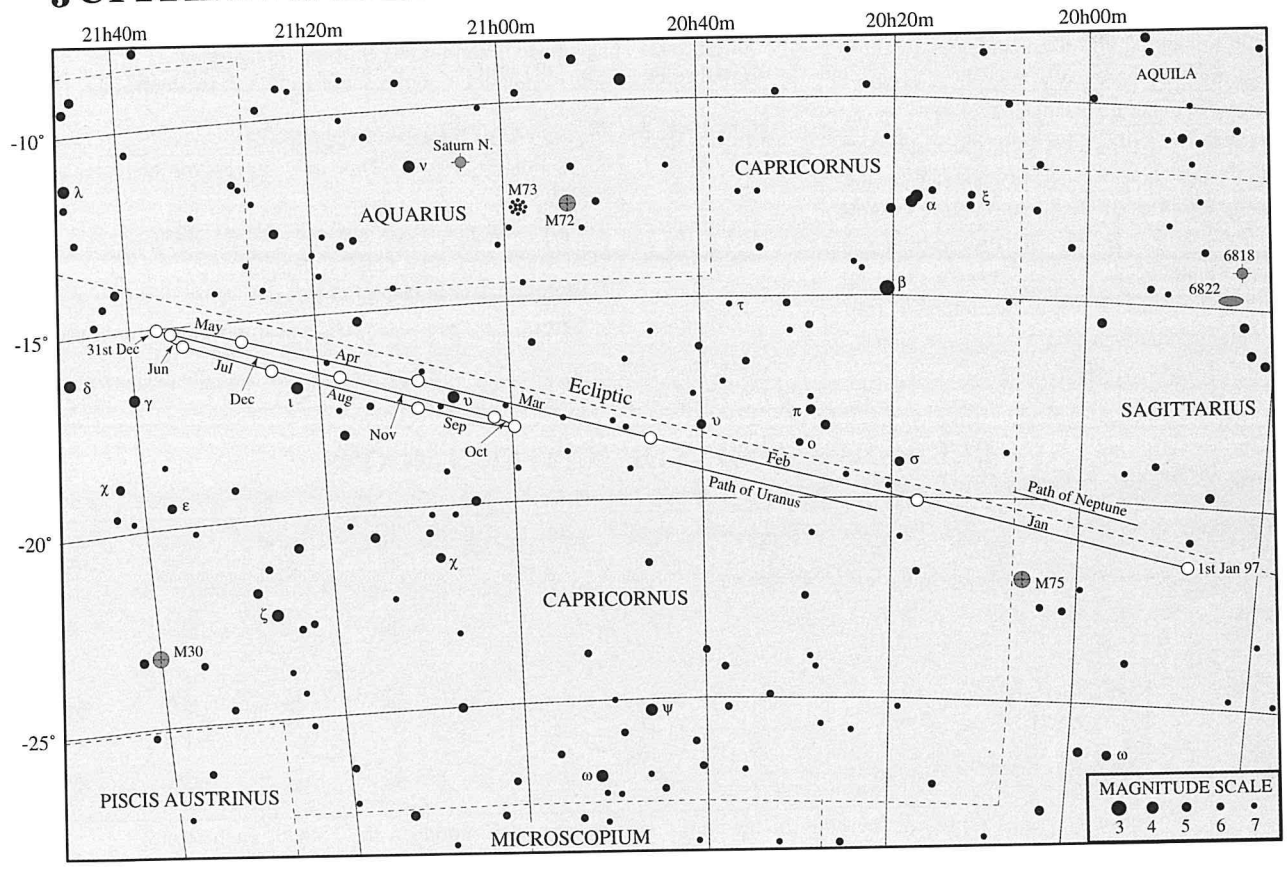
JUPITER

RISE, SET (for Perth, W.A.S.T.) AND GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

		RA h m s	DEC ° ' "	RISE h mm	SET h mm
Jan	4	19 51 53	- 21 17 39	6 15	20 11
	11	19 58 46	- 20 59 25	5 55	19 50
	18	20 05 40	- 20 40 04	5 35	19 28
	25	20 12 33	- 20 19 43	5 16	19 07
Feb	1	20 19 23	- 19 58 28	4 56	18 45
	8	20 26 08	- 19 36 29	4 36	18 23
	15	20 32 46	- 19 13 55	4 16	18 01
	22	20 39 16	- 18 50 58	3 56	17 39
Mar	1	20 45 35	- 18 27 48	3 36	17 16
	8	20 51 42	- 18 04 37	3 16	16 54
	15	20 57 35	- 17 41 41	2 55	16 31
	22	21 03 12	- 17 19 12	2 34	16 08
	29	21 08 31	- 16 57 24	2 13	15 45
Apr	5	21 13 30	- 16 36 33	1 52	15 21
	12	21 18 08	- 16 16 55	1 30	14 58
	19	21 22 22	- 15 58 46	1 07	14 33
	26	21 26 10	- 15 42 20	0 44	14 09
May	3	21 29 31	- 15 27 54	0 21	13 44
	10	21 32 23	- 15 15 42	23 53	13 19
	17	21 34 43	- 15 06 00	23 28	12 53
	24	21 36 30	- 14 58 59	23 03	12 27
	31	21 37 42	- 14 54 50	22 37	12 01
Jun	7	21 38 19	- 14 53 40	22 10	11 34
	14	21 38 18	- 14 55 34	21 42	11 06
	21	21 37 41	- 15 00 29	21 14	10 38
	28	21 36 28	- 15 08 19	20 44	10 10

		RA h m s	DEC ° ' "	RISE h mm	SET h mm
Jul	5	21 34 41	- 15 18 53	20 15	9 41
	12	21 32 22	- 15 31 51	19 44	9 12
	19	21 29 36	- 15 46 48	19 13	8 42
	26	21 26 27	- 16 03 12	18 42	8 12
Aug	2	21 23 01	- 16 20 30	18 10	7 42
	9	21 19 26	- 16 38 04	17 38	7 12
	16	21 15 50	- 16 55 15	17 06	6 42
	23	21 12 20	- 17 11 29	16 34	6 11
	30	21 09 03	- 17 26 14	16 03	5 41
Sep	6	21 06 07	- 17 39 03	15 32	5 11
	13	21 03 39	- 17 49 35	15 02	4 42
	20	21 01 42	- 17 57 35	14 32	4 13
	27	21 00 20	- 18 02 54	14 03	3 44
Oct	4	20 59 36	- 18 05 27	13 34	3 16
	11	20 59 32	- 18 05 11	13 07	2 48
	18	21 00 07	- 18 02 07	12 40	2 21
	25	21 01 20	- 17 56 20	12 14	1 55
Nov	1	21 03 10	- 17 47 52	11 49	1 28
	8	21 05 37	- 17 36 47	11 24	1 03
	15	21 08 36	- 17 23 12	11 00	0 38
	22	21 12 06	- 17 07 12	10 37	0 13
	29	21 16 04	- 16 48 52	10 14	23 45
Dec	6	21 20 27	- 16 28 19	9 52	23 21
	13	21 25 14	- 16 05 40	9 30	22 57
	20	21 30 20	- 15 41 01	9 09	22 34
	27	21 35 43	- 15 14 29	8 48	22 10

JUPITER FINDER CHART



JUPITER'S MOONS

Jupiter and its moons can be likened to a miniature solar system. Although there are currently 16 known Jovian satellites, most of them are too faint for amateur equipment. The four Galilean satellites, named after their discoverer, Galileo (who suggested calling them the 'Medicean Stars'), are bright enough to be visible in small telescopes (or moderate sized binoculars). The dance of these moons, as they pass back and forth across Jupiter, is illustrated in the monthly 'Jupiter's Moons' on pages 83 - 85. All the moons orbit in roughly the same plane, which is very close to the Earth's orbit. Hence we see the Jovian system as 'edge-on'. This is the key point to understanding the satellite phenomena. From our perspective on Earth, we see four types of events. They are:-

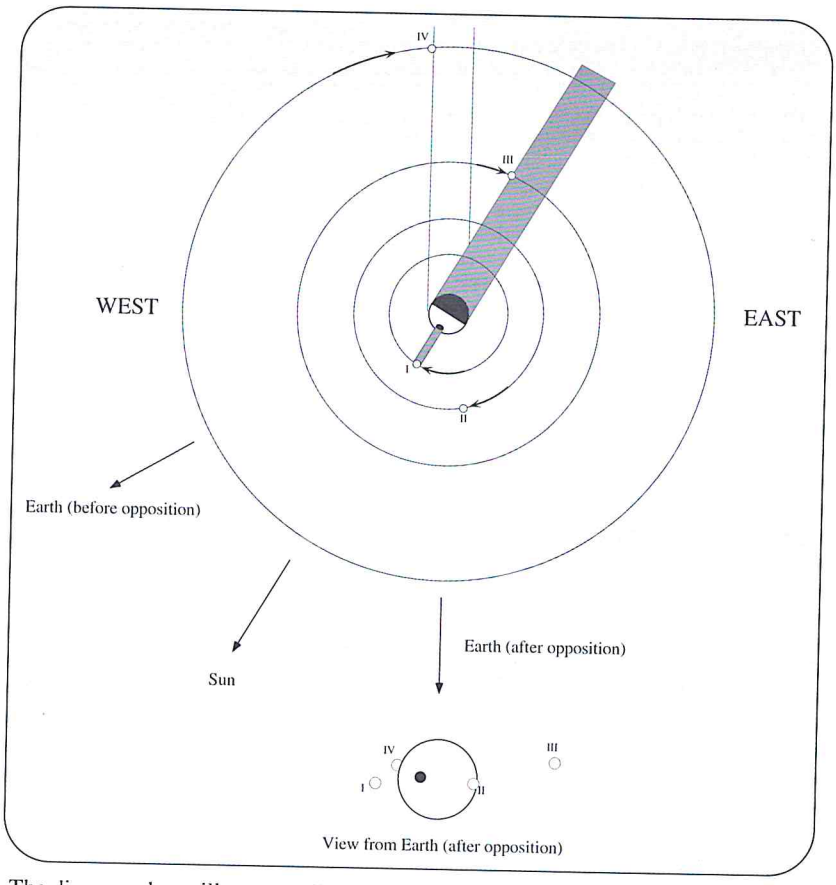
1 The satellite appears to pass in front of Jupiter. This is called a **Satellite Transit**.

2 The shadow of a satellite can move across the 'surface' of the planet. This is called a **Satellite Shadow Transit.** The start of a satellite or shadow transit is called its ingress, the finish - 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 1997 is August 9th.

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. Positions for the disappearance (d) and reappearance (r) for each moon, relative to Jupiter, for each month, are presented in the diagram below.



The diagram above illustrates all of the Jupiter satellite events. It is only an example and does not represent any particular date.

Viewed from the Earth (after opposition) :-

Satellite I Io's shadow is currently in transit. The satellite itself would have recently egressed from a transit.

Satellite II Europa has just commenced a satellite transit (ingress).

Satellite III Ganymede is about to be eclipsed (disappear)

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

JUPITER MOON EVENTS Legend (pp81-82)

Column 1 Date & time (in WAST). Date only appears for the first event for each day.

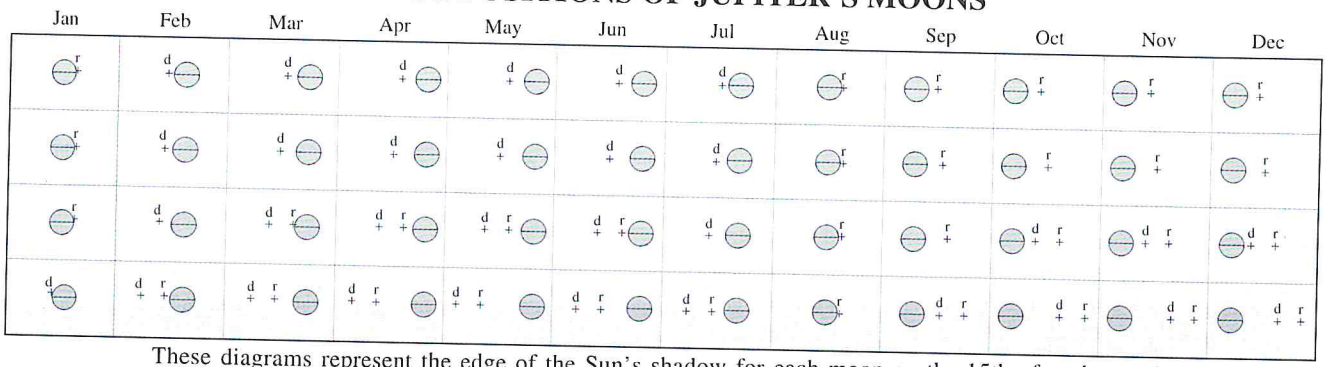
Column 2 I = Io, II = Europa, III = Ganymede, IV = Callisto

Column 3 Oc = Occultation, Sh = Shadow Transit, Tr = Satellite Transit, Ec = Eclipse

Column 4 I = Ingress, E = Egress, D = Disappearance, R = Reappearance

Note: Generally, only events occurring when Jupiter is above the horizon and the Sun has set are shown.

ECLIPSE POSITIONS OF JUPITER'S MOONS



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

JUPITER'S MOONS (WAST)

January

13	19:21	IV	Sh	I
	19:34	I	Ec	R
18	05:44	I	Tr	E
	05:45	I	Sh	E
20	19:11	I	Ec	D
22	05:52	IV	Ec	D
25	05:23	I	Sh	I
	05:29	I	Tr	I
28	18:53	III	Sh	I

February

3	05:18	II	Sh	E
	05:49	II	Tr	E
10	05:01	II	Sh	I
	05:46	II	Tr	I
	05:56	I	Sh	E
	06:18	I	Tr	E
12	04:31	III	Tr	I
17	05:33	I	Sh	I
	06:02	I	Tr	I
18	05:38	I	Oc	R
19	06:01	II	Oc	R
25	04:26	IV	Oc	R
	04:44	I	Ec	D
26	04:12	I	Sh	E
	04:41	II	Ec	D
	04:50	I	Tr	E
28	03:49	II	Tr	E

March

4	06:38	I	Ec	D
5	03:50	I	Sh	I
	04:34	I	Tr	I
	06:06	I	Sh	E
	06:15	IV	Sh	E
6	04:10	I	Oc	R
7	03:45	II	Tr	I
	05:05	II	Sh	E
	06:39	II	Tr	E
9	04:48	III	Ec	D
12	05:43	I	Sh	I
	06:33	I	Tr	I
13	06:11	I	Oc	R
14	03:20	I	Tr	E
	04:48	II	Sh	I
	06:34	II	Tr	I
16	03:47	II	Oc	R
20	04:55	I	Ec	D
	06:15	III	Tr	E
21	03:03	I	Tr	I
	04:22	I	Sh	E
	05:19	I	Tr	E
22	02:41	I	Oc	R
	05:07	IV	Tr	I
23	06:33	II	Oc	R
27	02:48	III	Sh	I
	06:21	III	Sh	E
	06:49	I	Ec	D
28	03:59	I	Sh	I
	05:01	I	Tr	I
	06:15	I	Sh	E
29	04:40	I	Oc	R
30	04:15	II	Ec	D
	06:09	IV	Ec	D

April

1	02:13	II	Sh	E
	04:26	II	Tr	E
3	06:48	III	Sh	I
4	05:53	I	Sh	I
	07:00	I	Tr	I
5	03:11	I	Ec	D
	06:38	I	Oc	R
6	02:37	I	Sh	E
	03:46	I	Tr	E
	06:50	II	Ec	D
7	05:03	III	Oc	R
8	01:56	II	Sh	I
	04:17	II	Tr	I
	04:49	II	Sh	E
	05:50	IV	Tr	E
12	05:05	I	Ec	D
13	02:15	I	Sh	I
	03:26	I	Tr	I
	04:31	I	Sh	E
	05:43	I	Tr	E
14	03:05	I	Oc	R
	04:18	III	Ec	R
	05:40	III	Oc	D
15	04:32	II	Sh	I
	07:01	II	Tr	I
16	04:56	IV	Ec	R
17	04:04	II	Oc	R
19	06:59	I	Ec	D
20	04:08	I	Sh	I
	05:23	I	Tr	I
	06:25	I	Sh	E
21	01:27	I	Ec	D
	04:43	III	Ec	D
	05:02	I	Oc	R
22	02:09	I	Tr	E
	07:08	II	Sh	I
24	01:16	II	Ec	D
	06:45	II	Oc	R
25	01:11	IV	Tr	E
	03:35	III	Tr	E
26	01:54	II	Tr	E
27	06:02	I	Sh	I
28	03:21	I	Ec	D
	06:58	I	Oc	R
29	01:48	I	Tr	I
	02:47	I	Sh	E
	04:05	I	Tr	E
30	01:27	I	Oc	R

May

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

June

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

July

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

JUPITER'S MOONS (WAST)

30	01:11	I	Sh	I
	01:27	I	Tr	I
	03:29	I	Sh	E
	03:46	I	Tr	E
	19:16	II	Sh	I
	19:47	II	Tr	I
	22:08	II	Sh	E
	22:28	I	Ec	D
	22:37	II	Tr	E
31	01:01	I	Oc	R
	19:39	I	Sh	I
	19:53	I	Tr	I
	21:58	I	Sh	E
	22:12	I	Tr	E

August

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

September

1	18:01	I	Tr	E
	18:35	I	Sh	E
5	03:01	IV	Tr	I
	04:36	I	Tr	I
	05:15	I	Sh	I
6	01:28	II	Oc	D
	01:50	I	Oc	D
	04:47	I	Ec	R
	23:03	I	Tr	I
	23:44	I	Sh	I
7	01:21	I	Tr	E
	02:02	I	Sh	E
	19:54	III	Tr	I
	20:05	II	Tr	I
	20:16	I	Oc	D
	21:28	II	Sh	I
	22:44	III	Sh	I
	22:56	II	Tr	E
	23:15	I	Ec	R
	23:32	III	Tr	E
8	00:19	II	Sh	E
	02:23	III	Sh	E
	18:13	I	Sh	I
	19:47	I	Tr	E
	20:31	I	Sh	E
9	17:44	I	Ec	R
	19:03	II	Ec	R
13	03:36	I	Oc	D
	03:48	II	Oc	D
	19:17	IV	Ec	D
14	00:06	IV	Ec	R
	00:50	I	Tr	I
	01:39	I	Sh	I
	03:07	I	Tr	E
	03:57	I	Sh	E
	22:02	I	Oc	D
	22:24	II	Tr	I
	23:20	III	Tr	I
15	00:03	II	Sh	I
	01:10	I	Ec	R
	01:14	II	Tr	E
	02:46	III	Sh	I
	02:54	II	Sh	E
	02:58	III	Tr	E
	19:16	I	Tr	I
	20:08	I	Sh	I
	21:34	I	Tr	E
	22:26	I	Sh	E
16	19:39	I	Ec	R
	21:41	II	Ec	R
18	20:17	III	Ec	R
21	02:38	I	Tr	I
	03:35	I	Sh	I
	18:08	IV	Tr	I
	22:56	IV	Tr	E
	23:50	I	Oc	D
22	00:44	II	Tr	I
	02:39	II	Sh	I
	02:50	III	Tr	I
	03:05	I	Ec	R
	03:25	IV	Sh	I
	03:34	II	Tr	E
	21:05	I	Tr	I
	22:04	I	Sh	I
	23:22	I	Tr	E
23	00:21	I	Sh	E
	18:17	I	Oc	D
	19:22	II	Oc	D
	21:34	I	Ec	R
24	00:20	II	Ec	R
	17:50	I	Tr	E
	18:50	I	Sh	E
25	18:46	II	Sh	E
	20:09	III	Oc	R
	20:40	III	Ec	D
26	00:19	III	Ec	R
29	01:38	I	Oc	D
	03:07	II	Tr	I
	22:54	I	Tr	I
	23:59	I	Sh	I
30	01:12	I	Tr	E
	02:17	I	Sh	E
	03:12	IV	Oc	D
	18:16	IV	Ec	R
	20:06	I	Oc	D
	21:48	II	Oc	D
	23:29	I	Ec	R

October

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

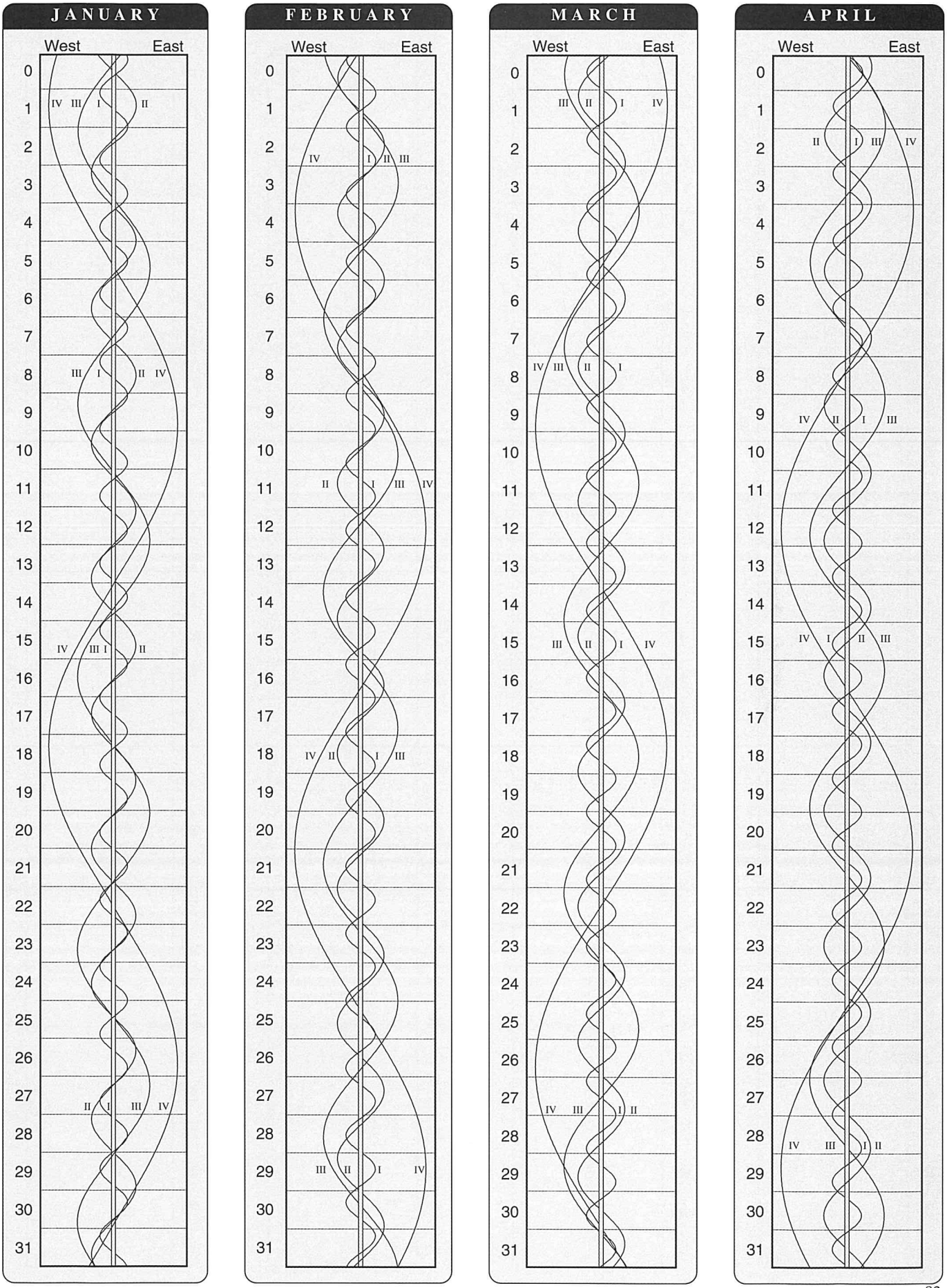
November

1	20:08	I	Ec	R
	21:13	II	Oc	D
3	18:14	II	Sh	I
	18:26	II	Tr	E
	21:03	II	Sh	E
6	23:57	I	Oc	D
7	19:02	III	Oc	R
	20:47	III	Ec	D
	21:17	I	Tr	I
	22:36	I	Sh	I
	23:34	I	Tr	E
8	00:26	III	Ec	R
	00:53	I	Sh	E
	18:25	I	Oc	D
	22:03	I	Ec	R
	23:51	II	Oc	D
9	19:22	I	Sh	E
10	20:50	II	Sh	I
	21:02	II	Tr	E
10	21:22	IV	Tr	I
	23:39	II	Sh	E
12	18:47	II	Ec	R
14	19:29	III	Oc	D
	23:08	III	Oc	R
	23:13	I	Tr	I
15	00:32	I	Sh	I
	20:22	I	Oc	D
	23:58	I	Ec	R
16	19:01	I	Sh	I
	20:00	I	Tr	E
	21:18	I	Sh	E
17	18:27	I	Ec	R
	20:51	II	Tr	I
	23:27	II	Sh	I
	23:41	II	Tr	E
18	18:37	III	Sh	E
19	20:08	IV	Ec	D
	21:24	II	Ec	R
21	23:38	III	Oc	D
22	22:19	I	Oc	D
23	19:41	I	Tr	I
	20:57	I	Sh	I
	21:58	I	Tr	E
	23:14	I	Sh	E
24	20:23	I	Ec	R
	23:31	II	Tr	I
25	19:03	III	Sh	I
	22:39	III	Sh	E
26	18:35	II	Oc	D
27	21:09	IV	Tr	E
30	21:39	I	Tr	I
	22:53	I	Sh	I

December

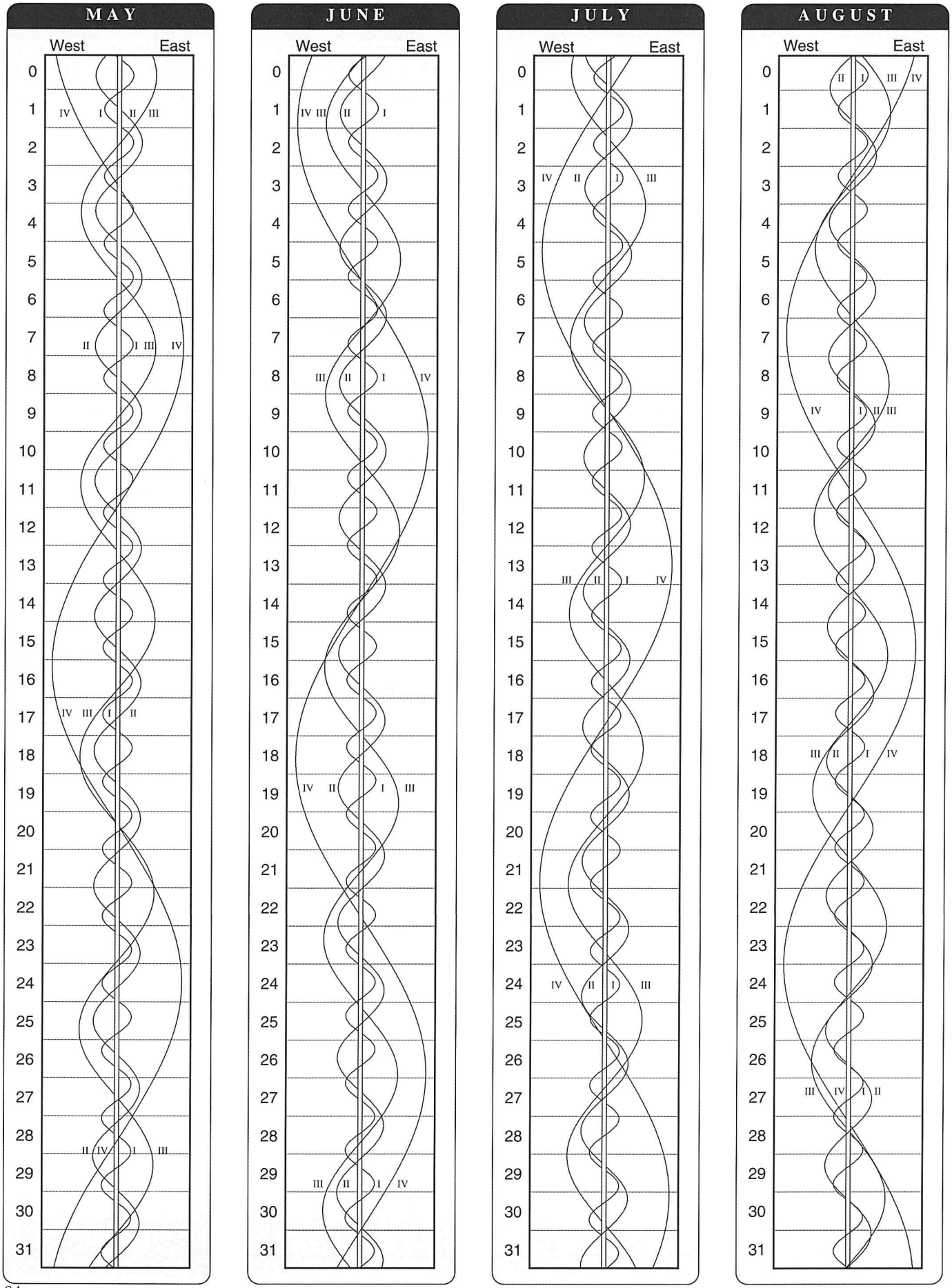
1	18:47	I	Oc	D
	22:18	I	Ec	R
2	19:38	I	Sh	E
	21:46	III	Tr	E
	23:04	III	Sh	I
3	21:20	II	Oc	D
5	20:48	II	Sh	E
6	18:59	IV	Ec	R
8	20:46	I	Oc	D
9	19:17	I	Sh	I
	20:25	I	Tr	E
	21:34	I	Sh	E
	22:26	III	Tr	I
12	20:35	II	Sh	I
	21:12	II	Tr	E
13	20:34	III	Ec	R
14	22:42	IV	Sh	I
15	22:46	I	Oc	D
16	20:08	I	Tr	I
	21:13	I	Sh	I
	22:25	I	Tr	E
17	20:38	I	Ec	R
19	21:06	II	Tr	I
20	20:25	III	Oc	R
	20:57	III	Ec	D
21	21:12	II	Ec	R
23	22:09	I	Tr	I
24	19:16	I	Oc	D
25	18:56	I	Tr	E
	19:54	I	Sh	E
27	21:08	III	Oc	D
28	19:04	II	Oc	D
31	21:17	I	Oc	D
	21:33	IV	Sh	E

JUPITER'S MOONS (WAST)



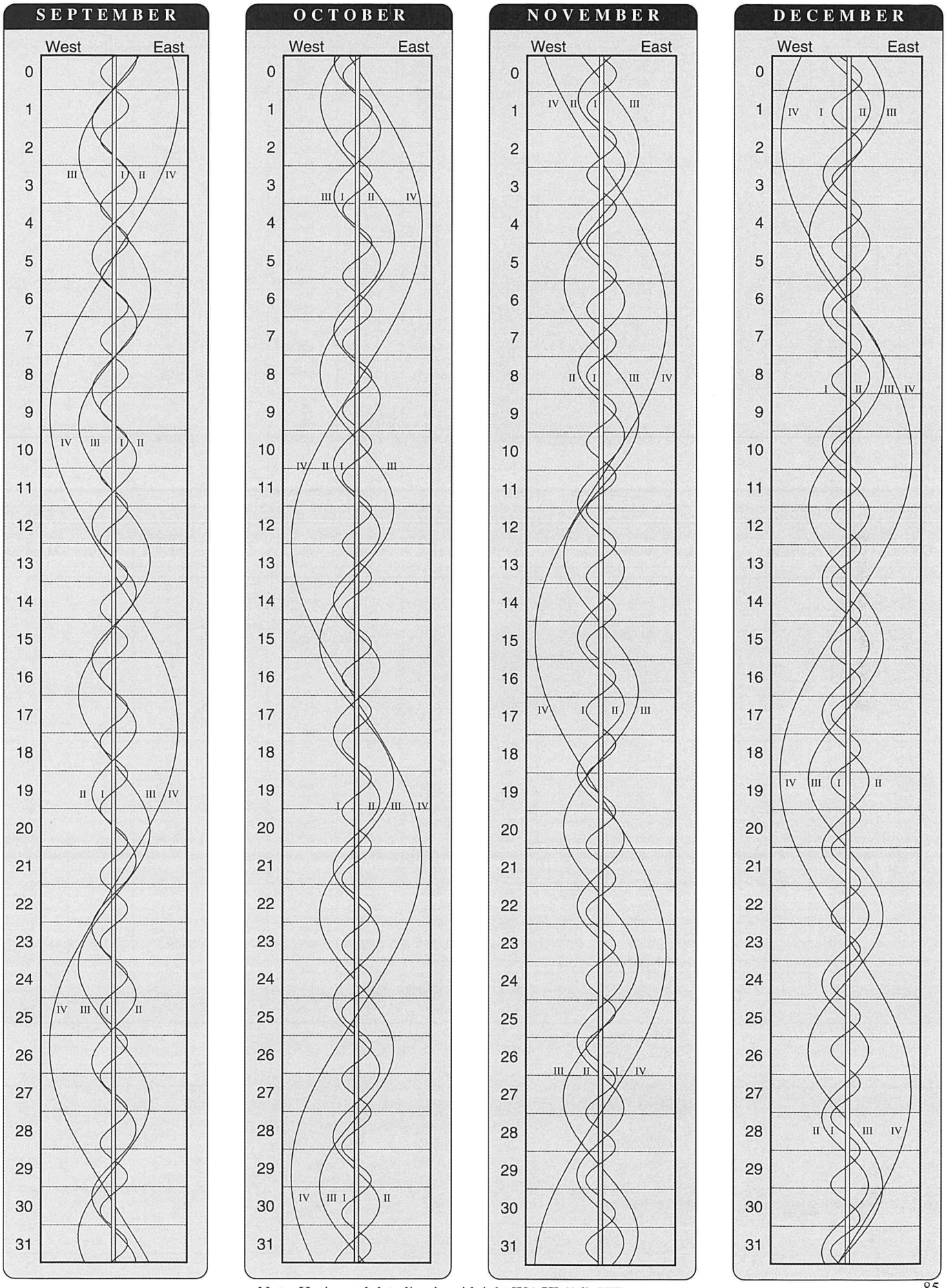
Note: Horizontal date line is midnight WAST (16h UT).

JUPITER'S MOONS (WAST)



Note: Horizontal date line is midnight WAST (16h UT).

JUPITER'S MOONS (WAST)



Note: Horizontal date line is midnight WAST (16h UT).

JUPITER — LONGITUDE OF CENTRAL MERIDIAN

SYSTEM I (0hr UT)

DATE	JAN °	FEB °	MAR °	APR °	MAY °	JUN °	JUL °	AUG °	SEP °	OCT °	NOV °	DEC °	DATE
1	100.5	308.0	043.7	254.1	308.9	163.9	223.5	082.6	301.1	358.7	210.4	261.6	1
2	258.1	105.7	201.4	051.9	106.7	321.9	021.5	240.7	099.1	156.5	008.2	059.3	2
3	055.8	263.4	359.1	209.7	264.6	119.8	179.5	038.7	257.0	314.4	165.9	216.9	3
4	213.4	061.1	156.9	007.5	062.5	277.8	337.6	196.7	055.0	112.2	323.7	014.6	4
5	011.1	218.8	314.6	165.3	220.3	075.7	135.6	354.8	213.0	270.1	121.4	172.3	5
6	168.7	016.5	112.3	323.1	018.2	233.7	293.6	152.8	010.9	067.9	279.1	329.9	6
7	326.4	174.1	270.1	120.9	176.1	031.7	091.6	310.8	168.9	225.7	076.9	127.6	7
8	124.0	331.8	067.8	278.7	334.0	189.6	249.7	108.9	326.8	023.6	234.6	285.3	8
9	281.7	129.5	225.6	076.5	131.9	347.6	047.7	266.9	124.8	181.4	032.3	082.9	9
10	079.3	287.2	023.3	234.3	289.7	145.6	205.7	064.9	282.7	339.2	190.0	240.6	10
11	237.0	084.9	181.0	032.1	087.6	303.5	003.8	223.0	080.7	137.0	347.7	038.2	11
12	034.7	242.6	338.8	189.9	245.5	101.5	161.8	021.0	238.6	294.9	145.5	195.9	12
13	192.3	040.3	136.5	347.8	043.4	259.5	319.8	179.0	036.5	092.7	303.2	353.5	13
14	350.0	198.0	294.3	145.6	201.3	057.5	117.9	337.0	194.5	250.5	100.9	151.2	14
15	147.6	355.7	092.0	303.4	359.2	215.4	275.9	135.1	352.4	048.3	258.6	308.9	15
16	305.3	153.4	249.8	101.2	157.1	013.4	073.9	293.1	150.3	206.1	056.3	106.5	16
17	103.0	311.1	047.5	259.0	315.0	171.4	232.0	091.1	308.2	003.9	214.0	264.2	17
18	260.6	108.8	205.3	056.9	112.9	329.4	030.0	249.1	106.1	161.7	011.7	061.8	18
19	058.3	266.5	003.1	214.7	270.8	127.4	188.1	047.1	264.0	319.5	169.4	219.5	19
20	216.0	064.2	160.8	012.5	068.8	285.4	346.1	205.2	062.0	117.3	327.1	017.1	20
21	013.6	221.9	318.6	170.4	226.7	083.4	144.1	003.2	219.9	275.0	124.8	174.8	21
22	171.3	019.7	116.3	328.2	024.6	241.4	302.2	161.2	017.8	072.8	282.5	332.4	22
23	329.0	177.4	274.1	126.1	182.5	039.4	100.2	319.2	175.6	230.6	080.2	130.0	23
24	126.6	335.1	071.9	283.9	340.4	197.4	258.3	117.2	333.5	028.4	237.8	287.7	24
25	284.3	132.8	229.7	081.7	138.4	355.4	056.3	275.2	131.4	186.1	035.5	085.3	25
26	082.0	290.5	027.4	239.6	296.3	153.4	214.4	073.2	289.3	343.9	193.2	243.0	26
27	239.6	088.2	185.2	037.4	094.2	311.4	012.4	231.2	087.2	141.7	350.9	040.6	27
28	037.3	246.0	343.0	195.3	252.2	109.4	170.4	029.2	245.1	299.4	148.6	198.3	28
29	195.0		140.8	353.1	050.1	267.5	328.5	187.1	042.9	097.2	306.2	355.9	29
30	352.7		298.5	151.0	208.0	065.5	126.5	345.1	200.8	254.9	103.9	153.5	30
31	150.4		096.3		006.0		284.6	143.1		052.7		311.2	31

SYSTEM II (0hr UT)

DATE	JAN °	FEB °	MAR °	APR °	MAY °	JUN °	JUL °	AUG °	SEP °	OCT °	NOV °	DEC °	DATE
1	155.6	126.6	008.6	342.5	168.4	146.9	337.5	320.1	302.0	130.7	106.0	288.3	1
2	305.6	276.7	158.7	132.7	318.6	297.2	127.9	110.5	092.4	280.9	256.1	078.3	2
3	095.6	066.7	308.8	282.8	108.8	087.5	278.3	260.9	242.7	071.2	046.2	228.3	3
4	245.6	216.8	098.9	073.0	259.1	237.8	068.7	051.3	033.1	221.4	196.3	018.4	4
5	035.7	006.8	249.0	223.2	049.3	028.1	219.1	201.7	183.4	011.6	346.4	168.4	5
6	185.7	156.9	039.1	013.3	199.6	178.5	009.5	352.1	333.7	161.8	136.5	318.5	6
7	335.7	307.0	189.2	163.5	349.8	328.8	159.9	142.5	124.0	312.0	286.6	108.5	7
8	125.7	097.0	339.3	313.7	140.0	119.1	310.3	292.9	274.4	102.2	076.7	258.5	8
9	275.8	247.1	129.5	103.9	290.3	269.5	100.7	083.3	064.7	252.4	226.8	048.6	9
10	065.8	037.1	279.6	254.0	080.6	059.8	251.1	233.7	215.0	042.6	016.9	198.6	10
11	215.8	187.2	069.7	044.2	230.8	210.2	041.5	024.1	005.3	192.8	167.0	348.6	11
12	005.8	337.3	219.8	194.4	021.1	000.5	191.9	174.5	155.6	343.0	317.1	138.6	12
13	155.9	127.3	009.9	344.6	171.3	150.9	342.3	324.9	305.9	133.2	107.2	288.7	13
14	305.9	277.4	160.0	134.8	321.6	301.2	132.7	115.3	096.2	283.4	257.2	078.7	14
15	095.9	067.5	310.2	285.0	111.9	091.6	283.1	265.7	246.5	073.5	047.3	228.7	15
16	246.0	217.6	100.3	075.2	262.1	241.9	073.5	056.1	036.8	223.7	197.4	018.7	16
17	036.0	007.6	250.4	225.4	052.4	032.3	223.9	206.5	187.1	013.9	347.5	168.8	17
18	186.0	157.7	040.5	015.6	202.7	182.6	014.3	356.9	337.4	164.0	137.5	318.8	18
19	336.1	307.8	190.7	165.8	353.0	333.0	164.7	147.3	127.7	314.2	287.6	108.8	19
20	126.1	097.9	340.8	316.0	143.3	123.4	315.1	297.7	277.9	104.4	077.7	258.8	20
21	276.1	247.9	130.9	106.2	293.5	273.7	105.6	088.0	068.2	254.5	227.7	048.8	21
22	066.2	038.0	281.1	256.4	083.8	064.1	256.0	238.4	218.5	044.7	017.8	198.9	22
23	216.2	188.1	071.2	046.6	234.1	214.5	046.4	028.8	008.7	194.8	167.9	348.9	23
24	006.3	338.2	221.3	196.8	024.4	004.8	196.8	179.2	159.0	345.0	317.9	138.9	24
25	156.3	128.3	011.5	347.0	174.7	155.2	347.2	329.5	309.3	135.1	108.0	288.9	25
26	306.4	278.4	161.6	137.2	325.0	305.6	137.6	119.9	099.5	285.2	258.0	078.9	26
27	096.4	068.5	311.8	287.4	115.3	096.0	288.0	270.3	249.8	075.4	048.1	228.9	27
28	246.4	218.5	101.9	077.7	265.6	246.3	078.4	060.6	040.0	225.5	198.1	018.9	28
29	036.5		252.1	227.9	055.9	036.7	228.9	211.0	190.2	015.6	348.2	169.0	29
30	186.5		042.2	018.1	206.2	187.1	019.3	001.3	340.5	165.8	138.2	319.0	30
31	336.6		192.4		356.5		169.7	151.7		315.9		109.0	31

SYSTEM I

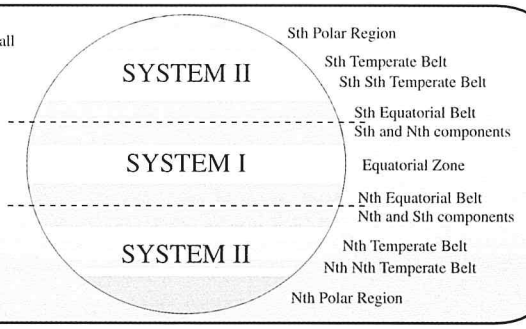
Rotation: 9h 50m 30.003s

hr	deg°	hr	deg°	min	deg°
01	036.6	13	115.5	05	03.0
02	073.2	14	152.1	10	06.1
03	109.7	15	188.7	15	09.1
04	146.3	16	225.3	20	12.2
05	182.9	17	261.8	25	15.2
06	219.5	18	298.4	30	18.3
07	256.1	19	335.0	35	21.3
08	292.6	20	011.6	40	24.4
09	329.2	21	048.2	45	27.4
10	005.8	22	084.7	50	30.5
11	042.4	23	121.3	55	33.5
12	079.0	24	157.9	60	36.6

Increase in longitude

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

SYSTEM II applies to the remainder of the surface.



SYSTEM II

Rotation: 9h 55m 40.062s

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

Increase in longitude

For further explanation see p. 58

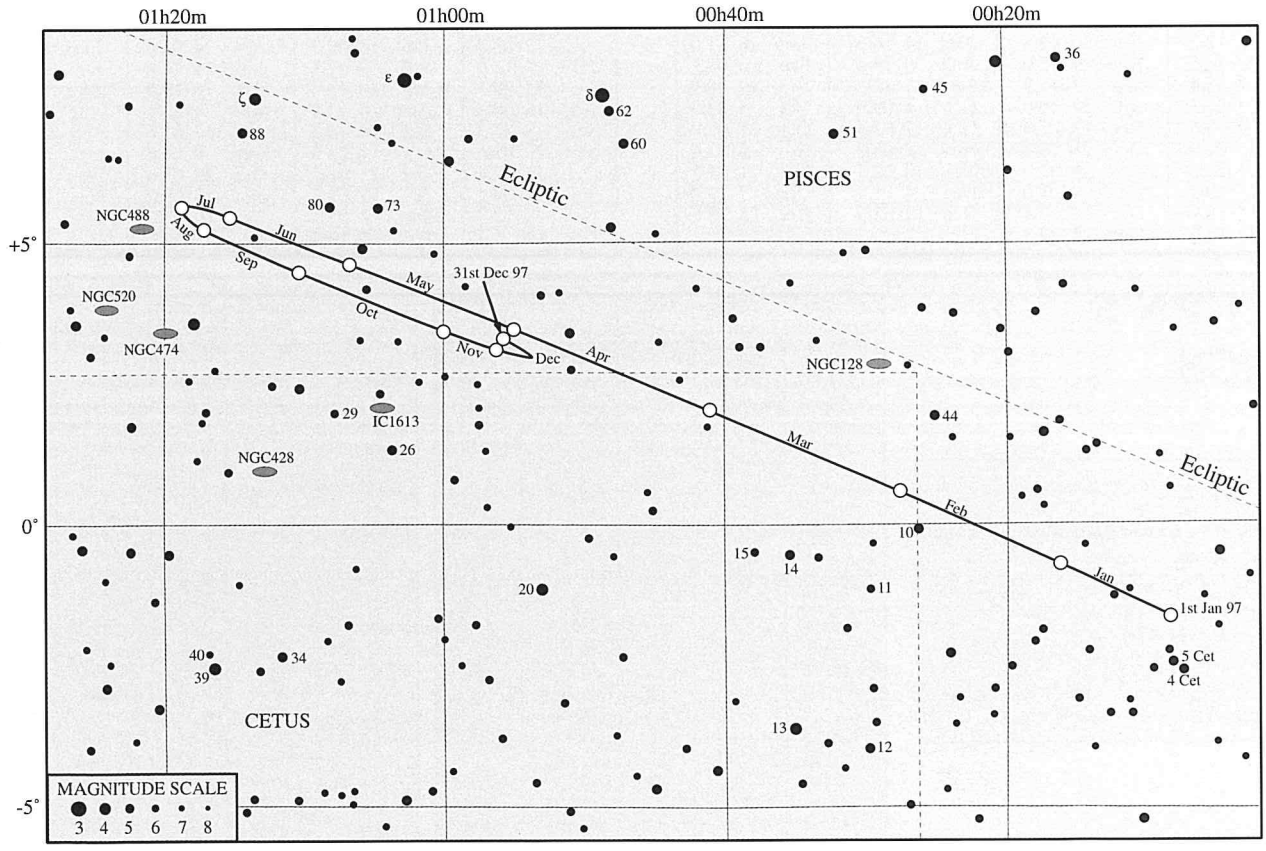
SATURN

RISE, SET (for Perth, W.A.S.T.) AND GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

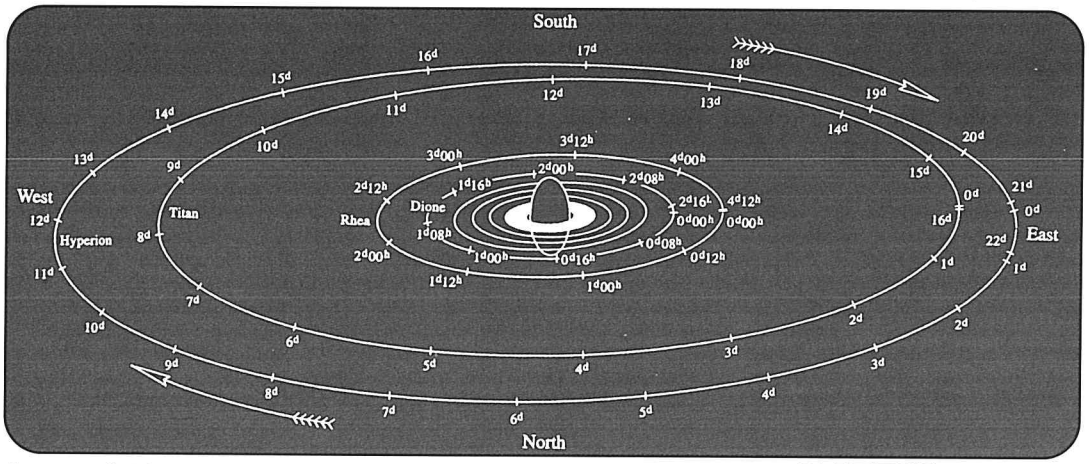
		RA h m s	DEC ° ' "	RISE h mm	SET h mm
Jan	4	00 09 22	- 01 32 32	11 24	23 35
	11	00 10 53	- 01 21 05	10 59	23 09
	18	00 12 40	- 01 07 58	10 33	22 43
	25	00 14 42	- 00 53 22	10 09	22 17
Feb	1	00 16 58	- 00 37 26	9 44	21 51
	8	00 19 26	- 00 20 19	9 20	21 25
	15	00 22 04	- 00 02 12	8 55	20 59
	22	00 24 53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

		RA h m s	DEC ° ' "	RISE h mm	SET h mm
Jul	5	01 16 36	+ 05 28 20	0 53	12 29
	12	01 17 42	+ 05 32 58	0 27	12 03
	19	01 18 31	+ 05 35 46	23 56	11 36
	26	01 19 01	+ 05 36 41	23 29	11 09
Aug	2	01 19 12	+ 05 35 44	23 02	10 41
	9	01 19 05	+ 05 32 55	22 34	10 14
	16	01 18 38	+ 05 28 16	22 06	9 46
	23	01 17 54	+ 05 21 55	21 37	9 18
	30	01 16 53	+ 05 13 58	21 09	8 50
Sep	6	01 15 35	+ 05 04 34	20 39	8 22
	13	01 14 04	+ 04 53 57	20 10	7 53
	20	01 12 20	+ 04 42 21	19 40	7 24
	27	01 10 28	+ 04 30 03	19 10	6 55
Oct	4	01 08 28	+ 04 17 21	18 40	6 26
	11	01 06 26	+ 04 04 36	18 10	5 57
	18	01 04 24	+ 03 52 08	17 40	5 28
	25	01 02 25	+ 03 40 18	17 10	4 59
Nov	1	01 00 32	+ 03 29 25	16 40	4 30
	8	00 58 49	+ 03 19 46	16 11	4 02
	15	00 57 19	+ 03 11 39	15 41	3 33
	22	00 56 03	+ 03 05 15	15 12	3 04
	29	00 55 03	+ 03 00 45	14 44	2 36
Dec	6	00 54 22	+ 02 58 16	14 15	2 08
	13	00 54 00	+ 02 57 54	13 47	1 40
	20	00 53 57	+ 02 59 39	13 20	1 12
	27	00 54 14	+ 03 03 30	12 53	0 45

SATURN FINDER CHART



SATELLITES OF SATURN



Apparent Orbits Diagram (at date of opposition, October 10)
Saturn appears to be egg shaped on this diagram due to the need to exaggerate the scale in the direction of the minor axis. This makes seeing the orbits of the satellites easier, especially the inner moons while Saturn has a very small tilt with respect to the Earth.

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

TITAN (WAST) Mean Synodic Period 15d 23.3h

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
		Jan 2 17.1	Jan 6 12.3
Jan 10 10.8	Jan 14 15.5	Jan 18 16.7	Jan 22 12.0
Jan 26 10.7	Jan 30 15.5	Feb 3 16.7	Feb 7 12.0
Feb 11 10.8	Feb 15 15.8	Feb 19 16.9	Feb 23 12.3
Feb 27 11.3	Mar 3 16.3	Mar 7 17.3	Mar 11 12.7
Mar 15 11.9	Mar 19 17.0	Mar 23 17.8	Mar 27 13.2
Mar 31 12.5	Apr 4 17.7	Apr 8 18.4	Apr 12 13.7
Apr 16 13.2	Apr 20 18.3	Apr 24 18.9	Apr 28 14.2
May 2 13.8	May 6 18.9	May 10 19.3	May 14 14.6
May 18 14.3	May 22 19.4	May 26 19.6	May 30 14.8
Jun 3 14.6	Jun 7 19.6	Jun 11 19.6	Jun 15 14.8
Jun 19 14.6	Jun 23 19.5	Jun 27 19.3	Jul 1 14.4
Jul 5 14.2	Jul 9 19.0	Jul 13 18.7	Jul 17 13.7
Jul 21 13.4	Jul 25 18.1	Jul 29 17.7	Aug 2 12.6
Aug 6 12.2	Aug 10 16.8	Aug 14 16.3	Aug 18 11.0
Aug 22 10.5	Aug 26 15.0	Aug 30 14.4	Sep 3 09.1
Sep 7 08.5	Sep 11 12.9	Sep 15 12.3	Sep 19 06.9
Sep 23 06.1	Sep 27 10.5	Oct 1 09.9	Oct 5 04.5
Oct 9 03.6	Oct 13 07.9	Oct 17 07.4	Oct 21 02.0
Oct 25 01.0	Oct 29 05.4	Nov 2 05.0	Nov 5 23.6
Nov 9 22.6	Nov 14 03.0	Nov 18 02.8	Nov 21 21.5
Nov 25 20.5	Nov 30 01.0	Dec 4 01.0	Dec 7 19.8
Dec 11 18.9	Dec 15 23.4	Dec 19 23.5	Dec 23 18.5
Dec 27 17.6	Dec 31 22.3		

IAPETUS (WAST) Mean Synodic Period 79d 22.1h

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
			Jan 18 02.3
Feb 6 11.8	Feb 27 11.5	Mar 20 15.3	Apr 9 06.8
Apr 28 22.7	May 20 02.1	Jun 9 23.6	Jun 29 07.2
Jul 18 17.1	Aug 8 09.8	Aug 28 16.6	Sep 16 11.7
Oct 5 09.7	Oct 25 15.9	Nov 14 20.4	Dec 3 18.4
Dec 22 21.5			

HYPERION (WAST) Mean Synodic Period 21d 7.6h

Greatest Eastern Elongation	Inferior Conjunction	Greatest Western Elongation	Superior Conjunction
		Jan 3 20.8	Jan 9 04.2
Jan 13 12.8	Jan 18 20.2	Jan 25 08.2	Jan 30 14.5
Feb 3 23.3	Feb 9 07.8	Feb 15 19.7	Feb 21 00.9
Feb 25 09.7	Mar 2 19.9	Mar 9 07.6	Mar 14 11.4
Mar 18 20.3	Mar 24 07.7	Mar 30 18.9	Apr 4 21.2
Apr 9 06.3	Apr 14 19.3	Apr 21 05.8	Apr 26 06.6
Apr 30 15.9	May 6 06.1	May 12 15.8	May 17 15.0
May 22 00.7	May 27 16.0	Jun 3 00.6	Jun 7 22.6
Jun 12 08.3	Jun 18 00.7	Jun 24 08.4	Jun 29 05.1
Jul 3 15.0	Jul 9 07.9	Jul 15 14.6	Jul 20 10.5
Jul 24 20.5	Jul 30 13.6	Aug 5 19.5	Aug 10 14.6
Aug 15 00.6	Aug 20 17.7	Aug 26 23.1	Aug 31 17.8
Sep 5 03.5	Sep 10 20.5	Sep 17 01.6	Sep 21 20.1
Sep 26 05.6	Oct 1 22.5	Oct 8 03.6	Oct 12 22.1
Oct 17 07.4	Oct 23 00.1	Oct 29 05.6	Nov 3 00.2
Nov 7 09.4	Nov 13 02.3	Nov 19 08.2	Nov 24 03.0
Nov 28 12.3	Dec 4 05.5	Dec 10 12.0	Dec 15 06.8
Dec 19 16.4	Dec 25 10.4	Dec 31 17.2	

SATURN'S RINGS

Major and Minor axes (in arc secs) are for the outer edge of the outer ring. To work out the dimensions of the other rings, multiply by the following factors.

Inner edge of outer ring	0.8932
Outer edge of inner ring	0.8596
Inner edge of inner ring	0.6726
Inner edge of dusky ring	0.5477

'U' and 'B' equal the Geocentric longitude and the tilt of the rings respectively.

Date	Major "	Minor "	U °	B °
Jan 04	39.17	2.42	231.707	-3.541
Jan 12	38.66	2.56	232.128	-3.791
Jan 20	38.19	2.72	232.634	-4.082
Jan 28	37.75	2.90	233.218	-4.410
Feb 05	37.36	3.11	233.872	-4.770
Feb 13	37.03	3.33	234.588	-5.156
Feb 21	36.74	3.56	235.357	-5.565
Mar 01	36.50	3.81	236.171	-5.990
Mar 09	36.33	4.07	237.020	-6.427
Mar 17	36.20	4.33	237.897	-6.871
Mar 25	36.13	4.60	238.792	-7.318
Apr 02	36.12	4.88	239.697	-7.762
Apr 10	36.16	5.16	240.604	-8.200
Apr 18	36.26	5.44	241.503	-8.627
Apr 26	36.41	5.72	242.388	-9.039
May 04	36.61	6.00	243.249	-9.433
May 12	36.87	6.28	244.078	-9.805
May 20	37.17	6.55	244.867	-10.152
May 28	37.53	6.82	245.607	-10.469
Jun 05	37.93	7.08	246.290	-10.754
Jun 13	38.37	7.33	246.909	-11.005
Jun 21	38.86	7.56	247.454	-11.218
Jun 29	39.37	7.78	247.920	-11.392

Date	Major "	Minor "	U °	B °
Jul 07	39.92	7.97	248.299	-11.523
Jul 15	40.49	8.15	248.585	-11.611
Jul 23	41.07	8.30	248.774	-11.655
Jul 31	41.65	8.41	248.861	-11.653
Aug 08	42.23	8.50	248.846	-11.606
Aug 16	42.78	8.54	248.729	-11.516
Aug 24	43.30	8.55	248.514	-11.384
Sep 01	43.77	8.51	248.206	-11.214
Sep 09	44.18	8.44	247.815	-11.010
Sep 17	44.51	8.32	247.352	-10.778
Sep 25	44.76	8.18	246.833	-10.525
Oct 03	44.90	8.00	246.275	-10.259
Oct 11	44.94	7.80	245.697	-9.990
Oct 19	44.88	7.58	245.120	-9.726
Oct 27	44.71	7.36	244.563	-9.477
Nov 04	44.45	7.15	244.045	-9.252
Nov 12	44.09	6.94	243.586	-9.060
Nov 20	43.66	6.76	243.200	-8.906
Nov 28	43.17	6.60	242.900	-8.797
Dec 06	42.64	6.48	242.696	-8.736
Dec 14	42.07	6.38	242.595	-8.726
Dec 22	41.48	6.32	242.598	-8.768
Dec 30	40.89	6.30	242.709	-8.861

For explanation see page 58

TIMES OF GREATEST EASTERN ELONGATION (WAST)

RHEA Mean Synodic Period 4d 12.5h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
2 12.3	3 04.0	2 07.3	2 23.3	4 15.3	5 07.1	2 10.1	3 01.2	3 15.8	5 06.1	1 08.1	2 22.7
7 00.8	7 16.5	6 19.9	7 11.9	9 03.9	9 19.6	6 22.6	7 13.6	8 04.2	9 18.5	5 20.5	7 11.1
11 13.3	12 05.1	11 08.5	12 00.5	13 16.4	14 08.1	11 11.0	12 02.0	12 16.5	14 06.8	10 08.8	11 23.5
16 01.9	16 17.6	15 21.0	16 13.0	18 05.0	18 20.6	15 23.5	16 14.4	17 04.8	18 19.1	14 21.2	16 11.9
20 14.4	21 06.2	20 09.6	21 01.6	22 17.5	23 09.1	20 11.9	21 02.7	21 17.2	23 07.4	19 09.5	21 00.3
25 02.9	25 18.7	24 22.2	25 14.2	27 06.1	27 21.6	25 00.4	25 15.1	26 05.5	27 19.8	23 21.9	25 12.8
29 15.4		29 10.8	30 02.8	31 18.6		29 12.8	30 03.5	30 17.8		28 10.3	30 01.2

DIONE Mean Synodic Period 2d 17.7h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
3 05.3	2 08.3	1 17.6	3 14.6	3 17.7	2 20.7	2 23.6	2 02.2	1 04.5	1 06.7	3 02.6	3 04.9
5 23.0	5 02.0	4 11.4	6 08.3	6 11.4	5 14.4	5 17.3	4 19.9	3 22.2	4 00.4	5 20.2	5 22.6
8 16.7	7 19.7	7 05.1	9 02.0	9 05.2	8 08.2	8 11.0	7 13.5	6 15.9	6 18.0	8 13.9	8 16.3
11 10.5	10 13.5	9 22.9	11 19.8	11 22.9	11 01.9	11 04.7	10 07.2	9 09.5	9 11.7	11 07.5	11 10.0
14 04.2	13 07.2	12 16.6	14 13.5	14 16.6	13 19.6	13 22.4	13 00.9	12 03.2	12 05.3	14 01.2	14 03.6
16 21.9	16 00.9	15 10.4	17 07.3	17 10.4	16 13.3	16 16.1	15 18.6	14 20.8	14 23.0	16 18.9	16 21.3
19 15.6	18 18.7	18 04.1	20 01.0	20 04.1	19 07.0	19 09.7	18 12.2	17 14.5	17 16.6	19 12.5	19 15.0
22 09.4	21 12.4	20 21.8	22 18.7	22 21.8	22 00.7	22 03.4	21 05.9	20 08.1	20 10.3	22 06.2	22 08.7
25 03.1	24 06.2	23 15.6	25 12.5	25 15.5	24 18.4	24 21.1	23 23.6	23 01.8	23 03.9	24 23.9	25 02.4
27 20.8	26 23.9	26 09.3	28 06.2	28 09.3	27 12.2	27 14.8	26 17.2	25 19.4	25 21.6	27 17.5	27 20.1
30 14.5		29 03.1	30 23.9	31 03.0	30 05.9	30 08.5	29 10.9	28 13.1	28 15.2	30 11.2	30 13.8
		31 20.8							31 08.9		

TETHYS Mean Synodic Period 1d 21.3h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
2 16.1	1 21.3	2 05.3	1 10.6	1 16.0	2 18.5	1 02.3	2 04.6	1 09.3	1 14.0	2 15.9	2 20.7
4 13.4	3 18.6	4 02.6	3 08.0	3 13.3	4 15.8	2 23.6	4 01.9	3 06.6	3 11.3	4 13.2	4 18.0
6 10.7	5 16.0	5 23.9	5 05.3	5 10.6	6 13.2	4 20.9	5 23.2	5 03.9	5 08.6	6 10.5	6 15.3
8 08.0	7 13.3	7 21.3	7 02.6	7 07.9	8 10.5	6 18.2	7 20.5	7 01.2	7 05.9	8 07.8	8 12.7
10 05.4	9 10.6	9 18.6	9 00.0	9 05.3	10 07.8	8 15.6	9 17.8	8 22.5	9 03.2	10 05.1	10 10.0
12 02.7	11 08.0	11 16.0	10 21.3	11 02.6	12 05.1	10 12.9	11 15.1	10 19.8	11 00.4	12 02.4	12 07.3
14 00.0	13 05.3	13 13.3	12 18.6	12 23.9	14 02.4	12 10.2	13 12.4	12 17.1	12 21.7	13 23.7	14 04.6
15 21.3	15 02.6	15 10.6	14 16.0	14 21.3	15 23.8	14 07.5	15 09.7	14 14.4	14 19.0	15 21.0	16 01.9
17 18.7	16 23.9	17 08.0	16 13.3	16 18.6	17 21.1	16 04.8	17 07.0	16 11.7	16 16.3	17 18.3	17 23.2
19 16.0	18 21.3	19 05.3	18 10.6	18 15.9	19 18.4	18 02.1	19 04.3	18 09.0	18 13.6	19 15.6	19 20.5
21 13.3	20 18.6	21 02.6	20 08.0	20 13.2	21 15.7	19 23.4	21 01.6	20 06.3	20 10.9	21 12.9	21 17.8
23 10.7	22 15.9	23 00.0	22 05.3	22 10.6	23 13.0	21 20.7	22 22.9	22 03.5	22 08.2	23 10.2	23 15.1
25 08.0	24 13.3	24 21.3	24 02.6	24 07.9	25 10.4	23 18.0	24 20.2	24 00.8	24 05.5	25 07.5	25 12.5
27 05.3	26 10.6	26 18.6	26 00.0	26 05.2	27 07.7	25 15.3	26 17.5	25 22.1	26 02.8	27 04.8	27 09.8
29 02.6	28 08.0	28 16.0	27 21.3	28 02.5	29 05.0	27 12.6	28 14.7	27 19.4	28 00.1	29 02.1	29 07.1
31 00.0		30 13.3	29 18.6	29 23.9		29 10.0	30 12.0	29 16.7	29 21.4	30 23.4	31 04.4
				31 21.2		31 07.3			31 18.6		

ENCELADUS Mean Synodic Period 1d 8.9h

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h	d hh.h
1 05.8	1 18.4	1 04.4	1 17.1	1 20.9	1 00.6	1 04.2	1 16.5	2 04.8	2 08.0	1 11.3	1 14.7
2 14.7	3 03.3	2 13.3	3 02.0	3 05.8	2 09.5	2 13.1	3 01.4	3 13.6	3 16.9	2 20.2	2 23.6
3 23.6	4 12.2	3 22.2	4 10.9	4 14.7	3 18.3	3 21.9	4 10.3	4 22.5	5 01.8	4 05.1	4 08.5
5 08.5	5 21.1	5 07.1	5 19.8	5 23.6	5 03.2	5 06.8	5 19.2	6 07.4	6 10.7	5 14.0	5 17.4
6 17.4	7 06.0	6 16.0	7 04.7	7 08.5	6 12.1	6 15.7	7 04.1	7 16.3	7 19.5	6 22.9	7 02.3
8 02.3	8 14.9	8 00.9	8 13.6	8 17.3	7 21.0	8 00.6	8 12.9	9 01.2	9 04.4	8 07.7	8 11.2
9 11.2	9 23.8	9 09.8	9 22.5	10 02.2	9 05.9	9 09.5	9 21.8	10 10.0	10 13.3	9 16.6	9 20.0
10 20.1	11 08.7	10 18.7	11 07.4	11 11.1	10 14.8	10 18.4	11 06.7	11 18.9	11 22.2	11 01.5	11 04.9
12 05.0	12 17.6	12 03.6	12 16.3	12 20.0	11 23.7	12 03.3	12 15.6	13 03.8	13 07.1	12 10.4	12 13.8
13 13.9	14 02.5	13 12.5	14 01.2	14 04.9	13 08.6	13 12.1	14 00.5	14 12.7	14 15.9	13 19.3	13 22.7
14 22.8	15 11.4	14 21.4	15 10.1	15 13.8	14 17.5	14 21.0	15 09.3	15 21.5	16 00.8	15 04.1	15 07.6
16 07.7	16 20.3	16 06.3	16 19.0	16 22.7	16 02.4	16 05.9	16 18.2	17 06.4	17 09.7	16 13.0	16 16.5
17 16.6	18 05.2	17 15.2	18 03.9	18 07.6	17 11.3	17 14.8	18 03.1	18 15.3	18 18.6	17 21.9	18 01.4
19 01.5	19 14.1	19 00.1	19 12.8	19 16.5	18 20.2	18 23.7	19 12.0	20 00.2	20 03.4	19 06.8	19 10.3
20 10.4	20 23.0	20 09.0	20 21.7	21 01.4	20 05.0	20 08.6	20 20.9	21 09.0	21 12.3	20 15.7	20 19.1
21 19.2	22 07.9	21 17.9	22 06.6	22 10.3	21 13.9	21 17.5	22 05.7	22 17.9	22 21.2	22 00.5	22 04.0
23 04.1	23 16.8	23 02.8	23 15.5	23 19.2	22 22.8	23 02.3	23 14.6	24 02.8	24 06.1	23 09.4	23 12.9
24 13.0	25 01.7	24 11.7	25 00.4	25 04.1	24 07.7	24 11.2	24 23.5	25 11.7	25 14.9	24 18.3	24 21.8
25 21.9	26 10.6	25 20.6	26 09.3	26 13.0	25 16.6	25 20.1	26 08.4	26 20.5	26 23.8	26 03.2	26 06.7
27 06.8	27 19.5	27 05.5	27 18.2	27 21.9	27 01.5	27 05.0	27 17.3	28 05.4	28 08.7	27 12.1	27 15.6
28 15.7		28 14.4	29 03.1	29 06.8	28 10.4	28 13.9	29 02.1	29 14.3	29 17.6	28 21.0	29 00.5
30 00.6		29 23.3	30 12.0	30 15.7	29 19.3	29 22.8	30 11.0	30 23.2	31 02.5	30 05.8	30 09.4
31 09.5		31 08.2				31 07.6	31 19.9				31 18.3

URANUS, NEPTUNE AND PLUTO

RISE AND SET TIMES (WAST)

URANUS Rise hh mm	URANUS Set hh mm	NEPTUNE Rise hh mm	NEPTUNE Set hh mm	PLUTO Rise hh mm	PLUTO Set hh mm	
6 51	20 39	6 21	20 12	3 17	16 05	Jan 4
6 25	20 13	5 55	19 46	2 50	15 38	11
5 59	19 47	5 29	19 19	2 24	15 12	18
5 34	19 20	5 03	18 52	1 57	14 45	25
5 08	18 54	4 36	18 26	1 30	14 18	Feb 1
4 43	18 28	4 10	17 59	1 03	13 51	8
4 17	18 02	3 44	17 33	0 36	13 24	15
3 51	17 36	3 17	17 06	0 09	12 56	22
3 26	17 09	2 51	16 39	23 38	12 29	Mar 1
3 00	16 43	2 24	16 12	23 10	12 01	8
2 34	16 17	1 58	15 45	22 43	11 34	15
2 08	15 50	1 31	15 19	22 15	11 06	22
1 41	15 24	1 04	14 51	21 48	10 38	29
1 15	14 57	0 37	14 24	21 20	10 10	Apr 5
0 48	14 30	0 10	13 57	20 52	9 42	12
0 22	14 03	23 39	13 30	20 24	9 14	19
23 51	13 36	23 11	13 02	19 56	8 46	26
23 24	13 09	22 44	12 35	19 28	8 17	May 3
22 56	12 41	22 16	12 07	19 00	7 49	10
22 29	12 14	21 49	11 40	18 32	7 21	17
22 01	11 46	21 21	11 12	18 04	6 53	24
21 33	11 18	20 53	10 44	17 35	6 24	31
21 05	10 50	20 25	10 16	17 07	5 56	Jun 7
20 37	10 22	19 57	9 48	16 39	5 28	14
20 08	9 54	19 28	9 20	16 11	4 59	21
19 40	9 26	19 00	8 52	15 43	4 31	28
19 11	8 58	18 32	8 24	15 14	4 03	Jul 5
18 42	8 29	18 03	7 56	14 46	3 35	12
18 13	8 01	17 35	7 28	14 18	3 07	19
17 45	7 32	17 06	6 59	13 50	2 40	26
17 16	7 04	16 38	6 31	13 23	2 12	Aug 2
16 47	6 36	16 10	6 03	12 55	1 44	9
16 18	6 07	15 41	5 35	12 27	1 17	16
15 49	5 39	15 13	5 07	11 59	0 50	23
15 21	5 10	14 45	4 39	11 32	0 22	30
14 52	4 42	14 17	4 11	11 04	23 51	Sep 6
14 24	4 14	13 49	3 43	10 37	23 24	13
13 56	3 46	13 21	3 15	10 10	22 58	20
13 27	3 18	12 53	2 47	9 43	22 31	27
13 00	2 50	12 25	2 20	9 16	22 04	Oct 4
12 32	2 23	11 58	1 52	8 49	21 38	11
12 04	1 55	11 30	1 25	8 22	21 11	18
11 37	1 28	11 03	0 57	7 55	20 45	25
11 10	1 00	10 36	0 30	7 28	20 18	Nov 1
10 43	0 33	10 09	23 59	7 01	19 52	8
10 16	0 06	9 42	23 32	6 35	19 26	15
9 50	23 36	9 15	23 05	6 08	18 59	22
9 23	23 09	8 48	22 38	5 41	18 33	29
8 57	22 42	8 22	22 11	5 15	18 07	Dec 6
8 31	22 16	7 55	21 45	4 48	17 40	13
8 05	21 49	7 29	21 18	4 22	17 14	20
7 39	21 23	7 02	20 51	3 55	16 47	27

POSITION (0hr UT Epoch 2000.0)

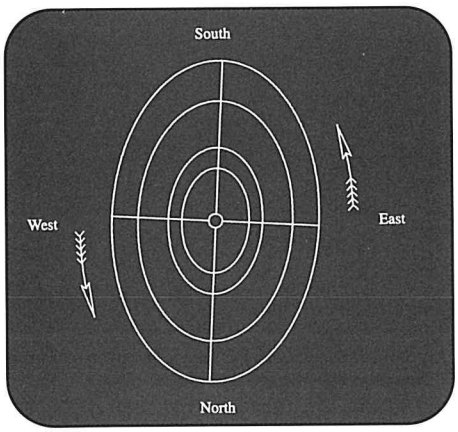
URANUS RA h m s	URANUS DEC ° ' "	NEPTUNE RA h m s	NEPTUNE DEC ° ' "	PLUTO RA h m s	PLUTO DEC ° ' "
20 23 43	- 19 55 45	19 55 47	- 20 20 35	16 19 23	- 08 50 34
20 25 22	- 19 50 08	19 56 52	- 20 17 37	16 20 15	- 08 51 22
20 27 03	- 19 44 22	19 57 59	- 20 14 36	16 21 03	- 08 51 42
20 28 44	- 19 38 30	19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

SATELLITES OF URANUS — GREATEST NORTHERN ELONGATION (WAST)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
					ARIEL						
2 09.9	1 15.6	1 08.9	3 03.1	3 09.0	2 14.5	2 20.6	2 02.5	1 08.5	1 14.4	3 08.8	1 02.2
4 22.3	4 04.1	3 21.4	5 15.6	5 21.5	5 03.2	5 09.1	4 15.0	3 21.0	4 02.9	5 21.3	3 14.7
7 10.8	6 16.6	6 09.9	8 04.1	8 09.9	7 15.7	7 21.6	7 03.5	6 09.5	6 15.4	8 09.8	6 03.2
9 23.3	9 05.0	8 22.4	10 16.6	10 22.4	10 04.2	10 10.1	9 16.0	8 22.0	9 03.9	10 22.3	8 15.7
12 11.8	11 17.5	11 10.9	13 05.1	13 10.9	12 16.7	12 22.6	12 04.5	11 10.4	11 16.4	13 10.8	11 04.2
15 00.3	14 06.0	13 23.3	15 17.5	15 23.4	15 05.2	15 11.1	14 17.0	13 23.0	14 04.9	15 23.3	13 16.7
17 12.8	16 18.5	16 11.8	18 06.1	18 11.9	17 17.7	17 23.6	17 05.5	16 11.4	16 17.4	18 11.8	16 05.2
20 01.2	19 07.0	19 00.3	20 18.5	21 00.3	20 06.2	20 12.1	19 18.0	18 23.9	19 05.9	21 00.2	18 17.7
22 13.7	21 19.5	21 12.8	23 07.0	23 12.8	22 18.7	23 00.5	22 06.5	21 12.4	21 18.4	23 12.8	21 06.2
25 02.2	24 08.0	24 01.2	25 19.5	26 01.3	25 07.2	25 13.0	24 19.0	24 00.9	24 06.9	26 01.2	23 18.6
27 14.7	26 20.4	26 13.7	28 08.0	28 13.8	27 19.6	28 01.5	27 07.5	26 13.4	26 19.4	28 13.7	26 07.2
30 03.1		29 02.2	30 20.5	31 02.3	30 08.1	30 14.0	29 20.0	29 01.9	29 07.8		28 19.6
		31 14.7							31 20.4		31 08.1
					UMBRIEL						
1 04.5	3 08.0	4 08.0	2 08.1	1 08.4	3 12.0	2 12.2	4 15.8	2 16.2	1 16.6	3 20.3	2 20.4
5 08.0	7 11.5	8 11.5	6 11.5	5 11.7	7 15.5	6 15.7	8 19.3	6 19.7	5 20.1	7 23.7	6 23.9
9 11.4	11 15.0	12 14.9	10 15.0	9 15.2	11 19.0	10 19.1	12 22.8	10 23.2	9 23.6	12 03.1	11 03.4
13 14.8	15 18.4	16 18.3	14 18.4	13 18.7	15 22.4	14 22.5	17 02.3	15 02.7	14 03.0	16 06.6	15 06.9
17 18.3	19 21.8	20 21.8	18 21.9	17 22.2	20 01.8	19 02.0	21 05.8	19 06.2	18 06.4	20 10.0	19 10.4
21 21.8	24 01.2	25 01.2	23 01.4	22 01.6	24 05.2	23 05.4	25 09.3	23 09.7	22 09.8	24 13.6	23 13.7
26 01.2	28 04.6	29 04.7	27 04.9	26 05.1	28 08.6	27 08.9	29 12.7	27 13.1	26 13.4	28 17.0	27 17.2
30 04.6				30 08.5		31 12.4			30 16.8		31 20.7
					TITANIA						
4 09.9	8 05.3	6 07.9	1 10.5	6 06.1	1 08.9	6 04.8	1 07.8	5 03.6	1 06.4	5 02.3	1 05.2
13 02.7	16 22.2	15 00.8	10 03.4	14 23.0	10 01.9	14 21.9	10 00.8	13 20.6	9 23.4	13 19.4	9 22.2
21 19.7	25 15.0	23 17.6	18 20.3	23 16.0	18 18.9	23 14.9	18 17.8	22 13.5	18 16.4	22 12.3	18 15.1
30 12.5			27 13.2		27 11.9		27 10.7		27 09.4		27 07.9
					OBERON						
10 13.7	6 11.6	5 09.6	1 07.6	11 16.7	7 14.9	4 13.1	13 22.8	9 21.5	6 19.8	2 18.1	13 02.7
24 00.7	19 22.4	18 20.5	14 18.7	25 03.8	21 02.0	18 00.1	27 10.2	23 08.6	20 07.0	16 05.0	26 13.8
			28 05.6			31 11.4				29 16.0	

SATELLITES OF URANUS

Apparent orbit of Satellites I-IV at date of opposition, July 29

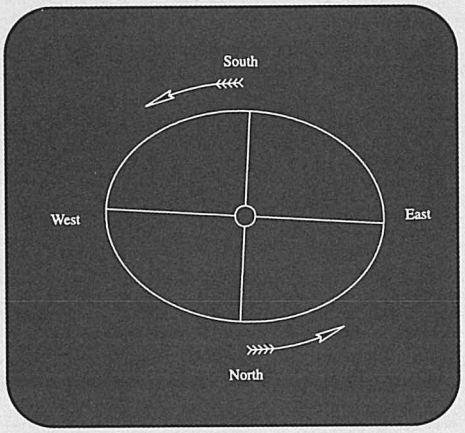


Name	Sidereal Period d	h
V Miranda	1	9.923
I Ariel	2	12.489
II Umbriel	4	03.460
III Titania	8	16.941
IV Oberon	13	11.118

See introduction to part II (page 58) for explanation.

SATELLITES OF NEPTUNE

Apparent orbit of Triton at date of opposition, July 21



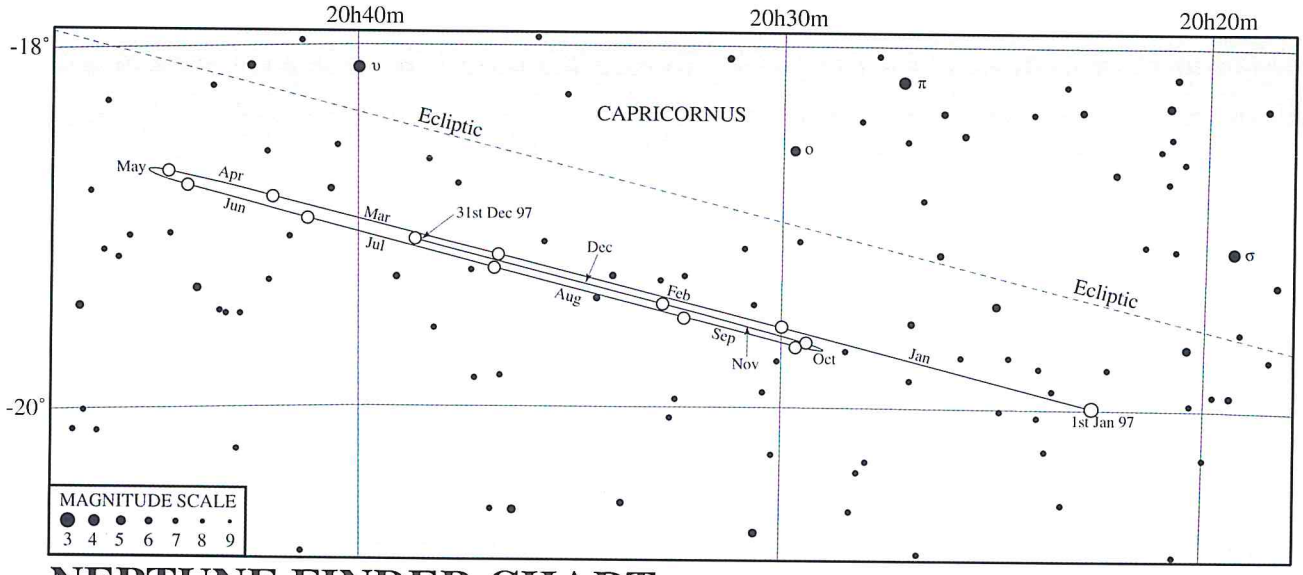
Name	Sidereal Period d	h
I Triton	5	21.044
II Nereid	360.2	

See introduction to part II (page 58) for explanation

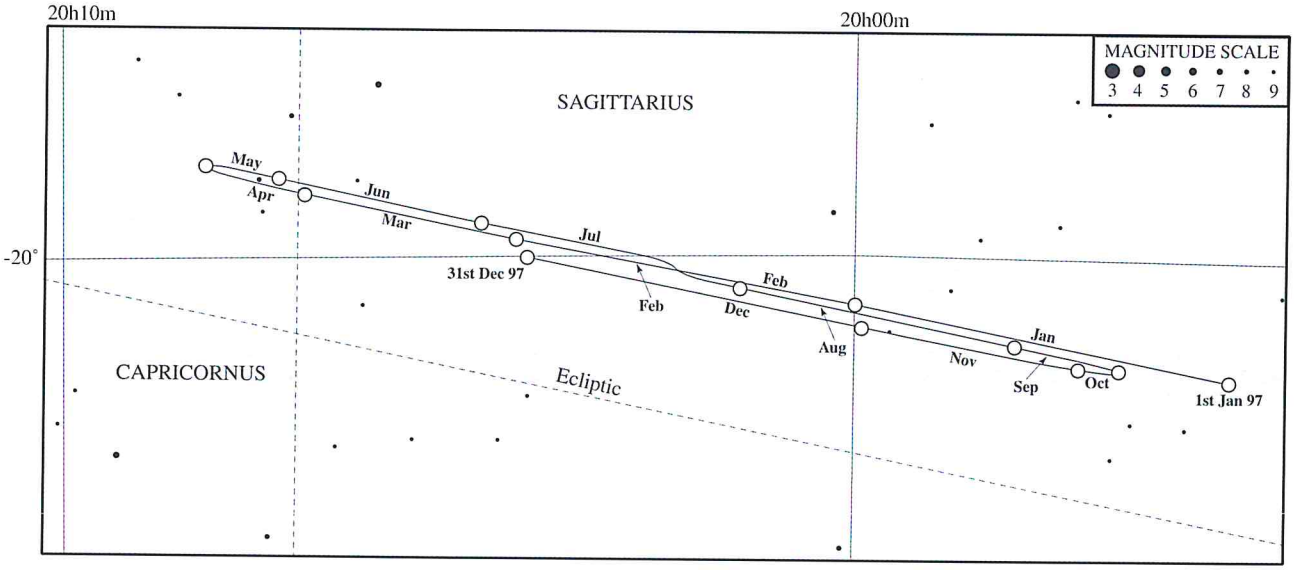
SATELLITE OF NEPTUNE — GREATEST EASTERN ELONGATION (WAST)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
					TRITON						
5 20.6	4 05.2	5 13.8	3 22.6	3 07.6	1 16.9	1 02.5	5 09.3	3 19.0	3 04.4	1 13.7	6 19.6
11 17.5	10 02.1	11 10.8	9 19.6	9 04.7	7 14.0	6 23.6	11 06.4	9 16.1	9 01.5	7 10.7	12 16.5
17 14.5	15 23.0	17 07.7	15 16.6	15 01.7	13 11.1	12 20.7	17 03.6	15 13.2	14 22.6	13 07.7	18 13.4
23 11.4	21 20.0	23 04.7	21 13.6	20 22.8	19 08.2	18 17.9	23 00.7	21 10.3	20 19.6	19 04.7	24 10.4
29 08.3	27 16.9	29 01.6	27 10.6	26 19.8	25 05.3	24 15.0	28 21.8	27 07.4	26 16.6	25 01.6	30 07.3
						30 12.2				30 22.6	

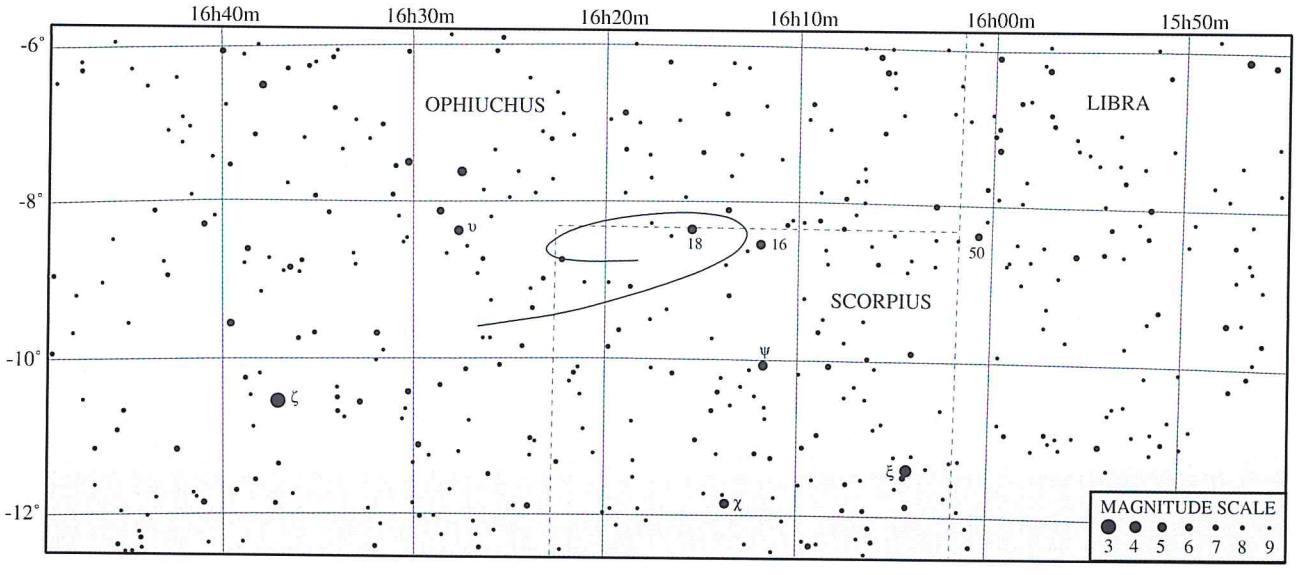
URANUS FINDER CHART



NEPTUNE FINDER CHART



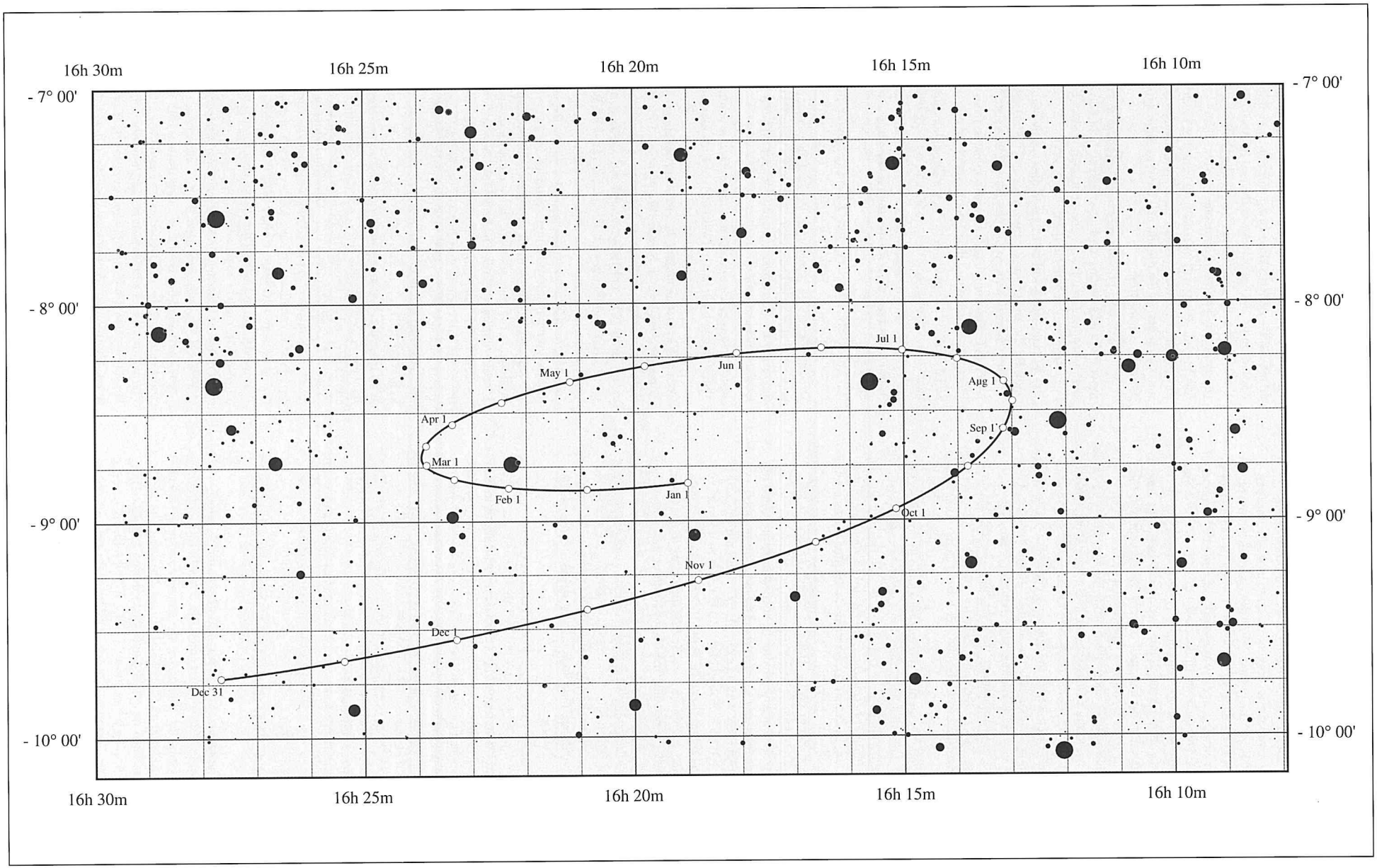
PLUTO POINTER CHART



See introduction to part II (page 58) for explanation

PLUTO FINDER CHART 1997 Epoch 2000.0

Stars range in magnitude from 5.5 to 14.5



See introduction to part II (page 58) for explanation

COMETS FOR 1997

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 takes just over 3 years to orbit the Sun. There are also a number of comets that are not expected to return for hundreds of years. Each year sees the discovery of around 5 to 10 new comets that have not been recorded before. The majority of these have either open ended orbits (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 or wind, on its outward journey from the Sun, sweeps the coma cloud away forming the 'tail' of the comet. The lost material from the coma will continue to be replenished from the nucleus as long as the comet stays close to the Sun.

Comets are normally named after their discoverers (up to the first two to report the find). There are also other designations given to comets (you will see examples on the following pages). The prefix 'P/' refers to the fact the comet is periodic. The number before the 'P' indicates the number of the periodic comet. For example Comet 46P/Wirtanen indicates Wirtanen was the 46th comet confirmed to be periodic. The is not assigned until the comet is found on a later return. Interestingly, Halley's Comet's prefix is 1P/ because it was the first comet shown to be periodic. In fact Halley did not find the comet. It was named after him after he successfully predicted its return. You will also see references to a new preliminary designation system. It is best to explain this with an example. You will notice Comet Hale-Bopp is also referred to as 'C/1995 O1'. 1995 refers to the year, O refers to the 14th half month period ('O' is the 15th letter but 'I' is not used) during the year and 1 shows it was the first discovery in this half month. Therefore Hale-Bopp was the first discovery in the last half of July 1995.

It is true that there is no such thing as a 'typical comet'. Like people, they are all slightly different. The orbits, the overall brightness, the size of the coma and the tail can vary dramatically from comet to comet. To watch one brighten, develop a tail and then fade away over a period of a few weeks, can be a fascinating experience.

This section is devoted to the 'periodic' comets that are expected to be observable during 1997. The table (opposite) lists these objects as well as their orbital elements (the data required to calculate their locations in the sky). This is followed by 'ephemerides' (a list of expected positions in the sky and magnitude estimates for different dates) for some of the brighter comets. These tables of positions and magnitudes are only approximate, for few of these comets (as of early October 96) had been found yet on this return. Hence the orbital elements and magnitude parameters, used to generate the ephemerides, have been based on their behaviour on previous returns. There are also non gravitational effects, associated with comets, which can render predicted ephemerides inaccurate.

Many of the comets expected in 1997 are extremely faint and would require professional size telescopes or long exposure astrophotographs to detect them. But who knows what new discoveries lie in the future!

NOTES ON SELECTED BRIGHT COMETS FOR 1997

by Greg Bryant

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

Hale-Bopp: In recent years, the attention of the amateur and professional communities has been focused on Comet Hale-Bopp, discovered in July 1995. It was expected to become a naked-eye comet during 1996/97. Hale-Bopp lived up to its expectations for most of 1996, with the first naked-eye sightings coming in May. However, since the middle of the year, its rate of brightening has dropped off dramatically, although an outburst in September/October saw it catch up on much of its lost ground.
The slump in Comet Hale-Bopp's rate of brightening has surprised many astronomers. The drop was far greater than most comet observers would have expected. There is now a renewed air of uncertainty about how bright Hale-Bopp will be at its peak in March/April 1997 for Northern Hemisphere observers. The same unknown factor applies to its brightness for us "down under" when we see it again from the end of April. Nevertheless, 1997 is shaping up to give us good views of Hale-Bopp.

JANUARY - APRIL: Hale-Bopp will not be visible from Australia during these months, except perhaps at the end of April. Perihelion occurs on April 1st. The comet could perhaps peak in brightness at 1st magnitude, giving people in the Northern Hemisphere a great show.

MAY: Hale-Bopp will be a difficult comet to observe during May. It begins the month in Taurus, setting before 7pm, perhaps at magnitude 2. It moves into Orion during the month, and fades to 3rd magnitude, still setting around the same time.

JUNE: The comet presents an even harder task to observe this month. It moves into Monoceros during the month, fading to 4th magnitude, and setting around 6pm. By the end of June, it is also rising around 6am, and our attention now turns to the morning sky.

JULY: Hale-Bopp will be easier to observe by mid-month, rising around 5am. By the end of July, it may have only faded half a magnitude, and will be rising around 4am. At this time it will be located in Canis Major.

AUGUST: This month sees Hale-Bopp move from Canis Major into Puppis. It ends the month at 5th magnitude, rising around 2am.

SEPTEMBER: Remaining in Puppis throughout the month, Hale-Bopp fades only slightly, and by month's end is rising before midnight.

OCTOBER: Still a naked-eye comet under dark skies, Hale-Bopp moves from Puppis into Vela. Rising around 8pm, it is visible for most of the night.

NOVEMBER: Hale-Bopp may have faded to 6th magnitude by the end of November, but it's visible all night. During this month it moves into Carina.

DECEMBER: The comet ends 1997 on the border of Carina and Dorado, and could still be naked-eye to eagle-eyed observers under dark skies. For the rest of us, the comet, at slightly fainter than 6th magnitude, will be at least a binocular object.

46P/Wirtanen: This comet was discovered in January 1948, on a photographic plate by Carl Wirtanen of Lick Observatory, whilst conducting a program of studying the proper motion of stars. Periodic Comet Wirtanen is making its 8th observed apparition. Prior to 1986, Comet Wirtanen never became brighter than 15th magnitude, making it too faint for the amateur observer. However, a combination of close approaches to Jupiter in 1972 and 1984 reduced Wirtanen's perihelion distance from 1.61 to 1.26 and finally to 1.08 AU. This enabled Wirtanen to be observed by amateurs at its returns in 1986 and 1991.

An analysis of Wirtanen's performance during the last two returns reveals that the comet displayed a more complex light curve than that used in the accompanying ephemeris. It showed a rapid surge in the comet's intrinsic brightness prior to perihelion, slowing until it reached a peak approximately 2 weeks after perihelion. The brightness then followed a steep decline after perihelion. It is interesting to note that 1991's intrinsic brightness was 0.5 to 0.7 magnitudes fainter than in 1986. Such a decrease, during the first few apparitions at a closer perihelion distance, is perhaps not unexpected. What does 1997's return hold in store?

81P/Wild 2: This is the second of four periodic comets discovered by Paul Wild from the Astronomical Institute of Berne. This one, discovered in January 1978 on photographs, is making its fourth observed apparition. The comet is noted for being a relatively "fresh" comet in the inner Solar System. A close encounter (0.2 AU) with Jupiter in 1974 (four years before the comet's discovery) moved the comet into its current orbit. Prior to 1974, the comet is calculated to have had a perihelion distance of 5 AU and a period of nearly 40 years. Comet Wild 2 will be the target of NASA's fourth "Discovery" mission when the comet next returns to the inner Solar System following its current appearance. The NASA probe, known as Stardust, will be launched in February 1999 for a flyby of the comet in January 2004.

C/1996 Q1 (Tabur): In August 1996, Canberra amateur astronomer Vello Tabur discovered this comet as a very diffuse 10th magnitude object. The comet subsequently brightened as it neared the Earth and the Sun. It became 5th magnitude by October as it became a northern hemisphere target only. Thus, it became 1996's third naked-eye comet, after Hyakutake and Hale-Bopp. Shortly after its orbit was calculated, it was discovered that it bore a striking resemblance to 1988's Comet Liller. It is now believed that Tabur split from Liller a few thousand years ago, when the comet was at its previous return. Tabur's return to our skies in 1997 will initially be as a 10th magnitude morning comet, slowly fading over the following few months.

2P/Encke: After Halley, one of the most well known comets is Encke. This visitor enters our neighbourhood every 3.3 years, making it the shortest period of any known comet.

In 1997, Encke is making its 57th observed return. Since its discovery, it has only been missed once (in 1944 due to unfavourable observing conditions and the war). On 4th July 1997 it will pass Earth at a distance of only 0.19 AU. Never since its discovery in 1786 has Encke passed so close to Earth.

Southern hemisphere observers are considerably favoured by this apparition. This is quite normal when Encke reaches perihelion between May and August. Observers should first sight the comet in June's evening sky. By mid month, the comet will be quite close to Hale-Bopp, at about 7th magnitude. It will continue to brighten to about 6th magnitude as it moves quickly through the southern half of the sky, becoming a circumpolar object and passing near the Coal Sack Nebula.

103P/Hartley 2: This relatively new periodic comet was discovered by Malcolm Hartley, on a plate taken on Siding Spring's Schmidt telescope in March 1986. It was determined that it was a short-period comet, which had reached perihelion in June 1985. It had previously gone unobserved due to poor observing geometry. However, it was discovered that Hartley 2 had made a close approach to Jupiter in 1982, which had shifted the comet into its current orbit. As no visual observations were made in 1986, Hartley 2's return in 1991 was the first opportunity for it to be visually followed. It surpassed expectations, reaching 8th magnitude in August and September of that year. Considering Hartley 2's performance in 1991, it is expected to similarly reach 8th magnitude by the end of 1997.

EXPLANATION OF COMET ELEMENTS TABLE

Perihelion Date Date of closest approach to the Sun.

q The perihelion distance, in AU (Astronomical units)

e The eccentricity of the comet's orbit. Values less than one indicate an elliptical orbit ie. a known periodic. NB. a value equal to one would indicate an open orbit which means either it is a once only visit to the Solar System or it has a very long period (thousands of years) or the comet is newly discovered and astronomers have not clearly defined its orbit.

Period The comet's period in years. The time it takes to complete one orbit of the Sun.

ω Argument of Perihelion. The angle from the ascending node to perihelion (measured in the plane of the comet's orbit in the direction of motion of the comet).

Ω Longitude of Ascending Node. The point of intersection between the plane of the comet's orbit and the plane of the earth's orbit (Ecliptic) as the comet moves north.

i Inclination. Angle between the plane of the comet's orbit and the plane of the Ecliptic. If the value is greater than 90°, the comets direction of orbit is retrograde ie. moving in the opposite direction to the planets.

H1 The absolute total magnitude of the comet, which is the theoretical brightness of the comet if it was one AU from the Sun and the Earth.

K1 A constant used in calculating the comet's total magnitude (see 'explanation of comet ephemerides' for further details)

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

EXPLANATION OF COMET EPHEMERIDES

DATE is for 0 hr UT or 8am WAST of date.

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

Δ (delta) Geocentric distance (distance from the Earth) in AU.

R Heliocentric distance (distance from the Sun) in AU .

ELG Elongation; angular distance of the comet from the Sun.

MAG This is the expected total magnitude of the comet. The value is only an estimate and for periodic comets it is invariably based on the behaviour of its brightness during previous return(s).

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

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

The brightness of Comet Encke behaves a little different from the above standard formula. Its magnitude estimate has been calculated using the following:

$$\text{Mag} = 9.8 + 5 \log (\Delta) + 2.5 (R^{1.8} - 1)$$

See the table of elements for the values of H1 and K1. For many comets the K1 value is equal to 10. For newly discovered comets the value of 'K1' is nearly always assumed to be equal to 10 until its light curve can be studied in detail. The brightness of a comet is often very uncertain; especially for those newly discovered. Comets have also been known to suddenly flare up or fade away and some have even shown a different behaviour in their light curve (changed values for 'H1' and 'K1') after perihelion compared to before. There are also constants of H2 and K2 used by astronomers which refer to the absolute magnitude and the K constant for the nucleus of the comet. These are not used in this publication.

COMETS FOR 1997 — ORBITAL ELEMENTS (EQUINOX 2000.0)

Comet Name	Perihelion Date		q	e	Period	ω	Ω	i	H1	K1
	yy mm	d.dd	A.U.		years	deg	deg	deg		
126P/IRAS	96 Oct	29.99534	1.7026876	0.6965898	13.29	356.88713	357.70068	045.96157	6.0	20.0
C/1996 Q1 (Tabur)	96 Nov	03.50783	0.8401956	1		057.36127	031.42215	073.34761	7.5	10.0
118P/Shoemaker-Levy 4	97 Jan	12.19504	2.0212441	0.4204769	6.51	301.98664	152.09726	008.47340	12.0	10.0
94P/Russell 4	97 Feb	03.47150	2.2292371	0.3651070	6.58	093.26811	070.96923	006.18807	9.0	15.0
P/1990 R2 (Holt-Olmstead)	97 Feb	06.65614	2.1534711	0.3704684	6.33	006.26874	014.06030	014.40611	11.0	15.0
46P/Wirtanen	97 Mar	14.14299	1.0637469	0.6567490	5.46	356.34322	082.20387	011.72255	9.0	15.0
117P/Helin-Roman-Alu 1	97 Mar	26.88237	3.7148324	0.1756995	9.57	215.07750	073.47305	009.74233	2.5	20.0
C/1995 O1 (Hale-Bopp)	97 Apr	01.14352	0.9141196	0.9950897		130.59101	282.47079	089.42846	0.5	5.0
85P/Boethin	97 Apr	17.70645	1.1581622	0.7743642	11.6	022.32520	014.41846	004.87686	6.5	20.0
81P/Wild 2	97 May	06.63871	1.5826168	0.5402247	6.39	041.77015	136.15508	003.24277	7.0	15.0
2P/Encke	97 May	23.59506	0.3313936	0.8500146	3.28	186.27131	334.72236	011.92974	9.8	
100P/Hartley 1	97 May	28.51694	1.8186806	0.4506097	6.02	178.93299	038.90289	025.72312	9.0	20.0
78P/Gehrels 2	97 Aug	07.07552	2.0003685	0.4635648	7.2	192.76673	210.63081	006.25790	5.5	20.0
D/1978 R1 (Haneda-Campos)	97 Aug	15.79529	1.2669765	0.6319746	6.39	307.05084	066.60938	004.94731	13.0	25.0
26P/Grigg-Skjellerup	97 Aug	30.30353	0.9968104	0.6638058	5.11	359.33182	213.30916	021.08677	12.0	40.0
43P/Wolf-Harrington	97 Sep	29.24189	1.5818249	0.5439830	6.46	187.13329	254.75666	018.51043	8.0	15.0
48P/Johnson	97 Oct	31.84978	2.3083076	0.3672594	6.97	207.99095	117.35357	013.66434	10.0	15.0
P/1989 U1 (Helin-Roman-Alu 2)	97 Nov	10.72684	1.9102598	0.5316421	8.24	220.97797	178.50210	005.77936	11.5	15.0
91P/Russell 3	97 Nov	19.19856	2.5100885	0.3440847	7.49	353.43441	248.67105	014.09579	7.5	15.0
P/1987 U1 (Shoemaker-Holt 1)	97 Nov	21.16559	3.0470270	0.3213812	9.51	210.21813	214.52727	004.36160	8.5	10.0
P/1990 R1 (Mueller 2)	97 Nov	22.50459	2.4124535	0.3438843	7.05	179.64748	214.28172	007.35567	11.0	10.0
69P/Taylor	97 Dec	12.29666	1.9478496	0.4659803	6.97	355.38034	108.85746	020.54695	9.5	30.0
103P/Hartley 2	97 Dec	21.94036	1.0317582	0.7003595	6.39	180.72297	219.95430	013.61974	8.5	20.0
55P/Tempel-Tuttle	98 Feb	28.07918	0.9766016	0.9054892	33.2	172.48546	235.25456	162.48474	10.0	25.0

COMETS

C/1995 O1 (Hale-Bopp)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1996 Dec 7	18 10.47	+00 09.9	2.873	2.069	29.1	4.4
1996 Dec 14	18 18.50	+01 12.7	2.801	1.981	27.5	4.2
1996 Dec 21	18 27.23	+02 25.9	2.717	1.892	26.9	4.1
1996 Dec 28	18 36.71	+03 51.3	2.621	1.804	27.2	3.9
1997 Jan 4	18 47.03	+05 30.8	2.515	1.715	28.4	3.7
1997 Jan 11	18 58.32	+07 27.1	2.398	1.627	30.3	3.5
1997 Jan 18	19 10.78	+09 43.2	2.273	1.539	32.6	3.2
1997 Jan 25	19 24.71	+12 22.4	2.141	1.452	35.2	3.0
1997 Feb 1	19 40.54	+15 28.8	2.004	1.368	37.9	2.7
1997 Feb 8	19 58.94	+19 06.4	1.866	1.286	40.4	2.4
1997 Feb 15	20 20.89	+23 18.5	1.730	1.207	42.7	2.1
1997 Feb 22	20 47.86	+28 04.9	1.602	1.134	44.5	1.8
1997 Mar 1	21 21.98	+33 17.3	1.489	1.067	45.7	1.5
1997 Mar 8	22 05.97	+38 31.6	1.398	1.010	46.2	1.2
1997 Mar 15	23 02.06	+42 59.1	1.338	0.964	46.0	1.1
1997 Mar 22	00 08.98	+45 33.1	1.315	0.932	45.0	0.9
1997 Mar 29	01 19.10	+45 25.5	1.332	0.916	43.4	0.9
1997 Apr 5	02 22.25	+42 47.9	1.386	0.917	41.4	1.0
1997 Apr 12	03 13.22	+38 38.4	1.468	0.935	39.0	1.2
1997 Apr 19	03 52.57	+33 54.5	1.571	0.968	36.4	1.4
1997 Apr 26	04 23.06	+29 12.1	1.685	1.015	33.7	1.7
1997 May 3	04 47.32	+24 47.1	1.805	1.074	31.0	1.9
1997 May 10	05 07.30	+20 44.2	1.924	1.141	28.3	2.2
1997 May 17	05 24.31	+17 02.5	2.041	1.215	25.9	2.5
1997 May 24	05 39.22	+13 39.2	2.153	1.294	23.9	2.7
1997 May 31	05 52.62	+10 31.0	2.258	1.376	22.4	3.0
1997 Jun 7	06 04.89	+07 34.6	2.356	1.461	21.6	3.2
1997 Jun 14	06 16.28	+04 47.1	2.446	1.548	21.6	3.4
1997 Jun 21	06 26.98	+02 06.1	2.529	1.636	22.4	3.6
1997 Jun 28	06 37.10	-00 30.6	2.603	1.724	23.9	3.8
1997 Jul 5	06 46.73	-03 04.7	2.671	1.813	26.0	3.9
1997 Jul 12	06 55.91	-05 37.6	2.731	1.901	28.5	4.1
1997 Jul 19	07 04.67	-08 10.6	2.785	1.990	31.4	4.2
1997 Jul 26	07 13.03	-10 44.5	2.832	2.078	34.6	4.3
1997 Aug 2	07 20.99	-13 20.2	2.874	2.166	37.9	4.5
1997 Aug 9	07 28.54	-15 58.3	2.911	2.253	41.4	4.6
1997 Aug 16	07 35.64	-18 39.3	2.944	2.340	45.0	4.7
1997 Aug 23	07 42.28	-21 23.2	2.973	2.426	48.6	4.8
1997 Aug 30	07 48.40	-24 10.4	3.000	2.512	52.3	4.9
1997 Sep 6	07 53.96	-27 00.7	3.024	2.597	55.9	5.0
1997 Sep 13	07 58.88	-29 54.0	3.047	2.681	59.6	5.1
1997 Sep 20	08 03.08	-32 49.6	3.070	2.765	63.1	5.1
1997 Sep 27	08 06.46	-35 46.9	3.093	2.848	66.6	5.2
1997 Oct 4	08 08.91	-38 45.2	3.117	2.930	70.0	5.3
1997 Oct 11	08 10.26	-41 43.2	3.143	3.012	73.3	5.4
1997 Oct 18	08 10.36	-44 39.4	3.172	3.093	76.4	5.5
1997 Oct 25	08 09.03	-47 32.3	3.205	3.174	79.3	5.5
1997 Nov 1	08 06.04	-50 19.7	3.241	3.254	82.0	5.6
1997 Nov 8	08 01.16	-52 59.4	3.281	3.333	84.4	5.7
1997 Nov 15	07 54.17	-55 28.7	3.327	3.412	86.5	5.8
1997 Nov 22	07 44.89	-57 44.9	3.377	3.490	88.3	5.9
1997 Nov 29	07 33.23	-59 45.1	3.433	3.568	89.8	5.9
1997 Dec 6	07 19.25	-61 26.3	3.493	3.645	90.9	6.0
1997 Dec 13	07 03.26	-62 46.1	3.559	3.721	91.7	6.1
1997 Dec 20	06 45.82	-63 42.9	3.629	3.797	92.2	6.2
1997 Dec 27	06 27.70	-64 16.0	3.704	3.872	92.4	6.3

Comet 46P/Wirtanen

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1996 Dec 7	21 51.31	-24 37.5	1.731	1.621	66.8	13.3
1996 Dec 14	22 04.55	-22 58.6	1.735	1.562	63.2	13.1
1996 Dec 21	22 18.81	-21 10.1	1.733	1.504	59.9	12.9
1996 Dec 28	22 34.04	-19 11.4	1.727	1.447	56.9	12.6
1997 Jan 4	22 50.19	-17 01.7	1.716	1.392	54.2	12.3
1997 Jan 11	23 07.25	-14 40.6	1.701	1.338	51.8	12.1
1997 Jan 18	23 25.21	-12 07.7	1.683	1.288	49.7	11.8
1997 Jan 25	23 44.07	-09 22.8	1.662	1.240	47.9	11.5
1997 Feb 1	00 03.88	-06 26.1	1.639	1.196	46.4	11.2
1997 Feb 8	00 24.67	-03 18.1	1.615	1.158	45.3	11.0
1997 Feb 15	00 46.52	+00 00.0	1.591	1.125	44.5	10.8
1997 Feb 22	01 09.49	+03 26.4	1.568	1.098	44.0	10.6
1997 Mar 1	01 33.68	+06 58.4	1.547	1.078	43.8	10.4
1997 Mar 8	01 59.19	+10 32.3	1.530	1.067	43.9	10.3
1997 Mar 15	02 26.11	+14 03.8	1.518	1.064	44.3	10.3
1997 Mar 22	02 54.48	+17 27.2	1.511	1.069	44.9	10.3
1997 Mar 29	03 24.29	+20 36.9	1.513	1.082	45.6	10.4
1997 Apr 5	03 55.43	+23 26.7	1.522	1.103	46.4	10.6
1997 Apr 12	04 27.70	+25 51.3	1.540	1.132	47.3	10.7
1997 Apr 19	05 00.72	+27 46.3	1.567	1.166	48.0	11.0
1997 Apr 26	05 34.01	+29 09.1	1.604	1.206	48.7	11.2
1997 May 3	06 07.03	+29 59.2	1.649	1.251	49.2	11.5
1997 May 10	06 39.28	+30 18.0	1.704	1.299	49.5	11.9
1997 May 17	07 10.30	+30 08.4	1.766	1.351	49.5	12.2
1997 May 24	07 39.76	+29 34.4	1.836	1.405	49.3	12.5
1997 May 31	08 07.48	+28 40.3	1.913	1.460	48.8	12.9
1997 Jun 7	08 33.40	+27 30.5	1.995	1.517	48.0	13.2
1997 Jun 14	08 57.58	+26 08.8	2.082	1.576	47.0	13.6
1997 Jun 21	09 20.09	+24 38.6	2.173	1.635	45.7	13.9
1997 Jun 28	09 41.07	+23 02.7	2.267	1.694	44.2	14.2

Comet 81P/Wild 2

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1996 Dec 7	08 20.63	+16 39.3	1.347	2.132	131.6	12.6
1996 Dec 14	08 22.46	+16 35.5	1.253	2.092	138.3	12.3
1996 Dec 21	08 22.83	+16 38.7	1.166	2.053	145.3	12.0
1996 Dec 28	08 21.67	+16 49.3	1.089	2.014	152.7	11.7
1997 Jan 4	08 18.99	+17 07.8	1.022	1.976	160.5	11.5
1997 Jan 11	08 14.91	+17 33.8	0.965	1.939	168.6	11.2
1997 Jan 18	08 09.75	+18 06.1	0.920	1.903	176.7	11.0
1997 Jan 25	08 03.96	+18 42.9	0.886	1.868	173.9	10.8
1997 Feb 1	07 58.13	+19 21.7	0.864	1.834	165.5	10.6
1997 Feb 8	07 52.90	+20 00.0	0.852	1.802	157.1	10.5
1997 Feb 15	07 48.93	+20 35.5	0.850	1.771	149.0	10.4
1997 Feb 22	07 46.76	+21 06.3	0.857	1.742	141.3	10.3
1997 Mar 1	07 46.72	+21 31.0	0.870	1.715	134.2	10.2
1997 Mar 8	07 48.99	+21 48.7	0.890	1.690	127.7	10.2
1997 Mar 15	07 53.63	+21 58.6	0.914	1.667	121.7	10.1
1997 Mar 22	08 00.55	+21 59.9	0.942	1.647	116.3	10.1
1997 Mar 29	08 09.56	+21 52.2	0.973	1.629	111.4	10.1
1997 Apr 5	08 20.45	+21 34.7	1.007	1.614	107.1	10.1
1997 Apr 12	08 32.98	+21 07.1	1.042	1.602	103.1	10.2
1997 Apr 19	08 46.91	+20 29.0	1.080	1.593	99.6	10.2
1997 Apr 26	09 01.98	+19 40.3	1.119	1.586	96.4	10.3
1997 May 3	09 17.94	+18 41.1	1.161	1.583	93.5	10.3
1997 May 10	09 34.61	+17 31.7	1.204	1.583	90.8	10.4
1997 May 17	09 51.79	+16 12.7	1.250	1.586	88.4	10.5
1997 May 24	10 09.31	+14 45.1	1.298	1.592	86.2	10.6
1997 May 31	10 27.01	+13 09.9	1.350	1.601	84.0	10.7
1997 Jun 7	10 44.79	+11 28.1	1.404	1.613	82.0	10.9
1997 Jun 14	11 02.58	+09 41.0	1.461	1.628	80.0	11.0
1997 Jun 21	11 20.30	+07 50.1	1.521	1.646	78.1	11.2
1997 Jun 28	11 37.88	+05 56.5	1.585	1.666	76.2	11.3
1997 Jul 5	11 55.32	+04 01.5	1.652	1.689	74.3	11.5
1997 Jul 12	12 12.59	+02 06.3	1.722	1.714	72.3	11.7
1997 Jul 19	12 29.68	+00 11.9	1.796	1.741	70.4	11.9
1997 Jul 26	12 46.59	-01 40.6	1.873	1.770	68.3	12.1
1997 Aug 2	13 03.33	-03 30.5	1.953	1.801	66.2	12.3
1997 Aug 9	13 19.92	-05 17.1	2.035	1.833	64.0	12.5
1997 Aug 16	13 36.35	-06 59.6	2.120	1.867	61.7	12.7
1997 Aug 23	13 52.64	-08 37.7	2.207	1.902	59.3	12.9
1997 Aug 30	14 08.81	-10 10.8	2.296	1.938	56.9	13.1

COMETS

Comet 2P/Encke

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Mar 15	00 43.88	+11 10.1	2.302	1.417	20.8	13.8
1997 Mar 22	00 58.93	+12 41.2	2.229	1.318	18.0	13.2
1997 Mar 29	01 15.49	+14 18.0	2.146	1.214	15.6	12.5
1997 Apr 5	01 33.89	+16 00.1	2.052	1.105	13.6	11.9
1997 Apr 12	01 54.59	+17 46.7	1.949	0.991	12.1	11.2
1997 Apr 19	02 18.20	+19 35.8	1.834	0.871	11.2	10.6
1997 Apr 26	02 45.56	+21 23.4	1.709	0.746	10.9	9.9
1997 May 3	03 17.79	+23 01.3	1.571	0.616	11.4	9.3
1997 May 10	03 56.09	+24 12.2	1.414	0.487	13.0	8.7
1997 May 17	04 40.40	+24 20.8	1.228	0.377	15.9	8.2
1997 May 24	05 24.51	+22 34.3	1.005	0.332	18.9	7.7
1997 May 31	05 56.01	+18 43.9	0.779	0.387	20.0	7.2
1997 Jun 7	06 14.90	+13 24.6	0.591	0.502	19.9	6.9
1997 Jun 14	06 29.56	+06 11.1	0.440	0.631	22.3	6.6
1997 Jun 21	06 47.68	-04 53.2	0.318	0.760	30.7	6.3
1997 Jun 28	07 21.40	-24 08.1	0.227	0.885	49.2	6.1
1997 Jul 5	08 55.56	-53 50.9	0.190	1.004	80.8	6.2
1997 Jul 12	13 27.46	-67 14.6	0.230	1.118	110.4	7.2
1997 Jul 19	16 01.52	-57 24.5	0.319	1.226	124.5	8.4
1997 Jul 26	16 50.59	-49 07.1	0.432	1.329	128.7	9.6
1997 Aug 2	17 14.77	-43 42.7	0.556	1.428	128.3	10.8
1997 Aug 9	17 30.73	-40 02.0	0.689	1.523	125.8	11.8
1997 Aug 16	17 43.26	-37 23.1	0.828	1.614	122.3	12.8
1997 Aug 23	17 54.17	-35 22.9	0.972	1.702	118.2	13.7

Comet C/1996 Q1 (Tabur)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1996 Dec 7	15 59.15	+20 09.1	1.472	1.042	44.9	8.5
1996 Dec 14	16 04.19	+17 51.3	1.556	1.119	45.7	8.9
1996 Dec 21	16 08.41	+15 52.3	1.622	1.202	47.5	9.3
1996 Dec 28	16 11.87	+14 09.6	1.673	1.289	50.2	9.7
1997 Jan 4	16 14.52	+12 41.5	1.709	1.378	53.7	10.1
1997 Jan 11	16 16.27	+11 26.2	1.731	1.470	58.0	10.4
1997 Jan 18	16 16.99	+10 22.2	1.739	1.562	63.0	10.6
1997 Jan 25	16 16.54	+09 28.3	1.737	1.655	68.6	10.9
1997 Feb 1	16 14.76	+08 43.0	1.726	1.748	74.7	11.1
1997 Feb 8	16 11.46	+08 05.1	1.707	1.840	81.5	11.3
1997 Feb 15	16 06.43	+07 33.5	1.682	1.933	88.8	11.5
1997 Feb 22	15 59.52	+07 06.5	1.656	2.024	96.6	11.7
1997 Mar 1	15 50.59	+06 42.6	1.630	2.116	105.0	11.8
1997 Mar 8	15 39.58	+06 20.2	1.608	2.206	114.0	12.0
1997 Mar 15	15 26.57	+05 57.5	1.594	2.296	123.3	12.1
1997 Mar 22	15 11.81	+05 32.6	1.591	2.385	133.0	12.3
1997 Mar 29	14 55.75	+05 04.2	1.603	2.474	142.8	12.5
1997 Apr 5	14 39.00	+04 31.3	1.633	2.561	152.3	12.6
1997 Apr 12	14 22.25	+03 53.6	1.682	2.648	160.4	12.9
1997 Apr 19	14 06.20	+03 11.6	1.752	2.734	165.0	13.1
1997 Apr 26	13 51.44	+02 26.1	1.841	2.819	163.1	13.3
1997 May 3	13 38.35	+01 38.2	1.950	2.904	156.8	13.6
1997 May 10	13 27.13	+00 48.7	2.076	2.988	149.1	13.8
1997 May 17	13 17.85	+00 01.6	2.217	3.071	141.2	14.1

Comet103P/Hartley 2

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Sep 6	18 33.80	-00 34.0	1.060	1.731	113.6	13.4
1997 Sep 13	18 33.90	-01 33.0	1.061	1.667	107.5	13.1
1997 Sep 20	18 36.30	-02 33.0	1.062	1.604	101.8	12.7
1997 Sep 27	18 41.00	-03 33.0	1.062	1.541	96.5	12.4
1997 Oct 4	18 47.90	-04 32.0	1.061	1.479	91.7	12.0
1997 Oct 11	18 57.10	-05 29.0	1.056	1.418	87.3	11.7
1997 Oct 18	19 08.42	-06 22.0	1.048	1.359	83.3	11.3
1997 Oct 25	19 22.00	-07 10.0	1.036	1.303	79.8	10.9
1997 Nov 1	19 37.70	-07 53.0	1.021	1.249	76.7	10.5
1997 Nov 8	19 55.70	-08 29.0	1.002	1.199	74.0	10.1
1997 Nov 15	20 15.80	-08 58.0	0.979	1.154	71.8	9.7
1997 Nov 22	20 38.30	-09 18.0	0.954	1.114	70.0	9.3
1997 Nov 29	21 03.06	-09 28.0	0.927	1.081	68.7	9.0
1997 Dec 6	21 30.20	-09 28.0	0.899	1.056	68.0	8.7
1997 Dec 13	21 59.60	-09 14.0	0.873	1.040	67.7	8.5
1997 Dec 20	22 31.20	-08 48.0	0.850	1.032	68.0	8.4
1997 Dec 27	23 04.73	-08 06.0	0.832	1.034	68.9	7.8

Comet 78P/Gehrels 2

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Jul 5	03 20.06	+18 28.5	2.505	2.019	50.6	13.6
1997 Jul 12	03 36.35	+19 10.9	2.446	2.012	53.4	13.5
1997 Jul 19	03 52.60	+19 46.4	2.386	2.007	56.2	13.4
1997 Jul 26	04 08.77	+20 15.0	2.326	2.003	59.1	13.4
1997 Aug 2	04 24.79	+20 36.4	2.266	2.001	62.0	13.3
1997 Aug 9	04 40.55	+20 50.5	2.205	2.000	65.0	13.2
1997 Aug 16	04 55.98	+20 57.4	2.144	2.002	68.1	13.2
1997 Aug 23	05 11.00	+20 57.1	2.083	2.005	71.4	13.1
1997 Aug 30	05 25.50	+20 50.0	2.022	2.009	74.8	13.1
1997 Sep 6	05 39.37	+20 36.5	1.961	2.016	78.3	13.1
1997 Sep 13	05 52.50	+20 17.0	1.900	2.023	82.1	13.0
1997 Sep 20	06 04.79	+19 52.1	1.839	2.033	86.0	13.0
1997 Sep 27	06 16.14	+19 22.7	1.779	2.044	90.1	13.0
1997 Oct 4	06 26.40	+18 49.4	1.719	2.056	94.6	12.9
1997 Oct 11	06 35.46	+18 13.2	1.660	2.070	99.3	12.9
1997 Oct 18	06 43.21	+17 34.9	1.603	2.086	104.3	12.9
1997 Oct 25	06 49.52	+16 55.7	1.548	2.103	109.6	12.9
1997 Nov 1	06 54.28	+16 16.6	1.496	2.121	115.4	12.9
1997 Nov 8	06 57.39	+15 38.7	1.449	2.140	121.5	12.9
1997 Nov 15	06 58.80	+15 03.1	1.406	2.160	128.0	12.9
1997 Nov 22	06 58.51	+14 30.9	1.370	2.182	134.9	13.0
1997 Nov 29	06 56.57	+14 03.0	1.341	2.204	142.1	13.0
1997 Dec 6	06 53.13	+13 40.4	1.321	2.228	149.6	13.1
1997 Dec 13	06 48.49	+13 23.5	1.312	2.252	157.1	13.1
1997 Dec 20	06 43.00	+13 12.8	1.315	2.277	164.2	13.2
1997 Dec 27	06 37.08	+13 08.2	1.330	2.304	169.3	13.4

Comet 43P/Wolf-Harrington

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
1997 Jul 5	03 36.46	+28 49.5	2.363	1.797	45.2	13.7
1997 Jul 12	03 57.47	+29 19.1	2.294	1.766	47.1	13.5
1997 Jul 19	04 18.95	+29 36.7	2.227	1.737	48.9	13.3
1997 Jul 26	04 40.80	+29 41.2	2.161	1.710	50.8	13.2
1997 Aug 2	05 02.91	+29 31.5	2.097	1.685	52.6	13.0
1997 Aug 9	05 25.13	+29 06.9	2.035	1.663	54.4	12.9
1997 Aug 16	05 47.29	+28 26.8	1.975	1.643	56.2	12.7
1997 Aug 23	06 09.26	+27 31.1	1.917	1.625	58.0	12.6
1997 Aug 30	06 30.89	+26 19.8	1.861	1.611	59.8	12.5
1997 Sep 6	06 52.01	+24 53.5	1.808	1.599	61.7	12.3
1997 Sep 13	07 12.51	+23 12.9	1.756	1.590	63.7	12.2
1997 Sep 20	07 32.28	+21 18.9	1.707	1.585	65.7	12.2
1997 Sep 27	07 51.23	+19 12.8	1.659	1.582	67.8	12.1
1997 Oct 4	08 09.29	+16 56.0	1.614	1.583	70.1	12.0
1997 Oct 11	08 26.39	+14 29.9	1.570	1.586	72.4	12.0
1997 Oct 18	08 42.48	+11 56.2	1.529	1.593	74.9	12.0
1997 Oct 25	08 57.53	+09 16.3	1.488	1.603	77.6	11.9
1997 Nov 1	09 11.48	+06 32.1	1.450	1.616	80.5	11.9
1997 Nov 8	09 24.26	+03 45.0	1.412	1.631	83.5	11.9
1997 Nov 15	09 35.83	+00 56.8	1.376	1.650	86.8	12.0
1997 Nov 22	09 46.12	-01 51.0	1.342	1.671	90.3	12.0
1997 Nov 29	09 55.03	-04 36.7	1.309	1.694	94.1	12.0
1997 Dec 6	10 02.45	-07 18.5	1.277	1.720	98.1	12.1
1997 Dec 13	10 08.29	-09 54.3	1.247	1.747	102.4	12.1
1997 Dec 20	10 12.45	-12 22.0	1.220	1.777	107.0	12.2
1997 Dec 27	10 14.82	-14 39.2	1.195	1.808	111.8	12.2

METEOR SHOWERS

The table of Meteor Showers has been compiled from the '1997 Meteor Shower Calendar' produced by the International Meteor Organisation (IMO). In addition to the showers catalogued, an average of about 5 to 10 sporadic meteors (originating from random points in the sky) are visible per hour under dark sky conditions. More meteors are seen in the morning sky than in the evening; as the morning sky is facing the Earth's motion in space we tend to 'run into' and 'sweep up' meteors, whereas evening meteors must have sufficient velocity to catch up to the speeding Earth.

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 or minor planets. 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 or after a bright star near the radiant.

SHOWER	MOON PHASE	ACTIVITY DURATION	MAX ACT	RADIANT		DIA	VEL km/s	ZHR
				R.A.	Dec			
Quadrantids	LQ	Jan 01-Jan 05	Jan 03	230°	+49°	5°	41	120
delta-Cancrids	FQ	Jan 01-Jan 24	Jan 17	130°	+20°	10°-5°	28	4
alpha-Centaurids	NM	Jan 28-Feb 21	Feb 07	210°	-59°	4°	56	6
delta-Leonids	FM	Feb 15-Mar 10	Feb 24	168°	+16°	5°	23	2
gamma-Normids	FQ	Feb 25-Mar 22	Mar 13	249°	-51°	5°	56	8
Virginids	FM	Jan 25-Apr 15	Mar 24	195°	-04°	15°-10°	30	5
Lyrids	FM	Apr 16-Apr 25	Apr 22	271°	+34°	5°	49	15
pi-Puppids*	FM	Apr 15 - Apr 28	Apr 23	110°	-45°	5°	18	*
eta-Aquarids	NM	Apr 19-May 28	May 05	338°	-01°	4°	66	60
Sagittariids	FM	Apr 15-Jul 15	May 19	247°	-22°	15°-10°	30	5
Pegasids	FQ	Jul 07-Jul 13	Jul 10	340°	+15°	5°	70	3
Phoenicids (July)*	FQ	Jul 10 - Jul 16	Jul 13	032°	-48°	7°	47	*
Pisces Austrinids	LQ	Jul 15-Aug 10	Jul 28	341°	-30°	15°-10°	35	5
Southern delta-Aquarids	LQ	Jul 12-Aug 19	Jul 28	339°	-16°	5°	41	20
alpha-Capricornids	NM	Jul 03-Aug 15	Jul 30	307°	-10°	8°	23	4
Southern iota-Aquarids	NM	Jul 25-Aug 15	Aug 04	334°	-15°	5°	34	2
Northern delta-Aquarids	FQ	Jul 15-Aug 25	Aug 08	335°	-05°	5°	42	4
Perseids	FQ	Jul 17-Aug 24	Aug 12	046°	+58°	5°	59	200
kappa-Cygnids	FM	Aug 03-Aug 25	Aug 17	286°	+59°	6°	25	3
Northern iota-Aquarids	FM	Aug 11-Aug 31	Aug 19	327°	-06°	5°	31	3
alpha-Aurigids	NM	Aug 25-Sep 05	Aug 31	084°	+42°	5°	66	10
delta-Aurigids	FQ	Sep 05-Oct 10	Sep 08	060°	+47°	5°	64	6
Piscids	FM	Sep 01-Sep 30	Sep 19	005°	-01°	5°	26	3
Draconids*	FQ	Oct 06 - Oct 10	Oct 09	262°	+54°	2°	20	*
Epsilon Geminids	FM	Oct 14-Oct 27	Oct 18	102°	+27°	5°	70	2
Orionids	LQ	Oct 02-Nov 07	Oct 21	095°	+16°	10°	66	20
Southern Taurids	NM	Oct 01-Nov 25	Nov 05	052°	+13°	10°-5°	27	5
Northern Taurids	FM	Oct 01-Nov 25	Nov 12	058°	+22°	10°-5°	29	5
Leonids	FM	Nov 14-Nov 21	Nov 17	153°	+22°	5°	71	40+
alpha-Monocerotids	LQ	Nov 15-Nov 25	Nov 21	110°	+03°	5°	65	Var
chi-Orionids	NM	Nov 26-Dec 15	Dec 02	082°	+23°	8°	28	3
Phoenicids	FQ	Nov 28-Dec 09	Dec 06	018°	-53°	5°	18	Var
Puppid-Velids	FQ	Dec 01-Dec 15	Dec 07	123°	-45°	10°	40	10
Monocerotids (Dec)	FQ	Nov 27-Dec 17	Dec 08	100°	+08°	5°	42	3
sigma-Hydrids	FM	Dec 03-Dec 15	Dec 11	127°	+02°	5°	58	2
Geminids	FM	Dec 07-Dec 17	Dec 13	112°	+33°	5°	35	110
Coma Berenicids	LQ	Dec 12-Jan 23	Dec 19	175°	+25°	5°	65	5
Ursids	LQ	Dec 17-Dec 26	Dec 22	217°	+76°	5°	33	10

NOTES ON TABLE ABOVE

SHOWER:
The name of the shower - it is associated with the constellation that the radiant appears in or a bright star near that point. A shower marked with an asterisk (*) is periodic or only occasionally active.

MOON PHASE:
The phase of the Moon nearest the date of maximum activity. If a Full Moon occurs near a shower's maximum period, only the very brightest of meteors will be seen.

ACTIVITY DURATION:
The approximate dates when the shower is active.

MAX ACTIVITY:
The date when maximum activity can be expected.

RADIANT, R.A. & Dec:
The position of the shower radiant in right ascension and declination (R.A. is expressed in degrees). These co-ordinates refer to the radiant position on the date of maximum activity.

DIA:
The radiant diameter. When two figures are given, the first is the spread in R.A. and the second the spread in Dec.

VEL km/s:
The apparent velocity through the atmosphere in kilometres per second. The range can be from about 11kms per second (very slow) to 72kms (very fast), medium speed is about 40kms per second.

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

PART III - THE APPENDICES

Brightest and Nearest Stars (p. 102) The column descriptions are:

Designation The name of the star in the system created by Bayer. He numbered the stars in the constellations using Greek letters (see p. 111). They were ordered by their brightness, alpha being the most brilliant.

Name Other common names for the stars.

Constellation The star's constellation.

RA and Dec. The position of the star, epoch 2000.0.

Magnitude App. The apparent magnitude as seen in the sky.

Magnitude Abs. The absolute magnitude. This is a good indication of how the star's true luminosities compare. It is the brightness of the star if placed at a distance of 10 parsecs (approx. 32.6 light years) from Earth.

Spectral Type The spectral classification of the star (see below).

Parallax see glossary.

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

The spectral type of a star gives a broad indication of its temperature and colour. The primary classes are **O**, **B**, **A**, **F**, **G**, **K** and **M**, remembered by the mnemonic **O**h **B**e **A** **F**ine **G**irl(Guy) **K**iss **M**e. These are then broken down into ten subclasses (1 to 10) and then even further subdivided into I, II, III, IV, etc. A discussion of these subclasses is beyond this publication.

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

It is interesting trying to see the colour in stars, but it is worthwhile knowing the limitations of the human eye. The photosensitive part of the eye is the retina. It consists of two types of light receptors, rods and cones. The cones perceive colour and rods see only in shades of grey. The cones only work when there is sufficient light. Starlight, to the unaided eye, activates rods and cones to different degrees. Faint stars are only seen as grey (ie. no colour).

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

NON-STELLAR OBJECTS (p. 100)

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

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

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

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

The column descriptions are:-

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

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

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

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

TYPE. Is the broad classification as discussed above.

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

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

CONSTELLATIONS - Abbreviations and Culmination at 9pm.

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

NON STELLAR OBJECTS

CAT	NUM	R.A.	DEC	SIZE	CON	TYPE	MAG	DESCRIPTION
NGC	55	00 14.9	-39° 11'	30'x6.3'	Scl	Spiral galaxy.	8.1	Brightest galaxy in Sculptor Group
NGC	104	00 24.1	-72° 05'	30.9'	Tuc	Globular cluster	3.8	47 Tucanae, one of the finest globulars
NGC	224	00 42.7	+41° 16'	185'x75'	And	Spiral galaxy	3.4	M31, The 'Andromeda Galaxy'
NGC	253	00 47.6	-25° 17'	30'x6.9'	Scl	Spiral galaxy	7.6	Small bright nucleus, complex central lens
	SMC	00 52.7	-72° 30'	5°X4°	Tuc	Galaxy	2.3	Small Magellanic Cloud. Visible to unaided eye from dark sky (away from city)
NGC	288	00 52.8	-26° 35'	13.8'	Scl	Globular cluster	8.1	Low central condensation, brightest stars = 12.6 magnitude
NGC	330	00 56.2	-72° 29'	1.9'	Tuc	Open cluster	9.6	Small cluster in Small Magellanic Cloud
NGC	346	00 59.1	-72° 11'	14'x11'	Tuc	Emission nebula		Largest diffuse nebula in Small Magellanic Cloud
NGC	362	01 03.2	-70° 51'	12.9'	Tuc	Globular cluster	6.5	62 Tucanae, high central condensation
NGC	598	01 33.9	+30° 39'	67'x41.5'	Tri	Spiral galaxy	5.7	M33, 'Triangulum' or 'Pinwheel Galaxy', member of Local Group of Galaxies
NGC	752	01 57.8	+37° 41'	50'	And	Open cluster	5.7	Rich cluster, 60 stars, brightest member 9th magnitude.
NGC	1068	02 42.7	-00° 01'	8.2'x7.3'	Cet	Spiral galaxy	8.9	M77, Seyfert type with very bright nucleus
NGC	1261	03 12.3	-55° 13'	6.9'	Hor	Globular cluster	8.3	Brightest stars = 13.5 magnitude
	Pleiades	03 47.0	+24° 07'	2°	Tau	Open cluster	1.2	M45 or 'Seven Sisters'. Naked eye cluster, the brighter stars Mag. 2.
	Hyades	04 27.0	+16° 00'	6°	Tau	Open cluster	0.5	A naked eye, 'V' shaped cluster. 28 stars, the brighter Mag. 3 and 4.
NGC	1647	04 46.0	+19° 04'	45'	Tau	Open cluster	6.4	Rich cluster, 200 stars, brightest member 8.6 magnitude
NGC	1837	05 04.9	-70° 43'		Men	Open cluster		Part of star cloud in LMC
NGC	1850	05 08.5	-68° 46'	3.4'	Dor	Open cluster	9.0	Rich in stars, nebulosity, part of LMC
NGC	1851	05 14.1	-40° 03'	11'	Col	Globular cluster	7.2	Rich, well resolved, bright centre
	LMC	05 23.6	-69° 45'	9°X10°	Dor	Galaxy	0.1	Large Magellanic Cloud. Visible to unaided eye from dark sky (away from city)
NGC	1904	05 24.5	-24° 33'	8.7'	Lep	Globular cluster	8.7	M79, rich and compressed, well resolved
IC	418	05 27.5	-12° 42'	12"	Lep	Planetary nebula	9.3	Disc structure with 10th magnitude central star
NGC	1912	05 28.7	+35° 50'	21'	Aur	Open cluster	6.4	M38, 100 stars magnitude 9.5 down in splendid field
NGC	1952	05 34.5	+22° 01'	6'x4'	Tau	Supernova remnant	8.4	M1, 'Crab nebula', remnant from supernova of A.D. 1054
NGC	1976	05 35.4	-05° 27'	65'x60'	Ori	Gaseous nebula	4.0	M42, 'Orion Nebula', emission and reflection nebula
NGC	1960	05 36.1	+34° 08'	12'	Aur	Open cluster	6.0	M36, 60 stars between 9th and 14th magnitude
NGC	2070	05 38.6	-69° 05'	30'x20'	Dor	Emission nebula	8.3	30 Doradus, 'Tarantula Nebula', bright complex looped structure
NGC	2024	05 41.9	-01° 51'	30'	Ori	Emission nebula		Nebula bisected by 3' wide dark lane
NGC	2068	05 46.7	+00° 03'	8'x6'	Ori	Reflection nebula		M78, brightest and largest in group of four nebulae
NGC	2099	05 52.4	+32° 33'	20'	Aur	Open cluster	5.6	M37, 150 stars magnitude range 9 to12.5, central concentration
NGC	2169	06 08.4	+13° 57'	6'	Ori	Open cluster	5.9	Rich loose cluster, 30 stars magnitude 7 and fainter
NGC	2168	06 08.9	+24° 20'	28'	Gem	Open cluster	5.3	M35, 200 stars magnitude range 9 to16, no central concentration
IC	2165	06 21.7	-12° 59'	4"	CMa	Planetary nebula	10.6	Irregular disk with 15th magnitude central star
NGC	2244	06 32.4	-04° 52'	23'	Mon	Open cluster	4.8	Rich cluster of 100 stars, with nebulosity (Rosette Nebula)
NGC	2264	06 41.1	+09° 53'	20'	Mon	Open cluster	3.9	40 stars, large brightness range, involved in nebulosity (Cone Nebula)
NGC	2287	06 47.0	-20° 44'	38'	CMa	Open cluster	4.5	M41, 80 stars 7th magnitude and fainter with 6.9 mag red star near centre
NGC	2301	06 51.8	+00° 28'	12'	Mon	Open cluster	6.0	Rich cluster, 80 stars, large magnitude range, central concentration
NGC	2323	07 03.2	-08° 20'	16'	Mon	Open cluster	6.9	M50, rich cluster, 80 stars mags 8 to 12th, slight central concentration
NGC	2362	07 18.8	-24° 57'	8'	CMa	Open cluster	4.1	60 stars, large brightness range (4th mag down), strong central concentration
NGC	2392	07 29.2	+20° 55'	15"	Gem	Planetary nebula	9.2	'Eskimo' or 'Clown Face Nebula', irregular disk with 10.5 mag central star.
NGC	2422	07 36.6	-14° 30'	29'	Pup	Open cluster	4.4	M47, Large coarse cluster with 30 bright and faint stars
NGC	2437	07 41.8	-14° 49'	27'	Pup	Open cluster	6.1	M46, rich open cluster, 100 stars, planetary nebula NGC2438 is same field
NGC	2447	07 44.6	-23° 52'	22'	Pup	Open cluster	6.2	M93, 80 stars magnitude 8 to 13 with strong central concentration
NGC	2451	07 45.4	-37° 58'	45'	Pup	Open cluster	2.8	Rich in stars with slight central concentration.
NGC	2477	07 52.3	-38° 33'	27'	Pup	Open cluster	5.8	160 stars around 10 -12th magnitude, strong central concentration
NGC	2467	07 52.6	-26° 23'	14'	Pup	Open cluster	7.1	50 stars, large brightness range, involved in nebulosity
NGC	2516	07 58.3	-60° 52'	29'	Car	Open cluster	3.8	80 stars 6th magnitude and fainter, strong central concentration
NGC	2547	08 10.7	-49° 16'	74'	Vel	Open cluster	4.7	Rich in stars with strong central concentration. Brightest stars mag. 6.
NGC	2548	08 13.8	-05° 48'	54'	Hya	Open cluster	5.8	M48, Large cluster of 80 stars 8 to 13th magnitude, strong central concentration
NGC	2632	08 40.1	+19° 59'	95'	Cnc	Open cluster	3.1	M44, 'Praesepe' or 'Beehive Cluster', very larger cluster, 50 stars 6th magnitude and fainter
IC	2391	08 40.2	-53° 04'	50'	Vel	Open cluster	2.5	Moderately rich in bright (approx. mag 3) and faint stars
IC	2395	08 41.1	-48° 12'	7'	Vel	Open cluster	4.6	40 stars 6th magnitude and fainter
NGC	2682	08 50.4	+11° 49'	29'	Cnc	Open cluster	6.9	M67, 200 stars 10 to 15th magnitude, large and rich
IC	2448	09 07.1	-69° 57'	8"	Car	Planetary nebula	10.4	Smooth disk of uniform brightness with 14th magnitude central star
NGC	2808	09 12.0	-64° 52'	13.8'	Car	Globular cluster	6.1	Large and rich, compressed centre, stars 13 to 15th magnitude
NGC	2867	09 21.4	-58° 19'	11"	Car	Planetary nebula	9.7	Ring structure, 15th magnitude central star
NGC	3114	10 02.7	-60° 07'	35'	Car	Open cluster	4.2	Rich cluster, stars 9 to 14th magnitude, slight central concentration

NON STELLAR OBJECTS

CAT	NUM	R.A.	DEC	SIZE	CON	TYPE	MAG	DESCRIPTION
NGC	3132	10 07.1	-40° 26'	30"	Vel	Planetary nebula	9.7	The 'Eight Burst Nebula', ring and disk, 10th magnitude central star
NGC	3199	10 16.8	-57° 57'	20'x15'	Car	Emission nebula		Ring shaped, many stars involved in nebulosity
NGC	3242	10 24.8	-18° 38'	16"	Hya	Planetary nebula	7.8	The 'Ghost of Jupiter', ring structure involved in larger and fainter disk
IC	2602	10 43.2	-64° 24'	50'	Car	Open cluster	1.9	Rich in stars, strong central concentration, brightest stars mag. 3.
NGC	3372	10 43.8	-59° 52'		Car	Emission nebula		The 'Eta Carinae Nebula', very bright, prominent dark lanes
NGC	3532	11 06.4	-58° 40'	55'	Car	Open cluster	3.0	Rich and large, slight central concentration, 150 stars 7-12th magnitude
NGC	3766	11 36.1	-61° 37'	12'	Cen	Open cluster	5.3	Rich cluster, 100 stars magnitude range 7 to 12th
NGC	3918	11 50.3	-57° 11'	12"	Cen	Planetary nebula	8.1	Smooth disk of uniform brightness, 13th magnitude central star
NGC	4374	12 25.1	+12° 53'	5.1'x4.1'	Vir	Galaxy	9.1	M84, very bright centre, in same field as M86
NGC	4372	12 25.8	-72° 39'	18.6'	Mus	Globular cluster	7.3	Large, faint and rich, stars from 12th magnitude down
NGC	4486	12 30.8	+12° 24'	7.1'	Vir	Elliptical galaxy	8.6	M87, radio source, bright, smooth and featureless
NGC	4579	12 37.7	+11° 49'	5.5'x4.6'	Vir	Spiral galaxy	9.7	M58, bright diffuse nucleus, dark lanes
NGC	4590	12 39.5	-26° 45'	12'	Hya	Globular cluster	7.7	M68, rich and compressed, stars magnitude 12 and fainter
NGC	4594	12 40.0	-11° 37'	7.1'x4.4'	Vir	Spiral galaxy	8.7	M104 'Sombrero Galaxy', very bright central bulge, spiral arms, dark lane
NGC	4755	12 53.6	-60° 20'	10'	Cru	Open cluster	4.2	The 'Jewel Box', rich in stars, large brightness range
NGC	4826	12 56.7	+21° 41'	9.2'x4.6'	Com	Spiral galaxy	8.5	M46 'Blackeye Galaxy', bright nucleus partly hidden by small dark lane
NGC	4833	12 59.6	-70° 53'	13.5'	Mus	Globular cluster	7.0	Dunlop 164, large and bright, stars 12th magnitude and fainter
NGC	4945	13 05.4	-49° 28'	23'x5.9'	Cen	Spiral galaxy	9.0	Large edge on spiral, good field, another small galaxy in same field
NGC	5024	13 12.9	+18° 10'	12.6'	Com	Globular cluster	7.5	M53, bright centre region, very compressed, slightly oval shape
NGC	5128	13 25.5	-43° 01'	31'x23'	Cen	Galaxy	6.7	Centaurus 'A', Dunlop 482, bright sphere crossed by dark lane, radio source.
NGC	5139	13 26.8	-47° 29'	36'	Cen	Globular cluster	3.5	Omega Centauri, perhaps the finest example of a globular cluster
NGC	5236	13 37.0	-29° 52'	15.5'x13'	Hya	Spiral galaxy	7.6	M83, nearly face on, bright central nucleus, radio source
NGC	5272	13 42.2	+28° 23'	16.2'	CVn	Globular cluster	5.9	M3, large bright globular, brightens suddenly towards the middle
NGC	5281	13 46.6	-62° 54'	5'	Cen	Open cluster	5.9	40 stars, moderately rich in bright and faint stars, magnitudes 6 to 12
NGC	5617	14 29.8	-60° 43'	10'	Cen	Open cluster	6.3	80 stars, large brightness range, strong central concentration
NGC	5822	15 05.2	-54° 21'	39'	Lup	Open cluster	6.4	Rich cluster with 150 stars, moderate brightness range
NGC	5904	15 18.6	+02° 05'	17.4'	Ser	Globular cluster	5.7	M5, bright, large very compressed in middle, slightly oval in shape
NGC	5986	15 46.1	-37° 47'	9.8'	Lup	Globular cluster	7.5	Very bright, rich, gradually brightening towards middle
NGC	5999	15 52.2	-56° 28'	5'	Nor	Open cluster	9.2	40 stars, moderate brightness range, strong central concentration
NGC	6025	16 03.7	-60° 30'	12'	TrA	Open cluster	5.1	60 stars, large brightness range, slight central concentration
NGC	6067	16 13.2	-54° 13'	12'	Nor	Open cluster	5.6	100 stars, large brightness range, strong central concentration
NGC	6093	16 17.0	-22° 59'	8.9'	Sco	Globular cluster	7.3	M80, strong central concentration, bright, large, easily resolved
NGC	6087	16 18.9	-57° 54'	12.5'	Nor	Open cluster	5.4	40 stars, moderate brightness range, slight central concentration
NGC	6121	16 23.6	-26° 32'	26.3'	Sco	Globular cluster	5.8	M4, conspicuous globular near Antares
NGC	6124	16 25.6	-40° 40'	29'	Sco	Open cluster	5.8	100 stars, large brightness range, strong central concentration
NGC	6167	16 34.4	-49° 36'	7'	Nor	Open cluster	6.7	Moderately rich in bright and faint stars, probably not a true cluster
NGC	6193	16 41.3	-48° 46'	14'	Ara	Open cluster	5.2	Few stars, large brightness range, slight central concentration
NGC	6205	16 41.7	+36° 28'	16.6'	Her	Globular cluster	5.7	M13, the 'Great Hercules Cluster', showpiece of northern skies
NGC	6231	16 54.0	-41° 48'	14'	Sco	Open cluster	2.6	A few stars with strong central concentration. Brightest stars mag.5.
NGC	6302	17 13.7	-37° 06'	50"	Sco	Planetary nebulae	9.6	The 'Bug Nebula', anomalous form
NGC	6388	17 36.3	-44° 44'	8.7'	Sco	Globular cluster	6.7	Dunlop 457, very bright, large and rich
NGC	6405	17 40.1	-32° 13'	33'	Sco	Open cluster	4.2	M6, the 'Butterfly Cluster', 80 stars, large brightness range
NGC	6397	17 40.7	-53° 40'	25.7'	Ara	Globular cluster	5.8	Loose, scattered structure, possibly the nearest of the globulars
NGC	6475	17 53.9	-34° 49'	80'	Sco	Open cluster	3.2	M7, 80 stars brighter than 10th magnitude, large brightness range
NGC	6494	17 56.8	-19° 01'	27'	Sgr	Open cluster	5.5	M23, 150 stars, moderate brightness range, lies in good star field
NGC	6514	18 02.3	-23° 02'	20'	Sgr	Gaseous nebula	5.0	M20 'Trifid Nebula', emission & reflection nebulosity cut by dark lanes
NGC	6523	18 03.8	-24° 23'	45'x30'	Sgr	Emission nebula	5.0	M8, the 'Lagoon', densest section known as the 'Hourglass', prominent dark lane
NGC	6572	18 12.1	+06° 51'	8"	Oph	Planetary nebula	8.1	Smooth disk with a brighter central region, 13th magnitude central star
NGC	6611	18 18.8	-13° 47'	21'	Ser	Open cluster	6.0	M16, 100 bright and faint stars, involved in the 'Eagle Nebula'
NGC	6618	18 20.8	-16° 11'	20'x15'	Sgr	Emission nebula	7.0	M17 'Omega' or 'Swan Nebula', very bright with conspicuous '2' shape
NGC	6626	18 24.5	-24° 52'	11.2'	Sgr	Globular cluster	6.8	M28, large, round, increasingly compressed in the middle
IC	4725	18 31.6	-19° 15'	32'	Sgr	Open cluster	4.6	M25, 30 stars loosely scattered
NGC	6656	18 36.4	-23° 54'	24'	Sgr	Globular cluster	5.1	M22. Fine Globular, only Omega Cen. and 47 Tuc are brighter.
NGC	6705	18 51.1	-06° 16'	13'	Sct	Open cluster	5.8	M11, The 'Wild Duck Cluster', one of the richest, most compact open cluster.
NGC	6720	18 53.6	+33° 02'	1.1'	Lyr	Planetary nebula	8.8	M57, the 'Ring Nebula', ring structure, 15th magnitude central star
NGC	6779	19 16.6	+30° 11'	7.1'	Lyr	Globular cluster	8.3	M56, irregularly round, very compressed in the middle
NGC	6853	19 59.6	+22° 43'	8'	Vul	Planetary nebula	7.3	M27 'Dumbbell Nebula', bright dumbbell shaped, 14th mag. central star
NGC	6885	20 12.0	+26° 29'	7'	Vul	Open cluster	8.1	30 stars, moderate brightness range, no central concentration
NGC	7009	21 04.2	-11° 22'	25"	Aqr	Planetary nebula	8.5	The 'Saturn Nebula', ring structure in a larger and fainter halo
NGC	7078	21 30.0	+12° 10'	12.3'	Peg	Globular cluster	6.0	M15, bright, irregularly round, well resolved into faint stars
NGC	7293	22 29.6	-20° 48'	12'	Aqr	Planetary nebula	7.3	The 'Helix Nebula', ring structure involved in larger and fainter disk, 14th mag central star

THE BRIGHTEST STARS

See introduction to part III (page 99) for explanation

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

THE NEAREST STARS

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

RISE/SET TIME CORRECTIONS FOR OTHER LOCATIONS

This page is designed to help people, who live outside of Perth (Lat. 31° 57' S, Long. 115° 51' E), to convert the rise/set times in this publication, to the corresponding 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 Perth, subtract or add respectively 4 minutes to both the rise and set times.** Examples of corrections for various towns/cities are given in table 1.

2. An adjustment for the difference in latitude, 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:-

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

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

You need to calculate the value of A for Perth (C= -31.95) and subtract the value of A for your location/ object's declination. Express the answer in degrees (some computers give output in radians); then multiply by 4 to convert to minutes.

Example of rise/set time corrections.

Calculate the rise/set times for the Sun on Jan 18 for Kalgoorlie (30° 45'S, 121° 28'E).

	Rise	Set
From page 66 the rise/set values are:-	5:28	19:25
Adjust for longitude (115.85 - 121.47) x 4	- :22	- :22
(or see table 1; value is negative due to Kalgoorlie being east of Perth.)		
Adjust for latitude/Declination of Sun from table 2	+:03	- :03
(Dec. = -20°34' see p. 65)		
Rise/Set times for Kalgoorlie are :-	5:09	19:00

TABLE 1

LONGITUDE ADJUSTS FOR SOME TOWNS/CITIES FROM PERTH

Location	Latitude (° ' S)	Longitude (° ' E)	Change in Longitude (decimal °)	correction (mins.)
W.A.				
Albany	35 01	117 53	-2.0	-8
Bickley Observatory	32 01	116 08	-0.3	-1
Bridgetown	33 58	116 08	-0.3	-1
Broome	17 58	122 14	-6.4	-26
Bunbury	33 20	115 38	0.2	1
Carnarvon	24 53	113 40	2.2	9
Denmark	34 58	117 21	-1.5	-6
Derby	17 19	123 38	-7.8	-31
Esperance	33 52	121 54	-6.1	-24
Eucla	31 41	128 53	-13.0	-52
Fitzroy Crossing	18 11	125 36	-9.8	-39
Geraldton	28 46	114 37	1.2	5
Giles Met. Stn	25 02	128 18	-12.5	-50
Kalgoorlie	30 45	121 28	-5.6	-22
Kellerberrin	31 38	117 43	-1.9	-7
Lake Grace	33 06	118 28	-2.6	-10
Marble Bar	21 10	119 45	-3.9	-16
Meekatharra	26 36	118 28	-2.6	-10
Mount Barker	34 38	117 40	-1.8	-7
Mount Magnet	28 04	117 51	-2.0	-8
Mount Newman	23 19	119 45	-3.9	-16
Mount Tom Price	22 41	117 47	-1.9	-8
Norseman	32 12	121 47	-5.9	-24
Northam	31 39	116 40	-0.8	-3
Onslow	21 38	115 07	0.7	3
Pemberton	34 27	116 02	-0.2	-1
Port Hedland	20 18	118 35	-2.7	-11
Rawlinna	31 01	125 20	-9.5	-38
Southern Cross	31 14	119 19	-3.5	-14
Wagin	33 19	117 20	-1.5	-6
Wiluna	26 35	120 14	-4.4	-18
Wyndham	15 28	128 06	-12.3	-49
Yampi Sound	16 08	123 36	-7.8	-31
OTHER AUSTRALIAN CITIES				
Adelaide	34 58	138 38	-22.8	-91
Brisbane	27 30	153 01	-37.2	-149
Darwin	12 21	130 55	-15.1	-60
Hobart	42 48	147 13	-31.4	-125
Melbourne	37 50	145 00	-29.2	-117
Sydney	33 54	151 15	-35.4	-142

TABLE 2 - RISE/SET CORRECTIONS FOR LATITUDE/DECLINATION FROM PERTH

Declination

South Latitude (negative)	30°	25°	20°	15°	10°	5°	0°	-5°	-10°	-15°	-20°	-25°	-30°
-12	-56	-45	-35	-25	-17	-8	0	8	17	25	35	45	56
-14	-51	-41	-32	-23	-15	-8	0	8	15	23	32	41	51
-16	-46	-37	-29	-21	-14	-7	0	7	14	21	29	37	46
-18	-41	-33	-25	-19	-12	-6	0	6	12	19	25	33	41
-20	-36	-29	-22	-16	-11	-5	0	5	11	16	22	29	36
-22	-30	-24	-19	-14	-9	-4	0	4	9	14	19	24	30
-24	-25	-20	-15	-11	-7	-4	0	4	7	11	15	20	25
-26	-19	-15	-12	-8	-6	-3	0	3	6	8	12	15	19
-28	-13	-10	-8	-6	-4	-2	0	2	4	6	8	10	13
-30	-7	-5	-4	-3	-2	-1	0	1	2	3	4	5	7
-32	0	0	0	0	0	0	0	0	0	0	0	0	0
-34	7	6	4	3	2	1	0	-1	-2	-3	-4	-6	-7
-36	15	12	9	6	4	2	0	-2	-4	-6	-9	-12	-15
-38	23	18	14	10	6	3	0	-3	-6	-10	-14	-18	-23
-40	31	25	19	13	9	4	0	-4	-9	-13	-19	-25	-31
-42	41	32	24	17	11	6	0	-6	-11	-17	-24	-32	-41
-44	51	39	30	22	14	7	0	-7	-14	-22	-30	-39	-51

JULIAN DATE — 1997

To calculate Julian Date (JD), first convert local time to Universal Time (UT); subtract 8 hrs from WAST, correcting the date if necessary. Next find the Julian date given in the table (below left) for the month you are interested in. Now add the day of the month. This will give you JD for 0hrs UT on the date in question. Then add the fraction of day from the second table (below right) that matches the time you are calculating for.

Example: you wish to know the Julian date at 21:00 WAST on July 17th. Subtract 8 hours to get UT.

21 - 8 = 13:00 hrs UT

From the table the JD for July is 2450629.5
Add the day of month, 17 gives us 2450646.5

Now add the hours as a fraction of a day from the 2nd table. 13hr is 0.542. Thus JD at 21:00hr 17 Jul 1997 WAST is 2450647.042

JULIAN DATE at 0hrs UT	
Month	Julian Date
Jan 0	245 0448.5
Feb 0	245 0479.5
Mar 0	245 0507.5
Apr 0	245 0538.5
May 0	245 0568.5
Jun 0	245 0599.5
Jul 0	245 0629.5
Aug 0	245 0660.5
Sep 0	245 0691.5
Oct 0	245 0721.5
Nov 0	245 0752.5
Dec 0	245 0782.5

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

SIDEREAL TIME — 1997

Greenwich mean sidereal time at 0hrs UT

Jan	0	6.6466	Jul	0	18.5400
Feb	0	8.6836	Aug	0	20.5770
Mar	0	10.5234	Sep	0	22.6140
Apr	0	12.5604	Oct	0	0.5853
May	0	14.5317	Nov	0	2.6223
Jun	0	16.5687	Dec	0	4.5936

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

GMST on day d of month at hour t U.T.

= GMST at 0h UT (from table above) + 0.06571 d + 1.00274 t

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

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

where longitude is expressed in HOURS (not degrees!)

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

Example:

Find LMST at 21:00 hours Perth time on 17th July 1997.

21:00 local time = 13:00 UT. GMST for July 0 is 18.5400 hrs.

GMST = 18.5400 + (0.06571 x 17) + (1.00274 x 13) = 32.6927

Perth's longitude is 115.85° which is 7.7233 hrs so

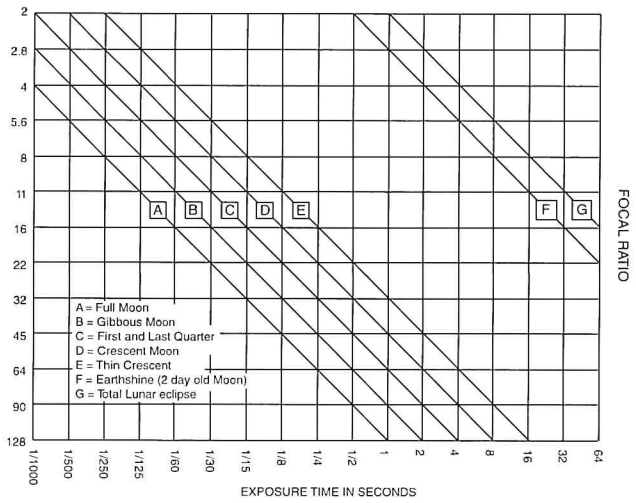
LMST = 32.6927 + 7.7233 = 40.4160

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

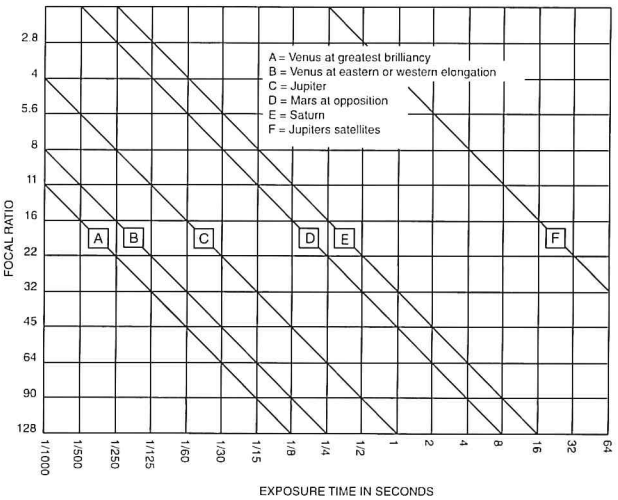
40.4160 - 24 = 16.4160 hrs or 16h 24m 58s

PHOTOGRAPHIC EXPOSURE GUIDES

PHOTOGRAPHIC EXPOSURE GUIDE for the MOON



PHOTOGRAPHIC EXPOSURE GUIDE for the PLANETS



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

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

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

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

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

PLACES OF ASTRONOMICAL INTEREST

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

WESTERN AUSTRALIA

PERTH OBSERVATORY

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

Hours: Sunday afternoon tour is provided at 3pm. Night tours and week day tours are available, bookings necessary.
Cost: Day Tours, $4 Adults and $2 Concessions. Night Tours, $9 Adults and $5 Concessions.
Contact: (09) 293-8255 or fax (09) 293-8138. Also a recorded information line (09) 293-8109.
email: perthobs@iinet.net.au http://www.wa.gov.au/perthobs

GOLDEN GROVE OBSERVATORY - ASTRO NIGHTS

This observatory is located at the Golden Grove Tourist Orchard in scenic Lower Chittering. Access is via the Tourist Drive 359 and is about one hour drive from Perth. Equipment includes; Meade DS16 and DS10 newtonian telescopes and a Celestron 8. The site has been designed with the amateur astronomer in mind and has a library and computer facility.

Hours: Open Saturday nights, 8 to 10pm (weather permitting). Other nights for special events/ groups can be arranged.
Cost: Adult $18, Child $10 and family $42 (special group rates).
Contact: Meg (09) 448-4987

BROOME- ASTRO TOURS OF THE KIMBERLY

Enjoy the Kimberly night air as you take in the spectacular skies on display through a 10 inch (250mm) diameter telescope, guided with simple explanations and imaginative and informative stories by bush philosopher and knowledgeable astronomer Greg Quicke.

Greg conducts 2 hour evening tours at a dark site close to Broome most nights of the week. He also hosts 3 day astronomy and adventure tours into the Great Sandy Desert.

Contact: Greg Quicke (091) 935 362

NEW SOUTH WALES

THE AUSTRALIA TELESCOPE - NARRABRI ARRAY

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

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

Hours: 8am to 4pm daily (not staffed weekends, except school holidays).
Cost: No charge to visit the centre. Booking are appreciated for groups.
Contact: Tim Kennedy (067) 90-4070.

BOWEN MOUNTAIN OBSERVATORY

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

Contact: Adrian Saw (045) 72-1568

(ACT) THE CANBERRA OBSERVATORY

This professional quality astronomy complex is located at the Downer Club in Canberra. The address is Hawdon Place, Dickson (off Antill Street). The telescopes of the observatory are world class and include a 41cm Newtonian-cassegrain IK6 with 17.8 cm Astro-Physics Starfire refractor (in a 5.2 metre dome), an Astro Physics 6" F12 planetary refractor (in a 3 metre dome) and a Celestron 14 (in a 4.2 metre dome). The astronomers, staffing the observatory, are members of the Canberra Astronomical Society. The observatory will be opening a planetarium, hopefully in Nov. 96. Being located at a club there is a bistro (12.00 - 2.30pm, 6.00 - 9.00pm).

Bookings: Groups of 10 or over must book. ph (06) 249-7817, Fax (06) 248-7238 or email planetarium@cfmeu.asn.au
Cost: $2 entrance fee
Internet: http://www.cfmeu.asn.au/planetarium/

CANBERRA DEEP SPACE COMPLEX (TIDBINBILLA)

The complex is located 40km southwest of Canberra, further along the same road you would take to visit Mt. Stromlo (Tourist Route 5). In fact, Stromlo and Tidbinbilla would make a fascinating day trip if you were visiting or living in the ACT. The Tidbinbilla complex is a major link in NASA's Deep Space Network. It has played a large role in nearly all of NASA's lunar and planetary probes.

Hours: 9:00am to 5:00pm, 7 days per week.
Cost: There is no charge for the Space Centre.
Contact (06) 201-7800
email: Darren.P.Osborne@jpl.nasa.gov

DARBY FALLS OBSERVATORY

The observatory is located on Observatory Road (off the road to Mt. McDonald) Darby Falls, Cowra. The observatory offers one of the largest telescopes accessible to the public ie. a 500mm newtonian.

Times: Winter: 7-10pm, Summer: 8.30-11pm, or by appointment.
Cost: Adults $5, Children $3, coaches and schools welcome.
Contact: Mark Monk (063) 45-1900 or Fax (063) 45-1920

GREEN POINT OBSERVATORY

The observatory is operated by the Sutherland Astronomical Society (SAS). Visitors are most welcome; the observatory is open on all Thursday nights. The society also runs regular open nights which are very popular with the general public. In 1997, open nights are scheduled for August 8th and 9th. Contact the SAS (under society appendix) for details.

GROVE CREEK OBSERVATORY

This observatory is a non-profit organisation located 60kms south of Bathurst. The facility caters for amateur astronomers and groups who are looking to use large aperture telescopes under very dark skies. The facility boasts a Celestron C-14, 12.5" Newtonian and Meade 10" LX-200 which includes full astrophotography and CCD equipment. The instruments are located in two observatory buildings at the site. Grove Creek Observatory has modern on-site accommodation, sleeping up to 10 people with full facilities available.

Phone: (02)9428-4334 (Jim Lynch)
email: astro@gco.apana.org.au
Internet: http://gco.apana.org.au

KINGS TABLELAND OBSERVATORY (BLUE MOUNTAINS)

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

Hours: Flexible to met demand.
Contact: Roger North, Sybil Barber (047) 57-2954

KOOLANG ASTRONOMY AND SCIENCE CENTRE.

This centre is located 50 km from Gosford (on the way to Wollombi) The observatory has a 0.5 metre telescope, in a roll-off building. There is also a display building. During the day, the centre offers live observing of the Sun.

Hours Open 7 days (and nights) per week. 12pm to 5pm with a fixed 2 hour programme in the evenings (call for times and bookings).
Contact: (049) 98-8216

MT. STROMLO OBSERVATORY

For many years, Mt Stromlo was largely responsible for the excellent worldwide reputation of Australian optical astronomical research. Since the establishment of Siding Spring Mountain Observatory many of the Astronomical breakthroughs are now being made in the dark, clear skies over the Warrumbungles. 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 visitor's gallery, which is built onto the side of the

1.9m telescope building, gives a view of this instrument through a window. The current visitor's centre is a static display of posters and photographs which illustrates the history and work at the observatory.

The **Stromlo Exploratory** is an exciting new interactive astronomy education and tourist centre, opening in July 1997. Visitors will be able to 'Explore the Universe' with their remote control Celestron Telescope or 'fly over the planets' using computer simulation. There will be a Heliostat built into the Exploratory so visitors can see what the sun REALLY looks like!

Cost: $5 adults, $3 Children/Concession. Groups welcome, discounts on application.

Address: 15 minutes from Canberra City, Mt Stromlo Observatory, off Cotter Road, Weston Creek, ACT

Exploratory: Open daily (except Christmas) 9.30am-4pm. Cafe & Giftshop

Contact: (06)249 0276.

PARKES RADIO TELESCOPE

The observatory is located on the western plains of NSW, twenty kilometres north of Parkes (just off the Newell Highway). The Parkes Telescope was indeed a pioneer in Radio Astronomy. It is still a 'work horse' and functions as part of the CSIRO Australia Telescope. At the observatory, public education has a high priority, hence their impressive visitor's complex. As well as a great view of the telescope, the centre has displays, interactives and an informed and friendly staff. The latest addition is an impressive public picnic area, consisting of a large shelter and gas barbecue facility. Souvenirs and educational material are available.

Hours: 8:30am to 4:15pm - daily except Christmas and Boxing Day.

Cost: Admission to visitor's centre is free. A modest charge is made for the Audio/Visual presentation.

Contact: (068) 61-1777

e-mail: rtwardy@atnf.csiro.au

Internet: http://wwwpks.atnf.csiro.au/visitors_centre/VCHomePage.html

SIDING SPRING OBSERVATORY

The Warrumbungle National Park indeed makes a magnificent setting for this world class observatory. One of the few located under the beautiful southern hemisphere skies. The Observatory is located 25 kilometres west of Coonabarabran. The most prominent feature, and the first sight to greet visitors, is the tall white dome of the Anglo-Australian Telescope (AAT). This 3.9 metre telescope is still the 'flag-ship' for optical astronomy in this country. Siding Spring Mountain also is the home for a number of other telescopes such as the Australian National University's (ANU) 0.4m, 0.6m, 1.0m and the 2.2m Advanced Technology Telescope (ATT). The 1.2m Schmidt Camera is also located on the mountain. For the public, the only telescope that is made available to visitors (except for open days) is the AAT itself. A viewing gallery offers visitors an excellent view of this telescope that has contributed so much to man's knowledge of the Universe. The Visitor's Centre or "Siding Spring Exploratory" consists of the 'Exploring the Universe' exhibition. This provides an introduction to the science and technology of modern astronomical research.

Hours: 9:30am to 4:00pm daily except Christmas Day.

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

Contact (068) 42-6211.

PORT MACQUARIE OBSERVATORY

Observing nights are organised as required. Contact the Port Macquarie Astronomical Society for more information.

SCIENCE CENTRE AND PLANETARIUM

Located at the University of Wollongong. Contact the university for details of show times/costs.

Internet: http://wits.uow.edu.au/science_centre/index.html

SKYWATCH NIGHT'N'DAY OBSERVATORY

This public observatory is the latest attraction in Coonabarabran (home of the Siding Spring Mountain Observatory). It is located on the Timor Road, 2km west of the Clock Tower. For the convenience of visitors all the displays, including the main dome/telescope and planetarium, are open during the day as well as the night. Light refreshments are also available at the complex.

Hours: 9:00am to 10:00pm (closed for one hour before sunset). Out of hours viewing, eg. late night photography can be arranged. Closed only Christmas day.

Contact: (068) 42-2506 or fax (068) 42-2978

SYDNEY OBSERVATORY

The observatory is located in a park just a short walk from the historic 'Rocks' district of Sydney. It is very close to the southern end of the Harbour Bridge. The centre is set up for a more 'hands-on' approach for visitors, with a number of displays and films on Astronomy. On weekends, visitors are invited to observe the Sun - the safe way (weather permitting). Night time tours include observations of the Moon and Planets through the observatory's historic telescopes.

Hours: 2pm to 5pm, Monday to Friday and 10am to 5pm, Saturday, Sunday and school holidays. Night sessions times are seasonal. Bookings are required for evening tours. On Saturdays, Sundays and School Holidays there are Planetarium shows (11.30am & 3.30pm). There are also open nights, bookings not required.

Cost: Charge for evening sessions - $6 Adults, $3 Students or concession and $15 for Families, Planetarium is $2.

Contact: (02) 9217-0485.

QUEENSLAND

THE SIR THOMAS BRISBANE PLANETARIUM

The planetarium is located in the beautiful surrounds of the Mt. Cootha Botanic Gardens in Brisbane. Regular programmes are presented, lasting about 45 minutes, based on specific astronomical themes. The 'Cosmic Skydome' has an artificial sky projected onto the interior surface of a 12.5m dome. This is certainly a world class planetarium and well worth the visit! The foyer and gallery areas contain an interesting collection of displays and artefacts related to astronomy. The planetarium also has an observatory with a 15cm refractor and a 41cm reflector. If sky conditions are suitable on nights of operation, viewing sessions can be organised for limited numbers.

Shows are 3:30pm & 7:30pm, Wednesday to Friday (also 1:30pm during Qld school holidays). Also 1:30pm, 3:30pm and 7:30pm on Saturday and 1:30pm and 3:30pm on Sunday. Visitors are requested to arrive at least 10 mins. before the starting time and bookings are advisable. Not recommended for children under 6.

Cost: $7.50 Adults, $4 Children (under 15 years) and concessions of $6 for Students / Pensioners.

Bookings: (07) 3403-2578 - Wednesday to Sunday ONLY (noon to 7pm).

Internet: http://enterprise.powerup.com.au/~stbp/stbp_.html

ALLOWAY OBSERVATORY

Operated by the Bundaberg Astronomical Society, this observatory is open to the public by appointment. The 48cm Newtonian reflector telescope is housed in a geodesic dome and is one of the largest telescopes in Queensland open to the public.

Cost: Over 10 persons - $3 adults, $2 children
Under 10 persons - $5 adults, $3 children

Contact: Karlene Galway (071) 59-9674

SOUTH AUSTRALIA

UNIVERSITY OF SOUTH AUSTRALIA PLANETARIUM

The planetarium was originally installed to teach surveying to students at the university. It is now available to the public.

TASMANIA

LAUNCESTON PLANETARIUM

The planetarium is in the Queen Victoria Museum, Wellington St.

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

Cost: $2 Children (under 15), $3 Adults and $7 family (children under 5 years old are not admitted)

Contact: (03) 6344-7100

VICTORIA

H.V.MCKAY MELBOURNE PLANETARIUM

The planetarium is located at the Museum of Victoria.

Contact (03) 9669-9973 (Museum of Victoria).

MELBOURNE OBSERVATORY

The historic Old Melbourne Observatory is located in the Botanic Gardens at South Yarra. Open days are on the last Sunday of each month (2-4pm), and open nights on the first Saturday (8-10pm). No bookings required.

Contact (03) 9669-9973 (Museum of Victoria).

ASTRONOMICAL COURSES, SOURCES OF INFORMATION

The following lists astronomy courses, events, magazines and radio programs known to the authors for 1997. This list is by no means intended to be exhaustive. Across the country there are no doubt many other evening courses held at various Universities and Colleges. Enquires from the general public are most welcome.

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

SKY AND SPACE MAGAZINE This astronomy and space exploration magazine is produced for enthusiasts in Australia and New Zealand. It has a wide range of astronomy related topics, catering to both the novice and the very experienced. The magazine is bi-monthly and available through newsagencies or by subscription. (02) 9369-6666, Fax (02) 9369-3366.

COMET TALES is a bi-monthly newsletter, edited by the former Southern Sky magazine comet columnist Greg Bryant. Designed to keep readers up-to-date on comets that are observable by amateurs, it is especially useful for the upcoming return of comet Hale-Bopp this year. The newsletter includes positions, observing guides and updates on their visual performance. The annual cost is only $10 (payable to G. Bryant). For further information, write to 2/100-104 Kissing Point Rd, Dundas. NSW. 2117.

ASSOCIATION AGAINST OBTRUSIVE LIGHTING

AAOL is a non-profit organisation which aims to protect the environment, the night sky, and the public from the detrimental effects of light pollution.

Contact: Qld - PO Box 363, Springwood QLD 4127, Ph (07) 3808-1810
Vic - PO Box 1023, Croydon VIC 3136, Ph (03) 9723-4356.

SKY AND TELESCOPE ASTRONOMY HOTLINE 'SKYLINE'.

Telephone 0011-1-617-497-4168. Internet: http://www.skypub.com/

N.A.C.A.A.

National Australian Convention of Amateur Astronomers is held every two years, over Easter. The next, in 1998, will be hosted by the Sutherland Astronomical Society (Sydney, NSW). See Astronomy 1998 for further details.

NEW SOUTH WALES

SOUTH PACIFIC STAR PARTY.

A national gathering of amateurs for a week of observing under country skies. This is held at the Astronomical Society of NSW's (ASNSW) property at Ilford, NSW. This major event usually attracts over 200 amateurs from all over Australia and overseas. The 1997 SPSP will be held from 8th to 11th of May. Contact the ASNSW for details (see p. 132).

PRACTICAL ASTRONOMY (SASPAC)

A practical astronomy course for beginners and interested amateurs. This is an 8 week course conducted by Sutherland Astronomical Society (SAS) during spring/autumn. Each 1 hour lecture is followed by observations with the society's equipment. Cost is $80. A course commences April 9 1997.

Venue: Green Point Observatory (Sutherland).
Contact: Brett McMillan (02) 9832-4082

ASTRONOMY (GOSFORD)

This course is conducted at Kariong, near Gosford, with urban observing included at each session. A field trip to Koolang Observatory (see p. 129) is also offered (for a small additional charge) to benefit from a dark sky site and a large telescope. The course is designed for beginners, and covers basic topics including eclipses, phases of the Moon, the Solar System, and telescopes. Some theoretical topics are also discussed and include stellar evolution, exotic objects, and the Big Bang. The course may run for 7 or 8 weeks each term (2 hour evening sessions). No prior experience is needed.

Bookings: Central Coast Community College (043) 48 4300.

CHATSWOOD EVENING COLLEGE

Courses conducted by A.James (Answering Service (02) 9819-6896)

Introduction to Astronomy: 11 weeks, Tuesday evenings (total 22 hrs), 3 courses per year. **Cosmology - 'A Brief History of Time'** 10 weeks, Thursday evenings (total 20 hrs), 3 courses per year.

Cost: $82 each, bookings (02) 9419-4190

W.E.A. - SYDNEY OBSERVATORY COURSE

Sydney Observatory and the WEA will run a number of beginner astronomy courses based at the observatory during 1997. Contact WEA (02) 9264-2781 for cost, timetable details.

NEPEAN COMMUNITY COLLEGE COURSES

Run at the Kings Tableland Observatory in Wentworth Falls (Blue Mountains).See entry under "Places of Astronomical Interest".

QUEENSLAND

1997 ASTROFEST

The Queensland AstroFest has been held annually since 1993 at the Lions Camp Duckadang, about 2 hours drive northwest of Brisbane. It is held at a site with superb living conditions, a Celestron-14 telescope (the Stewart Observatory) and a very dark sky. The event is held over six nights, with main events held on Thursday, Friday and Saturday night. Activities include; presentations from guest professional astronomers, awards in amateur astronomy, swap & sell, barbecue, smorgasboard, slide shows and light sports. For more information: http://www.sas.org.au/fest97.html or e-mail zac pujic: pujic@biosci.uq.oz.au

WEEKEND ASTRONOMY COURSES.

Held at the South Brisbane College of TAFE. Course is 17 hours (including 4 hours of practical at Manly Observatory).

contact: (07) 3844-1471 or J. Barclay (07) 3396-1391.
Manly observatory also offers professional day and night Astronomy courses for primary and secondary schools (contact J. Barclay, see above).

INTRODUCTION TO THE NIGHT SKY COURSE

Held by the Bundaberg Astronomical Society in conjunction with the Adult Education section of TAFE. These are conducted 3-4 times per year at the Alloway Observatory.

Contact: Karlene Galway (071) 59-9674

SOUTHERN STAR EDUCATION

This is a planetarium service which travels throughout South East Queensland (inc. Toowoomba and Warwick). The organisation caters mainly for schools and community groups. Enquires are welcome.

Contact: Paul Floyd (07) 5533-3610 (ssemps@ozemail.com.au)
96 Doncaster Drive, Beechmont, 4211,

SOUTH AUSTRALIA

W.E.A. COURSES (ADELAIDE)

Beginners courses run each semester. Contact the WEA (08) 223-1272.

TASMANIA

The 'Adult Education Department' (Hobart) occasionally run Astronomy courses conducted by members of the Astronomical Society of Tasmania.

Contact: Greg Burns, 002-782184.

VICTORIA

VASTROC

Victorian Amateur Astronomical Society's Conventions (VASTROC's) are held every second year (alternating between years with NACAA Conventions). Activities include speakers, keynote speakers, workshops, poster displays, forums, social gatherings at lunch/tea breaks and the Convention dinner. The 1997 VASTROC is being hosted by the Astronomical Society of Frankston. It will be held on 7-9 June.

Contact: Peter Lowe (aggro@peninsula.starway.net.au)

SKYLINE

A prerecorded information service, run by the Astronomical Society of Victoria, to cover the latest astronomical discoveries. Cost is only the phone call. Ph (03) 9888-7130. Updated weekly or more frequently as required.

THE SPACE SHOW

This Melbourne radio programme is run by Andrew Rennie & Mark Hillyer, Wed. Even. (1 hr) on 3SCB FM (88.3MHz).

C.A.E. COURSES

Beginners and advanced courses are run each semester. Contact the C.A.E. for costs and dates. Phone (03) 9652-0611.

AMATEUR ASTRONOMY SHORTWAVE STATION (VK3 EKH).

This service, run by members of the Astronomical Society of Victoria, broadcasts to Australia on Fridays from 10pm on 3.543MHz (LSB).

ASTRONOMICAL SOCIETIES

The following is a list of the amateur societies in Australia. A common philosophy within all these organisations is the emphasis they place on public education. Enquires from anyone with an interest in astronomy are most welcome. Where given, annual fees are subject to change. The authors of this publication are keen to keep the information in this section 'evergreen'. It would be appreciated if any significant change occurs (especially new organisations) that the society contact Quasar Publishing (see page 2). The deadline for ASTRONOMY 1998 will be 1st Sep. 97.

Please note that a number of the societies now have internet addresses. These can be excellent sources of information such as latest astronomical discoveries, society events and connections to other astronomy sites on the Web.

WEST AUSTRALIA

ASTRONOMICAL SOCIETY OF WA

The objectives of the Society are: the stimulation of a popular interest in astronomy, the association of observing astronomers (especially the possessors of small telescopes), for mutual help and their organisation in the work of astronomical observation. To this end the Society provides:

- A regular forum to enable members to meet, share ideas and discuss the latest advances and discoveries.
- Assists and encourages members with their astronomical projects.
- Promotes public awareness of astronomy by holding regular viewing nights for the public, and by providing speakers to schools, clubs and community groups.
- Courses in astronomy are conducted and classes are held monthly.

The Society owns a wealth of astronomical apparatus for use (and in some cases for loan) by Members, from binoculars and star maps to a range of powerful reflecting telescopes up to 17.5" diameter mirror.

A library is maintained which includes a large selection of Astronomical books magazines and other material which may be beyond the budget of an individual. Members are encouraged to borrow from the library for their research and interest.

The SIDEREAL TIMES is a Journal of the Society. Published bi-monthly it contains information regarding current and future astronomical phenomena, gleanings from lectures and publications of astronomical organisations around the world, and details of past and future activities within the Society.

The Society Conducts regular 'astrocamps' at remote locations with good accommodation and very dark skies. These provide an ideal opportunity for members and guests to get to know each other, and share ideas and plans beneath a perfect night sky.

It also promotes public awareness of astronomy by holding regular viewing nights for the public, and by providing speakers to schools, clubs and community groups.

The establishment of special-interest groups called Sections is encouraged, to enable those who specialise in particular aspects of astronomy to share their ideas, their plans and their successes. At present the Society supports two Sections dedicated to deep sky observing and solar observation. Additionally some members specialise in other aspects such as Comets, Meteors, Radio-Astronomy, Astro-Photography and occultation/eclipse timing.

The Society meets at 8 pm on the 2nd Monday of every month at the gymnasium of Wesley College situated on the corner of Coode and Angelo Streets South Perth, visitors are most welcome. Membership of the Society is open to all. Fees consist of a once only nomination fee and an annual subscription paid on 1 July each year as follows;

Fees: Ordinary Member, $10 Nom $30 Sub; Associate Member, $6 Nom, $15 Sub; Junior Member (under 18), $6 Nom, $15 Sub.
Address: P.O.Box 421 Subiaco WA 6008
Contact: (09) 384-2264.

MURDOCH ASTRONOMICAL SOCIETY

The Murdoch Astronomical Society is a very active body based at Murdoch University. Membership is open to the general public and no extensive knowledge of astronomy is required, only an interest. Meetings are conducted each month at the University and usually consisting of observation reports, slide shows, informal talks and occasional guest speakers. Regular viewing at the university's observatory as well as field and deep sky observing, at various places outside of Perth, are all part of the society's activities. The society owns a 30cm (suitable for astrophotography) and 15cm telescopes. The society has also been active in taking astronomy to the public via public viewing nights. Annual astro camps, for members, are also conducted at Meline sheep station near Mt. Magnet. There is also a small library of magazines and slides available to members.

Address: c/- Murdoch University, School of Mathematical and Physical Sciences, Murdoch WA 6150
Contact: Physics office (09) 360-2433

ASTRONOMICAL SOCIETY OF THE SOUTH WEST

The ASSW is a small group mainly interested in observing and in educating the general public about the wonders of the Universe.

Observing nights are held on Fridays either side of each New Moon, commencing 7.30pm at the society's observatory at Keble Heights, College Grove, Bunbury. There is an active junior section. Public observing nights and introductory courses are run at regular intervals. A fee applies on these occasions.

Fees: $20 members, $10 Junior/concession, $30 family
Address: PO. Box 1100 Bunbury WA 6231
Contact: (097) 21-1586

NEWMAN ASTRONOMICAL SOCIETY

Newman Contact: (091) 75-2660

PILBARA ASTRONOMICAL SOCIETY

South Hedland Contact: (091) 40-1512

NEW SOUTH WALES

ASTRONOMICAL SOCIETY OF COONABARABRAN

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

Address: C/- AAO Private Bag, Coonabarabran NSW 2357
Contact: Paul Cass (068) 42-2994

ASTRONOMICAL SOCIETY OF THE HUNTER

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

Fees: $20 adult, $25 family
Address: PO Box 69, Kurri Kurri NSW 2327
Contact: George Livanos (049) 69-2313

ASTRONOMICAL SOCIETY OF NSW

The society holds meetings twice per month at the 'Australian Catholic University', 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.

Fees $40 Full, $10 Juniors (under 18) and $30 Student (over 18). There is no joining fee.
Address: GPO Box 1123, Sydney, NSW, 2001.
Contact: Max Gardner (02) 9337-3371.
Internet: ASNSWI Home Page, http://www.ozemail.com.au/~asnsw/#obs

BRITISH ASTRONOMICAL ASSOCIATION - NSW BRANCH

The BAA meets at Sydney Observatory. The Association meets on the third Wednesday of each month, commencing at 7:45pm.

Address: Sydney Observatory, Watson Rd., The Rocks, Sydney 2000
Fees: $35 Full, $17.50 Junior (no joining fee) and there are family concessions available. There is a 50% Joining Fee.
Contact: Ralph Buttigieg (02) 9635-6797

(ACT) CANBERRA ASTRONOMICAL SOCIETY

Hold meetings at the ANU Jaeger Building on the 3rd Thursday of each month (except Dec/Jan) at 8:00pm.

Fees: $25 adult, $12 student/ pensioner and $40 Family.
Address: PO Box 1338, Woden ACT 2606
Contact: John Howard (06) 248-0552

HAWKESBURY ASTRONOMICAL ASSOCIATION

Meetings are held once a month on the 2nd Wednesday, commencing 7.45pm, in the 'Tebbutt rooms' at the Windsor Library (Dight St. Windsor).

Fees: $20 adult, $30 family and $10 Junior.
Address: PO Box 670 Windsor NSW 2756
Contact: Adrian Saw (045) 72-1568

ILLAWARRA ASTRONOMICAL SOCIETY

Meetings are held at the Uni. of Wollongong Science Centre, Fairy Meadow, on the second Tuesday of each month at 7:30pm.

Address: PO Box 1814, Wollongong NSW 2500
Contact: Peter MacKinnon (042) 29-6696

MACARTHUR ASTRONOMICAL SOCIETY

This is the newest astronomical society in Australia, having formed in early 1996. The society conducts monthly meetings at the University of Western Sydney (Macarthur) in Campbelltown.

Address: c/- 5 Boobook Place, Ingleburn NSW 2565
Contact: Phillip Ainsworth (pres.) (02) 9605-6174

THE NEWCASTLE ASTRONOMICAL SOCIETY

Meetings are held on the last Friday of each month (except December), at the University of Newcastle, Lecture Theatre EO1, Department of Physics at 7:30pm.

Fees: Family $20, Single $15, Student/Child $8, Guests $2
Address: c/- Dept. Physics, University of Newcastle, Callahagn, NSW,2308.
Contact: Jeanette Rothapfel (049) 42-6029
Internet: http://www.newcastle.edu.au/department/ph/plasma/NAS/nas_home.html

NORTHERN DISTRICTS SOCIETY OF AMATEUR ASTRONOMERS

Meetings are held at Riverview Observatory (St. Ignatius College), Lane Cove on the 3rd Tuesday of each month at 7:30pm.

Fees: $30 adult, $20 Student/Pensioner and $60 Family
Contact: Gordon Stott (02) 9871-7838

SHOALHAVEN ASTRONOMERS

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

Address: PO Box 388, Nowra NSW 2541
Contact: David Hawksworth (044) 41-5866

SUTHERLAND ASTRONOMICAL SOCIETY

The society operates from Green Point Observatory near Sutherland. This houses a 42cm reflecting telescope and has a well equipped library and meeting hall. Other telescopes include a high quality 150mm refractor. The SAS meets every Thursday at 8:00pm (visitors welcome).

Fees: $30 Full, $20 Student/Associate, $15 Junior/ Pensioners and $40 for families plus joining fee - Full/Family $20, others $10.
Address: PO Box 31, Sutherland NSW 2232.
Contact: Laurie Purcell (02) 9543-4261
Internet: The SAS is expected to have a home page by the end of 1996.

TAREE ASTRONOMICAL SOCIETY

The society meets at the Community Centre, Mabiac on the second Thursday of each month at 7:30pm.

Address: PO Box 111, Taree NSW 2430
Contact: Mr. Jim Ross (065) 50-2213

WESTERN SYDNEY AMATEUR ASTRONOMICAL SOCIETY

The society meets 3rd Wednesday of the month at the Nepean Astronomy Centre, Uni. of Western Sydney, Werrington Campus. There are also regular observing nights at the Beames Observatory at Linden and a bimonthly newsletter.

Fees: $20 Full, $15 Student/Concession, $30 family/school groups and $10 for newsletter only.
Address: PO Box 400, Kingswood NSW 2747
Contact: Peter Nakitch (02) 9835-1824 or Richard Piotrowski (047) 36-5493

PORT MACQUARIE ASTRONOMICAL ASSOCIATION

Meets at the Port Macquarie Observatory.

Address: PO Box 1453, Port Macquarie NSW 2444
Contact: Jim Daniel (065) 83-1933

QUEENSLAND

ASTRONOMICAL ASSOCIATION OF QUEENSLAND (AAQ)

Meetings are held on the Saturday nearest to full moon at 8pm at the association's clubhouse, Belmont Park, Morningside. Club observing nights are held 2 weeks later.

Fees: $35 adult, $50 family, $23 student and pensioner.
Address: PO Box 101, St. Lucia QLD 4067
Contact: Maria and Stephen Hutcheon (07) 3206-4338

BRISBANE ASTRONOMICAL SOCIETY

Meet on the second Friday of each month at 7:30pm. Venue is Kelvin Grove State High School Library. .

Fees: $25 adult, $30 family, $15 student and pensioner. Also a $5 joining fee.
Address: PO Box 204, Morningside QLD 4170
Contact: David Durham (07) 3286-5807
Internet: http://www.ozemail.com.au/~nwilliam/bas/bas.html

BUNDABERG ASTRONOMICAL SOCIETY

Meetings are held at Alloway Observatory on every Friday of each month at 7:30pm (except Jan.). The first Friday are general meetings.

Fees: $30 adult and $15 junior and $20 country (also joining fee for full members).
Address: PO Box 586, Bundaberg QLD 4670
Contact: Karlene Galway (071) 59-9674

CAIRNS ASTRONOMY GROUP

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

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

MT. ISA ASTRONOMY GROUP

The society meets at their dark sky observing site at the Lions Youth Camp on Lake Moondarra (17km outside of Mount Isa).

Address: PO Box 1556, Mount Isa, 4825
Contact: (077) 43-2955

SOUTH EAST QUEENSLAND ASTRONOMICAL SOCIETY

The society meets at Kedron State High School on the third Monday of each month.

Address: PO Box 516, Strathpine, 4500
Contact: Alan Thomson (07) 3261-3908
Internet: http://www.ozemail.com.au/~mhorn/seqas.html

SOUTHERN ASTRONOMICAL SOCIETY

Meetings are held at Ormeau State School monthly at 7:30pm.

Fees: $28 adult and $21 student.
Address: PO Box 867, Beenleigh QLD 4207
Contact: Kevin Dixon (07) 5537-3852
email: Zac Pujic pujic@biosci.uq.oz.au
Internet: http://www.sas.org.au

SUN COAST ASTRONOMICAL SOCIETY

Monthly meetings are held at Caloundra State High (except Dec/Jan.) at 7:30pm.

Address: PO Box 166, Kenilworth QLD 4574
Contact: Elaine Clark (07) 5441-5788

TOWNSVILLE ASTRONOMY GROUP

Meet on the last Wednesday of each month at 7pm at Kirwan State High.

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

SOUTH AUSTRALIA

ASTRONOMICAL SOCIETY OF FLINDERS UNIVERSITY

Contact: (08) 201-2954

BOWMAN PARK ASTRONOMICAL SOCIETY

The society meets twice monthly. It also runs an observatory with a 400mm telescope.

Contact: Justin Tilbarook (088) 42-3741 or David Clarke (086) 36 2446

ELEANORA CENTRE ASTRONOMY GROUP

Noarlunga Downs: Contact (08) 382-1490

ASTRONOMICAL SOCIETY OF SOUTH AUSTRALIA

Meetings are held on the 1st Wednesday of each month (except January) at the University of South Australia, Levels Campus. The society maintains two observatories. The Heights Observatory at Heights School, Modbury, houses a 300mm telescope. The society's country site is Stockport Observatory, 80km north of Adelaide, which has a 0.5m telescope. Public education is important to the ASSA with various lectures and observing nights. The society publishes a monthly newsletter and yearly ephemeris. Public field nights are held monthly at Stockport Observatory, the Heights Observatory, and at Douglas Scrub.

Fees: $34 adult (metropolitan), $10 spouse and $26 concession (student, country, pensioner)
Address: GPO Box 199, Adelaide SA 5001
Contact: Trish Ellin, Secretary Ph: (08) 82727352 a/h
email: assa@gist.net.au
Internet: http://www.gist.net.au/assa

TASMANIA

ASTRONOMICAL SOCIETY OF TASMANIA (AST)

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

Fees: $29 family, $27 full, $24 country (joining fee $5) and $17 concession (joining fee $2).
Address: C/- The Secretary, Mr. M. Mulcahy, PO Box 1654, Hobart Tas 7001
Contact: Karen Barnes 03-6344-7100 (northern Tasmania)
Merv Mulcahy 03-6244-2226 (Hobart)
internet: http:/www.vision.net.au/~peter/AST/index.html
peter@vision.net.au

VICTORIA

ASTRONOMICAL SOCIETY OF GEELONG

Holds a general meeting the last Friday of each month, plus meetings every other Friday.

Fees: $30 adult, $45 family and $15 junior and concession.
Address: PO Box 1799, Geelong VIC 3220
Contact: Miles Charlesworth (Pres.) (052) 53-1782 or Robert Cowdell (Sec.) (052) 55-2702.

ASTRONOMICAL SOCIETY OF FRANKSTON (ASF)

Meetings are friendly and held on the 3rd Wednesday of each month, except December, at 8pm, at The Peninsula School, Wooralla Drive, Mt.Eliza.

Fees: $30 adult, $25 concession, $20 student, $40 family, $35 family concession, $10 newsletter only.
Address: PO Box 596, Frankston VIC 3199
Contact: Don Leggett (059) 85-4927
Internet: http://www.peninsula.starway.net.au/asf

ALBURY WODONGA ASTRONOMICAL SOCIETY

The society has occasional meetings at Wodonga High.

Address: 1 Poplar St., Wodonga VIC 3690
Contact: John Hawkin (060) 24-5535

ASTRONOMICAL SOCIETY OF VICTORIA (ASV)

General Meetings in 1997 will be held on the 2nd Wednesday of each month, except January, at the Fire Brigade Training College theatrette (cnr Victoria & Burnley Streets, Abbotsford).

Fees: Ordinary members.$35, Country members.$24, Junior (Under 19).$24
(A once only joining fee of $20 applies to all excepting juniors.)
Address: GPO Box 1059J, Melbourne VIC 3001
Contact: Ms Linda Mockridge (Public Relations Officer) (03) 9596-5884
Internet: http://www.vicnet.net.au/~astrovic/asv.htm

BALLARAT ASTRONOMICAL SOCIETY

Through the Observatory it has had the use of three historic telescopes; the Jelbart - a 5" refractor, The Oddie - an 8" Newtonian, and The Baker Great Equatorial Telescope - a 26" Newtonian, which was commissioned in 1888. In addition there is a 14" Celestron Schmidt-Cassegrain telescope. The Society holds a General Meeting on the second Friday of each month and various activities are available on the other Friday evenings.

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

THE BENDIGO DISTRICT ASTRONOMICAL SOCIETY

The society meets at the London Campus, TAFE (Bendigo) on the 4th Wednesday of each month (excluding December).

Fees: $28 adult, $15 junior and $40 family.
Address PO Box 123, Golden Square, Bendigo VIC 3555
Contact: Lisa Hewitt (054) 74-8220
Internet: http://www.bendigo.net.au/~rbath/index.htm

LATROBE VALLEY ASTRONOMICAL SOCIETY

Meets at Monash Uni.(Room 5N148), Switchback Rd., Churchill, on the 2nd Tuesday of each month at 7:30pm (except Dec, Jan).

Fees: $25 adult and $13 associate
Address: PO Box 329, Glengarry VIC 3854
Contact: Geoff Thomas (051) 92-4347

NORTHERN TERRITORY

ASTRONOMICAL SOCIETY OF ALICE SPRINGS

The society holds meetings on the 2nd Monday of each month at the Motor Registry Office 'Metal Centre'.

Address: Box 739, Alice Springs NT 0871
Contact: Karl Kramer (Pres.) (089) 52-6426

DARWIN ASTRONOMY GROUP

Observing nights are held during the dry season. There are occasional meetings.

Address: GPO Box 3043, Darwin NT 0801
Contact: Robert Lang (089) 81-1985

1997

January

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2 ◐	3	4
5	6	7 ●	8	9	10	11
12	13	14	15	16 ◑	17	18
19	20	21	22	23 ○	24	25
26	27	28	29	30	31	

February

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1 ◐
2	3	4	5	6	7	8 ●
9	10	11	12	13	14 ◑	15
16	17	18	19	20	21	22 ○
23	24	25	26	27	28	

March

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2 ◐	3	4	5	6	7	8
9 ●	10	11	12	13	14	15
16 ◑	17	18	19	20	21	22
23	24 ○	25	26	27	28	29
30	31					

April

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1 ◐	2	3	4	5
6	7 ●	8	9	10	11	12
13	14	15 ◑	16	17	18	19
20	21	22	23 ○	24	25	26
27	28	29	30 ◐			

May

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7 ●	8	9	10
11	12	13	14 ◑	15	16	17
18	19	20	21	22 ○	23	24
25	26	27	28	29 ◐	30	31

June

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5 ●	6	7
8	9	10	11	12	13 ◑	14
15	16	17	18	19	20	21 ○
22	23	24	25	26	27 ◐	28
29	30					

July

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5 ●
6	7	8	9	10	11	12
13 ◑	14	15	16	17	18	19
20 ○	21	22	23	24	25	26
27 ◐	28	29	30	31		

August

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3 ●	4	5	6	7	8	9
10	11 ◑	12	13	14	15	16
17	18 ○	19	20	21	22	23
24	25 ◐	26	27	28	29	30
31						

September

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2 ●	3	4	5	6
7	8	9	10 ◑	11	12	13
14	15	16	17 ○	18	19	20
21	22	23 ◐	24	25	26	27
28	29	30				

October

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2 ●	3	4
5	6	7	8	9 ◑	10	11
12	13	14	15	16 ○	17	18
19	20	21	22	23 ◐	24	25
26	27	28	29	30	31 ●	

November

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8 ◑
9	10	11	12	13	14 ○	15
16	17	18	19	20	21	22 ◐
23	24	25	26	27	28	29
30 ●						

December

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7 ◑	8	9	10	11	12	13
14 ○	15	16	17	18	19	20
21	22 ◐	23	24	25	26	27
28	29	30 ●	31			

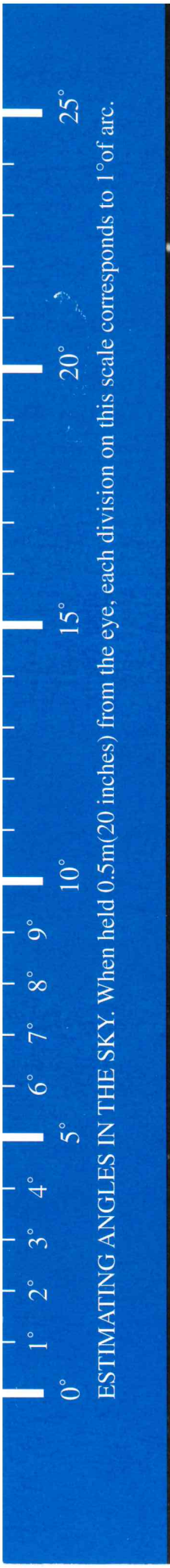
● New Moon ◑ First Quarter ○ Full Moon ◐ Last Quarter

GREEK ALPHABET

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

INDEX

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



There is no one who has not gazed on the beauty of the night sky and wondered:

What is that bright star ?
Why do some "stars" move from night to night ?
Which planet is that ?

This book is for you. No knowledge of Astronomy is needed to enjoy this publication. Not even a telescope! Five of the planets are easily visible to the unaided eye, just look up!

ASTRONOMY 1997 has everything you need to enjoy the night sky. With nothing other than your eyes, a sense of curiosity and a copy of this book you can start enjoying the most spectacular show nature has to offer. (Well... warm clothes and clear skies would also help)

FEATURES INCLUDE:

- Realistic views of the sky, easily identifying the planets from the stars.
- Guide to the best times to observe the planets.
- When to see Shooting Stars (Meteor showers).
- Easy to read monthly rise/set charts.
- Public observatories in Australia.
- Amateur astronomical societies.
- Comets.
- and much more ...

Quasar Publishing has been producing yearbooks since 1991 and ASTRONOMY 1997 continues to build on the high standard established over the last 7 years.
The authors have had many years of experience in observational astronomy, astronomical publications, public education and the amateur astronomical community.

> For the beginner, trying to get into the hobby of astronomy is like moving to a new town; everything is either unfamiliar or just plain unknown. . . After just a little practice with this celestial tourist guide, you'll know the sky better than you know the streets around your house. For the cost of a paperback novel, *Astronomy 1996* offers the beginner a comprehensive guide to celestial events for 1996.
>
> Sky and Space Magazine - December 1995

> Astronomy 1996 reinforces Quasar Publishing's status as Australia's premier provider of information on what's happening in the sky. To date, I have not seen an astronomy publication that surpasses the value of Astronomy 1996 for anyone with even a casual interest in the night sky. For the amateur astronomer, Astronomy 1996 is a must-have guide to 1996's night sky.
>
> Comet Tales Newsletter - Nov./Dec. 1995

QUASAR PUBLISHING **ISBN 0 646 29270 6**