ASTRONOMY 2001

WESTERN AUSTRALIAN EDITION

A PRACTICAL GUIDE TO THE NIGHT SKY



PERTH OBSERVATORY
Department of Conservation and Land Management

Glenn Dawes
Peter Northfield
Ken Wallace

2001

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
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28	29	30	31			

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29	30					

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29	30	31				

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October

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21	22	23	24 ◑	25	26	27
28	29	30	31			

November

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18	19	20	21	22	23 ◑	24
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December

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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

ASTRONOMY 2001

WESTERN AUSTRALIAN EDITION

A PRACTICAL
GUIDE TO
THE NIGHT
SKY

GLENN DAWES
KEN WALLACE
PETER NORTHFIELD

QUASAR PUBLISHING
2000

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Ken Wallace

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INTRODUCTION TO THE 2001 EDITION

Welcome to Astronomy 2001, our first yearbook of the new millennium. One pleasing aspect of doing this publication each year has been the opportunity it presents to highlight the excellent work being done by fellow Australian amateurs. This year is no exception and we are pleased to recognise the contributions by Queenslander Terry Lovejoy (his unusual comet discoveries) and Victorian Rod Stubbings (his observations of V4641 Sgr). Their stories are covered in the monthly section.

With regards to observing in 2001:

- The Partial Lunar Eclipse on the night of July 5/6 is well placed for Australian observers.
- Just when we thought the Leonid Meteor shower was passed its peak, astronomers predict it could still be impressive in 2001. WA could get front row seats to this display.
- In June, Mars goes into opposition, the best since 1988 and a good rehearsal for the next ideal opposition in 2003.
- A rare opportunity is presented to view Jupiter without any of the Galilean Moons seen outside the planet's disc on the morning of November 9.

This Western Australian Edition has been produced for Perth Observatory and designed for observers in WA. A separate publication has been produced for the rest of Australia (Eastern Australian edition).

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

As in previous editions of this yearbook, the authors would like to conclude this introduction with a brief word to the novice. Astronomy, like any science, may seem to be swamped in jargon. Unfortunately, it is impossible to avoid such words. However, where necessary, astronomical terms have been explained in the text or covered in the glossary. To a beginner, some of this information (especially the tables of numbers) may seem difficult to understand. It is important not to allow yourself to become overwhelmed. Understanding 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 2001 (US Naval and 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)
- Fifty Year Canon of Solar Eclipses 1986 - 2035 (NASA RP1178)
- Bureau des Longitudes for Jupiter satellite events
- Burnham's Celestial Handbook (Robert Burnham Jnr.)
- Hartung's Astronomical Objects for Southern Telescopes (revised by David Malin and David Frew)
- The New Patterns in the Sky (Julius D. W. Staal)
- Sky and Telescope Magazine - April 1999, June 2000
- International Meteor Organisation Calendar

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

- MICA ver 1.5 (US Naval Observatory)
- Occult ver 4.2 (David Herald)
- Deep Space ver 5.56 (David Chandler Company)
- Voyager II, the Interactive Desktop Planetarium ver 2 (Carina Software)
- TheSky for Mac ver 5 (Software Bisque)

Special thanks are extended to Greg Bryant for the comet text and monthly comet highlights for 2001 and Terry Lovejoy and Rod Stubbings for their contributions.

We would also like to thank the following for assistance in proofreading (certainly an important part of this complex publication),

Greg Bryant, Brenda McNamara, Richard Jaworski, Rob McIntyre, Elise Dott and Sue Dawes (typing and proofreading).

Illustrations

- The front cover is NGC 6744, a Milky Way like galaxy in the southern constellation of Pavo. Photograph by David Malin of the Anglo-Australian Observatory © AAO/D. Malin.
- Image from SOHO (p. 17). The SOHO/LASCO image used here is produced by a consortium of the Naval Research Laboratory (USA), Max-Planck-Institut fuer Aeronomie (Germany), Laboratoire d'Astronomie (France), and the University of Birmingham (UK). SOHO is a project of international cooperation between ESA and NASA.
- Photo of Terry Lovejoy (p. 17) supplied by him.
- V4641 Sgr outburst images (p. 41) taken by Makoto Uemura and Taichi Kato at the University of Kyoto, Japan
- Photograph of Leonid Meteor Shower in 1999 (p. 53) by Robert McNaught.
- Rear cover photo is the Magellan Observatory by Zane Hammond (6.5 hr exposure, Kodak PJ400, 20mm *f*5.6 lens).
- Images on pages 21 and 58 by Victorian amateur Robert Price.

Photographs and illustrations not otherwise credited are by the authors.

GETTING STARTED

If you are 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). Nor 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.

IS THIS USEFUL FOR WHERE I LIVE?

Astronomy 2001 can be used from anywhere in Western Australia. While the diagrams 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 as vast as Australia - is not significant (see also 'Effect of Latitude' on page 62). The rise/set graphs are useful since they give an approximate local time of rising and setting – no matter where you live!

Times in Part I are given in Western Australian Standard Time.

Part I 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.

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 Jupiter, Saturn, Aldebaran and the Moon on February 2nd and 3rd (see Sky View p. 18). These celestial dwellers all lie within a 15 degree circle in the northern evening sky. This is simply a chance alignment of these celestial bodies. They only look close together; in space they are still separated by enormous distances. When talking distances, beyond the Earth, it is difficult to use normal scales such as 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, Jupiter is 38 minutes, Saturn 73 minutes and Aldebaran 60 years. If you include the open star cluster, the Pleiades, we are out to 400 years. Distances in astronomy do challenge the imagination and, on the scale of the Milky Way, this cluster is just in our neighbourhood!

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

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

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

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 upward until it intersects the object of interest. The rise or set time of the object can now be read on the left-hand edge of the chart. For example, on January 28, The Moon and Venus set together around 9.30pm. Incidentally, when you see objects rising or setting together look for a Sky View on that date. There is a Sky View for this conjunction (see p. 15)

Each of these monthly sections also has diagrams showing the relative size and appearance of each planet, as seen through a telescope. There is also a description of celestial happenings and highlights - kind of like a celestial movie goer's guide - and in plain English! Want to know what Venus is up to in March? The description will tell you. A diary of events is also included that summarises the month's features. To see some of these celestial events, you'll need a pair of binoculars or a 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 as possible 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 upward 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 mostly concentrate on the ecliptic or zodiac regions of the sky i.e., where the planets and Moon wander. A good companion to this publication would be a basic star atlas or a planisphere. These will show all of the sky, but not the Sun, Moon and planets because they move. The planisphere is useful by showing at a glance all of the constellations visible at the time you are observing. 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 2001 contains more 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 (such as Perth), planetariums and courses can also be great resources. Use them.

A WORD ABOUT BINOCULARS

Probably the most cost-effective accessory for the beginner are binoculars. Good quality binoculars can be purchased at the same cost as a cheap, low quality telescope. Binoculars can also be useful for Mum and Dad, especially if their budding junior astronomer loses interest. They can at least be used for more terrestrial pursuits. Such an investment can be a cheap way of gauging their level of dedication. This does not mean the authors are suggesting the quality of the binoculars should be poor. It is recommended that even binoculars should be purchased from a reputable optics or telescope dealer. They are people who appreciate the quality required for stargazing. Astronomy is indeed a severe test on optics. Such shops can also assist with mounts to hold the binoculars steady. These are often brackets designed to attach to a tripod (sorry, another possible expense). To observe details on the Moon or looking for Jupiter's moons, it is recommended that binoculars are not hand held. Sometimes you can brace yourself on the arms of a chair or the roof of a car. This can be important if the power of the binoculars is more than 10X. A power of 7X is considered a reasonable compromise. It can give a good field of view with adequate magnification to glimpse some of the inner moons of Jupiter. The size of the aperture normally comes down to what is comfortable for the person to hand hold and the budget. 7X50 binoculars (7 times magnification, 50mm diameter front lens) are fairly popular with amateurs.

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

- Helping to find stars and planets in the bright twilight sky.
- Looking at the craters and rays on the Moon.
- Looking for fainter stars marked in star atlases or on the Sky Views and finder charts in this publication. This can be important in bright, light polluted skies.
- Looking for stars dimmed by the nearby Moon.
- The colours of the stars and planets are more obvious through binoculars. Check out the red colour of Mars, Aldebaran, Betelgeuse and Antares. Also, the contrast between the yellow of Alpha Centauri and the blue of Beta Centauri is interesting.
- The crescent phases of Venus.
- Stars and planets close to the horizon.
- Looking for Earth satellites in the early evening sky.
- Monitoring the change in magnitude of some of the brighter variable stars. There are also a number of organisations that can help with finder charts and predictions. Start with your local astronomical society.
- Observing the moons of Jupiter as they oscillate across the planet from night to night, see the diagrams on pages 85-87. It is also possible to observe an occasional eclipse disappearance or reappearance for one of the outer satellites (p. 83-84) as the moon passes into or out of the shadow of the planet.
- Lunar occultations of some of the brighter stars (see also Part II). Probably small binoculars are best suited for magnitude 4 or brighter events, preferably on a dark limb. There is no reason why one should not time the event as described on page 72.
- Looking for bright comets (from dark skies).
- Some of the bright deep sky objects such as the star clusters, Milky Way regions and the Magellanic Clouds.
- Looking for some of the brighter minor planets near opposition. A good exercise is to sketch the field a couple of times a few days apart and see which 'star' has moved.
- Searching out Uranus and Neptune, see finder charts on page 92.

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

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

SOME ASTRONOMICAL TERMS TO GET YOU STARTED

There are several astronomical terms you'll come across in Astronomy 2001, 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 11 gives a good overview. There are also a number (actually tens of thousands) of 'minor planets' that move around the Sun, mostly between the orbits of Mars and Jupiter. The Moon and all the planets we see in the sky do not glow in their own right. They are only visible because of reflected sunlight.

Star. Just like the Sun! A star is an enormous sphere of glowing gas that gives off tremendous amounts of light and heat. They shine by their own light caused by nuclear reactions going on deep inside them. It's a testament to the enormous distances between the stars when you realise that the Sun is a relatively average star, while some stars visible in the night sky are tens or hundreds of times larger and brighter, yet in our sky look so faint.

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.

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 do your own measurements of the objects' separations and compare your results with the predictions in this book.

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

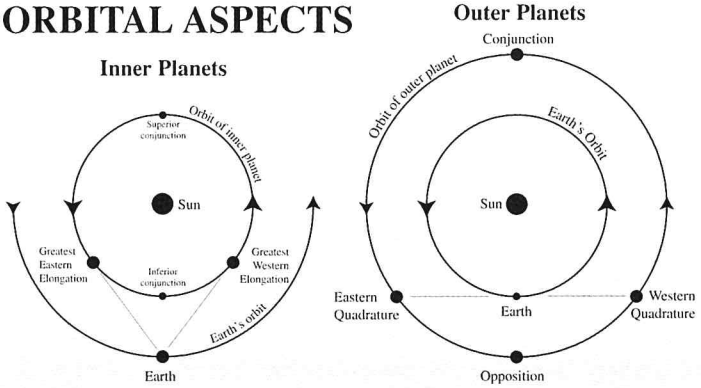
Culmination. When an object culminates it has reached its highest point in the sky and is generally considered to be the best time to observe it. For the planets, this is normally when they are due north.

HOW DO I USE THIS BOOK TO PLAN MY OBSERVING?

This publication was never intended to be read from cover to cover (but we don't mind if you do!). It is a reference work, which, if you look closely enough, gives you a number of pieces of the picture. Also, the picture is quite different depending on whether you are using your eyes, binoculars, or a telescope. The data that an astrophotographer would find useful could again differ. To illustrate how to use the book we will work through an example.

You are planning to go out and observe on the evening of February 25 (for once the weather looks OK). A good place to start is the 'Visibility Chart' (p. 10). Looking around late February we see Mercury, Mars, Uranus, Neptune and Pluto are in the morning sky, with Saturn, Jupiter and Venus in

ORBITAL ASPECTS



A **conjunction** of a planet and the Sun is when they are closest together in the sky (not the best time to observe the planet). When an inner planet is between us and the Sun it is said to be at inferior conjunction, when on the far side of the Sun we have a superior conjunction. It is also common to hear this word referring to any two or more objects when they are closest to each other in the sky, that is their minimum angular separation. See also page 5.

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

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

the evening. A quick check of the Rise/Set chart for February (p. 16) confirms this information. Venus and the Moon are setting together at around 8.20pm close to the end of twilight. The Sky View 'Feb 26 to Mar 1' on page 19 shows this event and also indicates that Saturn is nearby. Venus is heading towards inferior conjunction with the Sun in March, so it is getting lower in the evening sky as it gets larger, and the crescent gets narrower (see 'Appearance of the Planets' diagram, page 16 and 'Planetary Angular Size', page 65). It would be an excellent target for binoculars in the twilight sky. With the Moon setting so close to the Sun there are few opportunities to see any occultations of stars by our satellite on this evening. It is best to wait until the Moon spends more time in the night sky. For example on March 4, with the Moon now a couple of days past First Quarter, there is an occultation of a 5.8 magnitude star. From Perth it will disappear at 7.59pm (see 'Lunar Occultations', page 73).

Back to the evening of February 25. As per the Rise/Set chart, Jupiter and Saturn will set around 11pm. Both these planets are great targets for the smallest telescope. Saturn, this year, has its rings on display (as seen in the appearance diagram p. 16). It is also fascinating to watch Jupiter's moons as they move about the giant planet. A check of the 'Jupiter's Moons' section (page 83) shows that the second Moon (II) Europa will disappear behind (be occulted) by Jupiter at 9:54pm on Feb. 25.

So what does the morning sky of Feb. 26 have in store? If you stay up, Mars will rise around 11.15pm and should be still fairly close to the star Beta Scorpii, having made a close approach on the 22nd (see 'Diary of Events', page 18). It should look great amongst the bright stars of Scorpius (Sky View, Feb 15 to 17).

For those wishing to chase our most distant and faint planet, Pluto, it will rise just after midnight. You will need about a 20cm telescope and the finder charts on pages 92 and 93 for this world (not an exercise for a beginner). Neptune will rise about one hour before the start of twilight and Uranus is difficult to observe, being located in the eastern dawn sky.

Mercury will rise around 4.30am, close to the start of twilight. It has just passed between us and the Sun (inferior conjunction) on the 13th and it will show a distinct crescent in a small telescope (also see 'Appearance' diagram page 16). As you will see from the 'Movement of the Planets' diagram on page 9, we are coming into a good return for Mercury to the morning sky and it will be even higher by mid-March. While we are talking about the late morning sky, it might be worthwhile chasing Comet C/1999 T1 (McNaught-Hartley). See comets section on page 18.

The 'Diary of Events' (p. 18) shows a conjunction between minor planet 1 Ceres and the globular star cluster NGC 6642 in Sagittarius. A check with a planisphere shows Sagittarius to rise late this time of year and this would be a pre-dawn observation. This event is more for the advanced amateur and often attracts the astrophotographer wishing to catch a minor planet next to a deep sky object.

It is worthwhile glancing at the Meteor section each month (February's is on page 18) to see if there are any favourable 'showers' around your observing night. Looking for 'shooting stars' can be a lot of fun, whether there is a known shower on or not. The delta Leonids peak around the 25th of February, although they are a fairly minor shower, especially from the Southern Hemisphere.

This is an example of the way to apply the information within this book and how it can be a lot of fun planning an observing session.

THE MONTHLY SECTIONS

Each monthly chapter in Part I contains the following:

RISE/SET CHART

This will enable the reader to quickly determine when (or if) a planet or the Moon is visible in the night sky for any day in that month. Each chart has the midnight line centred, with the evening sky below this line and the 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 (close to rise or set times). Turbulence in the much thicker atmosphere (at low altitude) gives very poor 'boiling' images. If more accurate rise/set times are required, you will need to refer to the specific tables for the object of interest in Part II of this publication. You can also adjust for rural locations using the appendix on page 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 the north pole to the top.

MONTHLY HIGHLIGHTS

This lists a few of the more interesting events during the month.

THE MOON

This provides information on any events relating to the Moon. The data includes the Moon's phases, apogee, perigee, occultations of planets or bright stars and lunar and solar eclipses. The event does not have to be visible from Australia to be included. The description will normally indicate whether or not it can be seen. Throughout the monthly section the Earth–Moon distance quoted is between the centres of the two bodies.

There will be no occultations of bright stars by the Moon during 2001, the next bright star occultation will be in January 2005 when the 1st magnitude star Antares passes behind the lunar limb. The last time that there was a full calendar year without an occultation of a bright star was 1992. There will be 23 planetary and minor planet occultations this year plus the usual multitude of fainter star events (see also Lunar Occultations in Part II for details).

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 during that month, when it is brightest. It lists the magnitude and constellation the asteroid is in at the time of opposition.

COMETS

This section deals with the comets expected to be visible during 2001. It points out those that are observable during the month and includes any interesting conjunctions. Note, most of the known comets this year are relatively faint and will need a telescope.

It is likely that many other comets will be discovered during the year. We have seen some spectacular ones during the 1990s. Let's hope the trend continues in 2001.

METEOR SHOWERS

On any clear night we can sometimes see up to five shooting stars per hour, these are known as random or sporadic meteors. There are also annual 'showers' which return at the same time each year. Each shower seems to radiate from a focal point in the sky and is named after the constellation or a bright star the radiant lies near. For example, the radiant for the Leonids lies within the constellation of Leo. The monthly section lists the major showers for 2001 that are suitable for observation. These selected showers are those largely unaffected by moonlight during their peak period. Full details for all showers are given in Part II (p. 99). 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, away from light polluted cities. As a general rule, more meteors are seen after midnight. In November, the Leonids may put on a good display (p. 53)

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:

- Phase of the Moon.
- Key events in a planet's orbit.
- Selected conjunctions between the Sun, Moon, comets, minor planets (asteroids), brighter stars and deep sky objects (see also page 102 for descriptions of some of the brighter non stellar objects).

Conjunctions. Differences will be often found between the separation distances (and times quoted) and those found in the remainder of Part I. Conjunctions involving only the bright stars, the planets and the Moon are geocentric. This is how they would look from a position corresponding to the centre of the Earth. The exact time of closest approach may be in daylight from Australia, or the objects of interest may not be above the horizon for us.

The planetary text and Sky Views have been tailor made to suit Australia. Hence the times and angles given in the Diary of Events could differ from those on a Sky View. Sometimes a lunar conjunction is followed by 'Occn'. This indicates that from somewhere in the world, the object will be occulted (covered) by the Moon. The distance given is measured from the centre of the Moon (remember, the Moon has a diameter of 0.5°). Occultations involving the planets or the brightest stars are also mentioned in the 'Moon' text.

Abbreviations. These include:

- G which is for a galaxy (SG - spiral, IG - irregular, EG - elliptical).
- OC represents an 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 including:

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

FEATURE ARTICLE / CONSTELLATION OF THE MONTH

This section concentrates on a particular constellation or some topic in popular astronomy.

For a constellation such information can include:

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

SKY VIEWS

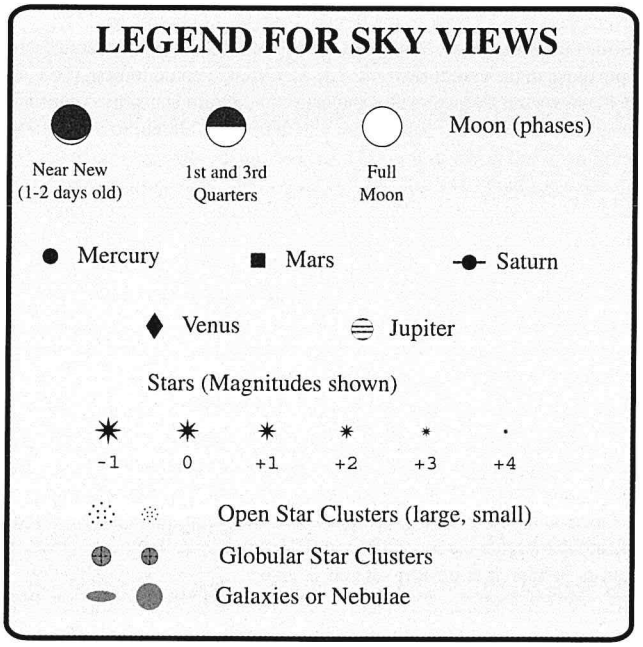
These diagrams are designed to help you find the planets. The date/time of each diagram has been carefully chosen to show the most interesting patterns of the planets and Moon. Sometimes the times chosen correspond to about one hour (or even down to 30 minutes) before sunrise or after sunset. Although,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

The 'Sky Views' (see also the legend below) 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 102 in 'Non Stellar Objects'.
- Constellations are labelled (capital letters) and have black lines joining key stars.

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

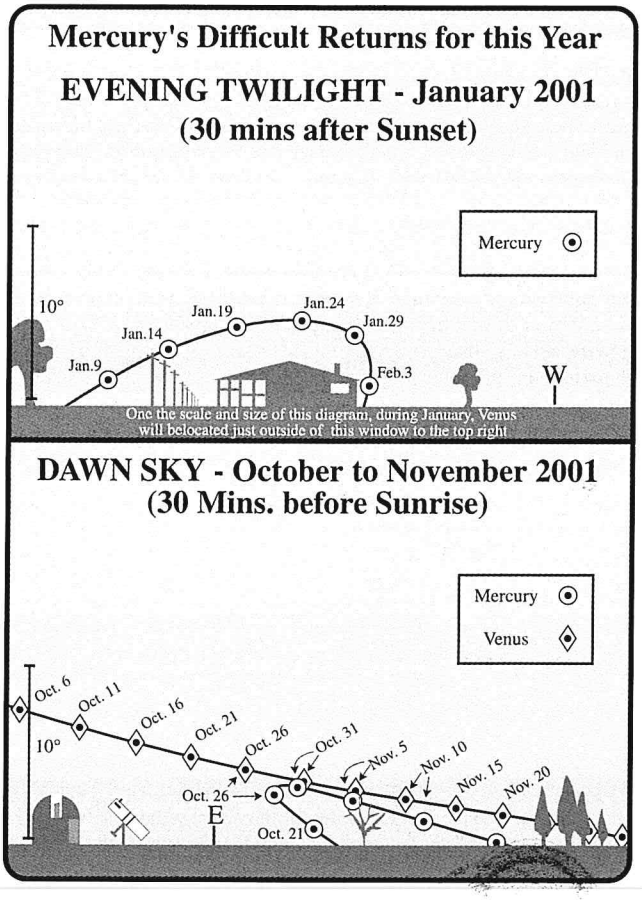
The Sky Views are useful for more than just the date and time shown. The pattern of stars relative to the horizon will appear the same one month later, but 2 hours earlier. Of course the planets and the Moon will have moved. Compare the Sky Views for Feb. 15 to 17 (1am) with March 13 to 16 (11pm). A few minutes playing with a planisphere will also illustrate this yearly motion of the stars.



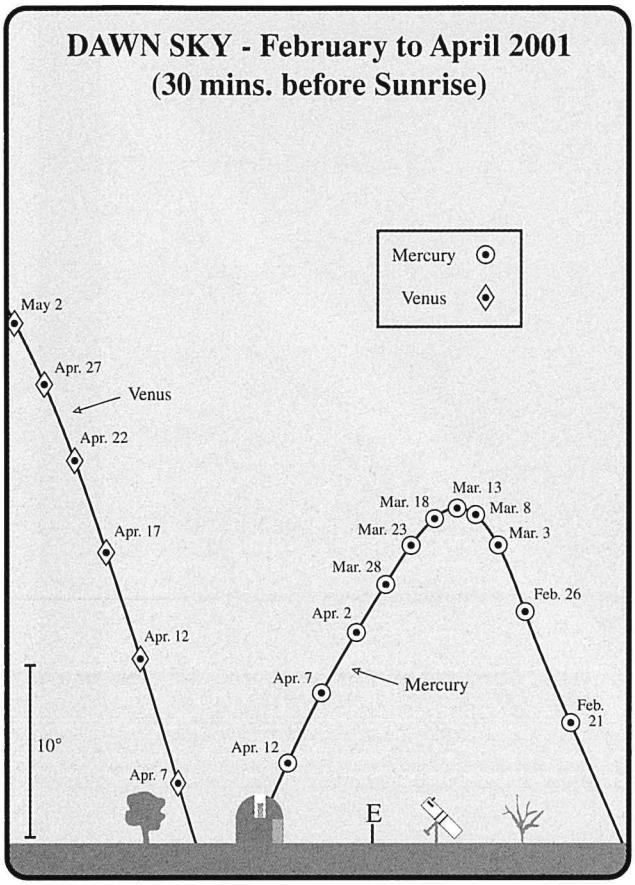
Uranus, Neptune and Pluto have been excluded from the Sky Views as they are not generally visible to the naked eye. To see Uranus you would certainly need dark sky conditions. Neptune will need binoculars, while Pluto will need at least a 20cm telescope to glimpse this faint member of our Solar System. In any case, because of the many faint stars of similar brightness close by, finder charts would be needed to identify these outer worlds. Charts for these planets are on pages 92-93.

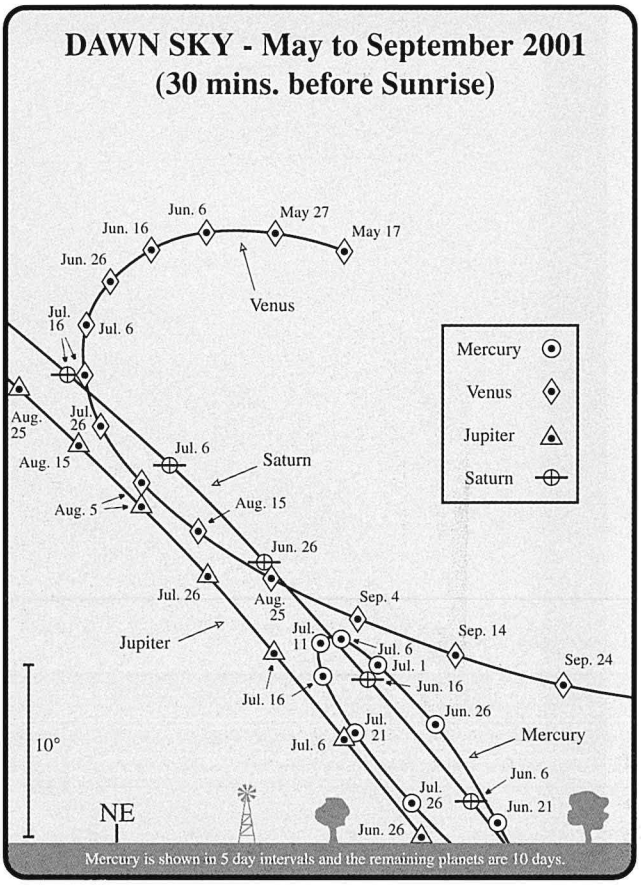
MOVEMENT OF THE PLANETS

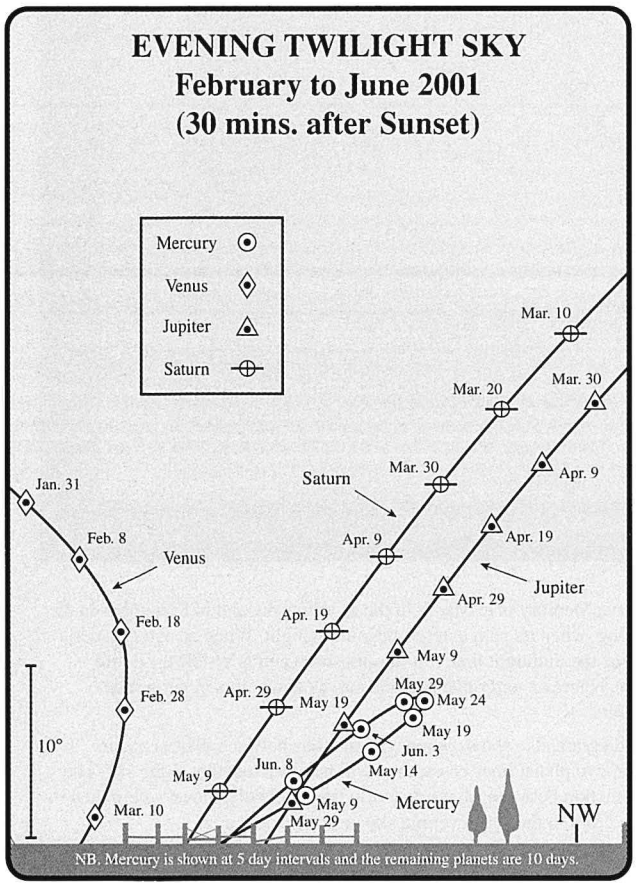
These diagrams are designed to help observers know when the planets first become observable after being in conjunction with the Sun, or when they are about to go into conjunction with our star. The drawings are particularly useful as an observing guide for Mercury. In addition, the Visibility of the Planets diagram (p. 10), allows you to see at a glance whether an object is in the morning or evening sky.

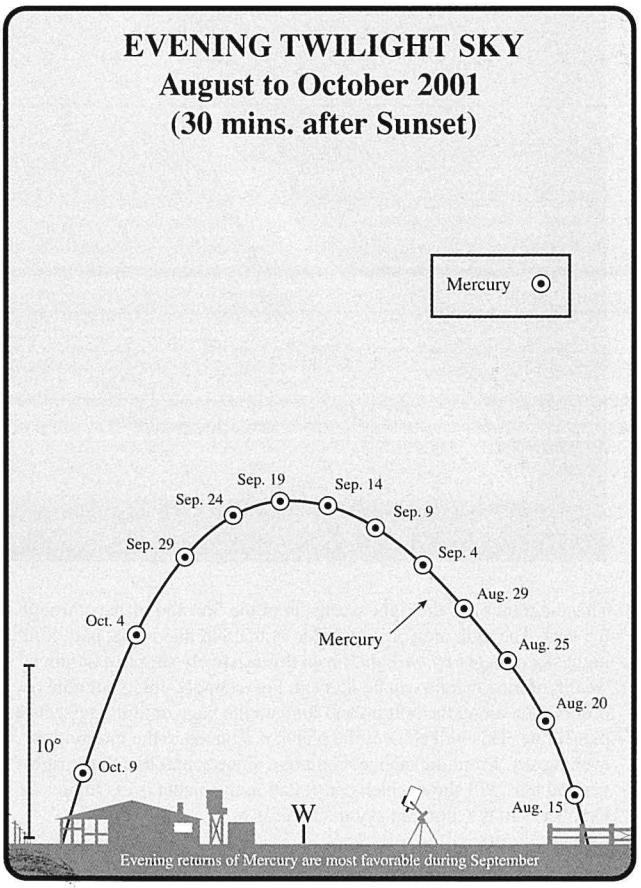


MOVEMENT OF THE PLANETS

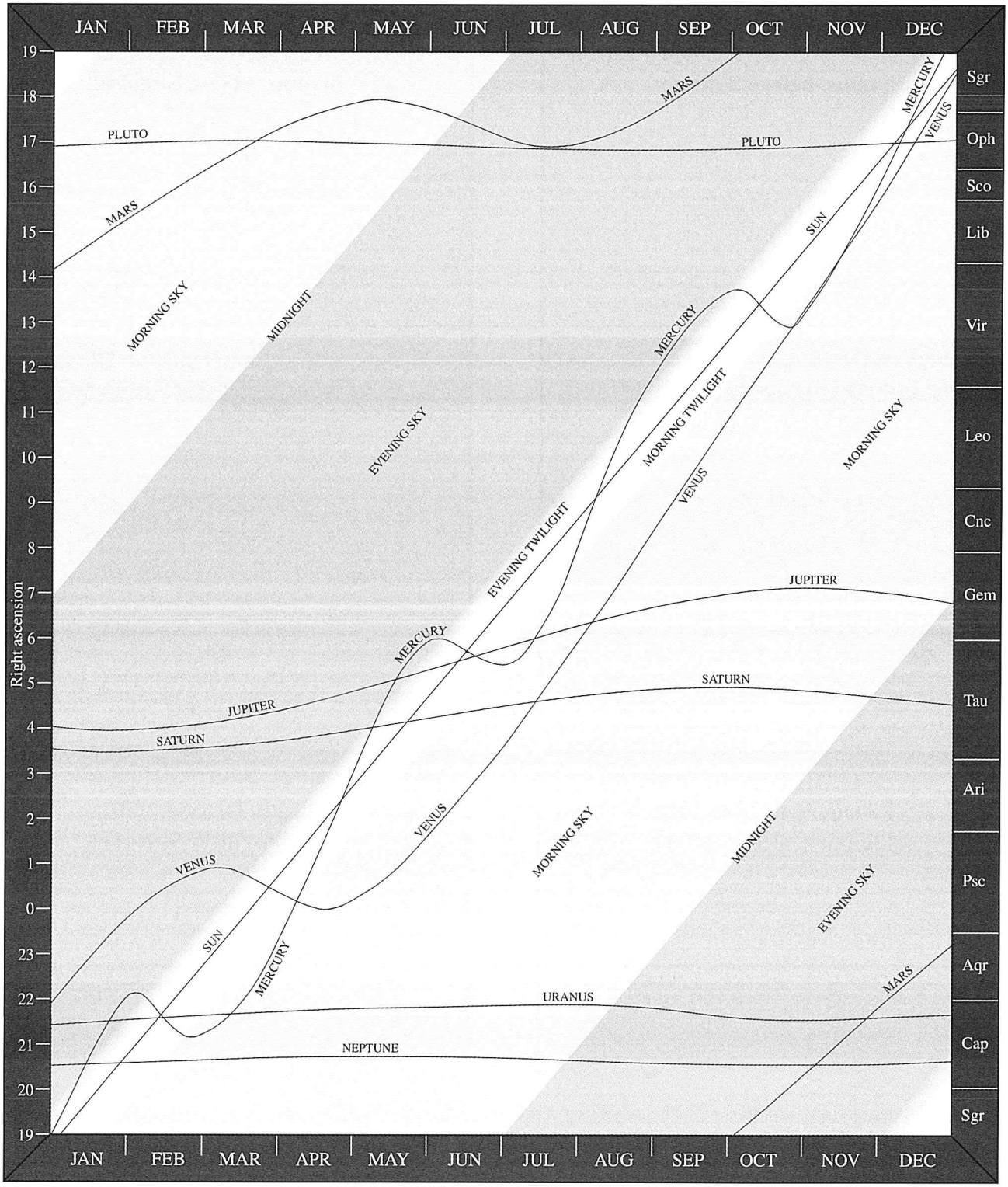








VISIBILITY OF THE PLANETS



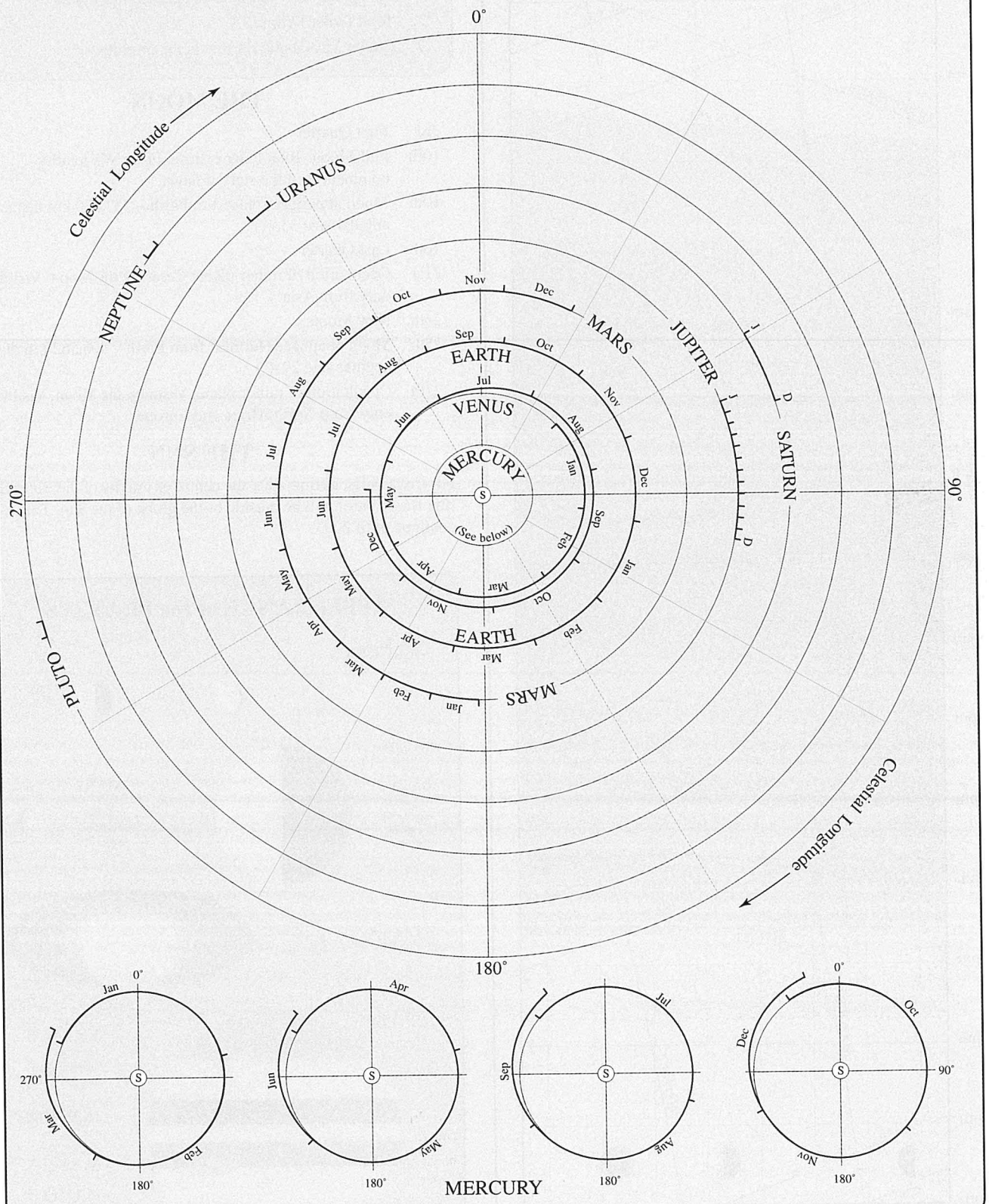
This diagram plots the right ascension of the Sun and planets throughout the year. The light area on either side of the Sun line is that part of the night sky affected by twilight. From this relatively simple diagram a wealth of information can be derived. For example, find your date of observation along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

Mercury and Venus are in conjunction when they cross the Sun line and at their greatest elongation when furthest from it. The best conditions to observe Mercury is in March in the morning sky and in September in the evening, when its path extends beyond twilight. When an outer planet crosses the midnight line, it is at opposition and is visible the entire night. Where an outer planet's line curves down, it is in retrograde motion.

The diagram also shows when conjunctions between planets occur. When two planet lines cross, they will be close together in the sky. The conjunction between Mercury and Jupiter is clearly shown where their paths cross in the May evening sky (see Sky View p. 31).

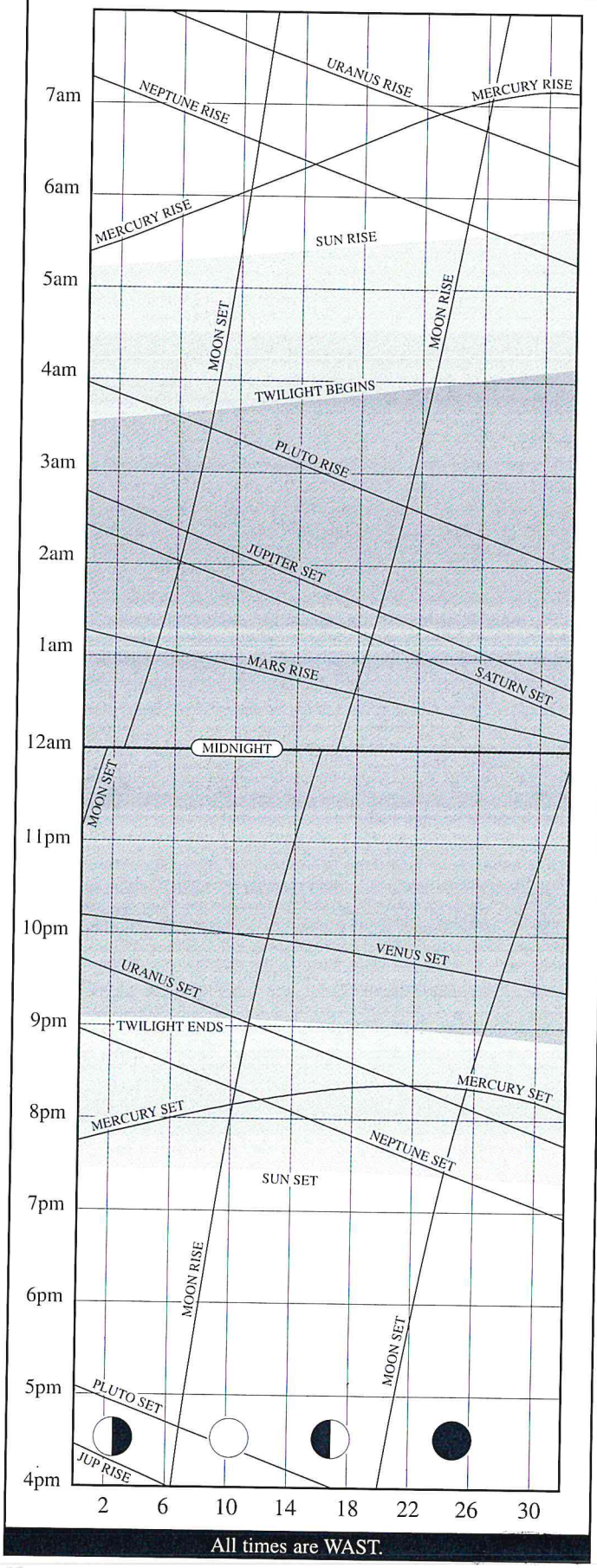
PLANET POSITIONS

This diagram illustrates the relative positions of the planets during the course of their orbits in the year 2001. The illustration clearly shows the relationship between the Solar System bodies. For example, this year's opposition of Mars occurs in June when the Earth appears closest to that planet. The diagram is drawn as viewed from below (south of) the Solar System. The drawing has been simplified in that the planetary orbits are not shown as ellipses and the Sun and planet distances are not drawn to scale.



JANUARY

RISE/SET CHART



All times are WAST.

JANUARY HIGHLIGHTS

- Mercury, greatest elongation east of the Sun (18°)
- Mercury near the thin lunar crescent
- Venus, greatest elongation east of the Sun (47°)
- Moon, Jupiter, Saturn near Aldebaran in Taurus
- Total Lunar Eclipse
- Comet McNaught-Hartley in the morning sky

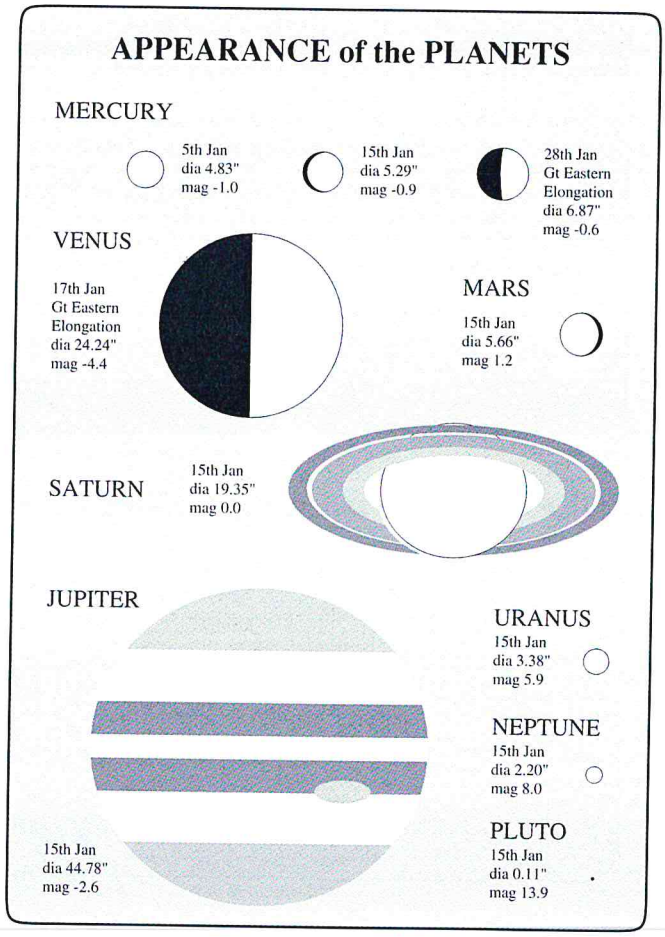
THE MOON

3rd	First Quarter
10th	Full Moon. Total lunar eclipse. From WA totality commences at the start of dawn.
10th	Moon at perigee (closest to Earth – 357,130 km distant, angular size 33.4°)
16th	Last Quarter
21st	Occultation of minor planet Ceres by the Moon. Visible only from Asia
24th	New Moon
25th	Moon at apogee (furthest from Earth – 406,562 km distant, angular size 29.4°)
27th	Occultation of minor planet Vesta by the Moon. Visible only from North Africa and Europe

THE SUN

For trivia buffs, during 2001 the centre of gravity of the Solar System (the Barycentre) will be outside of the globe of the Sun. This will continue until 2003.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is an evening object during January, reaching its greatest eastern elongation from the Sun on the 28th (18°). This apparition of the speedy messenger is not the best, with the planet setting well before the end of astronomical twilight. The best time to observe Mercury this year, in the evening sky, is during September, and in the morning sky from late February through to early April. Of interest this month, Mercury passes close to the outer planets Uranus and Neptune and the Messier globular M75 during the course of its journey through Sagittarius, Capricornus and Aquarius. Difficult in the twilight, but worth a look is the appearance of Mercury 3.2° below the 2-day old Moon on the 26th, with the brighter Venus further north and higher (see Sky View).

VENUS shines brilliantly in the western evening sky, reaching its greatest eastern elongation from the Sun on the 17th (47°). The 3-day old Moon appears 6.5° from the planet on the 28th (see Sky View), and on the following evening a little further away at 8°. The combination of the thin lunar crescent (with Earthshine) and the bright planet will make a great display. Venus spends most of its time in Aquarius, moving into Pisces during the last week of the month.

The **EARTH** is at perihelion (the closest point in its orbit from the Sun) on the 4th. The Earth/Sun distance is 0.9833 astronomical units, which is equivalent to about 146,995,000 km.

MARS rises around midnight (mid-month) and is in the early morning eastern sky. After spending December near the 1st magnitude star Spica, it leaves Virgo early in January and moves into Libra. On the 18th, the 23-day old waning crescent Moon will be 4.5° from Mars (see Sky View). The Red Planet will arouse much interest when it comes to opposition in June this year, and observers will note a steady increase in the planet's brightness leading up to this event. Although the next most favourable opposition is still 2 years away, the planet will present a good-sized disk of almost 21 arc seconds in June (compared with 25.2 arc seconds in 2003). Currently, the Martian disk is only just over 5 arc seconds across and a glance through any telescope this month will quickly demonstrate why these favourable oppositions are keenly awaited.

JUPITER, in Taurus, is high in the northern sky after dark, forming a triangle with Saturn and the 1st magnitude star Aldebaran. On the 6th, the 11-day old gibbous Moon will be located just 2.5° from Jupiter (see Sky View). With opposition last November, the planet still presents a good size 45 arc second diameter disk for the planetary observer.

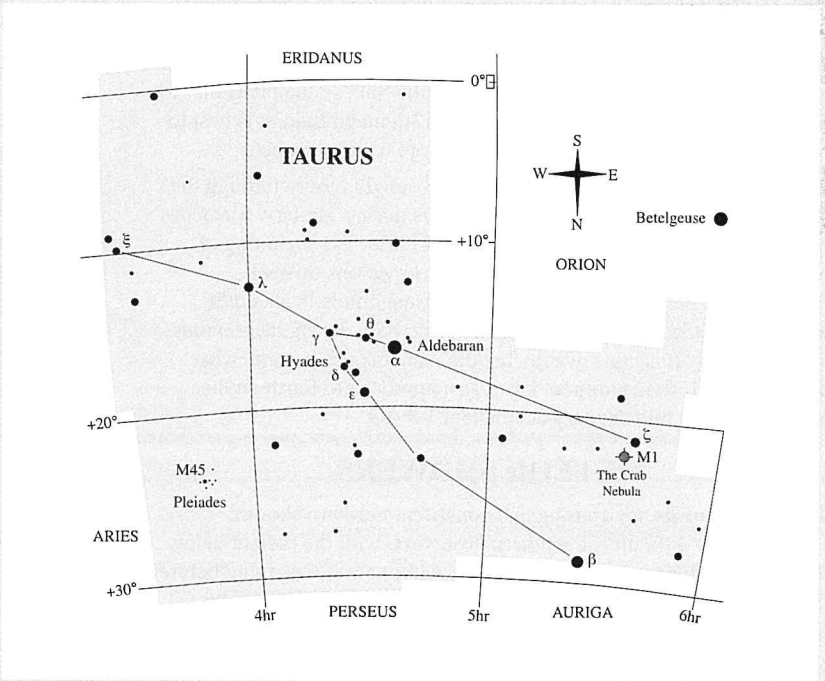
SATURN, Jupiter's companion in Taurus for the next few months, remains in the constellation of The Bull throughout the year. On the 5th, the 10-day old gibbous Moon appears 8° west of Saturn, with Jupiter 7.5° to the east – the trio forming a straight line. On the following evening the Moon is 6° from Saturn, and 2.5° from Jupiter (see Sky View).

CONSTELLATION of the MONTH — TAURUS (Tau)

Taurus, The Bull, the 2nd constellation of the zodiac, is generally considered to be one of the oldest constellations. Marking the vernal equinox (the First Point of Aries) from about 4000 to 1700 BC probably explains its prominence in ancient man's impressions of the sky. The actual form of the bull possibly came much later from the Babylonians.

Culminating in mid-January around 9pm, Taurus can be seen in the north sky below and west of Orion. The most visually striking feature of the constellation is the 'V' shaped cluster of stars known as the 'Hyades'. This group forms the face of the bull. Its brightest star, the 1st magnitude red giant Aldebaran, is its flaming eye. The horns of the bull extend out to Beta (El Nath, the 'butting one') and Zeta Tauri.

Two of the most conspicuous and magnificent open star clusters in the sky reside in Taurus: the aforementioned Hyades and the Pleiades. The Hyades with its large 'V' shape of bright stars is easily recognisable. The Pleiades, west of the Hyades, are fainter and smaller. Both clusters are excellent in binoculars. The Pleiades are further away from us than the Hyades, their distances being 400 and 130 light years respectively.



The Hyades is a cluster of about 130 stars that share the same proper motion in space and hence move together around the Milky Way galaxy as a family group. Aldebaran (Alpha Tauri), the brightest star, appears to be a member of the 'family', but is not attached and is only a line of sight foreground star. Aldebaran is one of only a few 1st magnitude stars that can be occulted by the Moon (the others are Regulus, Spica and Antares). The occultations occur in 'series', the last ending in February 2000. There is then a break of fifteen years, with the next Aldebaran series starting in January 2015.

The Pleiades, or Seven Sisters, are named after the seven nymphs who were the daughters of Atlas and Pleione (the group is named after the mother). The brightest stars bear the names of these daughters: Alcyone, Celeone, Electra, Maia, Merope, Asterope and Taygeta. Two other stars are named after Atlas and Pleione. The Pleiades are immersed in nebulosity, which is visible in photographs or larger telescopes and is particularly bright in the region illuminated by Merope.

Another famous object in the constellation is M1. This first object in Messier's catalogue was actually discovered in 1731 by John Bevis but then forgotten. Messier rediscovered it in 1758. M1 is commonly known as the Crab Nebula, and is the remnant of a star that became a supernova that was observed in the year AD 1054 by Chinese astronomers.

JANUARY

URANUS and **NEPTUNE** both set in the evening twilight, and will reappear in mid to late February as morning objects. Neptune will be in conjunction with the Sun on the 26th. This is the 2nd in a series of eight consecutive Neptunian conjunctions, where the planet is occulted by the Sun's disk (not exactly observable). The next series begins in the year 2080.

PLUTO rises in the early morning sky in Ophiuchus, and will remain in this constellation until February 2003 when it moves into Serpens.

COMETS

Comet C/1999 T1 (McNaught-Hartley), the brightest predicted comet in 2001, can be found in the morning sky in January, initially in the constellation of Libra. The comet reached perihelion last month, and it should be around 7th magnitude, easily visible in binoculars, under dark skies. By month's end, the comet has moved through Serpens into Hercules.

Comet C/1999 T2 (LINEAR) will, by the end of January, be rising around the time of morning astronomical twilight. The 12th magnitude comet will be found in Hercules.

Comet 41P/Tuttle-Giacobini-Kresak is in the morning sky in January. It begins the year in the constellation of Libra, and on New Year's Day the 12th magnitude comet is just north of 4th magnitude star Gamma Librae. Tuttle-Giacobini-Kresak reaches perihelion on the 6th, at a distance of 1.1 AU from the Sun. As January progresses, the comet visits Scorpius (briefly) and Ophiuchus before ending the month in Sagittarius. Tuttle-Giacobini-Kresak has a recent history of undergoing jumps in brightness, so it's worth watching.

Comet 47P/Ashbrook-Jackson begins 2001 in the constellation of Aquarius, low in the evening sky. By the end of the first week, the comet lies very close to Venus. Around the same time, on the 6th, it is at perihelion at a distance of 2.3 AU from the Sun, so the proximity to Venus is merely a line-of-sight effect. At 13th magnitude, it is best to observe the comet as early as possible before it sinks deeper.

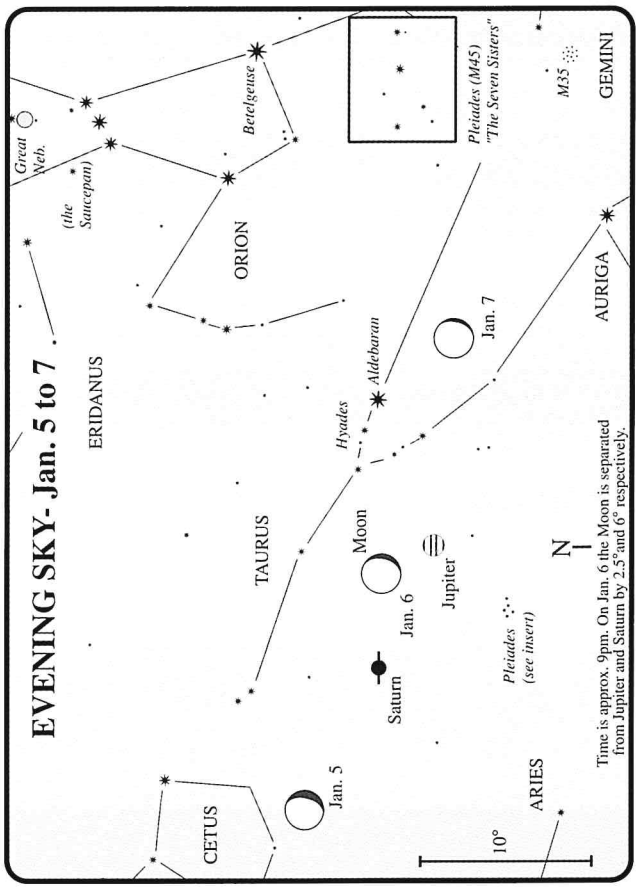
Comet 73P/Schwassmann-Wachmann 3 slowly moves through the constellations of Ophiuchus and Sagittarius during January. It reaches perihelion on the 27th and doesn't rise until after the beginning of morning astronomical twilight, making observations difficult. However, the predicted brightness of 13th magnitude is uncertain, given its spectacular split and heightened activity during its previous return in 1995. It is conceivable that the comet could be somewhat brighter than 13th magnitude. Its closest approach to Earth on this return occurs in mid-January at a distant 1.8 AU.

METEOR SHOWERS

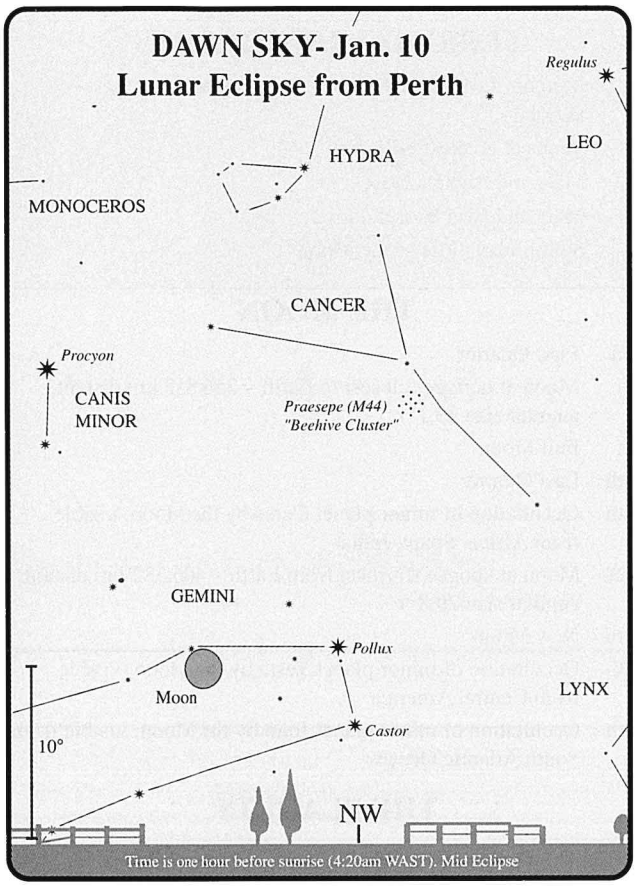
The **Quadrantids** are a strong and consistent northern shower. However, it is difficult for southern observers, with the radiant below the early morning northeastern horizon. Although, if observing before dawn, the occasional long-pathed member may be glimpsed. The Quadrantids are active from January 1-5, and peak on the 4th, the zenith hourly rate is 120, but can vary from 60 to 200.

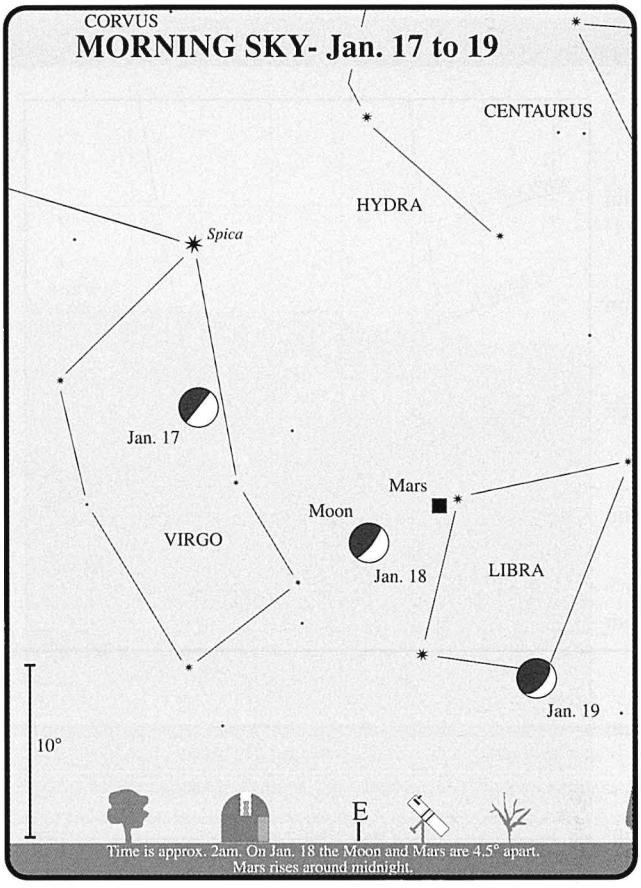
DIARY OF EVENTS

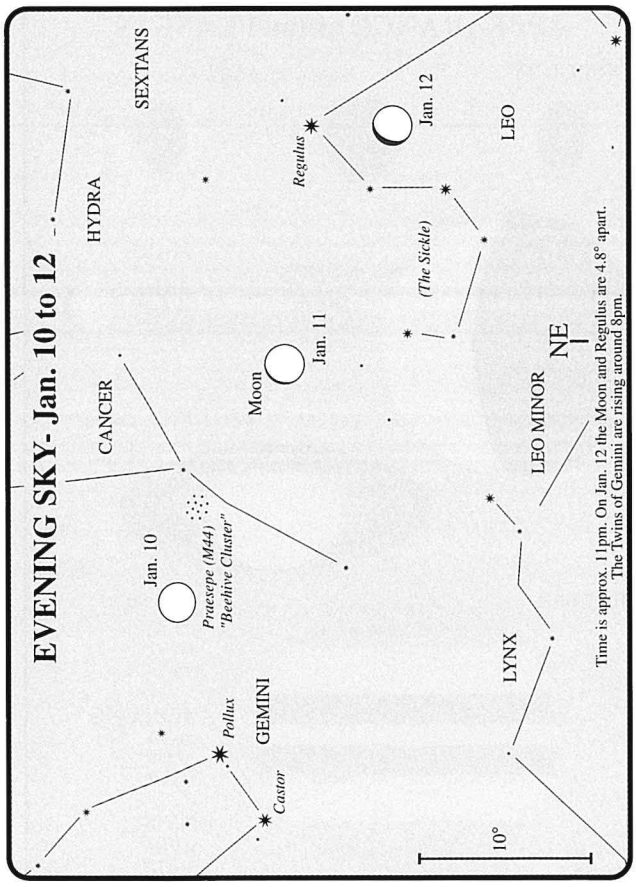
3rd		m.p. 29 Amphitrite 0.3°NE of NGC 4995 (SG) in Virgo
3rd	6:31 AM	First Quarter Moon
4th	5 PM	Earth at perihelion
5th		m.p. 6 Hebe 0.1°N of star Delta Virginis
6th	9 AM	Saturn 2° N of Moon
6th	10 PM	Jupiter 3° N of Moon
8th		Mercury at greatest latitude South
9th		m.p. 4 Vesta 0.2°SW of IC 5194 (SG) in Aquarius
9th		m.p. 532 Herculina 0.2°N of NGC 5363 (EG) in Virgo
9th		m.p. 532 Herculina 0.5°N of NGC 5364 (SG) in Virgo
10th	4:24 AM	Full Moon; eclipse
10th	5 PM	Moon at perigee
14th	1 AM	Mercury 2° S of Neptune
16th	8:35 PM	Last Quarter Moon
17th		Uranus 0.7°NW of m.p. 11 Parthenope
17th	2 PM	Venus greatest elongation East (47°)
18th	4 AM	Mars 4° S of Moon
19th		Mars 0.9°NE of star Alpha 2 Librae
19th		Venus at ascending node
21st	Noon	Ceres 0.7° S of Moon; occultation
23rd	2 AM	Mercury 0.4° S of Uranus
24th	9:07 PM	New Moon
25th	3 AM	Moon at apogee
25th	11 PM	Jupiter stationary
25th	Midnight	Saturn stationary
26th	11 AM	Mercury 3° N of Moon
26th	Noon	Neptune in conjunction with the Sun
27th		Mercury at ascending node
27th	7 PM	Vesta 0.8° S of Moon; occultation
28th	9 PM	Mercury greatest elongation East (18°)
28th	10 PM	Venus 6° N of Moon
30th		m.p. 29 Amphitrite 1.2°NE of Spica
31st		m.p. 1 Ceres 0.2°SW of NGC 6469 (OC) in Sagittarius

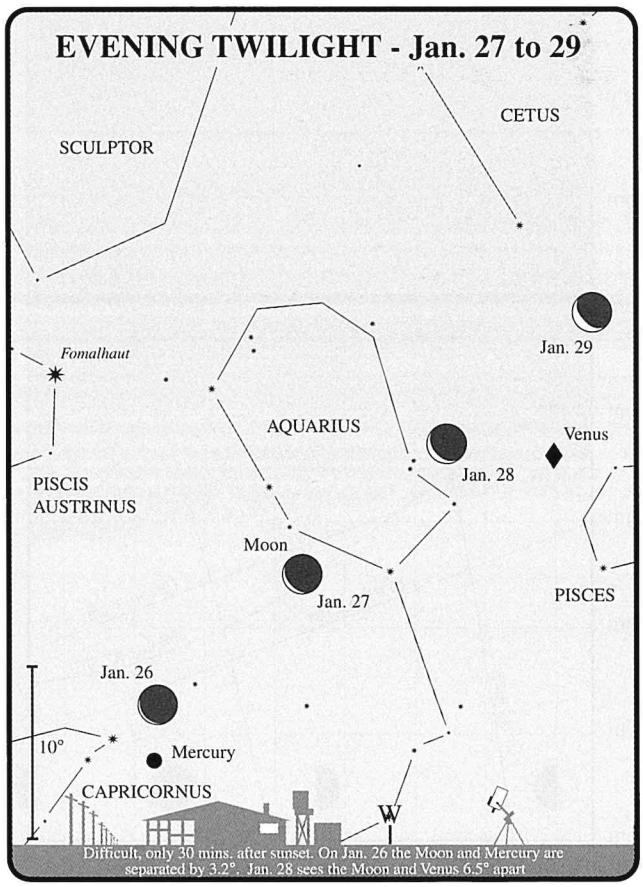


JANUARY


DAWN SKY- Jan. 10
Lunar Eclipse from Perth
Regulus
LEO
HYDRA
MONOCEROS
CANCER
Procyon
CANIS
MINOR
Praesepe (M44)
"Beehive Cluster"
GEMINI
Pollux
Moon
LYNX
Castor
10°
NW
Time is one hour before sunrise (4:20am WAST). Mid Eclipse

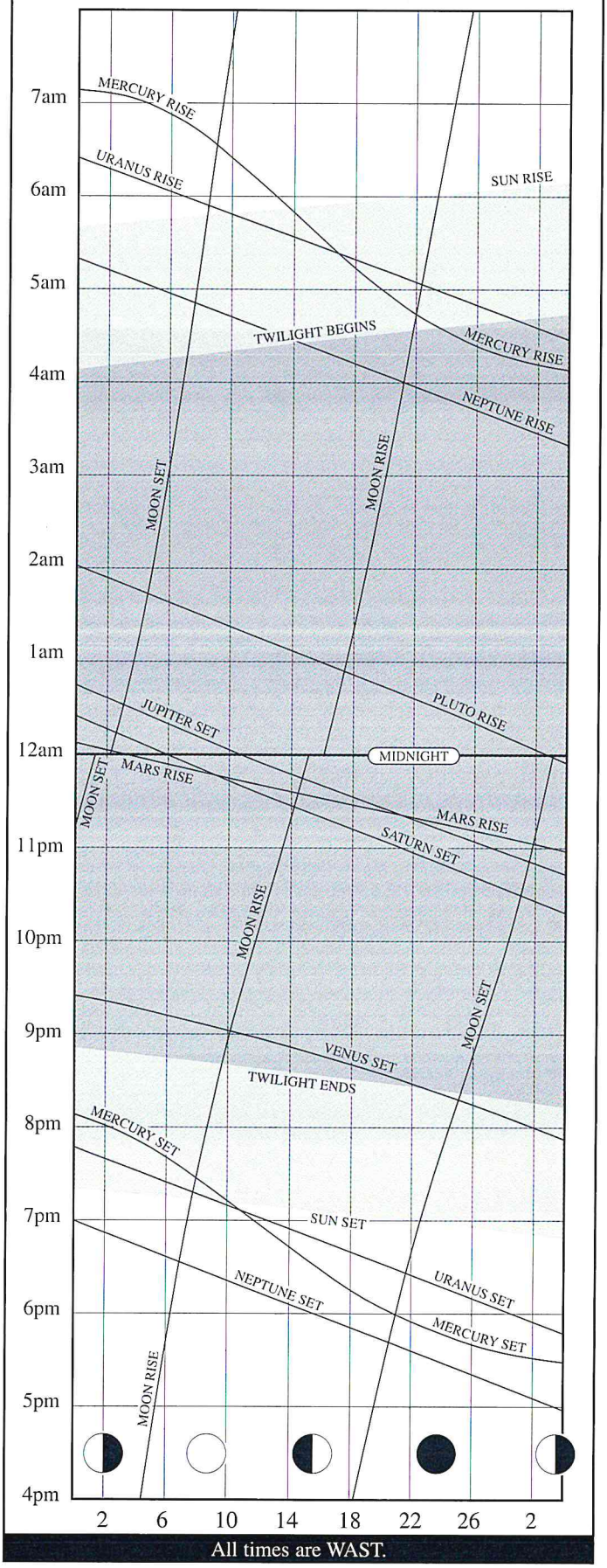

CORVUS
MORNING SKY- Jan. 17 to 19
CENTAURUS
HYDRA
Spica
Jan. 17
Mars
Moon
VIRGO
Jan. 18
LIBRA
Jan. 19
10°
E
Time is approx. 2am. On Jan. 18 the Moon and Mars are 4.5° apart.
Mars rises around midnight.


EVENING SKY- Jan. 10 to 12
SEXTANS
HYDRA
Regulus
Jan. 12
LEO
(The Sickle)
Jan. 11
Moon
NE
CANCER
LEO MINOR
Jan. 10
Praesepe (M44)
"Beehive Cluster"
LYNX
GEMINI
Pollux
Castor
10°
Time is approx. 11pm. On Jan. 12 the Moon and Regulus are 4.8° apart.
The Twins of Gemini are rising around 8pm.


EVENING TWILIGHT - Jan. 27 to 29
CETUS
SCULPTOR
Fomalhaut
Jan. 29
AQUARIUS
Venus
Jan. 28
PISCIS
AUSTRINUS
Moon
Jan. 27
PISCES
Jan. 26
10°
Mercury
CAPRICORNUS
W
Difficult, only 30 mins. after sunset. On Jan. 26 the Moon and Mercury are
separated by 3.2°. Jan. 28 sees the Moon and Venus 6.5° apart

FEBRUARY

RISE/SET CHART



All times are WAST.

FEBRUARY HIGHLIGHTS

- Mercury favourable for morning observation in late February
- Venus at greatest brilliancy
- Mars and Antares close
- Mars and Beta Scorpii close
- Saturn very close to the Moon

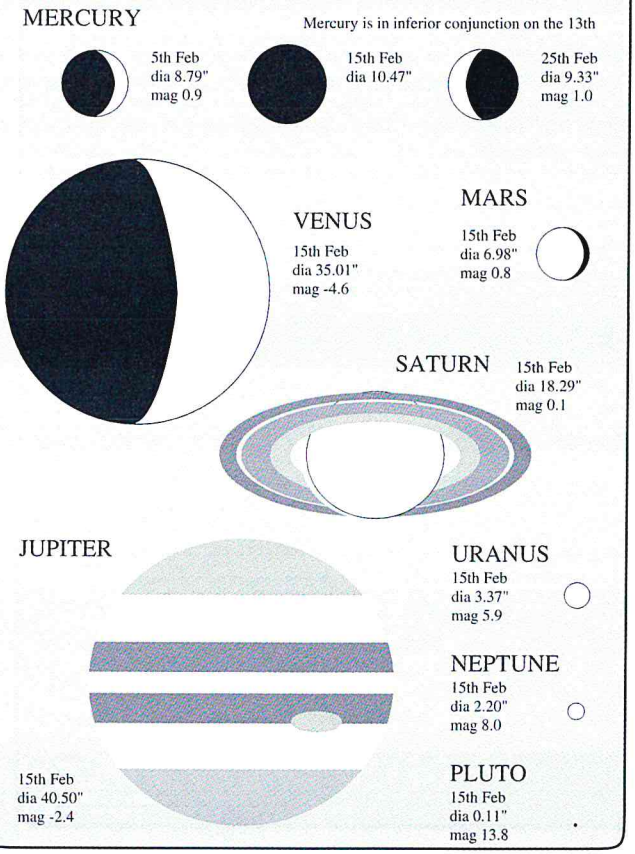
THE MOON

2nd	First Quarter
8th	Moon at perigee (closest to Earth – 356,852 km distant, angular size 33.1°)
8th	Full Moon
15th	Last Quarter
18th	Occultation of minor planet Ceres by the Moon, visible from Africa, Spain, India
21st	Moon at apogee (furthest from Earth – 406,332 km distant, angular size 29.8°)
23rd	New Moon
25th	Occultation of minor planet Vesta by the Moon, visible from Central America
26th	Occultation of minor planet Juno by the Moon, visible from South Atlantic Ocean

THE PLANETS

MERCURY is in inferior conjunction (between Earth and the Sun) on the 13th, and thereafter moves into the morning sky. From late this month through to early April, Mercury will be at its most favourable

APPEARANCE of the PLANETS



position this year for morning observation. Throughout the month Mercury moves from Aquarius into Capricornus, back to Aquarius before finally returning to Capricornus. On the 22nd, the thin crescent Moon will be 5.7° south of the planet (see Sky View).

VENUS is low in the western evening sky. It attains its greatest brilliancy this month at –4.6 magnitude, outshining the brightest star Sirius (Alpha Canis Majoris) by a factor of 12. Interestingly, the planet is so bright that it can cast a perceptible shadow, which is only visible under good dark skies away from city lights. Not a lot happens to Venus this month. It remains in the constellation of Pisces. The 3 day old thin crescent Moon appears 10° south of the planet on the 26th (see Sky View).

MARS rises around 11.30pm mid-month. It spends three weeks in Libra, before crossing over into Scorpius on its journey to the rich galactic regions of Ophiuchus and Sagittarius. On the 15th, the Last Quarter Moon is 10° from Mars, and closer at 4.7° on the following night (see Sky View). On the 21st and 22nd, the planet is located very close to, and in the same lower power telescope field as the 2.6 magnitude star Beta Scorpii (Graffias). Beta is considered one of the better bright double stars for small instruments and will make for a pleasant field with the Red Planet. By month's end, Mars will be within 6° of the 1st magnitude star Antares (Alpha Scorpii). The name Antares came from the ancient Greek 'Anti Ares' or 'rival to Mars' (Ares was the Greek God of War). When the pair happen to be close in the sky it is easy to see where 'rival to Mars' comes from, the two being very similar in colour and not easy to distinguish. Mars, at magnitude 0.6, is the brighter at this time.

JUPITER is prominent in the northwestern evening sky, situated 5° above the Pleiades in Taurus. The Pleiades, or Seven Sisters, is an open star cluster with about 300 members, of which 6 or 7 are visible to the unaided eye. The Moon, just past First Quarter, appears 6.5° from the planet on the 2nd (see Sky View), although on this evening the attention will be on Saturn's proximity to our natural satellite. On the following evening Jupiter will be equidistant from both the Moon and Saturn.

SATURN is situated 7° south of Jupiter in the western evening sky this month. Since their close conjunction last June, the two giant planets of our Solar System have been gradually drifting apart. By December, the separation will increase to over 30°. The next time the pair will appear close together is in December 2020, when Jupiter again overtakes the slower moving Saturn. On the 2nd, the 8 day old Moon will be a close 1.4° from the ringed planet (see Sky View).

URANUS is in conjunction on the 9th, then moves to the west of the Sun and into the morning sky.

AN AUSTRALIAN DISCOVERING COMETS THROUGH THE INTERNET

With the advent of today's technology the amateur astronomer's contributions no longer have to be generated at the eyepiece of a telescope or by guiding a telescope while a photographic film absorbs precious photons from the night sky. Queensland amateur Terry Lovejoy has made his mark on the scientific world by working with professional images off the Internet. This work is free from the worries of cloudy skies and you can do this work any time of the day or night! Here is Terry's story as told by him.

"My late grandmother would often recount how her family was shown Halley's Comet in 1910 by a local astronomer and how spectacular the comet looked. My interest in astronomy, particularly comets, I think came from this. My first amateur observations began about September 1977, at the age of 10. After attending an astro-night at the Sutherland Astronomical Society, in southern Sydney, I was well and truly hooked. By late 1978 I had a 20cm reflector, foregoing a trail bike in exchange!

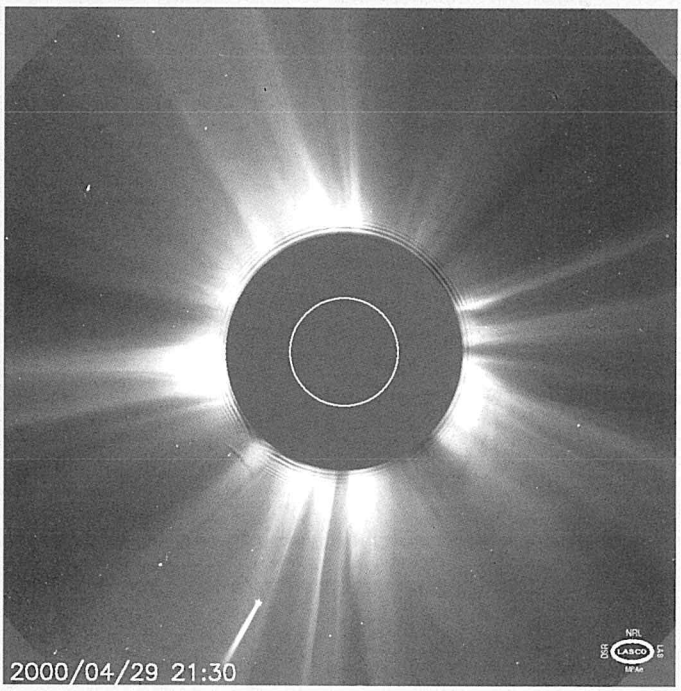
"Since then I have visually observed every planet (including Pluto), many deep-sky objects and countless comets. Several years ago I designed and built a CCD camera from which a number of images were published. I now no longer use this device, having returned to using conventional film (for its wide field of view and simplicity!).

"More recently, I have made a number of comet discoveries using SOHO's LASCO C3 camera. The C3 camera is a chronographic camera with a 16° field of view centred on the Sun and can image objects as faint as magnitude 10. Unfortunately, none of these comets could be seen from the ground although one of them reached magnitude 1 and developed a bright tail when it was near the Sun. To discover these comets I use real time images downloaded from the web which can be found on SOHO's LASCO site (see below). Generally, I download 2 or 3 images from exposures spaced 30-60 minutes apart and create a movie of them using readily available 'GIF animation' software. Suspect comets will be seen to clearly move against the starfield. If I suspect a comet, I will download more images to confirm this. The rule is that a suspect comet should be confirmed on at least 5 exposures before being reported. The SOHO site is at http://lasco-www.nrl.navy.mil/lasco.html



Terry is from Brisbane and works as a computer and network support person.

"So far I have discovered 9 comets using SOHO - these have been officially designated as: C/1999 O1, C/1999 O3, C/1999 Q1, C/1999 R1, C/1999 R4, C/2000 B6, C/2000 B7, C/2000 C6, C/2000 H2. Other amateurs are also discovering comets using images from SOHO."



LASCO image showing Terry's latest find (as of July 2000) Comet C/2000 H2, seen here just above the time (lower left).

What are SOHO and LASCO?

SOHO stands for Solar and Heliospheric Observatory. This is a spacecraft, launched in December 1995, that has been studying the Sun with a number of instruments. One of these is LASCO or Large Angle and Spectrometric Coronagraph. A coronagraph is a telescope designed to block out the light coming from the disc of the Sun to study the faint emissions coming from the region around the Sun called the corona. On the photograph the large black circle is the central obstruction and the white circle shows the position and size of the Sun on the scale of this photograph. LASCO is trying to address some of the fundamental questions about the corona such as how is it heated and where and how is the solar wind accelerated.

FEBRUARY

NEPTUNE, after conjunction late last month, moves into the morning sky mid-month.

PLUTO, rising around 1am in Ophiuchus, is in the early morning eastern sky.

COMETS

Comet C/1999 T1 (McNaught-Hartley) is well placed in the morning sky during most of February, spending the month in Hercules as it fades from 7th to 8th magnitude. Around mid-month, McNaught-Hartley and Comet C/1999 T2 (LINEAR) will lie very close together in the sky.

Comet C/1999 T2 (LINEAR) can be found in the morning sky during February. It spends the entire month in Hercules at a brightness of 12th magnitude. Around mid-month, it will be close to Comet C/1999 T1 (McNaught-Hartley).

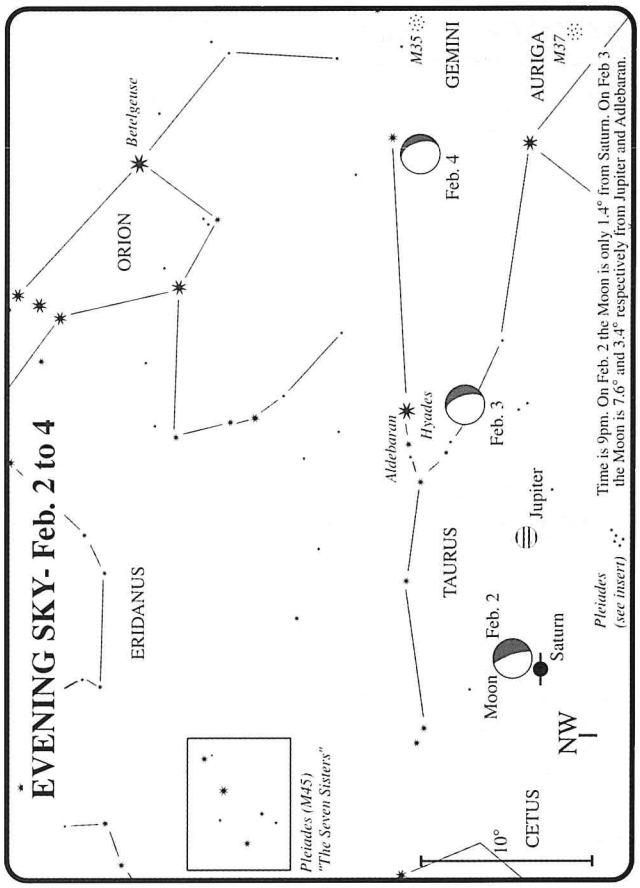
Comet 73P/Schwassmann-Wachmann 3 moves from Sagittarius into Capricornus during February. It remains a difficult comet to observe, as it isn't rising until around the beginning of morning astronomical twilight. Given that it is a newly fragmented comet, it is possible that it may be brighter than the predicted 13th magnitude.

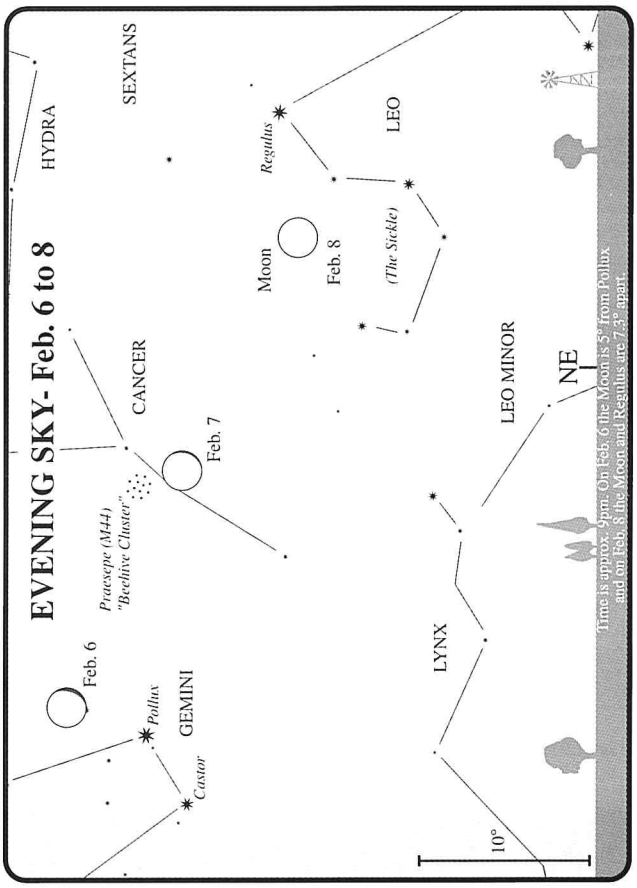
METEOR SHOWERS

The **delta-Leonids** are not well placed for southern observers, but with the radiant near the 'sickle' or 'head' of Leo, it will be above the northern horizon for a few hours late evening and early morning. With predominately faint meteors this shower is considered a minor one, active from 15th February to 10th March, with maximum on the 25th. A low zenith hourly rate of around 2 can be expected.

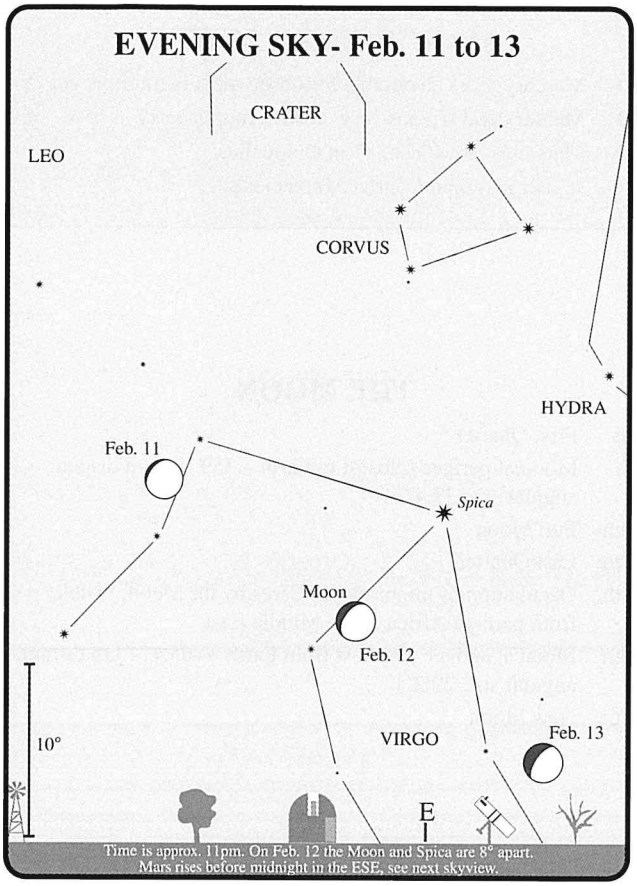
DIARY OF EVENTS

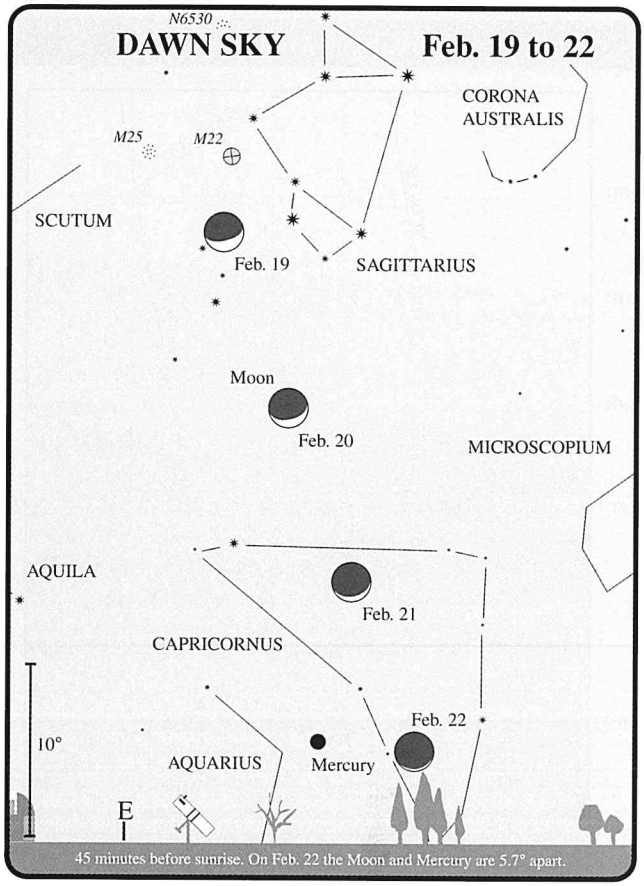
1st		Mercury at perihelion
1st	10:02 PM	First Quarter Moon
2nd	6 PM	Saturn 2° N of Moon
3rd	6 AM	Jupiter 3° N of Moon
3rd	8 PM	Mercury stationary
7th		m.p. 1 Ceres 0.4°NE of Trifid Neb. (M20) in Sagittarius
8th		m.p. 1 Ceres 0.2°S of M21 (OC) in Sagittarius
8th	6 AM	Moon at perigee
8th	3:12 PM	Full Moon
9th	8 PM	Uranus in conjunction with the Sun
10th		Comet 1999T1 McNaught-Hartley 0.7°SE of NGC 6210 (PN) in Hercules
10th		m.p. 1 Ceres 0.5°N of NGC 6546 (OC) in Sagittarius
11th		Mercury at greatest latitude North
13th	8 AM	Mercury in inferior conjunction
15th		m.p. 1 Ceres 0.8°S of NGC 6583 (OC) in Sagittarius
15th	11:23 AM	Last Quarter Moon
15th	6 PM	Mars 3° S of Moon
18th	3 PM	Ceres 0.5° S of Moon; occultation
20th		Neptune 1°S of m.p. 19 Fortuna
21st	6 AM	Moon at apogee
21st	7 AM	Neptune 2° N of Moon
22nd		m.p. 1 Ceres 0.2°NE of NGC 6629 (PN) in Sagittarius
22nd		Venus at perihelion
21st	Midnight	Mercury 6° N of Moon
22nd	1 AM	Mars 0.1°W of star Beta Scorpii
22nd	9 AM	Venus greatest brilliancy
23rd	4:21 PM	New Moon
25th	3 AM	Vesta 0.2° S of Moon; occultation
25th	10 AM	Mercury stationary
26th		m.p. 1 Ceres 0.4°N of NGC 6642 (GC) in Sagittarius
26th	1 AM	Juno 1.0° N of Moon; occultation
26th	4 PM	Venus 11° N of Moon

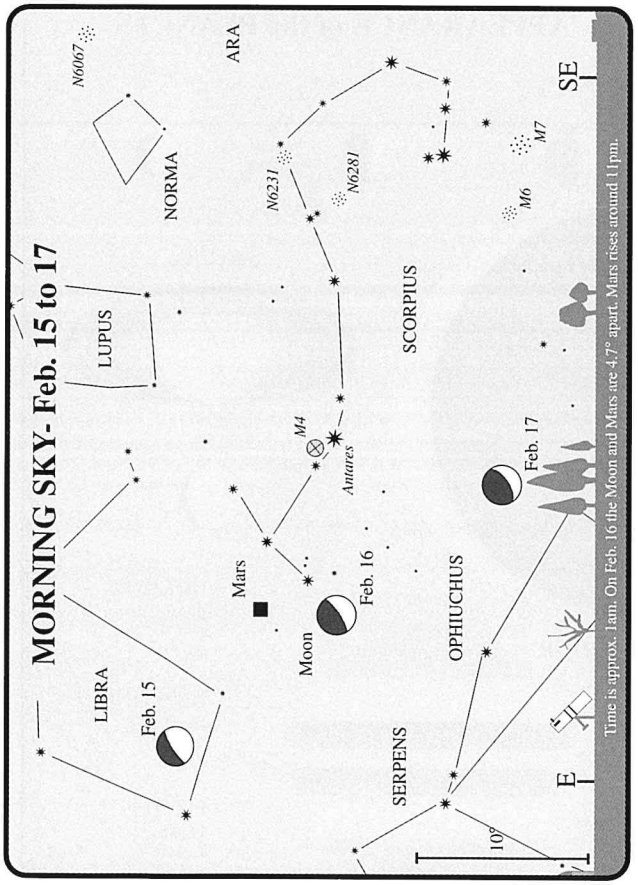


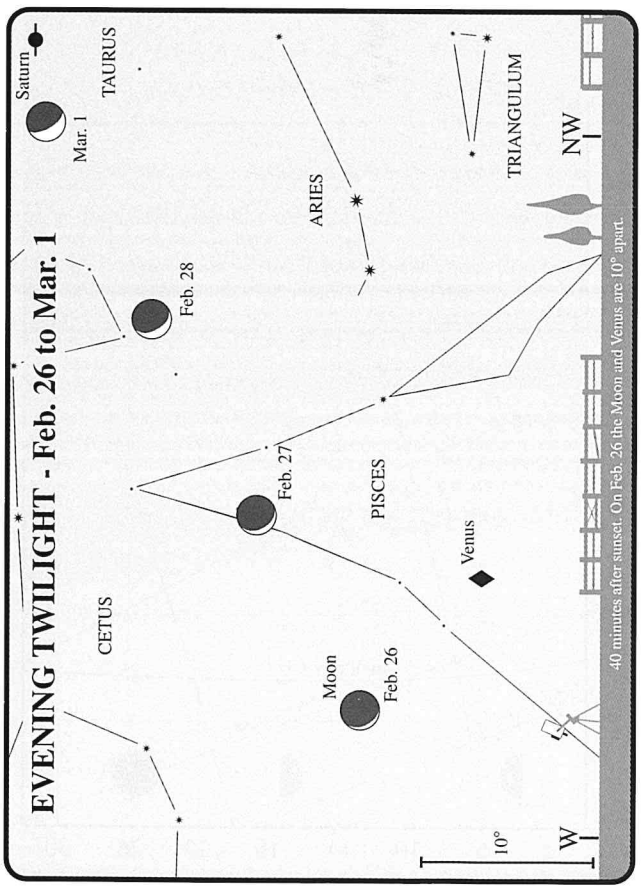


FEBRUARY


EVENING SKY- Feb. 11 to 13
CRATER
LEO
CORVUS
HYDRA
Feb. 11
Spica
Moon
Feb. 12
10°
VIRGO
Feb. 13
E
Time is approx. 11pm. On Feb. 12 the Moon and Spica are 8° apart.
Mars rises before midnight in the ESE, see next skyview.

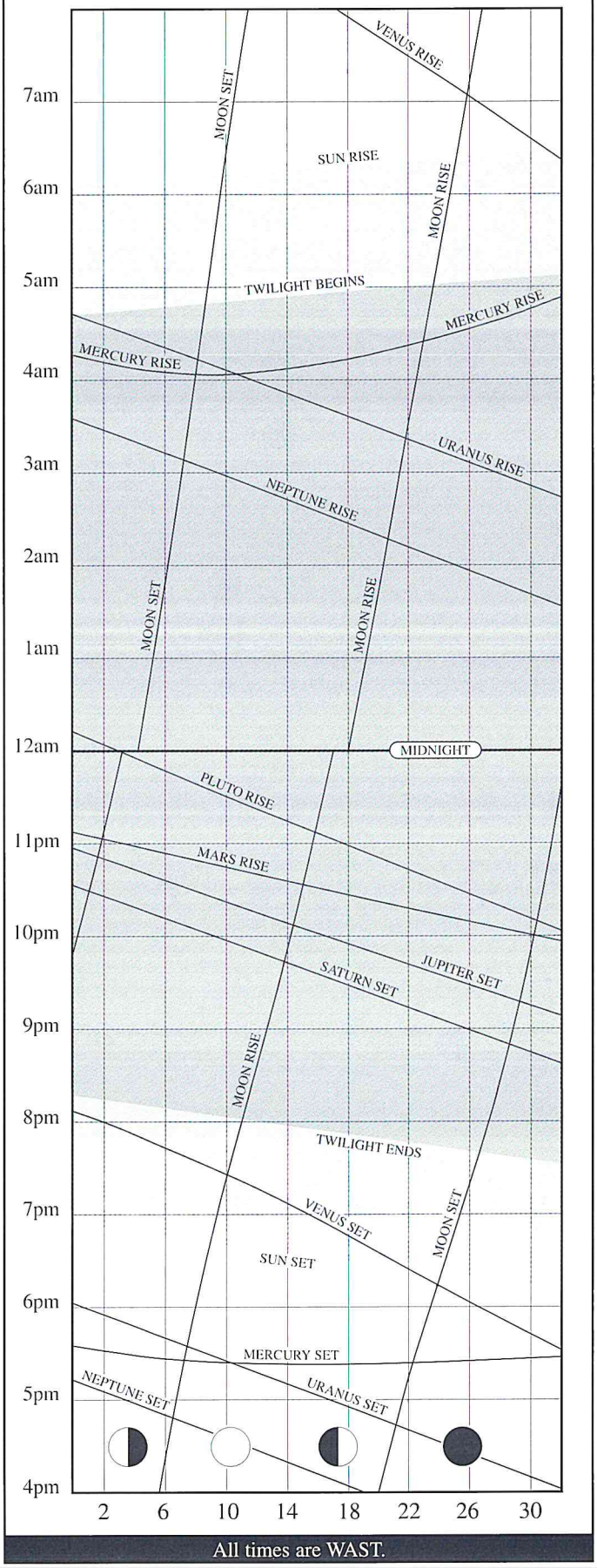

N6530
DAWN SKY
Feb. 19 to 22
CORONA AUSTRALIS
M25
M22
SCUTUM
Feb. 19
SAGITTARIUS
Moon
Feb. 20
MICROSCOPIUM
AQUILA
Feb. 21
CAPRICORNUS
10°
Feb. 22
AQUARIUS
Mercury
E
45 minutes before sunrise. On Feb. 22 the Moon and Mercury are 5.7° apart.


MORNING SKY- Feb. 15 to 17
N6067
ARA
NORMA
LUPUS
N6231
N6281
M7
M6
SE
SCORPIUS
M4
Antares
Feb. 17
Mars
Feb. 16
Moon
OPHIUCHUS
LIBRA
Feb. 15
SERPENS
10°
E
Time is approx. 1am. On Feb. 16 the Moon and Mars are 4.7° apart. Mars rises around 11pm.


EVENING TWILIGHT - Feb. 26 to Mar. 1
Saturn
Mar. 1
TAURUS
ARIES
TRIANGULUM
NW
Feb. 28
Feb. 27
PISCES
Venus
CETUS
Moon
Feb. 26
10°
W
40 minutes after sunset. On Feb. 26 the Moon and Venus are 10° apart.

MARCH

RISE/SET CHART



All times are WAST.

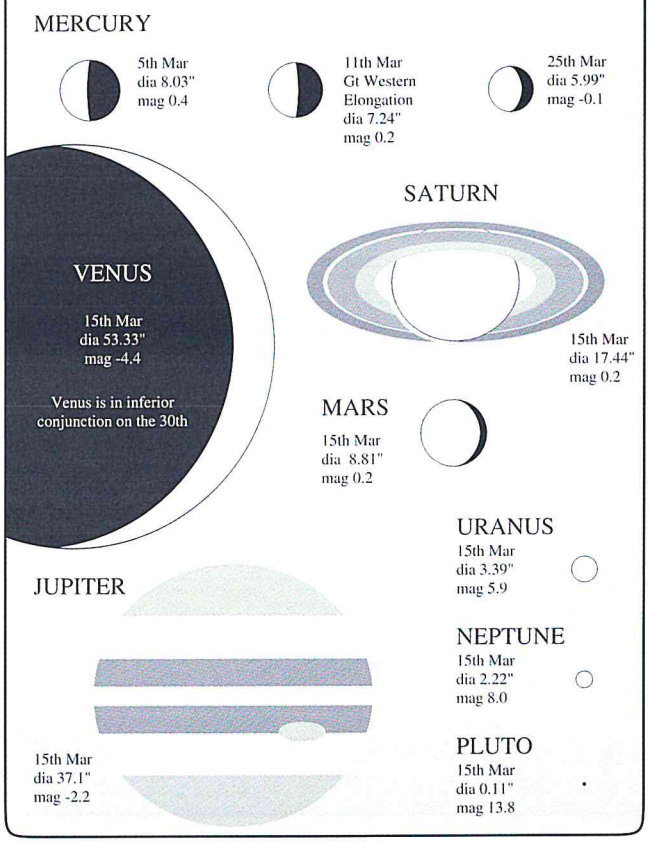
MARCH HIGHLIGHTS

- Mercury most favourable for observation in morning sky
- Mercury and Uranus very close in morning sky
- Mars close to NGC6287 in Ophiuchus
- Jupiter and First Quarter Moon close

THE MOON

3rd	First Quarter
8th	Moon at perigee (closest to Earth – 359,775 km distant, angular size 33.4°)
10th	Full Moon
17th	Last Quarter
18th	Occultation of minor planet Ceres by the Moon, visible from parts of Africa & the Middle East
20th	Moon at apogee (furthest from Earth – 405,474 km distant, angular size 29.2°)
25th	New Moon

APPEARANCE of the PLANETS



THE PLANETS

MERCURY will be at its most favourable position this month for morning observation, reaching its greatest western elongation from the Sun on the 11th (27.5°). Mercury has a close encounter with distant Solar System member Uranus this month. On the 10th, the pair will be 0.6° apart, and on the following morning a little closer at 0.3° (you will probably need binoculars to see Uranus). The 27-day thin crescent Moon appears 2.4° south of Mercury on the 23rd (see Sky View). The planet spends the first half of March in Capricornus, before moving into Aquarius.

VENUS, in Pisces, is lost as the Evening Star this month as it moves toward the Sun and inferior conjunction (between the Earth and the Sun) on the 30th. The planet, thereafter, will become the Morning Star and remain so until early next year when it returns to the evening twilight.

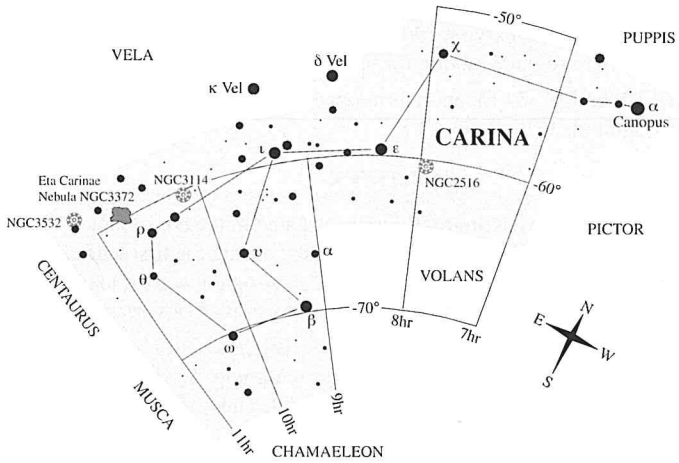
The **EARTH** is at Vernal Equinox on the 20th. The Sun is directly above the equator and day and night are equal.

MARS, rising around 10.30pm (mid-month), spends the first half of March in Ophiuchus within 6° of the 1st magnitude star Antares (Alpha Scorpii). On the 15th, the 21-day old gibbous Moon appears 3.3° from Mars, the pair forming a triangle with Antares (see Sky View). Between the 23rd and 25th the Red Planet will be located within 0.5° of the globular star cluster NGC6287. With opposition three months away, the planet has now reached that part of its orbit known as quadrature, when the Sun-Earth-Mars angle is 90° (see diagram page 6). Telescopically at this time the Martian disc appears

CONSTELLATION of the MONTH — CARINA (Car)

Carina was originally part of a larger constellation named Argo Navis, the Argonaut's ship from Greek mythology. For convenience Argo Navis was subdivided into the smaller constellations, Carina the Keel, Puppis the Stern and Vela the Sail. See also page 25 to read more about Argo Navis.

Culminating at 9pm mid-March in the south, Carina offers some of the best southern objects for binoculars and small telescopes. Open star clusters NGC2516, NGC3114 and NGC3532 are real gems in small apertures, as is the nebulosity known as the Keyhole Nebula (NGC3372) surrounding the remarkable star Eta Carinae. This is only a small sampling of the many objects in this region; a host of other clusters and superb double stars await the observer.



The Eta Carinae Nebula is gigantic, measuring some 300 light years across. This is about twenty times the size of the Great Nebula in Orion. The true immensity of the Eta Carinae Nebula becomes apparent when we learn that it lies about 9,000 light years from us yet still manages to span 2° of the sky (the Great Nebula in Orion, at 1500 light years, covers about 1°). The nebula is situated in a superb rich region of the southern Milky Way, and is visible to the unaided eye from dark skies.

Binoculars reveal three wedge shaped areas of nebulosity, separated by opaque dust lanes. Telescopes at low magnification 'sweeping' the region will uncover double stars, clusters, dark and light nebulae, all combining to make this an area of beauty and complexity with few equals. Sir John Herschel commented in the 1830s: 'Nor is it easy for language to convey a full impression of the beauty and sublimity of the spectacle it offers when viewed in a sweep, ushered in as it is by so glorious and innumerable a procession of stars, to which it forms a sort of climax, justifying expressions which, though I find them written in my journal in the excitement of the moment would be thought extravagant if transferred to these pages.' An apt description of this southern showpiece.

Within the brightest portion of the nebula is the remarkable orange star Eta Carinae. In 1677 Eta was recorded as 4th magnitude, since then the star has undergone some spectacular variations in brightness. In 1843 it was the second brightest star in the sky at -0.8 magnitude and today, after many fluctuations over the years, is around 6th magnitude. Eta is embedded in a tiny nebula known as the Homunculus and so never looks quite focused in the telescope.

Many people incorrectly call the Eta Carinae Nebula the 'Keyhole Nebula', however this name refers to a small dark region near the star Eta. Herschel's drawings in the 1830s indeed show a definite old fashioned keyhole shape, but since fading Eta no longer illuminates the near side of the keyhole and the original shape is now lost.

Carina's brightest star, Canopus (Alpha Carinae), at -0.7 magnitude is the second brightest star in the heavens. Aptly named after the pilot of the fleet of the Greek king Menelaus, Canopus is often used for spacecraft navigation. Midway between Canopus and the Southern Cross (Crux) is a group of four stars, which is sometimes confused with the real cross. Known as the False Cross it is larger and not as prominent as the real Crux. Two of the stars that form the False Cross are actually in the constellation of Vela.



Star Eta Carina and keyhole nebula. Exposure was 20 seconds on an SBIG ST7 CCD camera through a Celestron C11 telescope by Robert Price.

MARCH

distinctly gibbous (egg shaped), with the Sun illuminating only 89% of the disk.

JUPITER, setting in the western mid-evening sky, spends the month between the open star clusters the Pleiades and the Hyades. On the 2nd, the First Quarter Moon will be located 2° above Jupiter (see Sky View). On the 29th the 4-day old Moon is 7° from Jupiter, and on the following evening the Moon, Jupiter and the 1st magnitude star Aldebaran (Alpha Tauri) form a neat triangle (see Sky View).

SATURN is in the early NW evening sky with Jupiter. In March it has two visitations from the crescent Moon. On the 1st the 6-day old Moon is 4.5° from the ringed planet (see Sky View), and on the 29th, closer at 3° (see Sky View).

URANUS, rising in the late morning sky in Capricornus, has a close approach with Mercury. The pair begins the month a little over 6° apart and by the 11th will be a close 0.3° from each other.

NEPTUNE, rising in the morning sky about an hour ahead of Uranus, spends an uneventful month in Capricornus.

PLUTO now rises before midnight. This month it shares Ophiuchus with Mars and is stationary on the 19th (as viewed from Earth). Pluto will then be in retrograde motion for the coming five months.

MINOR PLANET 354 Eleonora is at opposition this month on the 16th at magnitude 9.7 in Leo.

COMETS

Comet C/1999 T1 (McNaught-Hartley), located in the constellation of Hercules, is low in the northern morning sky during the first half of March as it fades from 8th to 9th magnitude. During the second half of March, it falls below the horizon for many Australian observers.

Comet C/1999 T2 (LINEAR), maintaining a brightness of about 12th magnitude, can be found in the northern morning sky during March. During the month, it moves from Hercules into neighbouring Corona Borealis.

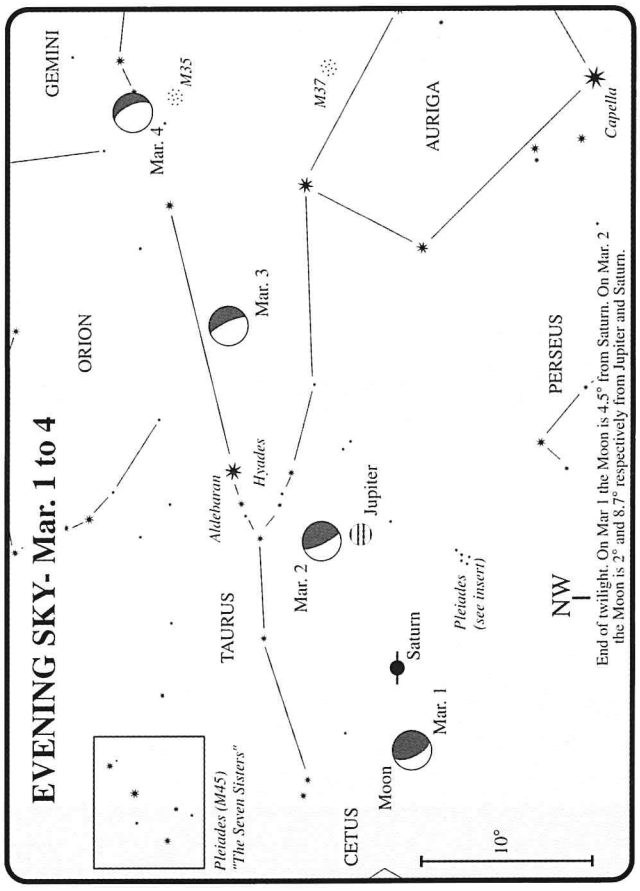
Comet 24P/Schaumasse brightens from 13th to 11th magnitude as it slowly moves north in the western evening sky. By mid-month, Schaumasse crosses over from Aries into Taurus, where it spends the rest of the month, passing close to the Pleiades around the 20th.

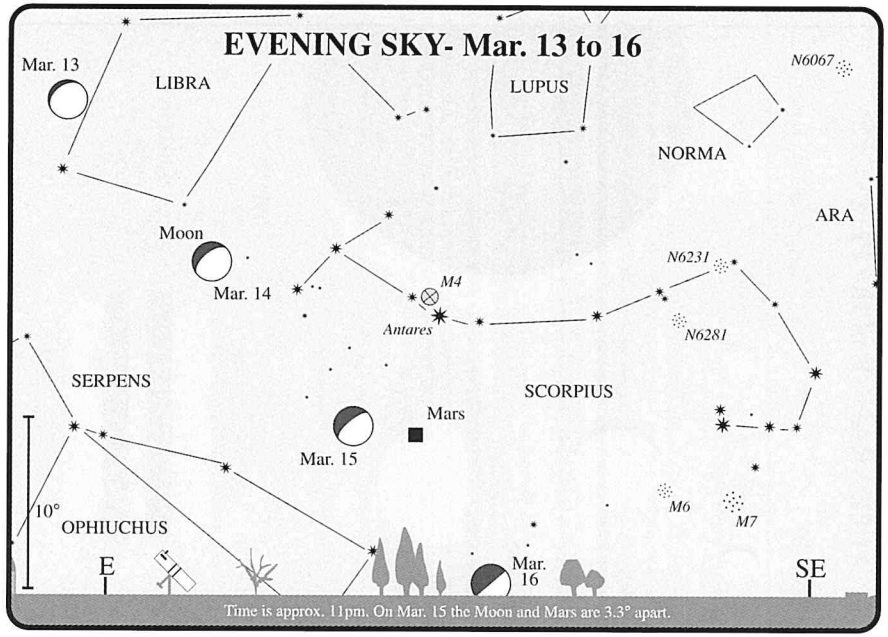
METEOR SHOWERS

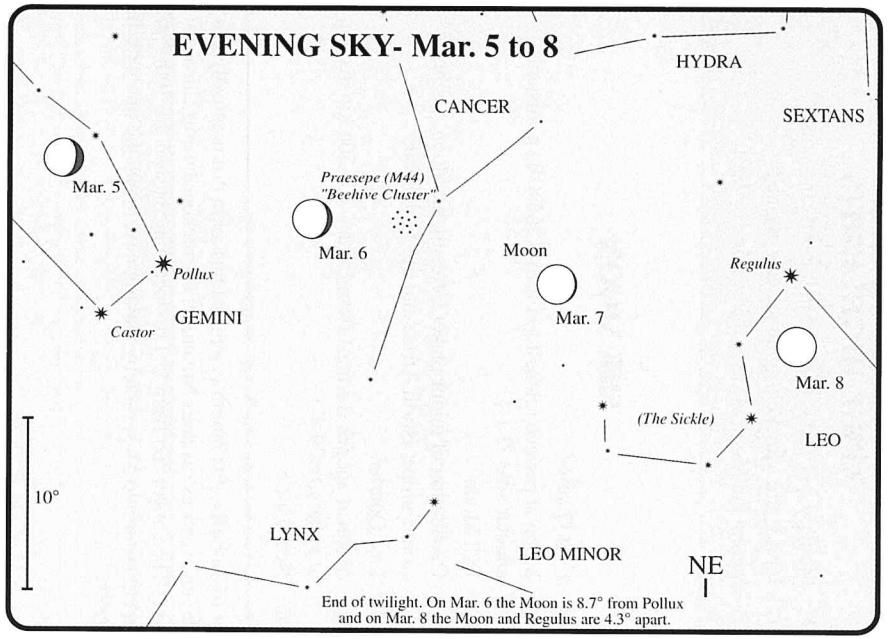
The **Virginids** are active from 25th January through to 15th April, with several peaks of maximum activity over the period. The radiant is near 1st magnitude Alpha Virginis (Spica), and the shower is best seen from late evening and into the morning hours. A zenith hourly rate of 5 slow meteors during peaks can be expected.

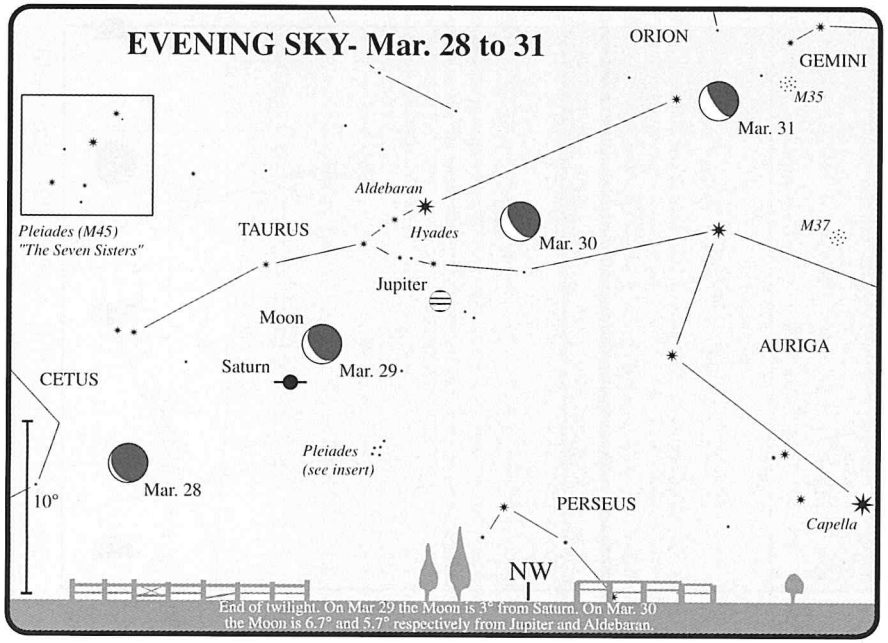
DIARY OF EVENTS

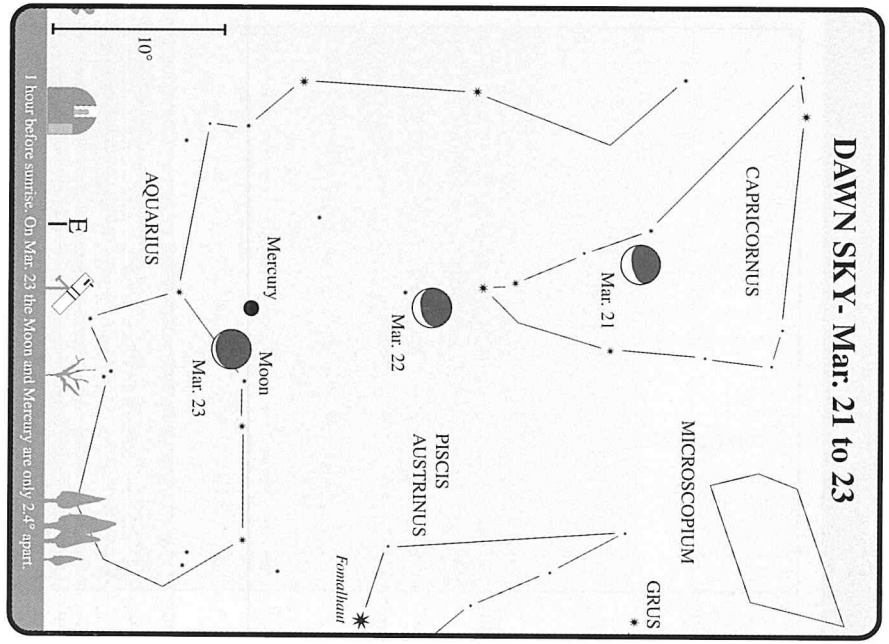
1st		m.p. 1 Ceres 0.7°N of M22 (GC) in Sagittarius
2nd	2 AM	Saturn 2° N of Moon
2nd	5 PM	Jupiter 3° N of Moon
3rd	10:03 AM	First Quarter Moon
4th	10 PM	Mars 5°N of Antares
7th		Mercury at descending node
7th	7 PM	Venus stationary
8th	5 PM	Moon at perigee
10th		m.p. 39 Laetitia 0.3°W of m.p. 89 Julia
10th	1:23 AM	Full Moon
10th	7 PM	Mercury 0.1° N of Uranus
11th	2 PM	Mercury greatest elongation West (27°)
11th	8 PM	m.p. 29 Amphitrite 0.5°S of Spica
11th	10 PM	m.p. 14 Irene 1°N of M9 (GC) in Ophiuchus
15th	10 PM	m.p. 14 Irene 0.1°N of NGC 6356 (GC) in Ophiuchus
16th		Venus at greatest latitude North
16th	5 AM	Mars 1.8° S of Moon
16th	9 PM	Mars 0.3°NW of NGC 6235 (GC) in Ophiuchus
17th		Mercury at aphelion
17th	4:45 AM	Last Quarter Moon
17th	7 PM	m.p. 6 Hebe 0.4°NE of NGC 4762 (SG) in Virgo
18th	3 PM	Ceres 0.5° S of Moon; occultation
19th	6 AM	Pluto stationary
20th	4 PM	Neptune 2° N of Moon
20th	7 PM	Moon at apogee
20th	10 PM	Equinox
21st		m.p. 10 Hygiea 0.1°N of m.p. 19 Fortuna
21st	10 PM	Uranus 3° N of Moon
23rd		Comet 24P/Schaumasse 0.7°SE of centre of Pleiades (OC) in Taurus
23rd	2 AM	Mercury 2° N of Moon
23rd	9 PM	Mars 0.4°N of NGC 6287 (GC) in Ophiuchus
25th	9:21 AM	New Moon
27th	3 PM	Vesta in conjunction with the Sun
29th	Noon	Saturn 1.7° N of Moon
29th	7 PM	m.p. 6 Hebe 0.2°NE of NGC 4654 (SG) in Virgo
30th		Mercury 0.2°SE of NGC 7596 (SG) in Aquarius
30th	5 AM	Jupiter 2° N of Moon
30th	Noon	Venus in inferior conjunction




EVENING SKY- Mar. 13 to 16
Mar. 13
LIBRA
LUPUS
N6067
NORMA
ARA
Moon
Mar. 14
M4
N6231
Antares
N6281
SERPENS
SCORPIUS
Mars
Mar. 15
M6
M7
10°
OPHIUCHUS
E
Mar. 16
SE
Time is approx. 11pm. On Mar. 15 the Moon and Mars are 3.3° apart.

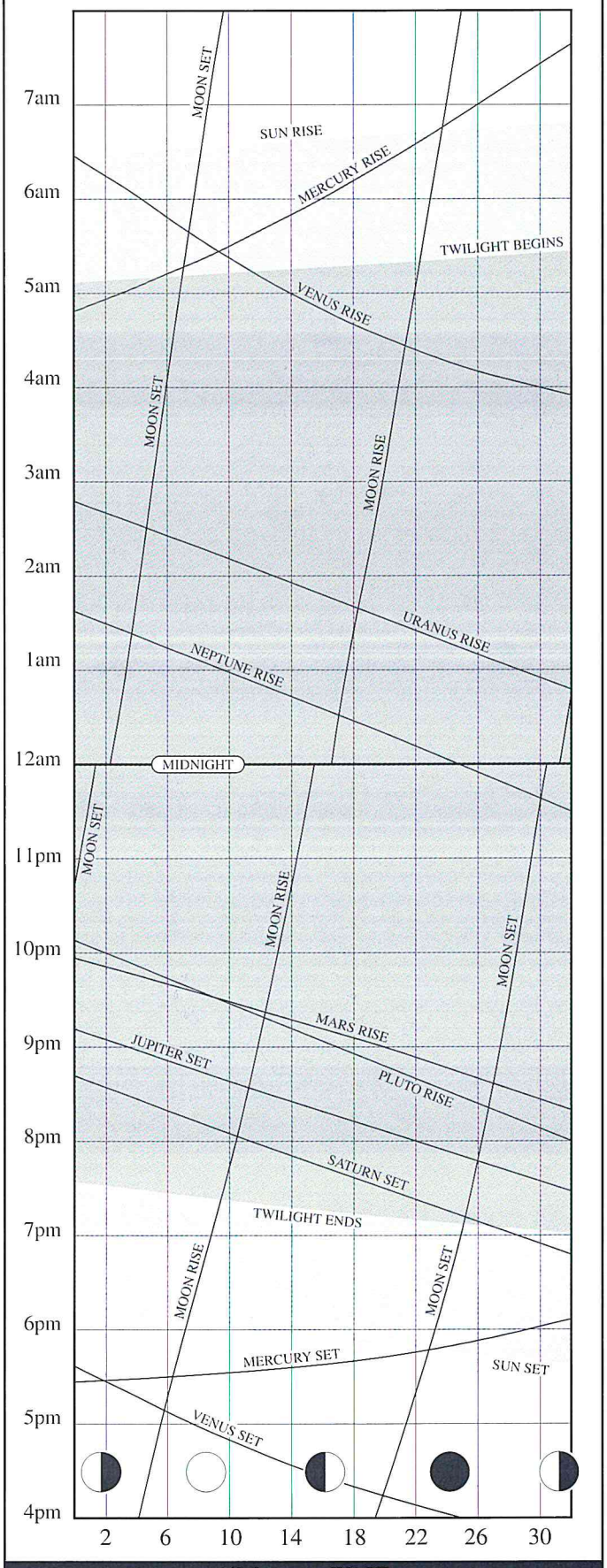

EVENING SKY- Mar. 5 to 8
HYDRA
CANCER
SEXTANS
Mar. 5
Praesepe (M44)
"Beehive Cluster"
Mar. 6
Moon
Mar. 7
Regulus
Pollux
Castor
GEMINI
Mar. 8
(The Sickle)
LEO
10°
LYNX
LEO MINOR
NE
End of twilight. On Mar. 6 the Moon is 8.7° from Pollux
and on Mar. 8 the Moon and Regulus are 4.3° apart.


EVENING SKY- Mar. 28 to 31
ORION
GEMINI
M35
Mar. 31
Aldebaran
Pleiades (M45)
"The Seven Sisters"
TAURUS
Hyades
Mar. 30
M37
Jupiter
Moon
Saturn
Mar. 29
AURIGA
CETUS
Pleiades
(see insert)
10°
Mar. 28
PERSEUS
Capella
NW
End of twilight. On Mar 29 the Moon is 3° from Saturn. On Mar. 30
the Moon is 6.7° and 5.7° respectively from Jupiter and Aldebaran.


DAWN SKY- Mar. 21 to 23
10°
1 hour before sunrise. On Mar. 23 the Moon and Mercury are only 2.4° apart.
AQUARIUS
E
Mercury
Moon
Mar. 23
Mar. 22
Mar. 21
CAPRICORNUS
PISCIS
AUSTRINUS
MICROSCOPIUM
Fomalhaut
GRUS

APRIL

RISE/SET CHART



All times are WAST.

APRIL HIGHLIGHTS

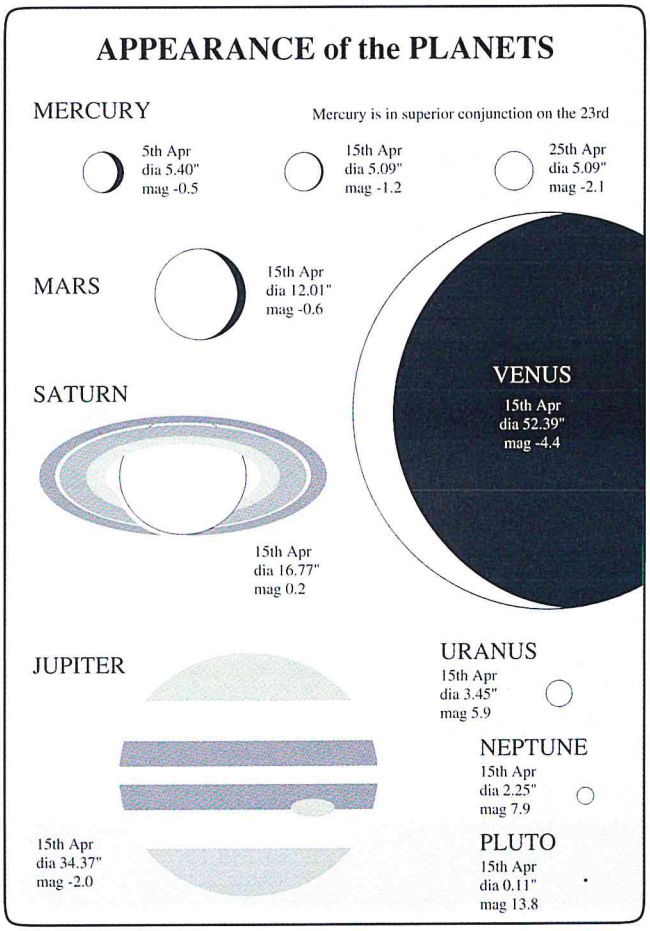
- Mercury and Venus together in the early morning
- Jupiter and Moon close in the early evening
- Saturn and Moon close in the evening twilight

THE MOON

1st	First Quarter
5th	Moon at perigee (closest to Earth – 364,810 km distant, angular size 33.1°)
8th	Full Moon
15th	Occultation of minor planet Ceres by the Moon, visible from Europe, North Africa and the Middle East
16th	Last Quarter
17th	Moon at apogee (furthest from Earth – 404,506 km distant, angular size 29.4°)
24th	New Moon

For trivia buffs, this month is a little unusual in that it actually has five lunar phases (as does November) as reckoned using Universal Time. The conversion from U.T. to local time pushed the 30th April First Quarter into May, thereby making next month the one with five phases.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is visible in the eastern morning twilight early in the month. During the later part of April the planet is too close to the Sun to observe and is at superior conjunction (opposite side of the Sun to the Earth) on the 23rd. On its journey from the morning to the evening sky, the Solar System's speedy little messenger travels through Aquarius, Pisces, Cetus and Aries. Between the 7th to 12th Mercury will be around 10° from Venus (see Sky View).

VENUS begins its term as the Morning Star in Pisces, and by month's end will be high in the eastern morning twilight. As Venus gains altitude it passes 10° north of Mercury between the 7th and 12th (see Sky View). On the 21st, the 27-day old thin crescent Moon will be 9° south of the planet (see Sky View).

MARS rises around 9pm and spends the month in the rich galactic regions of Ophiuchus and Sagittarius. On the 12th, the 19-day old Moon will be 5.7° above Mars, and on the following evening 7° below. On the 14th and 15th the planet will be within 0.5° of the 9th magnitude globular cluster NGC6401, situated near the Ophiuchus/Sagittarius border. The red planet ends the month 2.5° from the well-known nebulae, the Lagoon (M8) and the Trifid (M20). With the coming opposition in June, the planet has increased dramatically in brightness since early in the year (magnitude -1.0 by month's end).

JUPITER sets around 8pm, and remains within 6° of the 1st magnitude star Aldebaran (Alpha Tauri) throughout the month. On the 26th, the 3-day old thin crescent Moon will be 2.8° from the planet, forming a triangle with Aldebaran (see Sky View).

SATURN, setting about half-hour ahead of Jupiter, will soon be lost in the evening twilight sky as the planet moves into conjunction next month. If a good western horizon is available, the 2-day old thin crescent Moon will be 4.2° from Saturn on the 25th.

URANUS and **NEPTUNE** can be found in Capricornus in the morning sky. The 23-day old Moon approaches within 2.5° of Neptune on the 17th, and on the following day it appears 3° from Uranus.

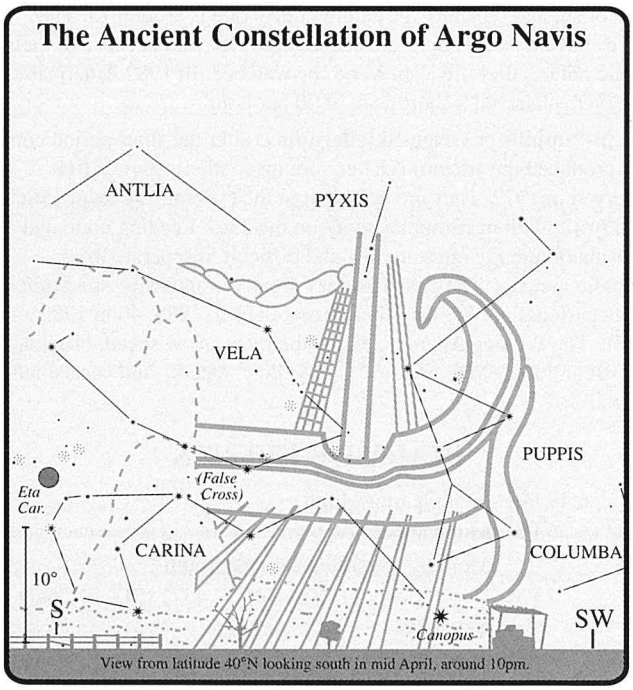
PLUTO rises in the mid-evening sky and transits the meridian around 3am.

ARGO NAVIS — The Forgotten Constellation

If you happened to visit the Northern Hemisphere this month you could see a majestic ship briefly sail across the southern horizon in the evening sky. It is the mythical ship, the Argo, used by Jason and the Argonauts to search for the Golden Fleece. When the voyage was completed, Athena, who had been the ship's protectoress, was said to have placed it in the sky. It was an impressive ship being some 70 degrees in length and composed of some 800 naked eye stars, gliding along on the Milky Way. One of these stars, Alpha Carinae or Canopus, is the second brightest star in the heavens, only outshone by the nearby Sirius (Alpha Canis Majoris). Argo is sometimes drawn with its bow missing having been lost as it passed between the Justling Rocks (or Planctae Rocks) at the mouth of the Euxine Sea. Argo Navis was one of the original 48 constellations (according to the Greeks) described by Ptolemy (73-151AD) in the Almagest. His star catalogue reflected that of Hipparchus, being only adjusted for the effects of precession since the time of Hipparchus. The writings of Ptolemy had such an influence on astronomy that Argo Navis has the distinction of being the only constellation from this work no longer in use.

Today the constellation has been subdivided into Carina the Keel, Vela the Sail and Puppis the Stern. There was also the group of stars known as Malus, the Mast, but this has fallen into disuse. It's probably just as well Argo has been broken up. From Australia we don't see a ship sitting on the horizon. Instead we see this star pattern pass overhead as a worthy prelude to the beauty of the Southern Cross, Centaurus and the rest of the Milky Way which now stretches from the eastern horizon to the zenith. This is a view not available to the Northern Hemisphere people that created these legends and put them in the sky so long ago (if you detect a bit of Southern Hemisphere bias – good, it makes a pleasant change). It is interesting to speculate how the star patterns would have been named if the ancients of Europe and the Middle East, who created the constellations, had lived in the Southern Hemisphere.

Argo Navis was certainly an enormous constellation. If you take today's constellation boundaries and look at the combined area of Carina, Vela and Puppis you get approximately 1,600 square degrees. Today, Hydra is the largest constellation in area being 1,300 square degrees but it would have come second to Argo Navis. The influence of Argo extends beyond these three constellations for we also have



Pyxis, the Ship's Compass. The nearby constellation of Columba the Dove (further west of Puppis) is also associated with the legend. As the Argonauts neared the closing rocks of the Symplegades, Jason released a dove to help the Argo pass through without being crushed. Minerva was said to have placed the dove in the sky. It is interesting that some sources claim the dove was the one released by Noah, which brought back the olive branch, which proved the waters of the great flood were receding.

Another surviving influence of Argo Navis dates back to when French astronomer Lacaille carved up this constellation back in the 1750's. Some of the stars retained their original designations hence Vela does not contain an Alpha or Beta star, both of these now lie in Carina.

APRIL

MINOR PLANETS at opposition this month include: 6 Hebe on the 1st at magnitude 9.9 in Coma Berenices, 29 Amphitrite on the 6th at magnitude 9.5 in Virgo and 532 Herculina on the 29th at magnitude 8.9 in Bootes.

COMETS

Comet C/1999 T2 (LINEAR), still at 12th magnitude, is visible for most of the night in the northern sky. It spends the month in the constellations of Corona Borealis and Bootes.

Comet 24P/Schaumasse can be found low in the northwest evening sky during April. By the middle of the month, it has moved from Taurus into Auriga, and has brightened from 11th to 10th magnitude - its peak for this return.

Comet 45P/Honda-Mrkos-Pajdusakova, having reached perihelion late last month, moves out of the solar glare into the evening sky by the end of April, setting shortly after the end of evening astronomical twilight. In late April, when it will be found in the constellation of Taurus, near Jupiter, it will be fading from 11th to 12th magnitude. On the 18th, the comet passes between Saturn and the Pleiades.

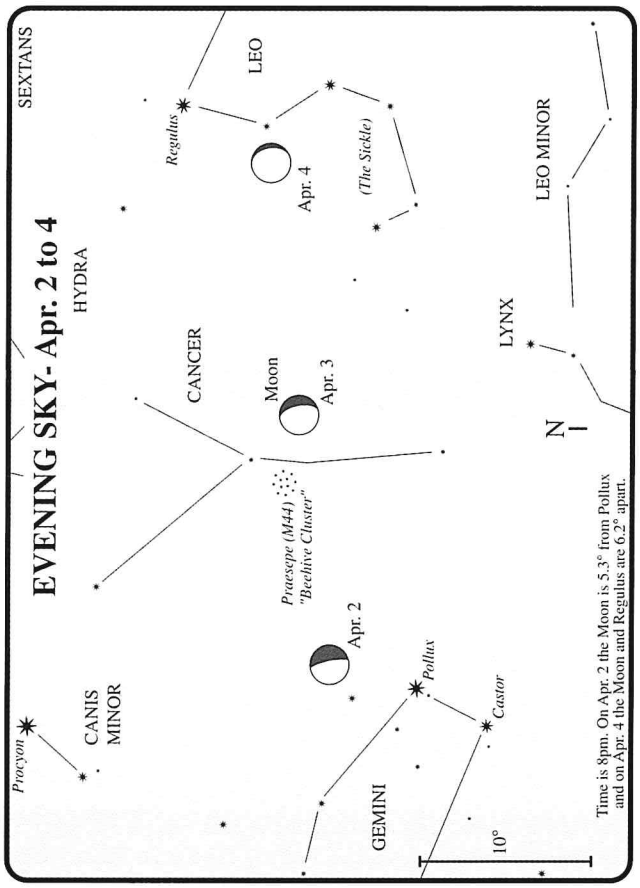
METEOR SHOWERS

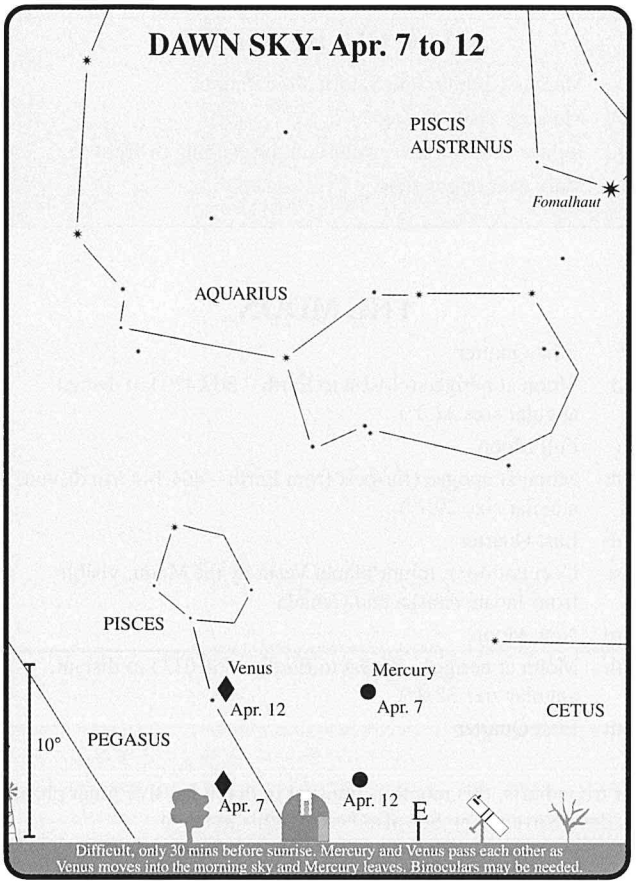
The **Lyrids** are a northern shower, but can be observed south of the equator. They are best seen from 2am to dawn from the 16th to 25th April, with maximum on the 21st. Maximum rates may only last an hour or so, and typically the zenith hourly rate is around 15. The Lyrids have on occasion produced higher rates, and because of their erratic nature, they are a shower to be watched. In 1982 American observers observed a short peak of 90 per hour.

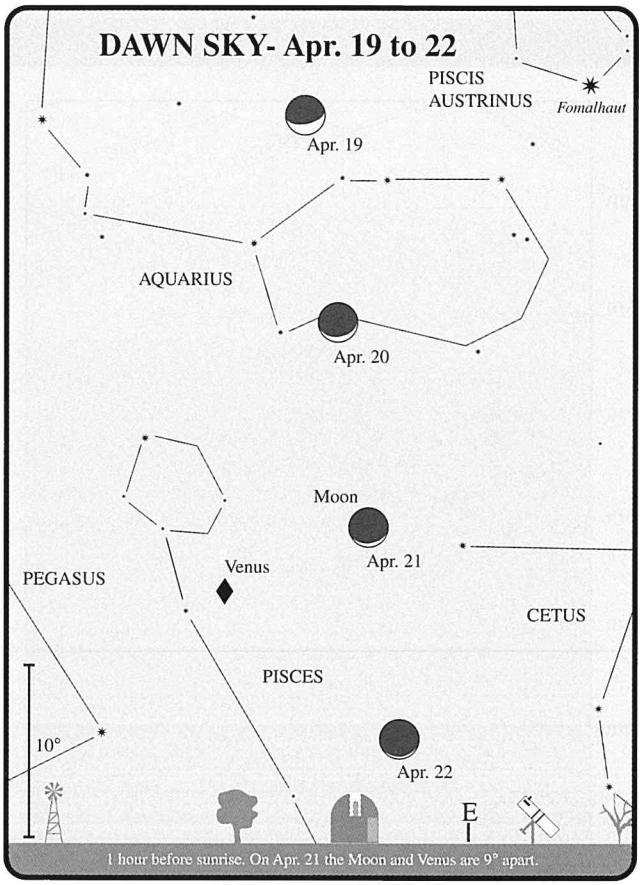
The **pi-Puppids** or **Grigg-Skjellerupids** (after the short period comet that produced the stream) is a very young southern shower first observed in 1972. They are best seen in the evening sky from 15th to 28th April, with maximum activity on the 23rd. Leading up to and after maximum the rates are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

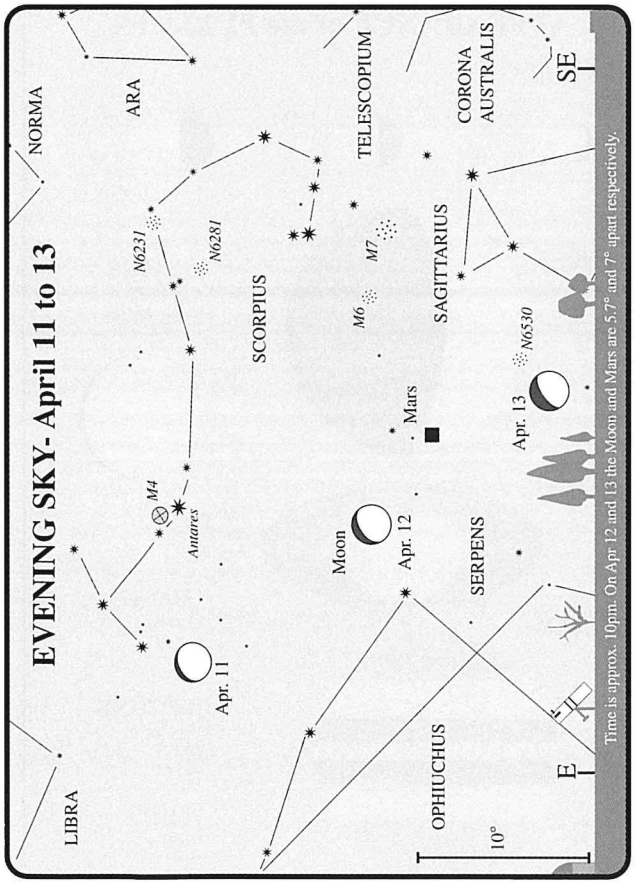
DIARY OF EVENTS

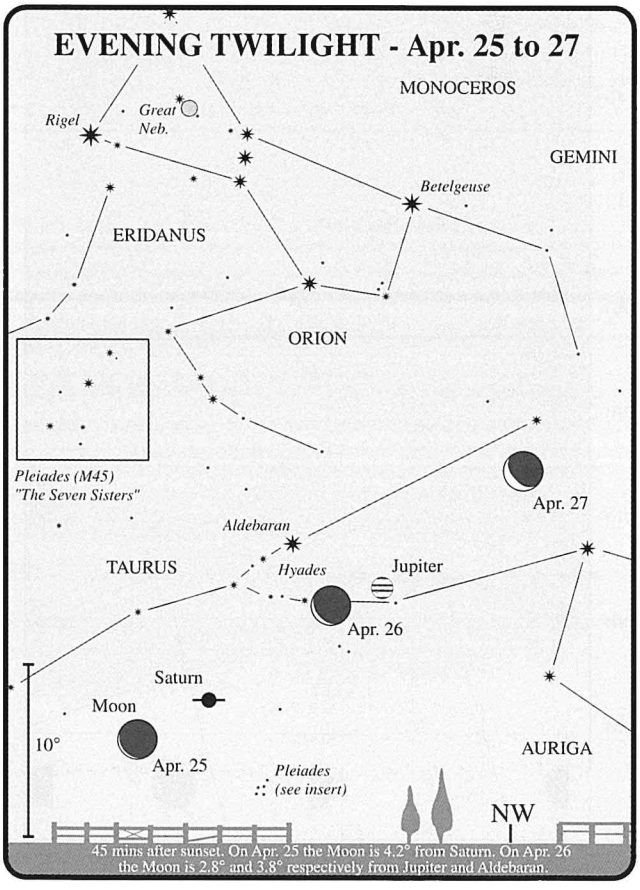
1st	6:49 PM	First Quarter Moon
5th	6 PM	Moon at perigee
6th		Mercury at greatest latitude South
6th	7 PM	m.p. 6 Hebe 0.1°NE of NGC 4571 (SG) in Coma Berenices
6th	8 PM	m.p. 29 Amphitrite 0.5°SW of NGC 4939 (SG) in Virgo
7th	5 AM	Mercury 10°S of Venus
7th	9 PM	m.p. 42 Isis 0.1°W of NGC 6356 (GC) in Ophiuchus
8th	11:22 AM	Full Moon
8th	7 PM	m.p. 6 Hebe 0.1°E of M91 (SG) in Coma Berenices
10th	10 AM	Pallas stationary
11th	7 PM	m.p. 6 Hebe 0.5°NE of M88 (SG) in Coma Berenices
12th		Mars at descending node
13th	10 AM	Mars 1.3° S of Moon
14th	7 PM	m.p. 29 Amphitrite 0.5°NE of NGC 4781 (SG) in Virgo
14th	9 PM	Mars 0.5°N of NGC 6401 (GC) in Ophiuchus
15th	Noon	Ceres 0.9° S of Moon; occultation
15th	11:31 PM	Last Quarter Moon
16th	10 PM	Jupiter 5°N of Aldebaran
16th	Midnight	Neptune 3° N of Moon
17th	2 PM	Moon at apogee
18th		Comet 45P/Honda-Mrkos-Pajdusakova 2.7°N of Saturn
18th	1 AM	Venus stationary
18th	7 AM	Uranus 3° N of Moon
19th		Comet 24P/Schaumasse 1°N of star Beta Tauri
21st	4 AM	Venus 10° N of Moon
23rd	5 PM	Mercury in superior conjunction
23rd	11:26 PM	New Moon
25th		Comet 45P/Honda-Mrkos-Pajdusakova 2°N of Jupiter
25th		Mercury at ascending node
25th	Midnight	Saturn 1.4° N of Moon
26th	7 PM	m.p. 6 Hebe 0.1°S of M100 (SG) in Coma Berenices
26th	9 PM	Jupiter 1.8° N of Moon
28th		Comet 45P/Honda-Mrkos-Pajdusakova 1°N of NGC 1746 (OC) in Taurus
30th		Mercury at perihelion
30th	10 AM	Juno in conjunction with the Sun




DAWN SKY- Apr. 7 to 12
PISCIS AUSTRINUS
Fomalhaut
AQUARIUS
PISCES
Venus
Apr. 12
Mercury
Apr. 7
CETUS
10°
PEGASUS
Apr. 7
Apr. 12
E
Difficult, only 30 mins before sunrise. Mercury and Venus pass each other as Venus moves into the morning sky and Mercury leaves. Binoculars may be needed.

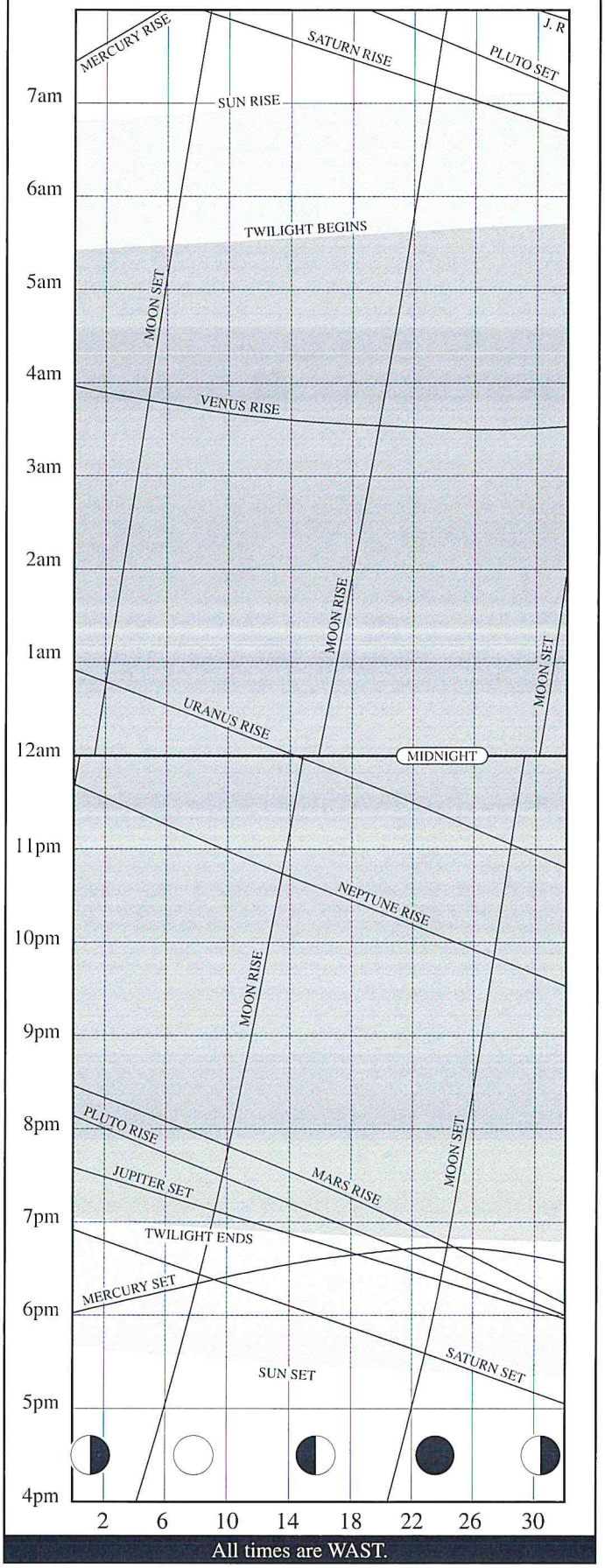

DAWN SKY- Apr. 19 to 22
PISCIS AUSTRINUS
Fomalhaut
Apr. 19
AQUARIUS
Apr. 20
Moon
Apr. 21
Venus
PEGASUS
CETUS
PISCES
10°
Apr. 22
E
1 hour before sunrise. On Apr. 21 the Moon and Venus are 9° apart.


EVENING SKY- April 11 to 13
NORMA
ARA
TELESCOPIUM
CORONA AUSTRALIS
SE
N6231
N6281
M7
SCORPIUS
SAGITTARIUS
M6
N6530
Mars
Apr. 13
M4
Antares
Moon
Apr. 12
SERPENS
Apr. 11
LIBRA
OPHIUCHUS
E
10°
Time is approx. 10pm. On Apr 12 and 13 the Moon and Mars are 5.7° and 7° apart respectively.


EVENING TWILIGHT - Apr. 25 to 27
MONOCEROS
Rigel
Great Neb.
GEMINI
Betelgeuse
ERIDANUS
ORION
Pleiades (M45)
"The Seven Sisters"
Apr. 27
Aldebaran
TAURUS
Hyades
Jupiter
Apr. 26
Saturn
Moon
10°
Apr. 25
AURIGA
Pleiades
(see insert)
NW
45 mins after sunset. On Apr. 25 the Moon is 4.2° from Saturn. On Apr. 26 the Moon is 2.8° and 3.8° respectively from Jupiter and Aldebaran.

MAY

RISE/SET CHART



All times are WAST.

MAY HIGHLIGHTS

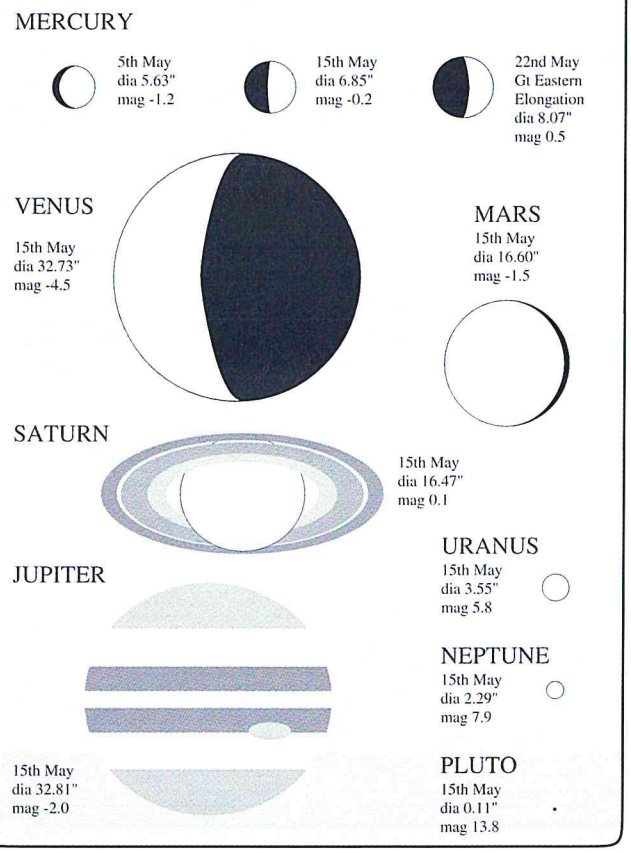
- Mercury, Jupiter and Saturn all in Taurus
- Mercury visits Jupiter
- Jupiter and Moon very close in the evening twilight
- Mars near opposition

THE MOON

1st	First Quarter
2nd	Moon at perigee (closest to Earth – 369,420 km distant, angular size 32.3°)
7th	Full Moon
15th	Moon at apogee (furthest from Earth – 404,144 km distant, angular size 29.7°)
15th	Last Quarter
21st	Occultation of minor planet Vesta by the Moon, visible from Japan, Alaska and Canada
23rd	New Moon
27th	Moon at perigee (closest to Earth – 368,033 km distant, angular size 32.8°)
30th	First Quarter

For trivia buffs, this month is unusual in that it has five lunar phases (as does November). See also last month's notation.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY returns to the evening sky this month. Moving from Aries early in May, the planet joins Saturn and Jupiter in Taurus. Early in the month Mercury has some interesting configurations with the other planets and Aldebaran, though all occur at low altitude in the western twilight sky. Mercury will be 3° from Jupiter on the 16th. On the 25th, the thin crescent 2-day old Moon is situated 7° above and northward of the planet (see Sky View). Mercury reaches its greatest elongation (22°) east of the Sun on the 22nd.

VENUS is high in the eastern morning sky as twilight begins. In the constellation of Pisces for the whole month, the planet is dazzling in a region that is devoid of bright stars. On the 19th, the 25-day old Moon appears 7.8° above Venus, and on the following morning a closer at 6° (see Sky View).

MARS, in Sagittarius, rises in the early eastern evening sky, and is visible all night. It is near the well-known nebulae, the Lagoon (M8) and the Trifid (M20). With opposition approaching next month, the planet (mid-month) shines brilliantly at –2 magnitude. This opposition is the lead up to the long awaited 'most favourable one' in 2003, and the planet is now at its brightest and nearest since the 1988 opposition (in fact, slightly brighter than Jupiter setting in the west). The motion of Mars against the background stars has been slowing, as it nears the stationary point in its orbit on the 12th. Thereafter it begins its east to west (retrograde motion) movement across the sky until July, when it again slows down and reverses (see also 'Retrograde Motion' on page 61 and the Mars finder chart on page 81). On the 10th, the 18-day old Moon appears 3.6° from Mars (see Sky View).

JUPITER, in Taurus, is low in the western evening twilight sky during May. The giant planet and Mercury appear within 3° of each other on the 16th. Worthwhile for those with a good western horizon will be the sight of the slender 1 day old Moon a close 0.8° south of Jupiter on the 24th (see Sky View). With Jupiter nearing conjunction with the Sun mid-June, this month is the last opportunity to see the planet in the evening sky until late October.

SATURN, in the western evening twilight, is soon lost as it nears the Sun. The planet is in conjunction with the Sun on the 25th and will reappear in the morning sky next month.

URANUS and **NEPTUNE**. Neptune now rises around 11pm (mid-month) with Uranus a little over 1 hour behind it. They both have near approaches by the Moon this month. By dawn on the 14th the Moon will be less than 4° from Neptune and on the early morning of the 16th, 5° from Uranus. Both planets go into retrograde motion this month, this west to east motion across the sky continues until October (see discussion on retrograde motion in Part II).

PLUTO is at opposition early next month and is visible the entire night. Unlike some of the closer planets, opposition means little to this tiny distant world, and any difference in angular size or magnitude from conjunction to opposition is insignificant.

MINOR PLANETS at opposition this month include: 7 Iris on the 8th at magnitude 9.6 in Libra, 15 Eunomia on the 20th at magnitude 9.7 in Lupus and 43 Ariadne on the 5th at magnitude 9.7 in Libra.

COMETS

Comet C/1999 T2 (LINEAR) can be found in the northern sky during May, visible for most of the night. As it fades from 12th to 13th magnitude, LINEAR moves from Bootes into Canes Venatici, and back into Bootes, passing close to the globular cluster M3 near the end of the month.

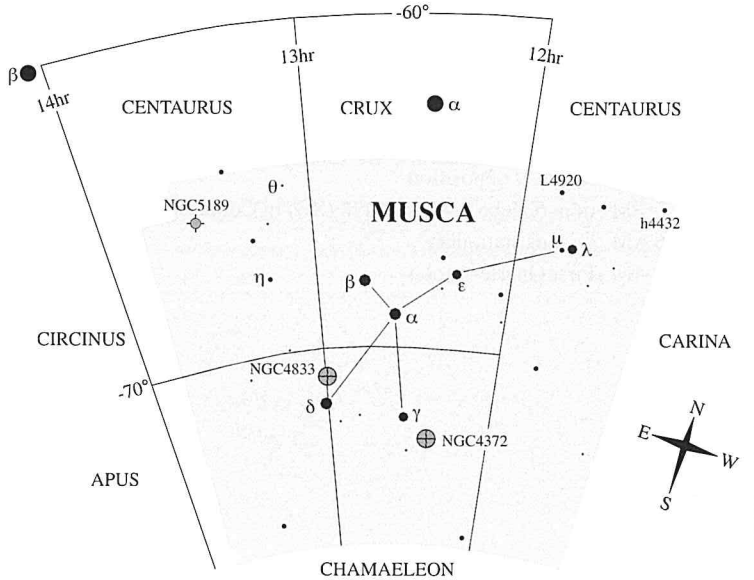
Comet 24P/Schaumasse reaches perihelion this month on the 2nd at 1.2 AU from the Sun. It fades from 10th to 11th magnitude as it slowly moves through Auriga, Gemini, and Cancer in the northwest evening sky.

CONSTELLATION OF THE MONTH — MUSCA (MUS)

Musca, Latin for the Fly, is a small constellation directly south of Crux, the Southern Cross, and culminates in the middle of the month at 9pm. The German astronomer Johann Bayer named this constellation Apis, the Bee, early in the 1600s. It is not known with certainty who renamed the group, but Lacaille's maps of 1763 display it as a fly. Musca was also known as Musca Australis (the Southern Fly), or Musca Indica (the Indian Fly), to differentiate it from a now abandoned northern constellation, Musca Borealis (the Northern Fly). The Southern Fly was once part of Centaurus and its past northern relative was a part of Aries.

Musca, although a small grouping of stars, has an area twice that of the smallest constellation, its northern neighbour Crux. There are about 20 double and multiple stars in the Fly; the four best are h4432, L4920, Beta, and Theta. Some of these will certainly test the seeing conditions and the resolving power of smaller telescopes.

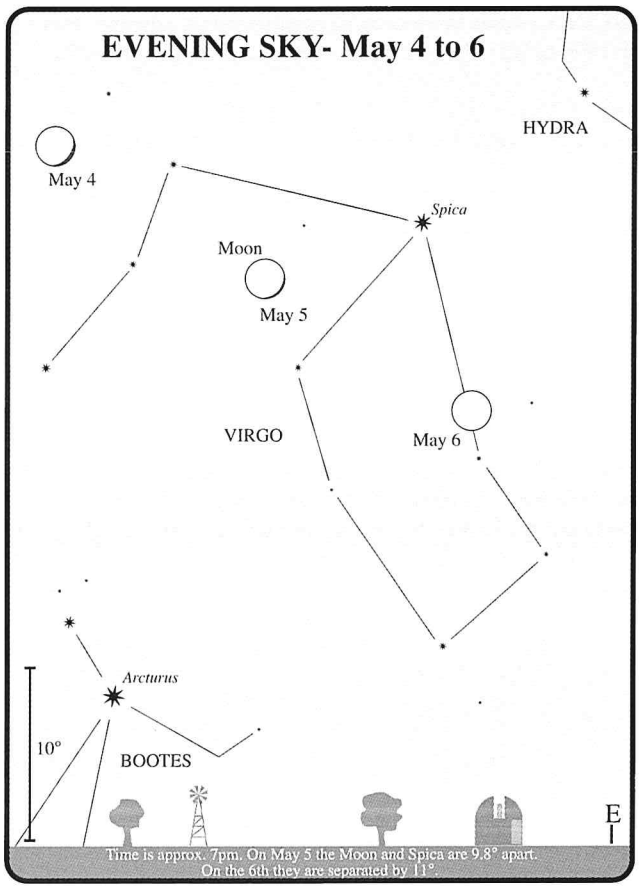
There are a number of other objects worthy of observation, including two good globular star clusters, NGC4372 and NGC4833. These would be even brighter if not for some obscuration by dark absorbing matter/nebula in the area. The planetary nebula NGC5189 is one of the most remarkable of the planetaries, being rather strange and complex in structure. There has been much confusion with observers as to its nature. John Herschel, in 1835, labelled NGC5189 as a 'very strange object'. Others have described it as being three nebulae, or a barred spiral galaxy. It is set in a fine starry field and is excellent in small instruments.

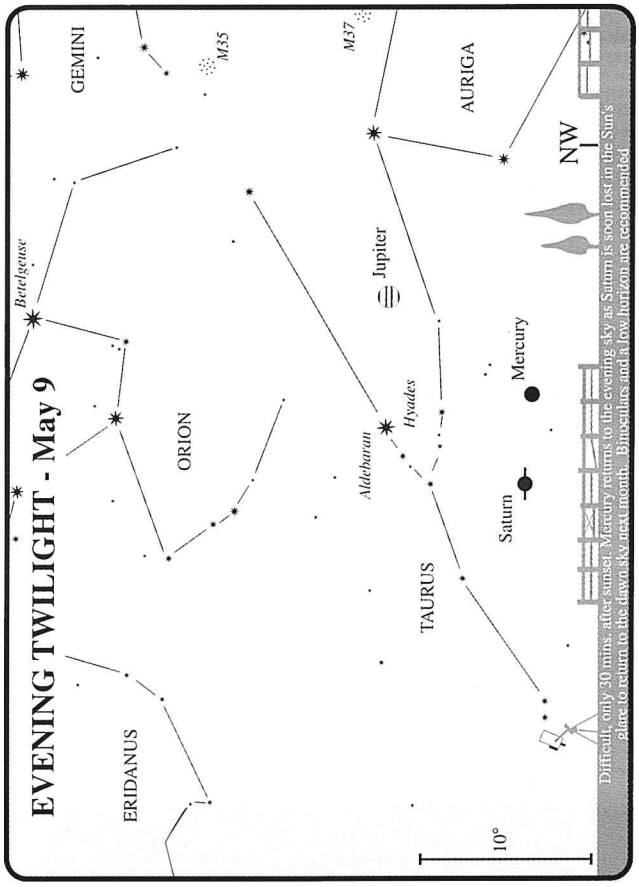


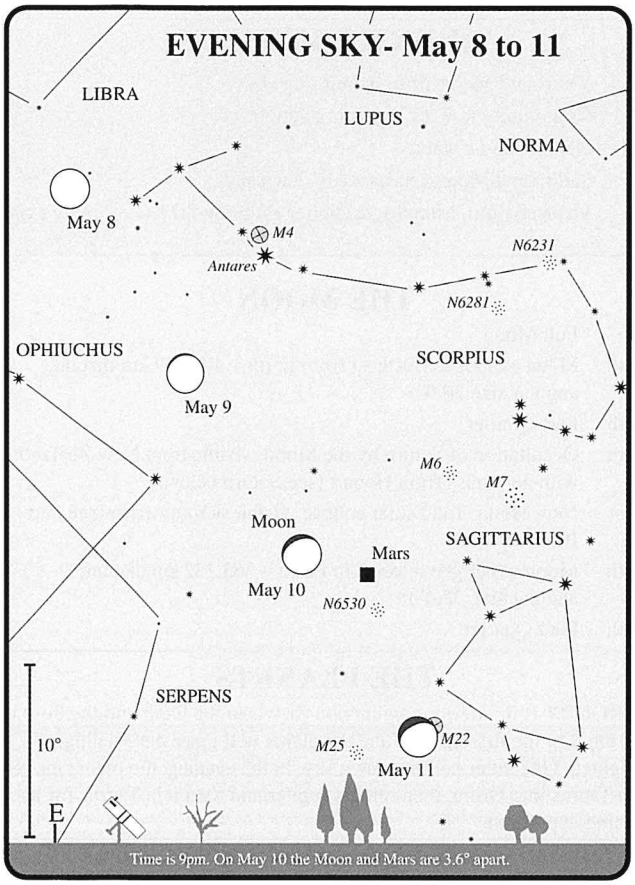
MAY

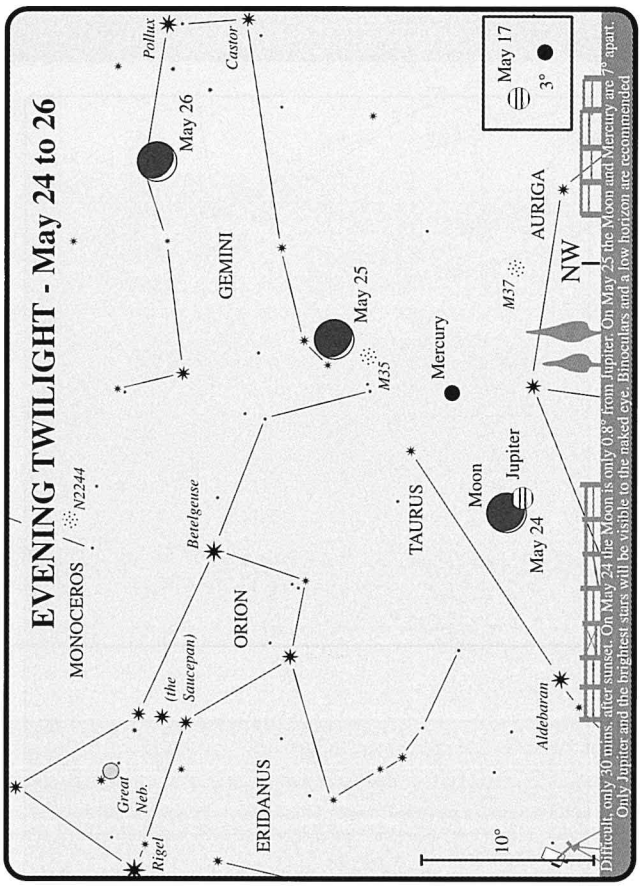
DIARY OF EVENTS

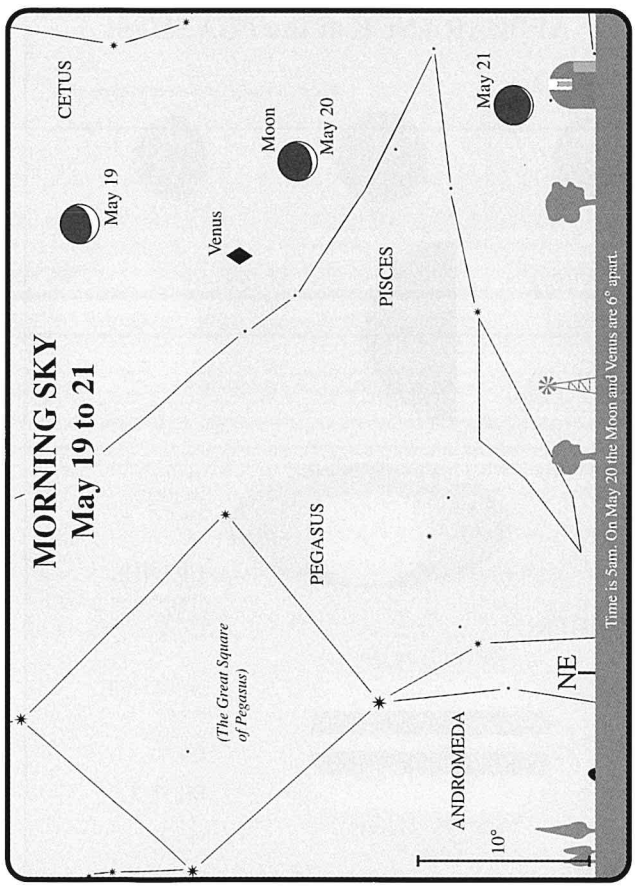
1st	1:08 AM	First Quarter Moon
2nd	Noon	Moon at perigee
3rd		m.p. 349 Dembowska 0.3°NW of M30 (GC) in Capricornus
5th	2 AM	Venus greatest brilliancy
6th		Mercury 2.3°SE of M45 (Pleiades OC) in Taurus
7th		Comet 45P/Honda-Mrkos-Pajdusakova 1.5°N of M35 (OC) in Gemini
7th	9:52 PM	Full Moon
8th	1 AM	Mercury 4°N of Saturn
10th		Venus 0.4°S of NGC 128 (SG) in Pisces
10th		Mercury at greatest latitude North
11th		Venus at descending node
11th	3 AM	Mars 1.9° S of Moon
11th	10 AM	Neptune stationary
11th	11 PM	Mars stationary
12th	6 PM	Mercury 8° N of Aldebaran
14th	8 AM	Neptune 3° N of Moon
15th	9 AM	Moon at apogee
15th	4 PM	Uranus 3° N of Moon
15th	6:11 PM	Last Quarter Moon
16th		Jupiter 1.4°S of NGC 1746 (OC) in Taurus
16th		Mercury 1.5°N of NGC 1746 (OC) in Taurus
17th		m.p. 11 Parthenope 0.2°NE of NGC 488 (SG) in Pisces
17th	1 AM	Mercury 3° N of Jupiter
18th		Comet 24P/Schaumasse 1°S of star Castor
19th	5 AM	Ceres stationary
19th	5 PM	Venus 4° N of Moon
20th	9 PM	m.p. 42 Isis 0.2°NW of NGC 6342 (GC) in Ophiuchus
21st	5 AM	Vesta 0.6° S of Moon; occultation
22nd	Noon	Mercury greatest elongation E (22°)
23rd	10:46 AM	New Moon
24th	3 PM	Jupiter 1.3° N of Moon
25th	3 AM	Mercury 3° N of Moon
25th	9 PM	Saturn in conjunction with the Sun
26th	7 PM	m.p. 29 Amphitrite 0.7°SE of NGC 4487 (SG) in Virgo
27th	3 PM	Moon at perigee
28th	2 AM	Pallas at opposition
28th	7 PM	m.p. 6 Hebe 0.4°E of M98 (SG) in Coma Berenices
30th	6 AM	Uranus stationary
30th	6:09 AM	First Quarter Moon

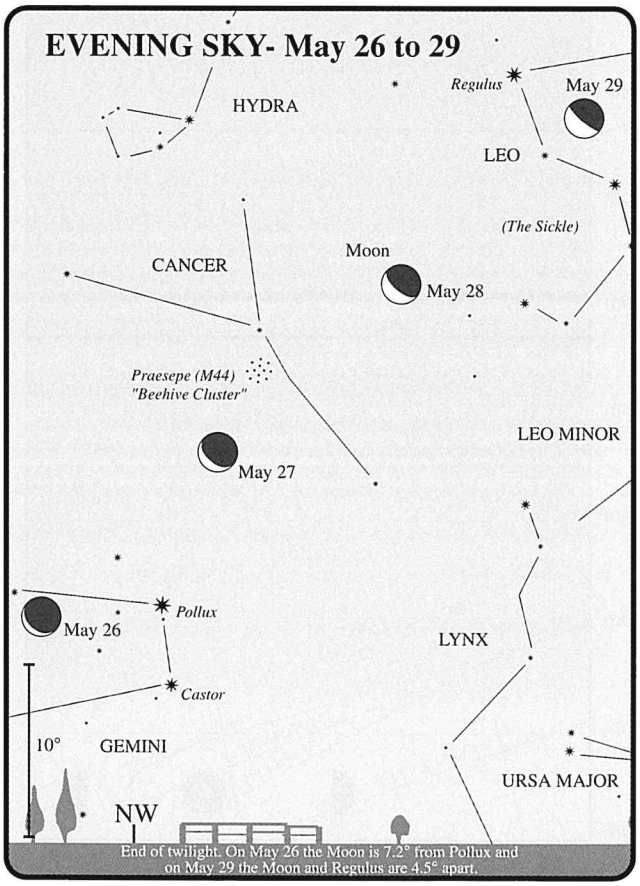





EVENING SKY- May 8 to 11
LIBRA
LUPUS
NORMA
May 8
M4
Antares
N6231
N6281
OPHIUCHUS
SCORPIUS
May 9
M6
M7
Moon
Mars
SAGITTARIUS
May 10
N6530
SERPENS
10°
M25
M22
May 11
E
Time is 9pm. On May 10 the Moon and Mars are 3.6° apart.

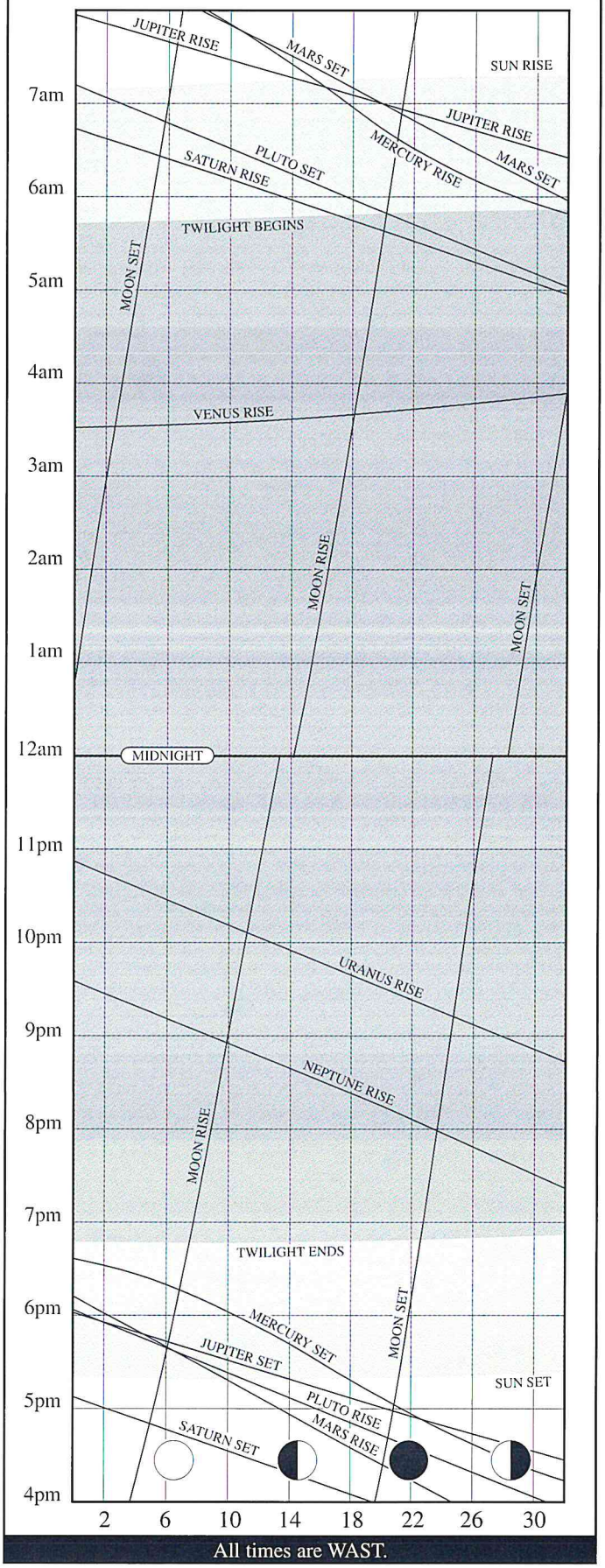

EVENING TWILIGHT - May 24 to 26
Pollux
Castor
May 26
May 17
3°
GEMINI
May 25
AURIGA
M37
NW
M35
Mercury
N2244
Betelgeuse
TAURUS
Moon
Jupiter
May 24
MONOCEROS
ORION
(the Saucepan)
Aldebaran
Great Neb.
Rigel
ERIDANUS
10°
Difficult, only 30 mins. after sunset. On May 24 the Moon is only 0.8° from Jupiter. On May 25 the Moon and Mercury are 7° apart. Only Jupiter and the brightest stars will be visible to the naked eye. Binoculars and a low horizon are recommended.


MORNING SKY
May 19 to 21
CETUS
May 19
Moon
May 20
May 21
Venus
PISCES
PEGASUS
(The Great Square of Pegasus)
ANDROMEDA
NE
10°
Time is 5am. On May 20 the Moon and Venus are 6° apart.


EVENING SKY- May 26 to 29
HYDRA
Regulus
May 29
LEO
(The Sickle)
CANCER
Moon
May 28
Praesepe (M44)
"Beehive Cluster"
LEO MINOR
May 27
Pollux
May 26
LYNX
Castor
10°
GEMINI
URSA MAJOR
NW
End of twilight. On May 26 the Moon is 7.2° from Pollux and on May 29 the Moon and Regulus are 4.5° apart.

JUNE

RISE/SET CHART



All times are WAST.

JUNE HIGHLIGHTS

- Venus and Moon close in morning sky
- Opportunity to view Venus in daylight
- Opposition of Mars
- Saturn and Moon very close in dawn sky
- Venus, Saturn, Mercury & Jupiter gather in the late morning sky

THE MOON

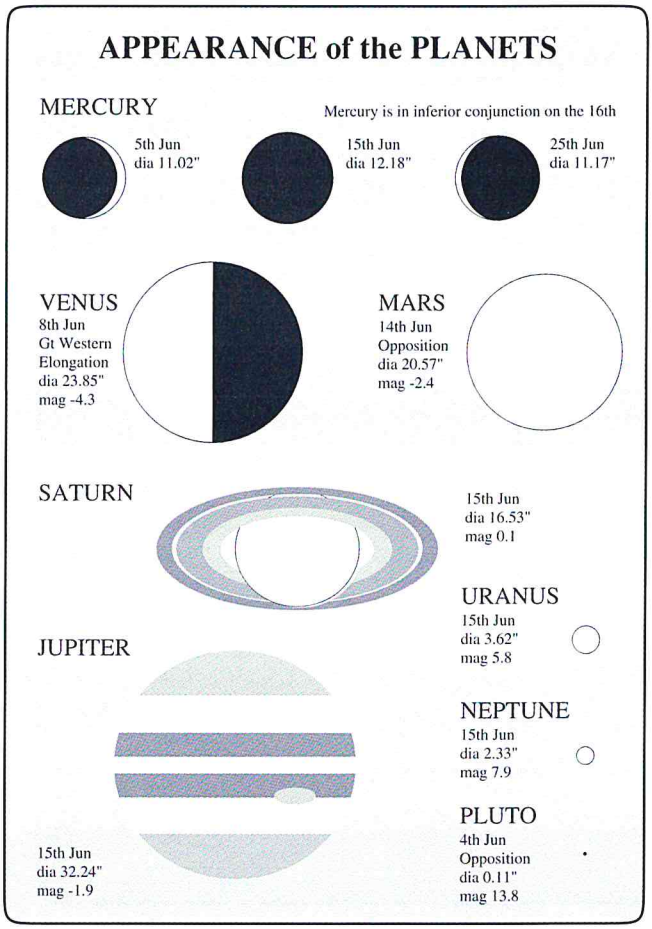
6th	Full Moon
12th	Moon at apogee (furthest from Earth – 404,629 km distant, angular size 30.0°)
14th	Last Quarter
20th	Occultation of Saturn by the Moon, visible from New Zealand with near miss from Hobart (see Saturn below)
21st	New Moon. Total solar eclipse, visible across Africa (see Part II for details)
24th	Moon at perigee (closest to Earth – 363,132 km distant, angular size 32.4°)
28th	First Quarter

THE PLANETS

MERCURY is in inferior conjunction (between the Earth and the Sun) on the 16th. For the first half of June the planet will grace the evening twilight and the latter half the dawn sky. In the evening, the planet moves from Taurus into Orion, then rejoins Jupiter and Saturn in Taurus for its morning apparition.

VENUS is at its greatest elongation (46°) west of the Sun on the 8th, and spends the month high in the morning eastern sky (rising around 3.30am). An ideal opportunity to see Venus with the unaided eye in the daytime is

APPEARANCE of the PLANETS



provided on the 18th when the crescent Moon is near the planet (see Sky View). Trying to pick a point of light against the light blue sky can be a real challenge, especially without any reference such as the Moon to focus your eyes on (although it is possible). At 6am, just after the commencement of dawn, Venus will be closest to the Moon being only 1° below and left of its crescent. They remain close together during the day with the distance slowly increasing. The separation is 3° when they set in the west at 3pm. Once located you may be surprised at how bright Venus is, and how easy it is to see during the day (at least with the Moon as a guide). Should the weather be unfavourable this month, another opportunity exists in July under similar circumstances.

EARTH is at Solstice on the 21st. At noon on this day the Sun is directly overhead at latitude 23.5° N and the days in the southern hemisphere are at their shortest.

MARS is at opposition on the 14th, and at magnitude -2.4 is at its brightest and nearest (67,340,000 km or 0.45 AU) since the 1988 opposition. As oppositions go this one is pretty good, thirteen years have elapsed since a better one occurred, and we are now just 26 months away from an 'as-good-as-you-can get' type. This prelude to the 'big one', sees Mars with an equatorial diameter of 20.8 arc seconds, making it (in this instance) the largest angular sized planet in the Solar System aside from Venus (just) and Jupiter. At this time, it is also the brightest object in the sky aside from the Sun, Moon and Venus. Weather permitting, observers should take every opportunity this month to view and record a polar cap and surface markings. The actual opposition does not necessarily coincide with the time of closest approach of Earth and Mars, in fact this year closest approach occurs 8 days later on the 22nd. See also Part II where the Martian oppositions are covered in more detail. On the 6th, the Full Moon will be 6.2° north of Mars (see Sky View).

JUPITER is in conjunction on the 14th, and will be lost in the Sun's glare until it reappears in the morning sky next month.

SATURN, now past conjunction, appears in the early morning sky in Taurus. Early in the month the planet is about 6° north of 1st magnitude star Aldebaran, and by month's end less than 4°. On the 20th, the thin crescent Moon appears very near the ringed planet (see Sky View) and from New Zealand an occultation is seen. Perth will not see the closest approach, with Saturn being 1° away when the moon rises at around 6am. Eastern mainland cities will see a separation a little under 0.5°. From Hobart, the planet will be approximately 1 arc minute from the lunar limb.

URANUS and **NEPTUNE** are in Capricornus, visible in the late evening sky. The 19-day old Moon is 4.0° from Neptune when they rise on the evening of the 10th, and on the following evening 3° from Uranus.

PLUTO is at opposition on the 4th and is visible the entire night. This is a good opportunity to try and find this faint outer world. For this

ALPHA CENTAURI - OUR NEXT DOOR NEIGHBOUR

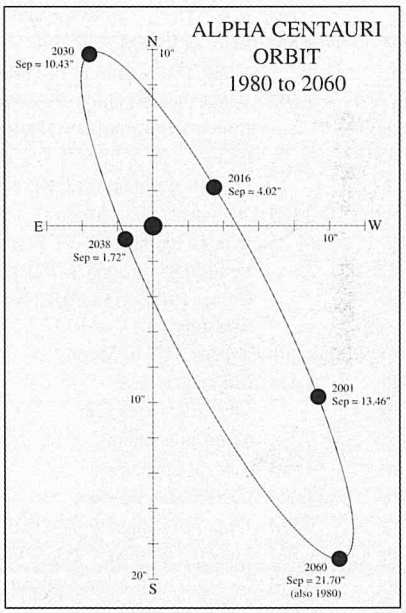
If you were to look high in the southern sky in the early evening this month, you would see one of the brightest and recognisable star patterns of the Southern Hemisphere - the Southern Cross and Pointers (see the Sky View 'Early August' on p. 42). The two pointers, Alpha and Beta, are the brightest stars of the constellation of Centaurus the Centaur. These stars show quite a colour contrast with Alpha (the left star, furthest from the Cross) appearing yellow and Beta being blue. Centaurus has the distinction of being the only constellation, besides Orion, to contain two first magnitude stars. The stars are traditionally located near the 'feet' of this mythical beast which is half man (from the waist up), on a horse's body. In fact Alpha Centauri is sometimes referred to in old star atlases as Rigel Kentaurus from Al Fijl al Kentaurus, the centaur's foot. Centaurus is one of two centaurs in the sky, the other being Sagittarius.

It is interesting to see Alpha and Beta being referred to as the 'Pointers'. If you draw a line joining the stars and extend it towards the Cross, it passes over the top – for the time being. Alpha has a high proper motion and is moving towards Beta. The direction of this line is swinging towards the south. By about 4000AD the separation of these stars will be half the current 4.5° and the line will be pointing at the centre of the Cross. Alpha will make its closest approach to Beta around 6200AD when it will be 23' north - less than the diameter of the Moon away!

Alpha Centauri's claim to fame (besides being the destination for the space family Robinson in the sixties television series Lost in Space) is being the closest 'star' to our Solar System; a little over 4 light-years away. Let's not forget that on the scale of the Solar System, this is still an enormous distance, when you consider the light from the Sun only takes 8 minutes to reach us, and the light from Alpha Centauri takes 4 years However when we start to look from the prospective of the Universe, it's only next door. The Milky Way galaxy itself is around 100,000 light years in diameter and the Andromeda Galaxy about 2 million light years away and we still haven't left our local group of Galaxies!

The distance to Alpha was first determined by Henderson from the Cape of Good Hope in 1839, using the technique of stellar parallax. This was only two months after the first such measurement ever performed by F.W. Bessel on the star 61 Cygni. This method can be best demonstrated by holding up a finger in front of your face. Look at the finger from one eye (closing the other) and then the other and see how its position against the background shifts between the views. The closer the finger, the larger the shift. In the case of stellar parallax the position of the eyes is the Earth on opposite sides of the Sun and the background is the distant field of stars.

Alpha Centauri is also one of the finest and brightest visual binaries in the heavens, both components being clearly visible in the smallest of telescopes. Father Richaud from Pondicherry, India discovered the duplicity of the star in 1689, while he was observing a comet. Alpha Centauri is a true binary, being made up of two Sun-like stars of magnitudes -0.04 and 1.17 in orbit about each other. The orbital motion of the pair has been followed since the first accurate measurements, from the Cape of Good Hope in 1752, by Lacaille. The orbital period of the stars is about 80 years and they form quite an elongated or eccentric ellipse. The true distance between the stars varies from 11 to about 35 AU or to compare it to the Solar System - a little beyond the distance from the Sun to Saturn out to half way between Neptune and Pluto. From Earth the orbit is tilted from edge-on by about 11°, hence the highly elongated appearance as per the above diagram. As you can see the separation is currently closing, but a small telescope should have no trouble seeing the two stars no matter where they are in their orbits. By the closest approach in 2038 (only 1.72") a reasonably high powered eyepiece may be required.



Alpha Centauri is in fact a triple star with a much more distant, faint companion called Proxima Centauri. It is located approximately 2° SW of Alpha and is only magnitude 10.7 (definitely needing a small telescope to find) and a little closer to us than its much brighter brothers. It was discovered by measurements of its proper motion by R.T. Innes in 1915. Being so close and faint it comes as no surprise to learn it is one of the least luminous stars ever found. If it replaced the Sun it would only be as bright as 45 Full Moons and about 1/20 of its diameter. The star is believed to be gravitationally linked to Alpha Centauri but 400 times further away than the mean separation of the main pair and taking around a million years to complete one orbit.

JUNE

challenge, you will need a telescope of at least 200mm aperture, a good dark sky, and our finder chart in Part II. Since the planet will appear similar to any other 14th magnitude star in the neighbourhood, it is a good idea to sketch (or photograph) the field twice, about a week or two apart, the one that moves is Pluto.

MINOR PLANETS at opposition this month include: 2 Pallas on the 3rd at magnitude 9.2 in Hercules, 14 Irene on the 10th at magnitude 9.1 in Ophiuchus and 42 Isis on the 7th at magnitude 9.8 in Ophiuchus.

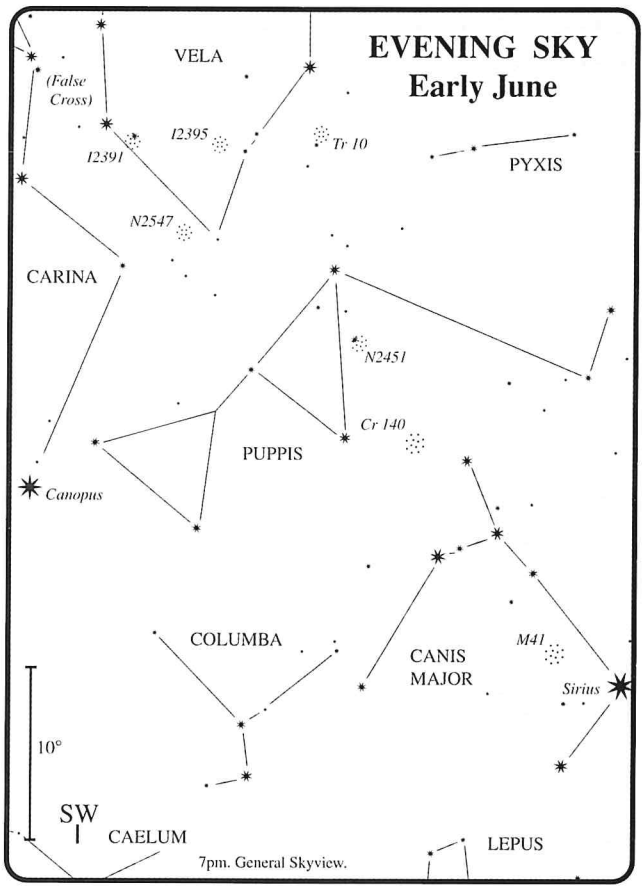
COMETS

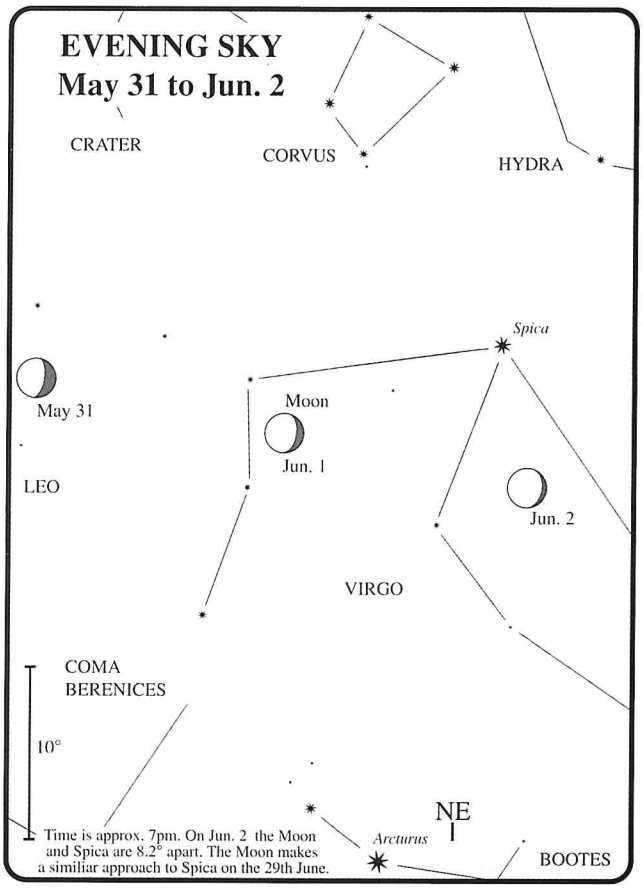
Comet 19P/Borrelly is in the morning sky, moving through the constellations of Cetus and Eridanus, ending the month near the border with Taurus. It visits a number of galaxies in these constellations. During June, Borrelly can be expected to brighten from 13th to 12th magnitude.

Comet 24P/Schaumasse, a month past perihelion, can be found in the northwest evening sky moving through Cancer and Leo. During this time, it will decline in brightness from 11th to 13th magnitude.

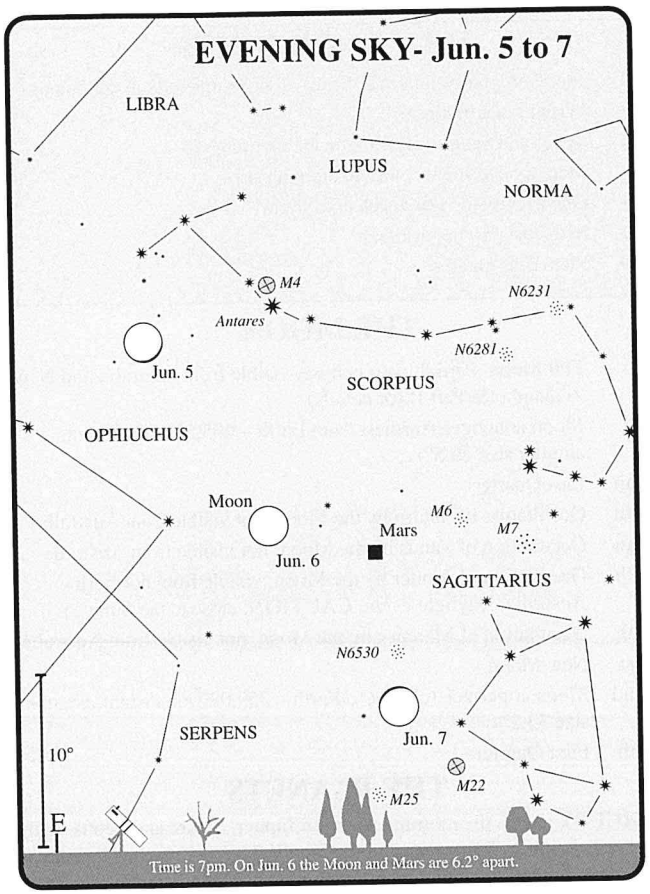
DIARY OF EVENTS

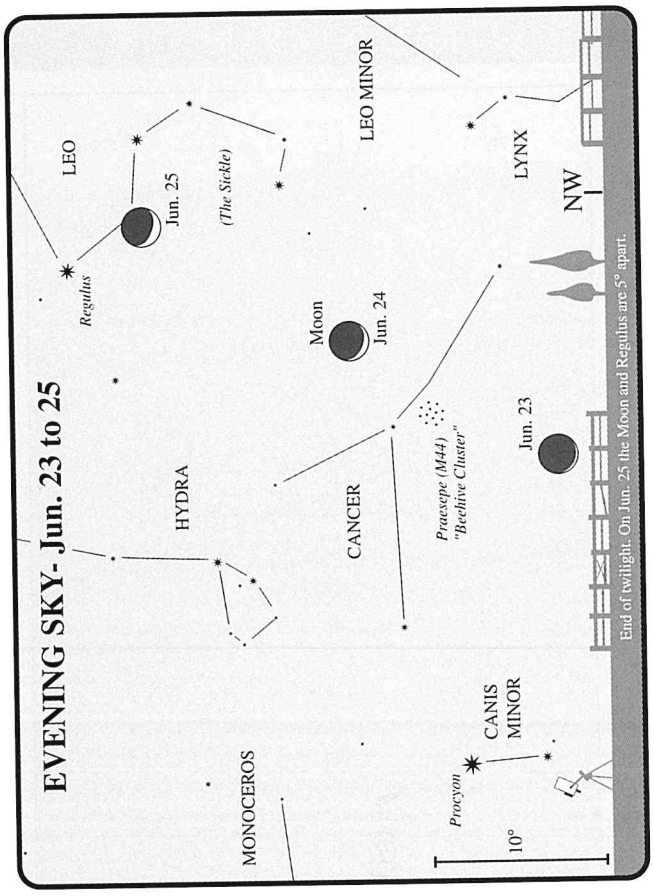
3rd		Mercury 0.3°W of NGC 2129 (OC) in Gemini
3rd		Mercury at descending node
4th	1 PM	Mercury stationary
4th	8 PM	Pluto at opposition
6th	9:39 AM	Full Moon
6th	7 PM	m.p. 6 Hebe 0.4°SW of M99 (SG) in Coma Berenices
7th	3 AM	Mars 4° S of Moon
8th		Venus 1°NW of m.p. 11 Parthenope
8th	1 PM	Venus greatest elongation W (46°)
10th		Comet 19P/Borrelly 1°NW of NGC 1052/1042 (EG/SG) in Cetus
10th		m.p. 40 Harmonia 0.2°NE of NGC 1111 (SG) in Aries
10th	4 PM	Neptune 3° N of Moon
11th		m.p. 11 Parthenope 0.2°SE of IC 198 (SG) in Pisces
11th		Venus 0.8°SE of NGC 821 (EG) in Aries
12th		Comet 19P/Borrelly 0.8°NW of NGC 1084 (SG) in Eridanus
11th	Midnight	Uranus 3° N of Moon
12th	4 AM	Moon at apogee
13th		Mercury at aphelion
14th		Venus at aphelion
14th	2 AM	Mars at opposition
14th	11:28 AM	Last Quarter Moon
14th	9 PM	Jupiter in conjunction with the Sun
16th	7 PM	Mars 0.2°S of NGC 6355 (GC) in Ophiuchus
16th	9 PM	Mercury in inferior conjunction
18th	6 AM	Venus 1.7° N of Moon
19th	9 PM	m.p. 42 Isis 0.9°NW of NGC 6235 (GC) in Ophiuchus
20th	6 AM	Saturn 0.9° N of Moon; occultation
21st	4 PM	Solstice
21st	7:58 PM	New Moon; eclipse
22nd		Comet 19P/Borrelly 0.3°SE of NGC 1225 (SG) in Eridanus
22nd	7 AM	Mars closest approach
22nd	7 PM	m.p. 14 Irene 0.8°N of NGC 6287 (GC) in Ophiuchus
22nd	7 PM	m.p. 6 Hebe 0.3°SW of M84 (EG) in Virgo
23rd	7 PM	m.p. 6 Hebe 0.3°SW of NGC 4388 (SG) in Virgo
24th	1 AM	Moon at perigee
25th	7 PM	m.p. 7 Iris 1°S of m.p. 43 Ariadne
25th	7 PM	Mars 0.3°SE of NGC 6293 (GC) in Ophiuchus
27th		Comet 19P/Borrelly 0.4°E of NGC 1323 (SG) in Eridanus
27th		Comet 24P/Schaumasse 0.3°NW of NGC 3227 (SG) in Leo
28th	11:19 AM	First Quarter Moon
28th	3 PM	Mercury stationary
30th		Venus 0.3°W of m.p. 40 Harmonia

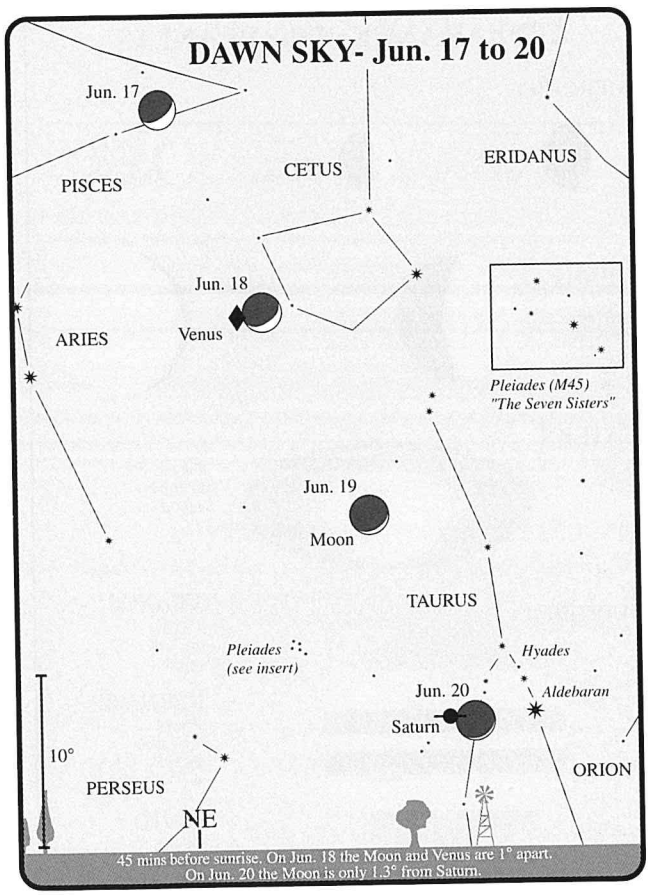


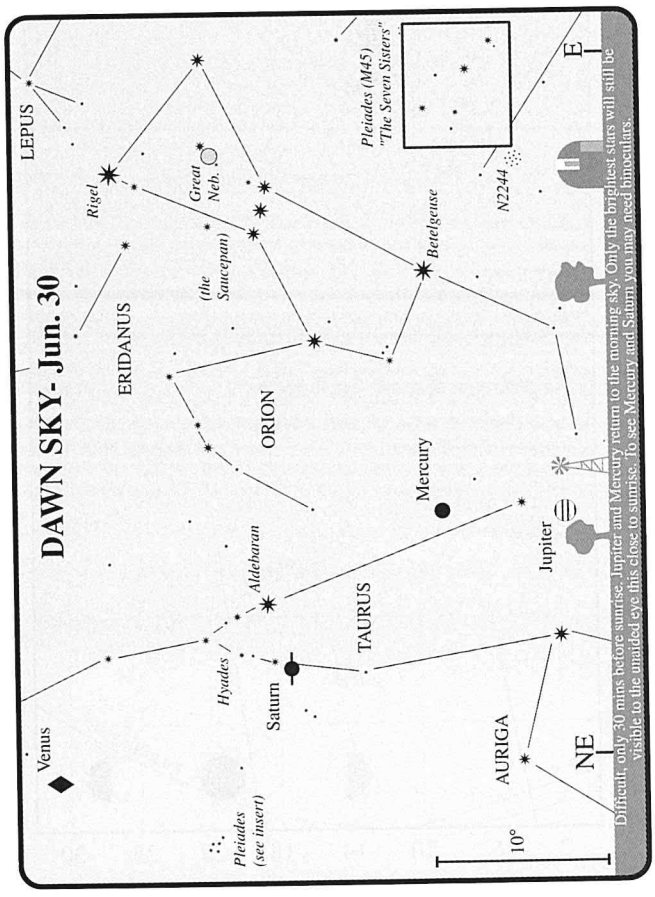


JUNE


EVENING SKY- Jun. 5 to 7
LIBRA
LUPUS
NORMA
M4
Antares
N6231
N6281
Jun. 5
SCORPIUS
OPHIUCHUS
Moon
Jun. 6
Mars
M6
M7
SAGITTARIUS
N6530
SERPENS
Jun. 7
M22
M25
10°
E
Time is 7pm. On Jun. 6 the Moon and Mars are 6.2° apart.

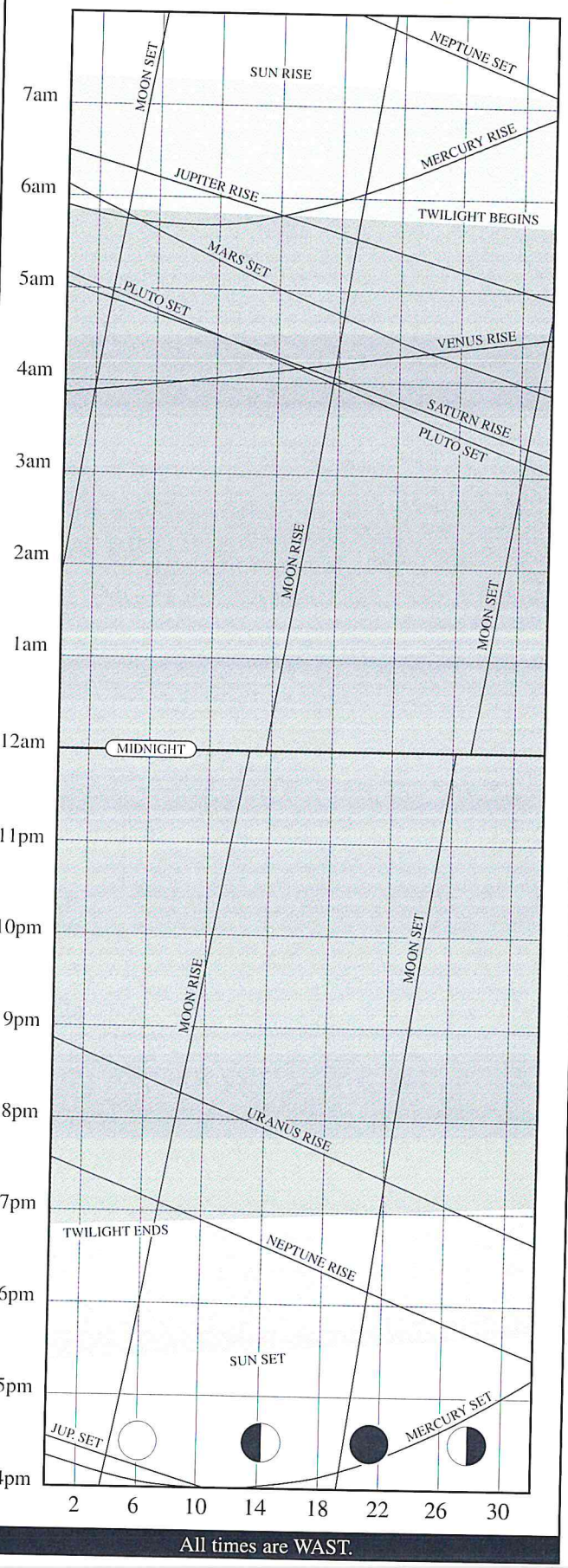

EVENING SKY- Jun. 23 to 25
LEO
Regulus
Jun. 25
(The Sickle)
LEO MINOR
LYNX
NW
Moon
Jun. 24
HYDRA
CANCER
Praesepe (M44)
"Beehive Cluster"
Jun. 23
MONOCEROS
CANIS MINOR
Procyon
10°
End of twilight. On Jun. 25 the Moon and Regulus are 5° apart.


DAWN SKY- Jun. 17 to 20
Jun. 17
PISCES
CETUS
ERIDANUS
Jun. 18
Venus
ARIES
Pleiades (M45)
"The Seven Sisters"
Jun. 19
Moon
TAURUS
Pleiades
(see insert)
Hyades
Jun. 20
Aldebaran
Saturn
10°
PERSEUS
ORION
NE
45 mins before sunrise. On Jun. 18 the Moon and Venus are 1° apart.
On Jun. 20 the Moon is only 1.3° from Saturn.


DAWN SKY- Jun. 30
LEPUS
Rigel
Great Neb.
Pleiades (M45)
"The Seven Sisters"
E
N2244
(the Saucepan)
Betelgeuse
ERIDANUS
ORION
Mercury
Aldebaran
Jupiter
TAURUS
Hyades
Saturn
Venus
AURIGA
Pleiades
(see insert)
10°
NE
Difficult; only 30 mins before sunrise. Jupiter and Mercury return to the morning sky. Only the brightest stars will still be visible to the unaided eye this close to sunrise. To see Mercury and Saturn, you may need binoculars.

JULY

RISE/SET CHART



All times are WAST.

JULY HIGHLIGHTS

- Jupiter, Mercury, Saturn & Venus all in Taurus early in the month
- Partial Lunar Eclipse
- Venus and Saturn very close in the morning sky
- Mercury and Jupiter close in morning sky
- Opportunity to view Venus in daylight
- Mars just past opposition
- Mars near Antares

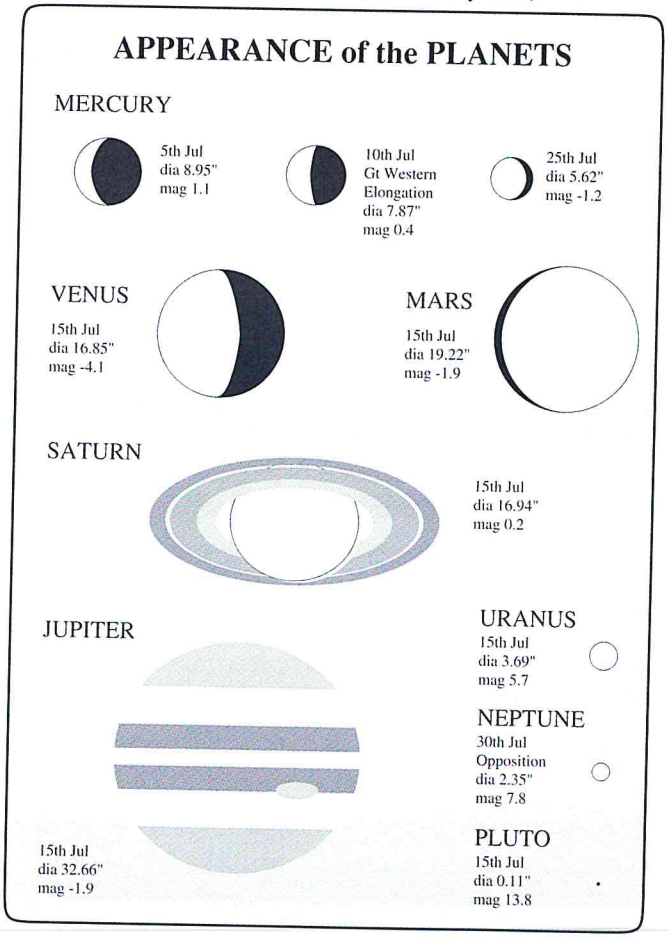
THE MOON

5th	Full Moon. Partial lunar eclipse, visible from Australia and New Zealand (see Part II for details)
9th	Moon at apogee (furthest from Earth – 405,567 km distant, angular size 29.5°)
14th	Last Quarter
17th	Occultation of Saturn by the Moon, not visible from Australia
18th	Occultation of Venus by the Moon, not visible from Australia
19th	Occultation of Jupiter by the Moon, visible from northern Australia. Daylight event, **CAUTION**, close to the Sun (25°).
19th	Occultation of Mercury by the Moon, not visible from Australia
21st	New Moon
22nd	Moon at perigee (closest to Earth – 359,027 km distant, angular size 33.2°)
27th	First Quarter

THE PLANETS

MERCURY shares the morning sky with Jupiter, Saturn and Venus, with all planets being in Taurus early in the month. Mercury reaches its greatest elongation west of the Sun on the 10th, and subsequently moves closer to the Sun on its journey into the evening sky next month. On the 13th and 14th, Mercury and Jupiter appear 2° apart (see Sky View).

APPEARANCE of the PLANETS



JULY

VENUS is high in the morning sky above Saturn, Jupiter and Mercury. On the 12th, a neat triangle is formed when Venus is near Saturn and Aldebaran (see Sky View). Venus and Saturn make a fine sight on the 16th when the pair is 0.8° apart. On the 18th, the 26-day old Moon is 3° below Venus (see Sky View). From the U.S.A. the Moon occults the planet. This close approach of Venus and the Moon provides another opportunity (refer to Venus in June monthly text) to see the planet in broad daylight, exactly one month after the last. At sunrise Venus will be 4° above and left of the lunar crescent. Throughout the day the separation increases to 6° one hour before moonset (around 2pm). Once located you may be surprised at how bright Venus is and how easy it is to see against the bright sky (at least with the Moon as a guide).

The **EARTH** is at aphelion (the furthermost point in its orbit from the Sun) on the 4th. The Earth/Sun distance is 1.0167 astronomical units, which is equivalent to about 151,988,500 km.

MARS is now just past opposition, and still worth telescope time this month. In mid-July, Mars is still a little over 19 arc seconds in diameter, and just a shade under -2 magnitude, is brilliant in the early eastern evening sky. Beginning the month close to the globular cluster M19 in Ophiuchus, the planet moves toward its rival, the 1st magnitude Antares (see also February Mars monthly text). The planet is around 16 times brighter than Antares, the pair are at their closest at 5.5° late in the month. Twice during the month the waxing gibbous Moon appears near Mars. On the late evening of the 3rd, the pair are 6° apart (see Sky View) and on the early evening of the 30th, they are separated by 6.7° (see Sky View). On the 2nd, Mars will be 0.6° from M19, an excellent globular that was first observed by Messier in 1764. After being in retrograde motion since May, the planet appears stationary on the 20th and then reverts to its eastward direction.

JUPITER, in Taurus since June 2000, moves into Gemini mid-month. Now past conjunction, the planet becomes a morning object rising around the beginning of twilight. Jupiter and Mercury appear 2° from each other between the 13th and 14th. On 19th, the thin lunar crescent will be 1° from the planet (see Sky View), from Indonesia there is an occultation.

SATURN is in the late eastern morning sky, rising at 4am (mid-month). This ringed giant begins the month just 4° from the 1st magnitude star Aldebaran. Saturn and Venus have a close encounter as detailed above. On the 18th, the 26-day old crescent Moon will be 5.5° from Saturn, with Venus midway between the two (see Sky View).

URANUS and **NEPTUNE** rise in the early evening sky. The near Full Moon approaches within 3° of Neptune on the evening of the 7th, and around 3° from Uranus in the pre-dawn sky on the 9th. On the 30th, Neptune will be at opposition, and on this day, if any Neptunians happen to be looking our way, they will witness a transit of the Earth across the face of the Sun. This rare series of transits began last year, and continue to occur at each opposition until the year 2006.

PLUTO, now 4 weeks past opposition, is still visible most of the night.

MINOR PLANETS 1 Ceres is at opposition this month on the 8th at magnitude 7.4 in Sagittarius.

COMETS

Comet 19P/Borrelly remains a morning object during July. Moving through the constellations of Eridanus, Taurus, and Orion, Borrelly can be expected to brighten from 12th to 10th magnitude.

Comet 24P/Schaumasse fades from 13th to 15th magnitude during July. It can be found in the evening sky, moving through Leo and Virgo. Around mid-month, it passes near the galaxies M65 and M66 in Leo.

METEOR SHOWERS

The **Piscis Austrinids** are visible from the 15th July to 10th August. The shower generally provides 1 or 2 meteors per hour and on occasion 3 or 4. The zenith hourly rate increases to 8 or 10 meteors on the 27th of this month. However this can vary from as little as 5 to as many as 15 per hour. Visible from about 8pm to the beginning of morning twilight the Piscis Austrinids are generally blue, white or yellow in colour, with some leaving trains.

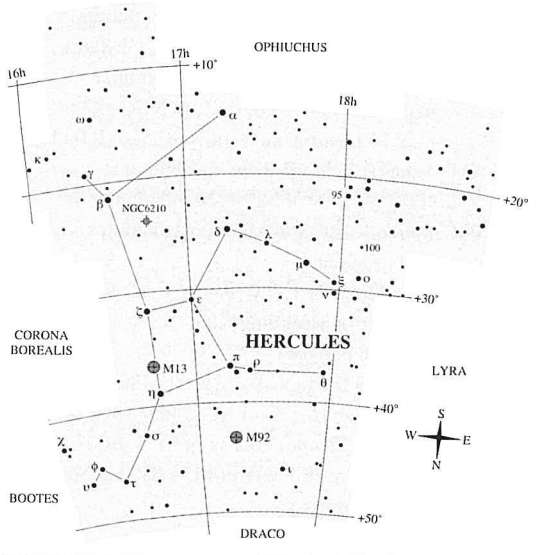
The **Southern delta-Aquarids** are one of the strongest and most consistent of the southern showers, visible late evening until dawn. The range of activity of these medium paced meteors extends from 12th July through to 19th August. The maximum this month is on the 27th with a zenith hourly rate of 20. They are generally faint (bright meteors are the

CONSTELLATION OF THE MONTH - HERCULES (Her)

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

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

Hercules contains a few scattered galaxies that are of no real interest, and also the very distant and consequently very faint galaxy clusters known as Abell 2151 and Abell 2199. The planetary nebula known as NGC6210 is an easier target for small telescopes, located about four degrees north east



of Beta Herculis. The planetary appears bluish and bright, slightly oval (about 16 by 20 arc seconds in size), with a 12th magnitude central star.

The constellation contains some fine binary stars suitable for all apertures. The following stars are relatively easy in small telescopes: Alpha Herculis, a nice bright pair, orange and white, separation 4.7" magnitude 3.2 and 5.4; Rho Herculis, a fine pair of white stars, separation 4.1" magnitude 4.6 and 5.6; 95 Herculis, very nice, yellow and deep yellow, separation 6.3" magnitude 5.0 and 5.1 and 100 Herculis, attractive equal white pair, separation 14.2" magnitude 5.9 and 6.0.

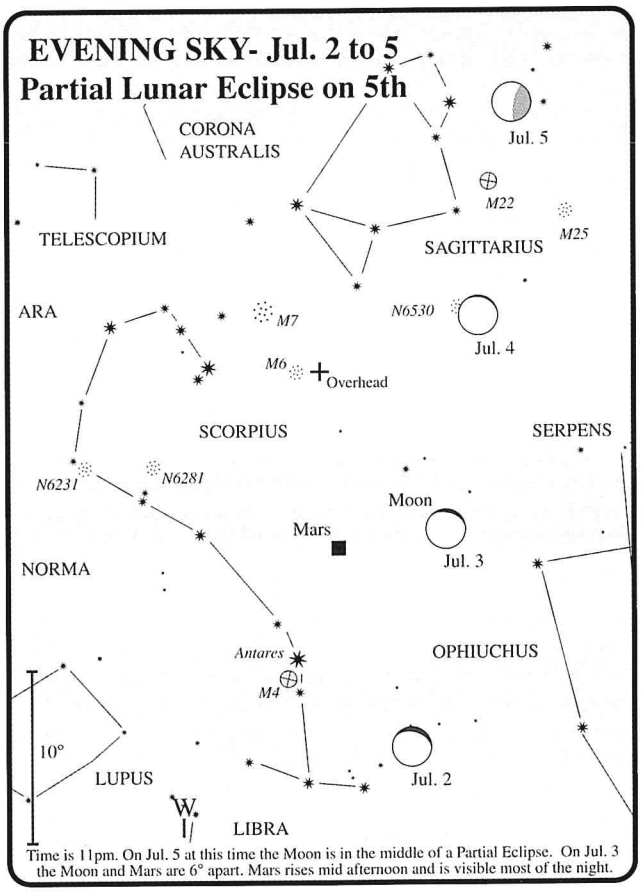
JULY

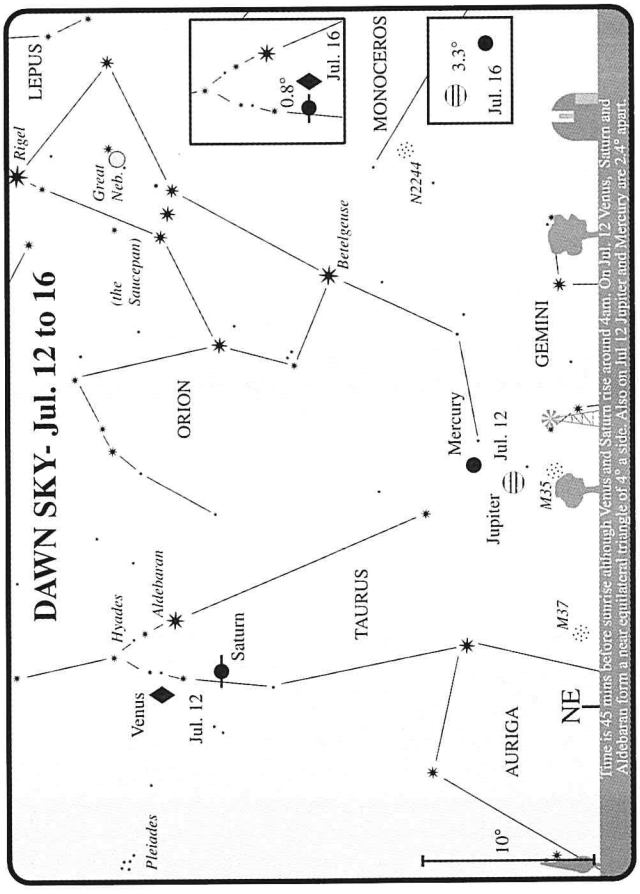
exception), typically white with some blue members, occasionally leaving trains. The Sky View shows the radiant.

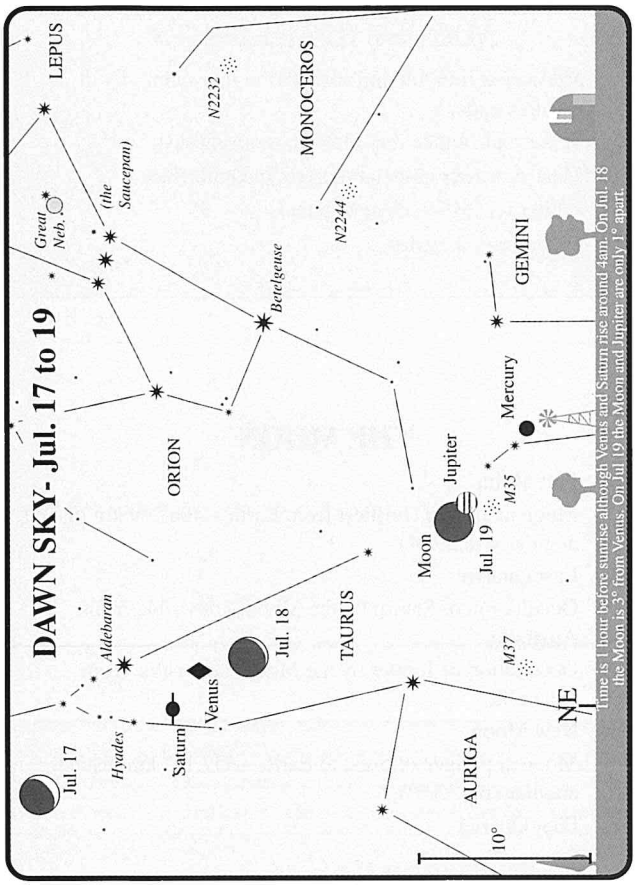
The **alpha-Capricornids** are noted for their bright, slow meteors with long paths and frequent fireballs. The shower is visible late evening until dawn, from 3rd July through to 15th August. Maximum activity occurs on the 29th, when a zenith hourly rate of 4 can be expected. The low hourly rates are generally compensated by their spectacular nature.

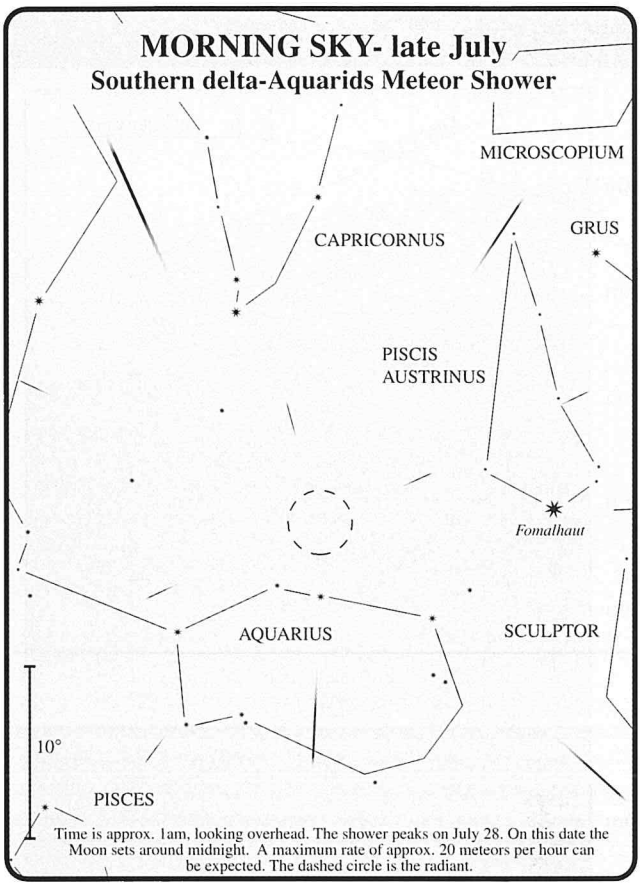
DIARY OF EVENTS

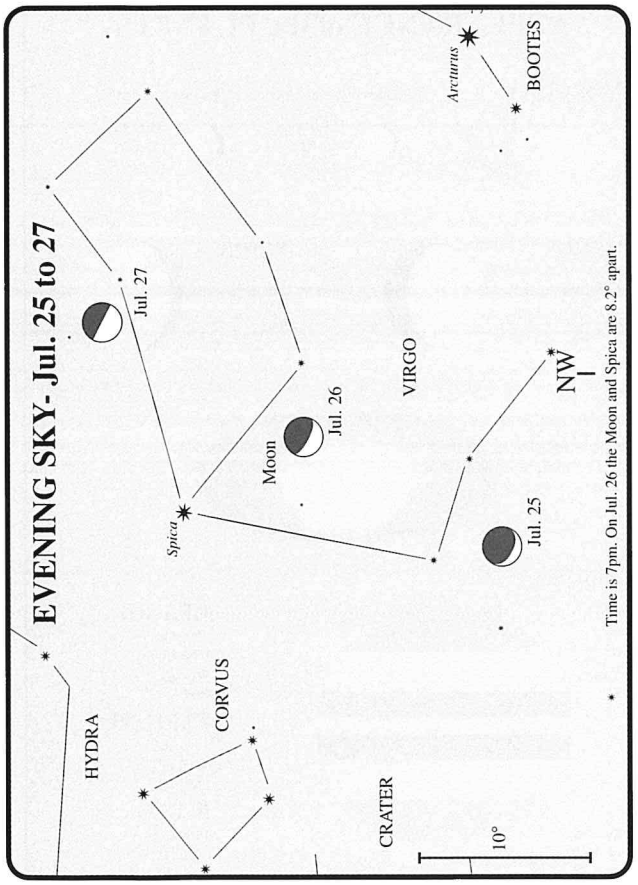
2nd	7 PM	Mars 0.6°S of M19 (GC) in Ophiuchus
3rd		Mercury at greatest latitude South
3rd	6 PM	Mars 6° S of Moon
4th	6 PM	m.p. 6 Hebe 0.1°E of NGC 4503 (EG) in Virgo
4th	7 PM	m.p. 14 Irene 0.5°SE of NGC 6235 (GC) in Ophiuchus
4th	10 PM	Earth at aphelion
6th		m.p. 354 Eleonora 0.3°N of M98 (SG) in Coma Berenices
6th		Venus at greatest latitude South
5th	11:04 PM	Full Moon; eclipse
7th	10 PM	Neptune 3° N of Moon
8th		Mercury 1°SE of star Zeta Tauri
8th	3 AM	Ceres at opposition
9th	6 AM	Uranus 3° N of Moon
9th	7 PM	Moon at apogee
10th		m.p. 354 Eleonora 0.2°N of M99 (SG) in Coma Berenices
10th	1 AM	Mercury greatest elongation W (21°)
11th		m.p. 29 Amphitrite 0.1°NW of NGC 4781 (SG) in Virgo
13th	6 AM	Mercury 1.9° S of Jupiter
13th	4 PM	Saturn 4° N of Aldebaran
13th	6 PM	m.p. 6 Hebe 0.2°SW of NGC 4596 (SG) in Virgo
14th		Jupiter 0.1°S of NGC 2129 (OC) in Gemini
14th	2:45 AM	Last Quarter Moon
15th		m.p. 39 Laetitia 0.8°S of NGC 488 (SG) in Pisces
15th	9 AM	Venus 3° N of Aldebaran
15th	1 PM	Venus 0.7° S of Saturn
16th	7 PM	m.p. 1 Ceres 0.2°SE of star Zeta Sagittarii
17th		Mercury 0.5°SW of star Mu Geminorum
17th		Venus 1°NW of NGC 1647 (OC) in Taurus
17th	9 PM	Saturn 0.6° N of Moon; occultation
18th		m.p. 354 Eleonora 0.3°NE of NGC 4438 (SG) in Virgo
18th		m.p. 39 Laetitia 0.8°N of NGC 520 (IG) in Pisces
18th	2 AM	Venus 0.3° S of Moon; occultation
19th	8 AM	Jupiter 0.2° N of Moon; occultation
19th	9 PM	Mercury 1.0° S of Moon; occultation
20th	7 AM	Mars stationary
21st	3:44 AM	New Moon
22nd		Mercury at ascending node
22nd	5 AM	Moon at perigee
23rd		m.p. 354 Eleonora 0.2°SW of M89 (SG) in Virgo
23rd	6 PM	m.p. 6 Hebe 0.1°N of NGC 4698 (SG) in Virgo
25th		m.p. 354 Eleonora 0.3°N of M58 (SG) in Virgo
25th	7 PM	m.p. 1 Ceres 0.1°SW of M54 (GC) in Sagittarius
26th	5 PM	Pallas stationary
27th		Mercury at perihelion
27th	6:08 PM	First Quarter Moon
28th		m.p. 3 Juno 0.2°NW of NGC 2169 (OC) in Orion
28th		m.p. 354 Eleonora 0.1°SW of M59 (EG) in Virgo
28th		Venus 0.3°NW of star Zeta Tauri
27th	11 PM	Mercury 6° S of Pollux
29th		m.p. 354 Eleonora 0.2°SW of M60 (EG) in Virgo
30th		m.p. 354 Eleonora 0.1°N of NGC 4660 (EG) in Virgo
30th	8 PM	Neptune at opposition
30th	10 PM	Mars 6° S of Moon

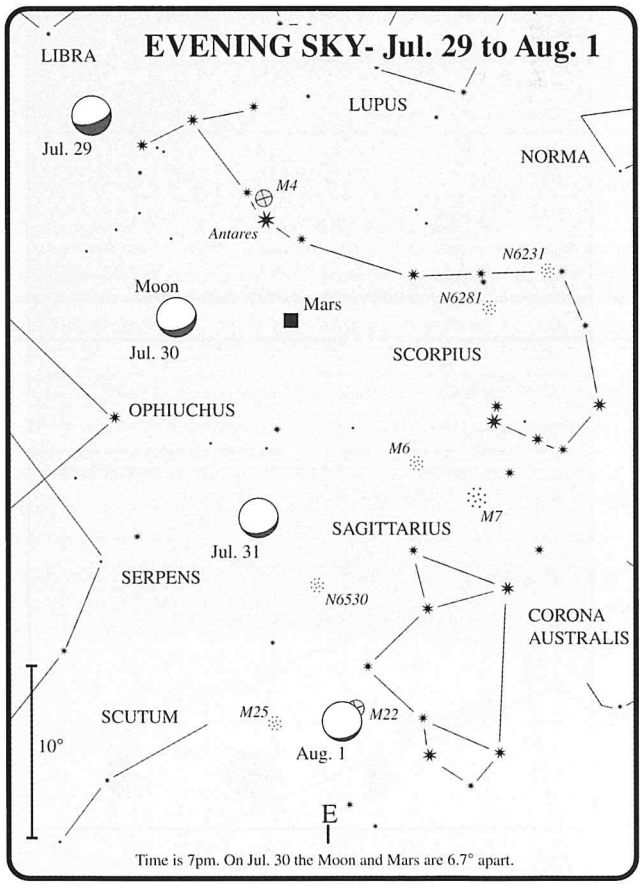





DAWN SKY- Jul. 17 to 19
LEPUS
Great Neb.
(the Saucepan)
N2232
MONOCEROS
N2244
Betelgeuse
GEMINI
ORION
Mercury
Jupiter
M35
Moon
Jul. 19
Jul. 18
TAURUS
Aldebaran
Hyades
Saturn
Venus
Jul. 17
M37
AURIGA
NE
10°
Time is 1 hour before sunrise although Venus and Saturn rise around 4am. On Jul. 18 the Moon is 3° from Venus. On Jul. 19 the Moon and Jupiter are only 1° apart.

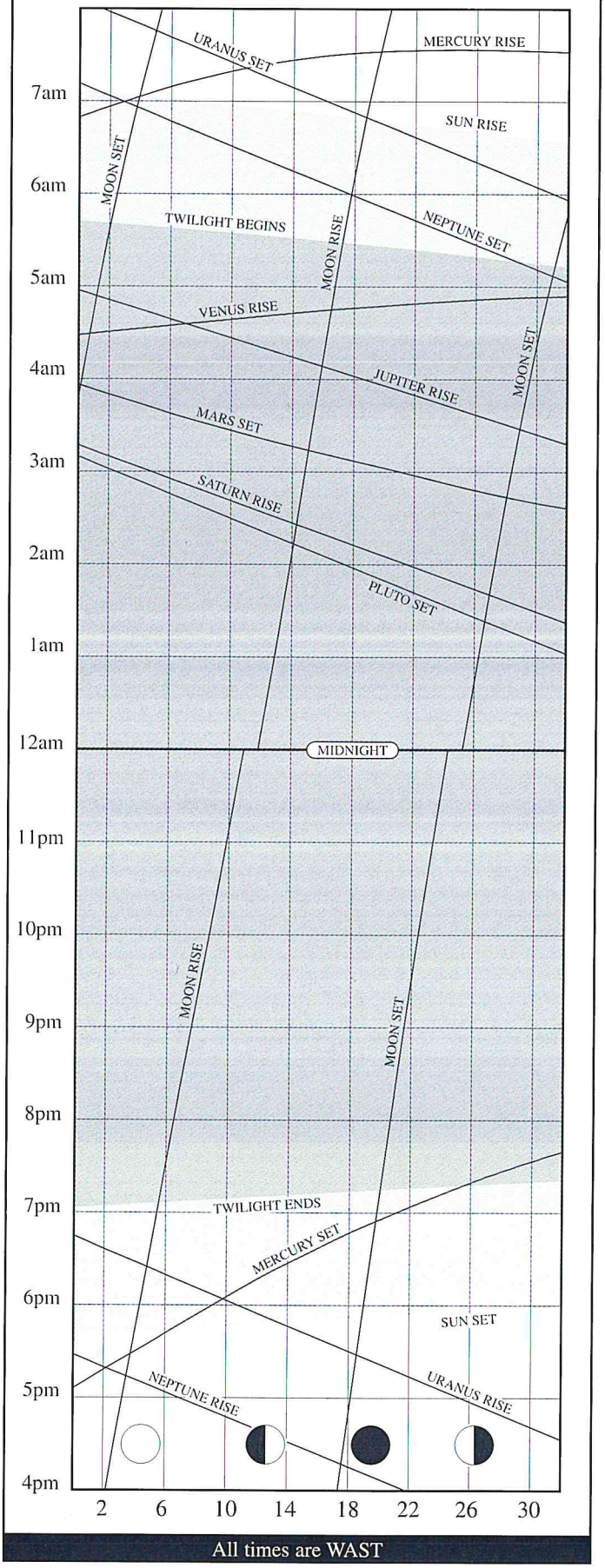

MORNING SKY- late July
Southern delta-Aquarids Meteor Shower
MICROSCOPIUM
CAPRICORNUS
GRUS
PISCIS AUSTRINUS
Fomalhaut
AQUARIUS
SCULPTOR
10°
PISCES
Time is approx. 1am, looking overhead. The shower peaks on July 28. On this date the Moon sets around midnight. A maximum rate of approx. 20 meteors per hour can be expected. The dashed circle is the radiant.


EVENING SKY- Jul. 25 to 27
Arcturus
BOOTES
Jul. 27
VIRGO
Moon
Jul. 26
Spica
Jul. 25
NW
HYDRA
CORVUS
CRATER
10°
Time is 7pm. On Jul. 26 the Moon and Spica are 8.2° apart.


EVENING SKY- Jul. 29 to Aug. 1
LIBRA
LUPUS
Jul. 29
NORMA
M4
Antares
N6231
Moon
Mars
N6281
Jul. 30
SCORPIUS
OPHIUCHUS
M6
M7
SAGITTARIUS
Jul. 31
SERPENS
N6530
CORONA AUSTRALIS
SCUTUM
M25
M22
Aug. 1
10°
E
Time is 7pm. On Jul. 30 the Moon and Mars are 6.7° apart.

AUGUST

RISE/SET CHART



All times are WAST

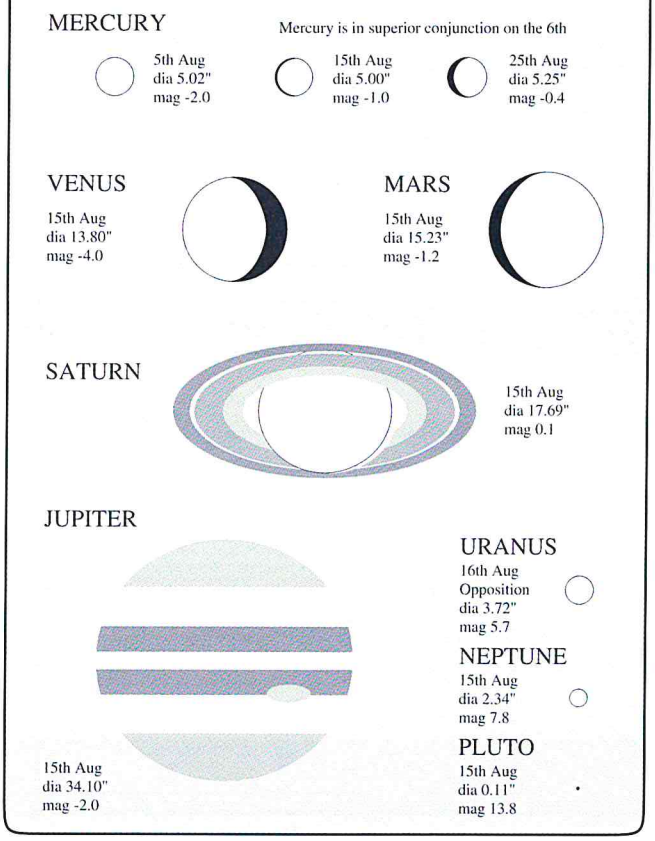
AUGUST HIGHLIGHTS

- Mercury favourable for observation in evening sky at month's end
- Venus and Jupiter very close in morning sky
- Mars near four globular clusters in Ophiuchus
- Jupiter and Moon close together
- Uranus at opposition

THE MOON

4th	Full Moon
6th	Moon at apogee (furthest from Earth – 406,269 km distant, angular size 29.4°)
12th	Last Quarter
14th	Occultation of Saturn by the Moon, not visible from Australia
16th	Occultation of Jupiter by the Moon, not visible from Australia
19th	New Moon
19th	Moon at perigee (closest to Earth – 357,157 km distant, angular size 33.6°)
26th	First Quarter

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is in superior conjunction (Mercury and Earth on opposite sides of the Sun) on the 6th, and thereafter moves into the evening sky. From late this month through to September, Mercury will be at its most favourable position this year for evening observation. Mercury spends the first week of August in Cancer, then moves into Leo, before finally entering Virgo at month's end. On the 20th, the thin crescent 1-day old Moon is situated 5.4° north of the planet (see Sky View).

VENUS rises in the pre-dawn sky. It spends the first week within 5° of Jupiter, and is closest at 1.2° on the 6th - a superb sight in the morning sky (see Sky View). The 27-day old crescent Moon appears 6.5° below Venus on the 17th (see Sky View). The 'Goddess of Love' spends most of the month in Gemini, being 7° from 1st magnitude Pollux (Beta Geminorum - the brighter of the twins), on the 23rd. Towards the end of the month the planet moves into Cancer, finishing up 3.5° from the large bright open cluster Praesepe (M44 or the Beehive).

A DRAMATIC EVENT – V4641 Sagittarii

If you look up at the night sky after dark this month you will see the familiar teapot of Sagittarius almost overhead. To the unaided eye it looks the same as any other night, but as you will see below it is hiding one of the most spectacular objects the Universe has to offer (and in our own backyard - astronomically speaking). It took the dedication of Victorian amateur Rod Stubbings to reveal its presence. Here is the story as told by him.

"One of the most fascinating aspects of astronomy is the observation of variable stars. Variable stars can be observed with the naked eye, binoculars and telescopes depending on what type of variable interests you. A real contribution to astronomy can be made when a variable star's brightness is recorded and sent on to the proper organisations. One particular class of variable is the cataclysmic (explosive and nova-like) star – you never know what to expect on any given night.

"I had been observing the variable star V4641 Sgr, in the constellation of Sagittarius near the centre of our galaxy. The star was showing some rapid variations ranging from magnitude 11.1 to 11.9 over a number of nights. On September 15 1999, in the course of my observing program, I went outside to make a few observations in between clouds as there was a storm approaching. First up was V4641 Sgr, WOW! Now this is what you call an outburst. The star had exploded to magnitude 8.8. I raced inside and sent an e-mail message around the world. (Editors note. A three magnitude jump means the star had increased in brightness by 15 times)

"Within an hour the outburst was confirmed with CCD images at the Kyoto University Japan. Japanese astronomer, Taichi Kato, recalled that this object had been associated with X-ray emissions and forwarded the message to professional astronomers. Astronomers at the Massachusetts Institute of Technology diverted a NASA X-ray telescope to take a look and showed a rapid rise and fall in X-ray brightness. Within 24 hours, the Very Large Array (VLA) radio telescope in New Mexico was observing V4641 Sgr. Other radio telescopes observing the object were: NRAO's Green Bank Interferometer in West Virginia, the Australian Telescope Compact Array, the Molonglo Observatory Synthesis Telescope (also in Australia), the Merlin array in Britain, the Ratan 600 metre radio telescope in Russia and radio telescopes at the Owens Valley Radio Observatory in California.

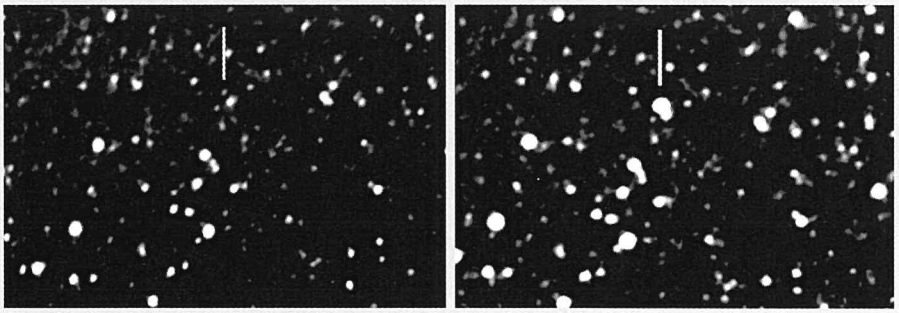
"This outburst lasted less than half a day and was gone!

"The neutron star at the heart of the well known Crab Nebula is so regular in its rotation and brightness that astronomers use it as a standard candle for measuring the brightness of other x-ray sources. V4641 Sgr became 1,200 times more luminous than the Crab, and for a brief moment was the brightest source in the sky.

"The (VLA) radio telescope revealed the presence of twin jets escaping the system at nine-tenths the speed of light. The size of the jets was around 125 Astronomical Units, more than three times the distance from the Sun to Pluto. From all the information collected it is now believed V4641 Sgr is a black-hole binary system. Being only 1,600 light years away makes it the nearest black hole.

"One could hardly think that such a simple observation of a variable star would reveal such a dramatic event around the world."

Rod is a member of the Latrobe Valley Astronomical Society. He has been observing variable stars since May 1993 and mainly monitors the dwarf novae class of variable star for outbursts. He averages over 1400 observations a month which are sent to the RASNZ. His total observations to the end June 2000 are over 80,000. Rod typically detects between 30 - 50 outbursts each month and when such an event is found he immediately reports this to VSNET, AAVSO and RASNZ. He also gets requests from astronomers to monitor stars for them as well as important program stars from each variable star organisation.



V4641 Sgr Outburst. The images were taken on the 9th September (before the outburst, left image) and on 15th September (during outburst, right image) using an unfiltered ST-7 CCD camera attached to a 25cm Schmidt Cassegrain telescope at the University of Kyoto, Japan. Makoto Uemura and Taichi Kato.

AUGUST

MARS is visible most of the night, setting around 3am (mid-month). Its disk shrinks to around 14 arc seconds this month, equivalent to the size at a poor opposition. Even after dropping in magnitude to -1.2 (-2.4 at opposition), the planet is still brilliant in the early evening sky, situated overhead in Ophiuchus. Planetary surface detail by this time may be difficult, but being confined to the rich galactic regions of the Milky Way some attractive photographic and low power telescopic views present themselves. Mars will be near the following globular clusters.

- from the 3rd to the 9th, within 1° of M19 (closest on 6th at 0.6°)
- on the 12th and 13th, 0.5° from NGC6293
- on the 17th, 1° from NGC6316
- on the 21st, 0.7° from NGC6355

The 9-day old waxing gibbous Moon appears 5° from the planet on the 27th (see Sky View).

JUPITER is in the late eastern morning sky, rising at 4am (mid-month). This gas giant and Venus provide a grand sight in the dawn sky when they move within 1.2° of each other on the 6th (see Sky View). On the 16th, the 26-day old waning crescent Moon appears 1.9° from the planet (see Sky View), and from parts of the Northern Hemisphere the Moon will occult Jupiter.

SATURN is in the morning sky, rising about 2 hours before Jupiter. It begins the month 4.5° from the 1st magnitude star Aldebaran in Taurus, the separation increasing to 6° by month's end. On the 14th, the 24-day old crescent Moon will be 3° from the planet forming a triangle with Aldebaran (see Sky View). Although not seen from our part of the globe, an occultation of Saturn occurs for parts of Africa, India and Indonesia.

URANUS and **NEPTUNE** rise before sunset and are visible most of the night. The Full Moon appears 3° from Neptune on the morning of 4th and 6° from Uranus on the evening of 5th. On the 15th, Uranus will be at opposition.

PLUTO is in the evening sky, setting around 2am (mid-month). After being in retrograde motion for the past five months, this distant world appears stationary on the 25th, thereafter reverting to its eastward direction.

MINOR PLANETS at opposition this month include 10 Hygiea on the 30th at magnitude 9.8 in Aquarius and 349 Dembowska on the 17th at magnitude 9.7 in Piscis Austrinus.

COMETS

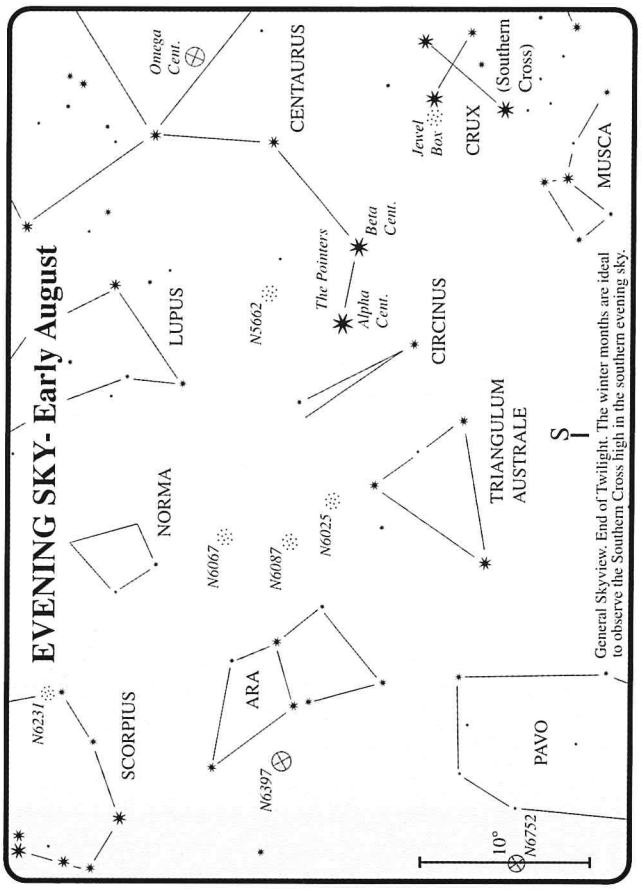
Comet 19P/Borrelly brightens from 10th to 9th magnitude during August, and it can be found in the morning sky. Most of the month, Borrelly can be found in the constellation of Orion, entering Gemini near the end of August. At month's end, the comet is near Gamma Geminorum.

METEOR SHOWERS

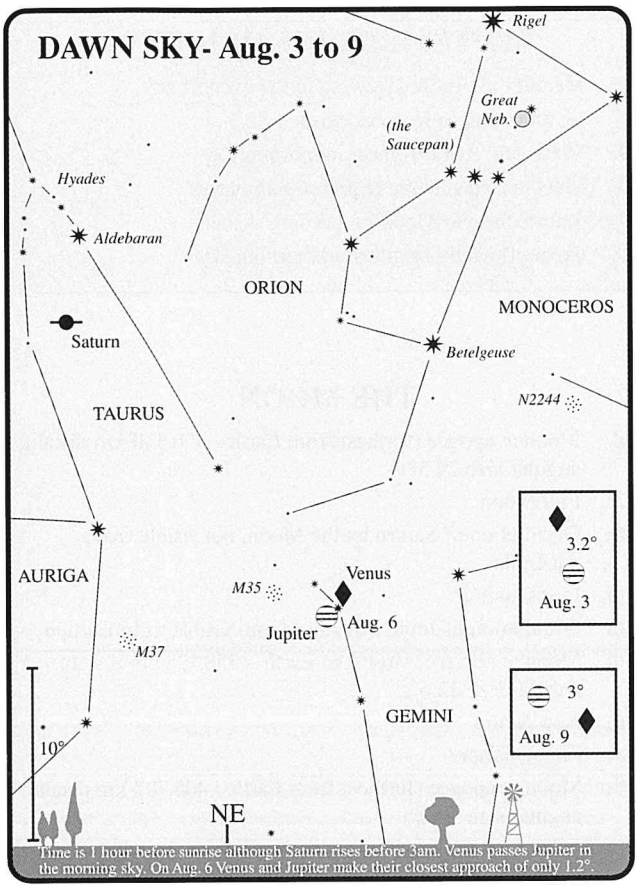
The **Northern iota-Aquarids** are a minor shower active from the 11th through to the 31st August, with maximum activity on the 19th. The hourly rate is 3, and the shower is visible late evening in the eastern sky until dawn in the west.

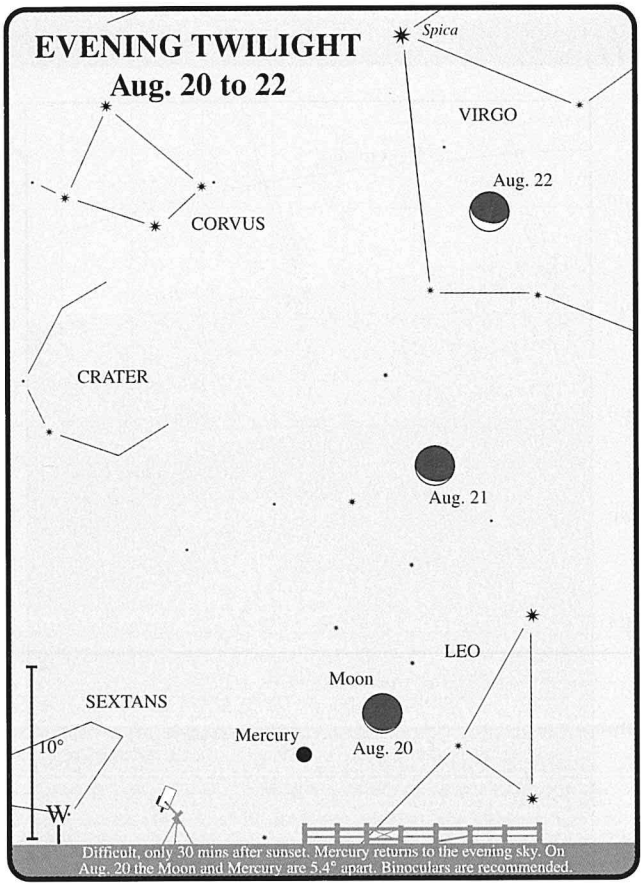
DIARY OF EVENTS

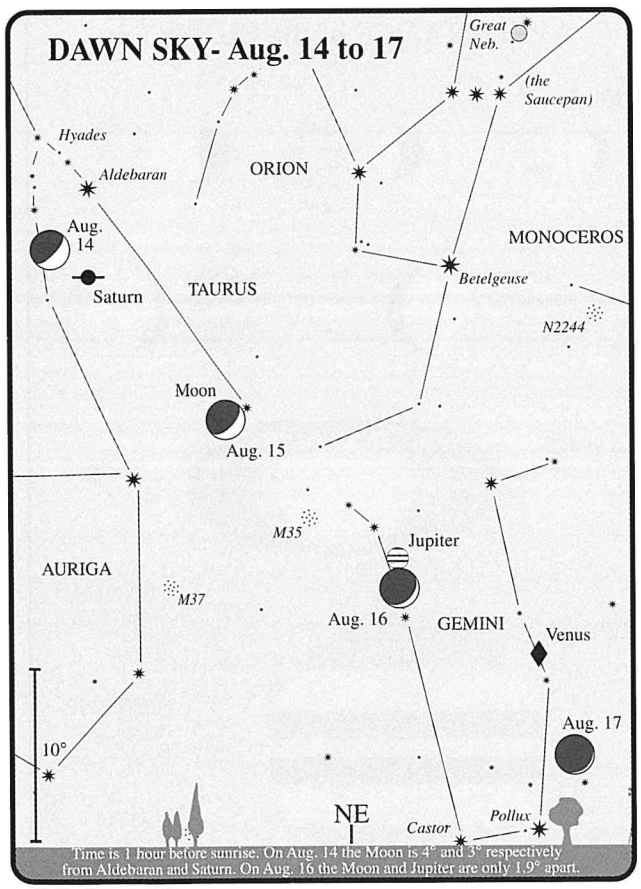
1st		m.p. 40 Harmonia 0.3°SE of star Epsilon Tauri
4th	3 AM	Neptune 3° N of Moon
4th	1:56 PM	Full Moon
5th		m.p. 29 Amphitrite 0.3°S of NGC 5079 (SG) in Virgo
5th	11 AM	Uranus 3° N of Moon
6th		Mercury at greatest latitude North
6th	5 AM	Moon at apogee
6th	6 AM	Mercury in superior conjunction
6th	8 AM	Venus 1.2° S of Jupiter
6th	7 PM	Mars 0.6°S of M19 (GC) in Ophiuchus
7th		Jupiter 0.6°N of star Mu Geminorum
7th		Saturn 1.6°N of NGC 1647 (OC) in Taurus
7th		Venus 1°SE of star Mu Geminorum
10th		m.p. 40 Harmonia 0.5°N of NGC 1647 (OC) in Taurus
12th		Comet 19P/Borrelly 0.4°NE of star Lambda Orionis
12th		Saturn 1°N of m.p. 40 Harmonia
12th	3:53 PM	Last Quarter Moon
12th	7 PM	Mars 0.4°S of NGC 6293 (GC) in Ophiuchus
14th	11 AM	Saturn 0.2° N of Moon; occultation
14th	7 PM	m.p. 1 Ceres 1.2°N of M70 (GC) in Sagittarius
15th		m.p. 89 Julia 0.4°SE of NGC 925 (SG) in Triangulum
15th	11 PM	Uranus at opposition
16th	4 AM	Jupiter 0.4° S of Moon; occultation
16th	9 PM	Venus 1.9° S of Moon
17th		Mars 1°N of NGC 6316 (GC) in Ophiuchus
19th	10:55 AM	New Moon
19th	2 PM	Moon at perigee
20th		Venus 0.6°E of NGC 2392 (Eskimo Neb.) in Gemini
21st		Venus 0.8°SW of NGC 2420 (OC) in Gemini
21st	7 PM	Mars 0.7°S of NGC 6355 (GC) in Ophiuchus
22nd	9 PM	Venus 7° S of Pollux
24th		Comet 19P/Borrelly 0.6°N of NGC 2194 (OC) in Orion
25th	3 PM	Pluto stationary
26th	3:55 AM	First Quarter Moon
27th	8 PM	Mars 5° S of Moon
28th	10 AM	Ceres stationary
30th		Mercury at descending node
30th	7 PM	m.p. 14 Irene 0.7°SW of NGC 6284 (GC) in Ophiuchus
31st	8 AM	Neptune 3° N of Moon

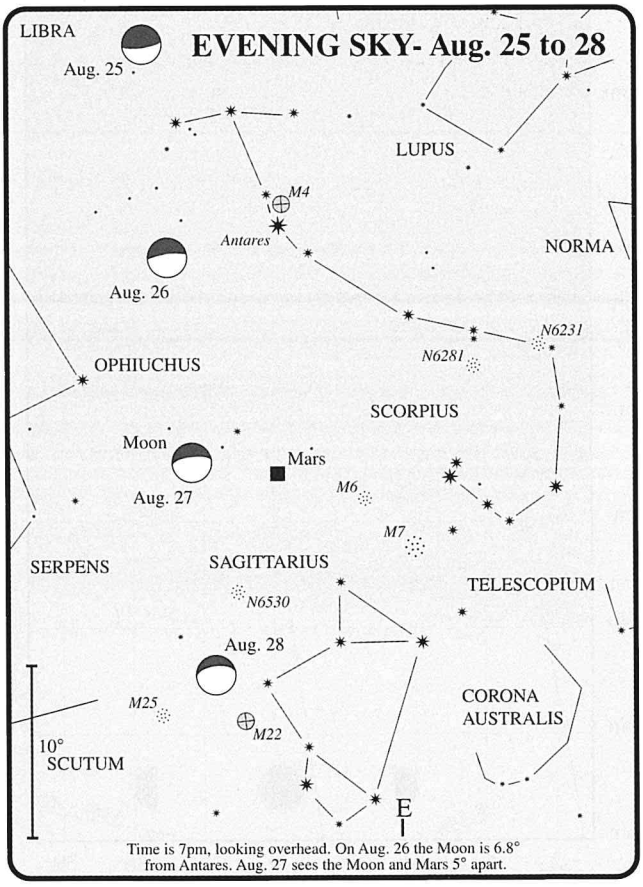


AUGUST


DAWN SKY- Aug. 3 to 9
Rigel
Great Neb.
(the Saucepan)
Hyades
Aldebaran
ORION
MONOCEROS
Saturn
Betelgeuse
N2244
TAURUS
AURIGA
M35
Venus
Jupiter
Aug. 6
M37
3.2°
Aug. 3
3°
Aug. 9
GEMINI
10°
NE
Time is 1 hour before sunrise although Saturn rises before 3am. Venus passes Jupiter in the morning sky. On Aug. 6 Venus and Jupiter make their closest approach of only 1.2°.

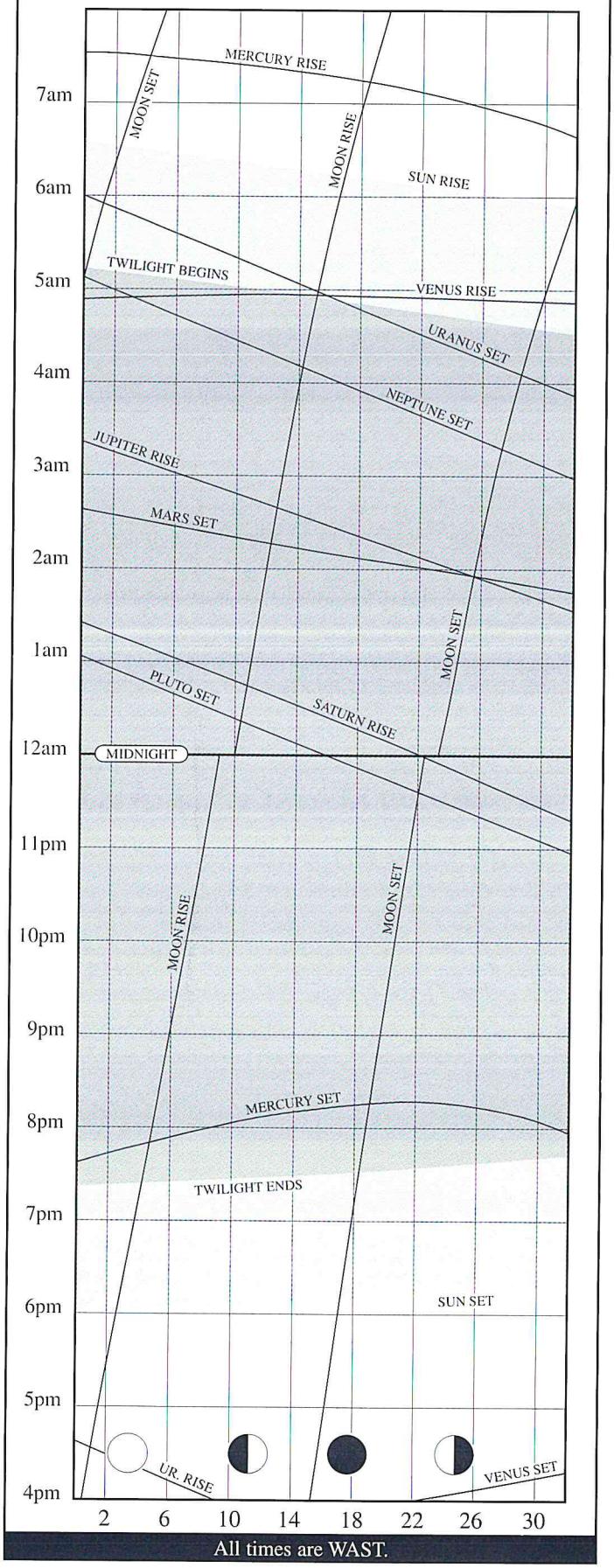

EVENING TWILIGHT
Aug. 20 to 22
Spica
VIRGO
Aug. 22
CORVUS
CRATER
Aug. 21
LEO
Moon
SEXTANS
Mercury
Aug. 20
10°
W
Difficult, only 30 mins after sunset. Mercury returns to the evening sky. On Aug. 20 the Moon and Mercury are 5.4° apart. Binoculars are recommended.


DAWN SKY- Aug. 14 to 17
Great Neb.
(the Saucepan)
Hyades
Aldebaran
ORION
Aug. 14
MONOCEROS
Saturn
TAURUS
Betelgeuse
N2244
Moon
Aug. 15
M35
Jupiter
AURIGA
M37
Aug. 16
GEMINI
Venus
Aug. 17
10°
NE
Castor
Pollux
Time is 1 hour before sunrise. On Aug. 14 the Moon is 4° and 3° respectively from Aldebaran and Saturn. On Aug. 16 the Moon and Jupiter are only 1.9° apart.


LIBRA
Aug. 25
EVENING SKY- Aug. 25 to 28
LUPUS
M4
Antares
NORMA
Aug. 26
N6231
N6281
OPHIUCHUS
SCORPIUS
Moon
Mars
Aug. 27
M6
M7
SERPENS
SAGITTARIUS
TELESCOPIUM
N6530
Aug. 28
M25
M22
CORONA AUSTRALIS
10°
SCUTUM
E
Time is 7pm, looking overhead. On Aug. 26 the Moon is 6.8° from Antares. Aug. 27 sees the Moon and Mars 5° apart.

SEPTEMBER

RISE/SET CHART



All times are WAST.

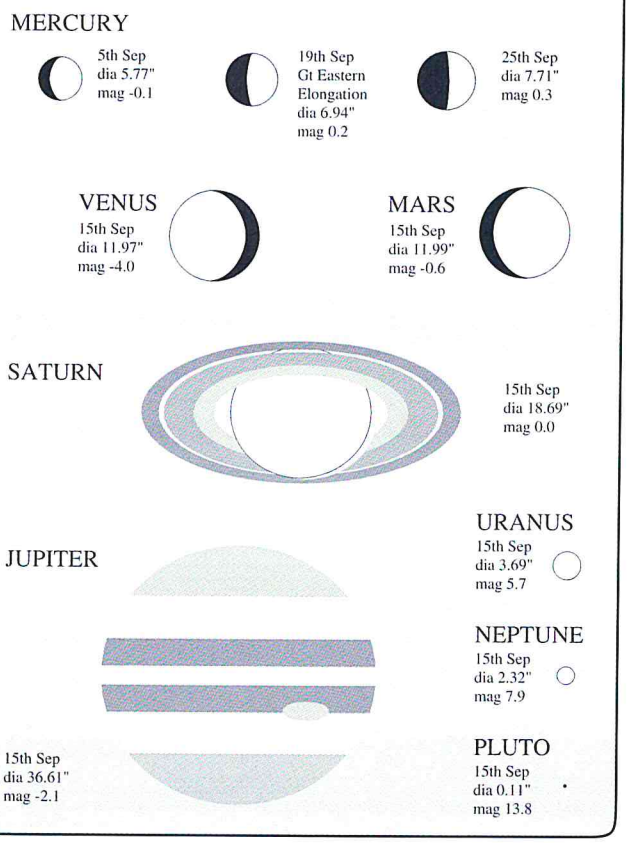
SEPTEMBER HIGHLIGHTS

- Mercury at best for viewing in the evening sky
- Mercury and Spica very close
- Venus and Regulus meet in morning sky
- Mars in rich galactic region of Sagittarius
- Saturn close to Moon in morning sky
- Comet Borrelly brightest in morning sky

THE MOON

2nd	Moon at apogee (furthest from Earth – 406,330 km distant, angular size 29.5°)
3rd	Full Moon
10th	Occultation of Saturn by the Moon, not visible from Australia
11th	Last Quarter
12th	Occultation of Jupiter by the Moon, visible from Europe
16th	Moon at perigee (closest to Earth – 358,128 km distant, angular size 32.6°)
17th	New Moon
24th	First Quarter
29th	Moon at apogee (furthest from Earth – 405,787 km distant, angular size 30.0°)

APPEARANCE of the PLANETS



THE PLANETS

MERCURY reaches its greatest elongation (27°) east of the Sun on the 19th, and for the entire month is at its best in the evening sky in Virgo. Between the 18th and 22nd, Mercury will be within 2° of the first magnitude star Spica (Alpha Virginis), the pair are closest on the 20th at 0.8° apart (Mercury is slightly brighter and passes south of Spica). On the 19th, the 2-day old thin crescent Moon will be a little over 7° from the planet and star (see Sky View).

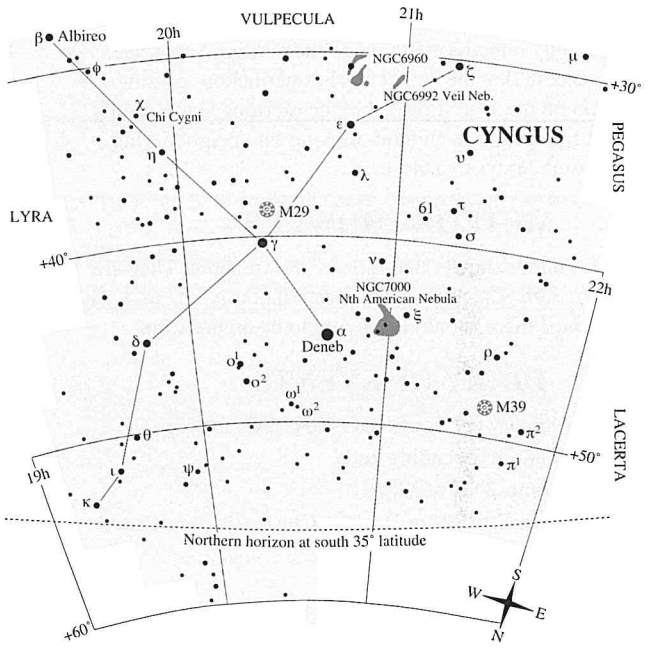
VENUS is in the late morning sky, rising around the start of twilight. It spends the first few days of September within 2.5° of the large bright open cluster Praesepe (M44 or the Beehive) in Cancer. On the 15th the crescent Moon will be 7.2° from the planet (see Sky View). After crossing into Leo mid-month, Venus moves directly toward the 1st magnitude star Regulus (Alpha Leonis), approaching within a close 0.5° on the 21st.

The **EARTH** is at Vernal Equinox on the 23rd. The Sun is directly above the equator and day and night are equal. The Sun will continue to move southwards towards the December Solstice.

MARS is high in the evening sky, setting around 2am. The 'God of War' begins the month on the Ophiuchus/Sagittarius border, then moves through the fine, object rich regions of the Milky Way in Sagittarius. By mid-month it will be quite distinctive as it interrupts the familiar pattern of the Teapot. The First Quarter Moon is 7° from the Red Planet on the 24th, and closer at 5.7° on the following evening (see Sky View). On the 30th, Mars is just 0.5° from 2nd magnitude Sigma Sagittarii, one of the stars forming the handle of the Teapot.

CONSTELLATION OF THE MONTH — Cygnus (Cyg)

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



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

The Cygnus area is bathed in nebulosity and two of the best known are visible in binoculars, assuming good dark skies. The North American Nebula (NGC7000, about 3° east of Deneb) has a shape that looks extraordinarily similar to its terrestrial counterpart, including the Gulf of Mexico. As the nebula is about two degrees across, binoculars are best, but small telescopes at low magnification do quite well. More difficult to observe is the Great Cygnus Loop (NGC6960 & NGC6992), between Epsilon Cygni and the Vulpecula border. This is a vast expanding cloud like bubble, the remains of a supernova. The bright portion known as the Veil Nebula (NGC6992) is visible in binoculars. The full beauty, seen in photographs, requires a very large amateur telescope equipped with a nebula filter. The authors were fortunate to see this nebula through 50 cm Dobsonian binoculars from the Northern Hemisphere in 1995. The view, at an altitude of 2,100m, was breathtaking as we slowly moved the telescope through the region, allowing the fine delicate filament-like structure to unfold before us.

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

Considered by many to be one of the finest binary stars in the sky is Albireo (Beta Cygni). This is a real gem in small telescopes and set in a good field. The stars have good colour contrast and appear yellow and blue. Their magnitudes are 3.1 and 5.1 and the separation is a wide 35 arc seconds. Another double is 61 Cygni. These are two red dwarf stars with magnitudes of 5.2 & 6.0, separated by 30 arc seconds. 61 Cygni was the first star to have its parallax measured (in 1838), from these measures the star was found to be close by at only 11 light years (the 15th closest star to our Solar System). From its motion it is thought that the brighter of the two stars has at least one body (about 8 times the mass of Jupiter) in orbit.

Chi Cygni is a Mira type variable star, which varies from 14.2 magnitude at minimum, to about 4.5 at maximum (it has at times reached 3.5 magnitude). This red star, which fluctuates with a period of 408 days is the second brightest of the Mira variables

SEPTEMBER

JUPITER rises in the early morning eastern sky in Gemini. On the 13th, the 24-day old waning crescent Moon appears 5.6° from the planet (see Sky View).

SATURN appears in the early morning sky around 6° from the 1st magnitude star Aldebaran (rising at midnight). On the 10th, the Last Quarter Moon appears 10° from the ringed planet, forming a triangle with Aldebaran. On the following evening the Moon and Saturn appear closer being only 4.2° apart (see Sky View).

URANUS and **NEPTUNE**, in Capricornus, are high in the northern sky around 9pm mid-month. The Moon is less than 4° from Uranus on the evenings of the 1st and 28th, and also 4° from Neptune on the evening of 27th.

PLUTO sets in the late evening sky this month and next, providing the last opportunity to locate this distant world in 2001.

MINOR PLANET 19 Fortuna is at opposition this month on the 27th at magnitude 9.4 in Pisces.

COMETS

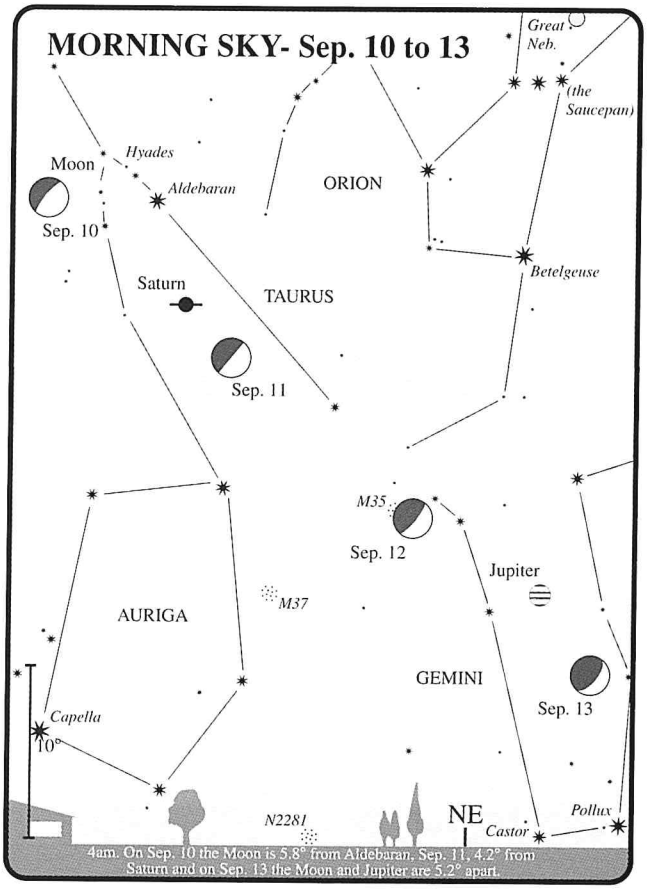
Comet 19P/Borrelly remains at 9th magnitude during September. This is also the month that the comet reaches perihelion, passing 1.4 AU from the Sun on the 14th. Located in the morning sky, Borrelly spends much of September in Gemini, moving into neighbouring Cancer as the month draws to a close.

METEOR SHOWERS

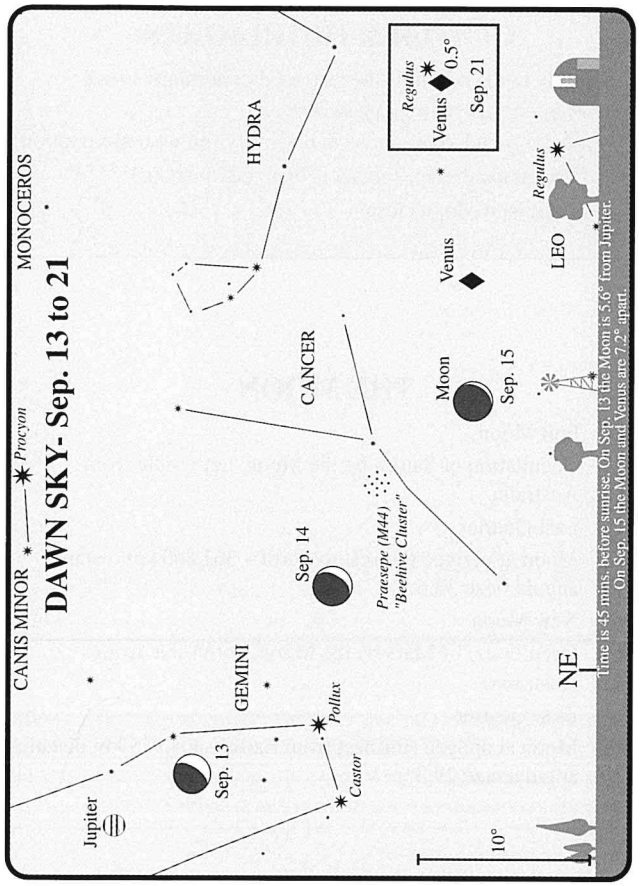
The **Piscids** are a minor shower that little is known about. They are active from 1st to 30th September, with a zenith hourly rate of 3. The date of maximum (if there is one) is thought to be on the 19th.

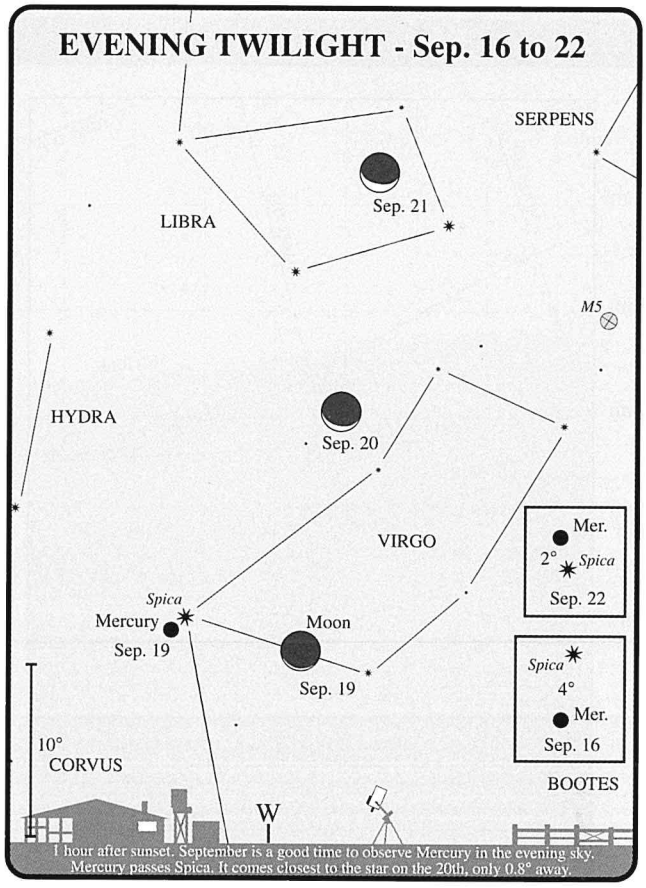
DIARY OF EVENTS

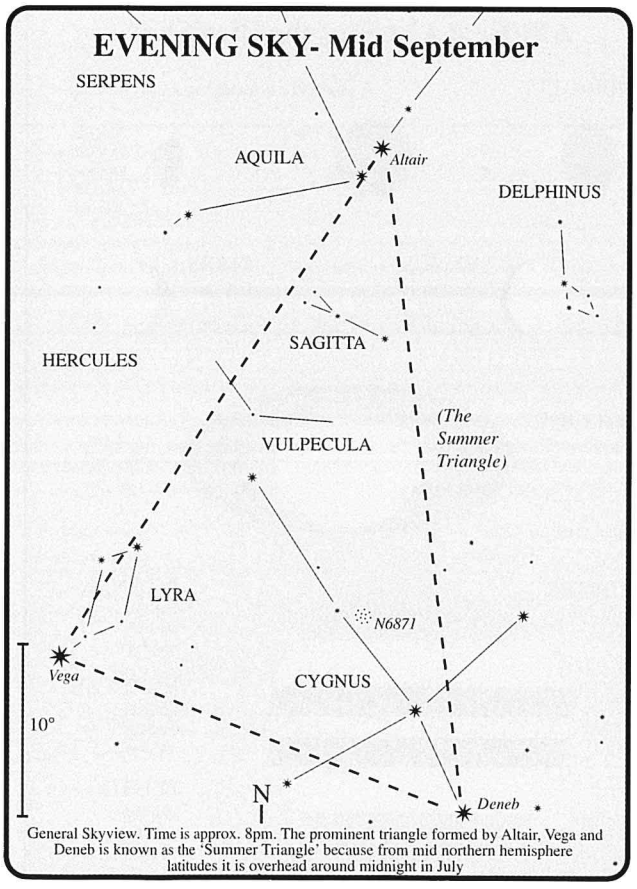
1st		Mercury 0.7°N of NGC 4030 (SG) in Virgo
1st		Venus at ascending node
1st	3 PM	Uranus 3° N of Moon
2nd		Venus 1.6°SW of Beehive Cluster (OC) in Cancer
2nd	7 AM	Moon at apogee
3rd	5:43 AM	Full Moon
5th		m.p. 4 Vesta 1.2°S of star Aldebaran
5th		m.p. 43 Ariadne 0.4°SE of star Beta Scorpii
8th	7 PM	m.p. 14 Irene 0.9°NE of NGC 6293 (GC) in Ophiuchus
9th		Mercury 0.5°S of NGC 4593 (SG) in Virgo
9th		Mercury at aphelion
10th	9 PM	Saturn 0.2° S of Moon; occultation
11th		Mercury 0.8°SW of NGC 4731 (SG) in Virgo
11th	2:59 AM	Last Quarter Moon
11th	7 PM	m.p. 42 Isis 0.4°NE of NGC 6316 (GC) in Ophiuchus
12th	7 PM	Mars 0.9°S of NGC 6553 (GC) in Sagittarius
12th	8 PM	Jupiter 1.0° S of Moon; occultation
13th		m.p. 15 Eunomia 0.4°S of star Pi Scorpii
13th		Mercury 0.3°NE of NGC 4818 (SG) in Virgo
15th		Mercury 1°NE of NGC 4939 (SG) in Virgo
15th	3 PM	Venus 3° S of Moon
16th		Mars at greatest latitude South
16th	Midnight	Moon at perigee
17th	6:27 PM	New Moon
19th	6 AM	Mercury greatest elongation E (27°)
19th	10 AM	Mercury 8° S of Moon
19th	7 PM	m.p. 14 Irene 0.1°N of NGC 6355 (GC) in Ophiuchus
21st	4 AM	Mercury 0.9° S of Spica
21st	4 AM	Venus 0.5° N of Regulus
21st	7 PM	Mars 0.9°S of NGC 6638 (GC) in Sagittarius
23rd	7 AM	Equinox
24th	5:31 PM	First Quarter Moon
25th	9 AM	Mars 2° S of Moon
27th		m.p. 3 Juno 0.5°SW of star Beta Cancri
27th		m.p. 43 Ariadne 0.8°N of NGC 6235 (GC) in Ophiuchus
27th	11 AM	Saturn stationary
27th	1 PM	Neptune 3° N of Moon
27th	7 PM	Mars 1°N of star Phi Sagittarii
28th		m.p. 11 Parthenope 0.6°S of star Gamma Tauri
28th	7 PM	Uranus 3° N of Moon
29th		Mercury at greatest latitude South
29th	2 PM	Moon at apogee
30th	9 PM	Mars 0.6°N of star Sigma Sagittarii

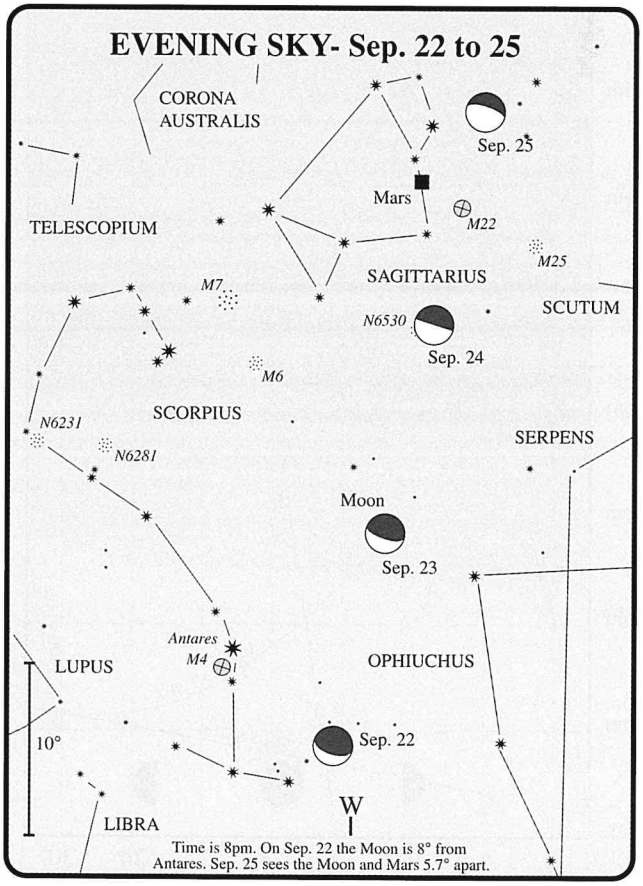


SEPTEMBER


DAWN SKY- Sep. 13 to 21
MONOCEROS
HYDRA
CANCER
LEO
GEMINI
CANIS MINOR
Procyon
Regulus
Venus
0.5°
Sep. 21
Regulus
Venus
Moon
Sep. 15
Sep. 14
Praesepe (M44)
"Beehive Cluster"
Pollux
Castor
Sep. 13
Jupiter
NE
10°
Time is 45 mins. before sunrise. On Sep. 13 the Moon is 5.6° from Jupiter.
On Sep. 15 the Moon and Venus are 7.2° apart.

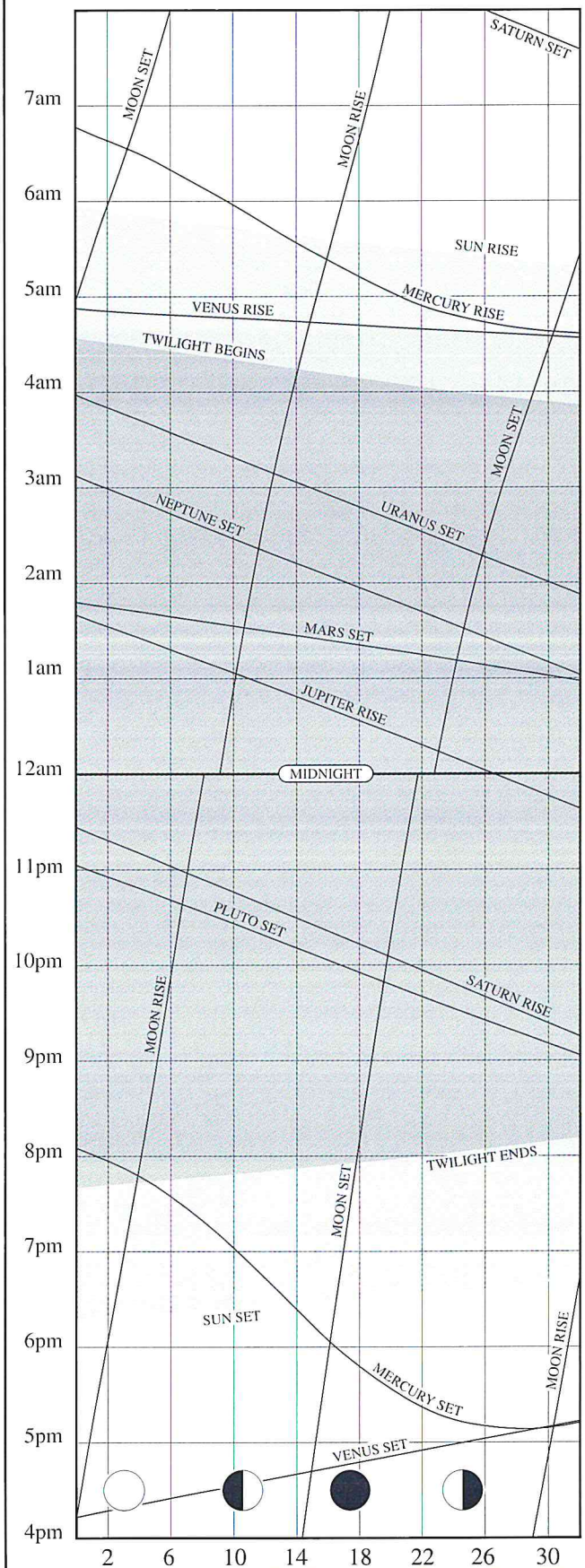

EVENING TWILIGHT - Sep. 16 to 22
SERPENS
LIBRA
Sep. 21
M5
HYDRA
Sep. 20
VIRGO
Mer.
2°
Spica
Sep. 22
Spica
Mercury
Sep. 19
Moon
Sep. 19
Spica
4°
Mer.
Sep. 16
10°
CORVUS
BOOTES
W
1 hour after sunset. September is a good time to observe Mercury in the evening sky.
Mercury passes Spica. It comes closest to the star on the 20th, only 0.8° away.


EVENING SKY- Mid September
SERPENS
AQUILA
Altair
DELPHINUS
SAGITTA
HERCULES
VULPECULA
(The
Summer
Triangle)
LYRA
N6871
Vega
CYGNUS
10°
N
Deneb
General Skyview. Time is approx. 8pm. The prominent triangle formed by Altair, Vega and
Deneb is known as the 'Summer Triangle' because from mid northern hemisphere
latitudes it is overhead around midnight in July


EVENING SKY- Sep. 22 to 25
CORONA
AUSTRALIS
Sep. 25
Mars
M22
TELESCOPIUM
M25
SAGITTARIUS
M7
SCUTUM
N6530
Sep. 24
M6
SCORPIUS
N6231
N6281
SERPENS
Moon
Sep. 23
Antares
M4
LUPUS
OPHIUCHUS
10°
Sep. 22
W
LIBRA
Time is 8pm. On Sep. 22 the Moon is 8° from
Antares. Sep. 25 sees the Moon and Mars 5.7° apart.

OCTOBER

RISE/SET CHART



All times are WAST.

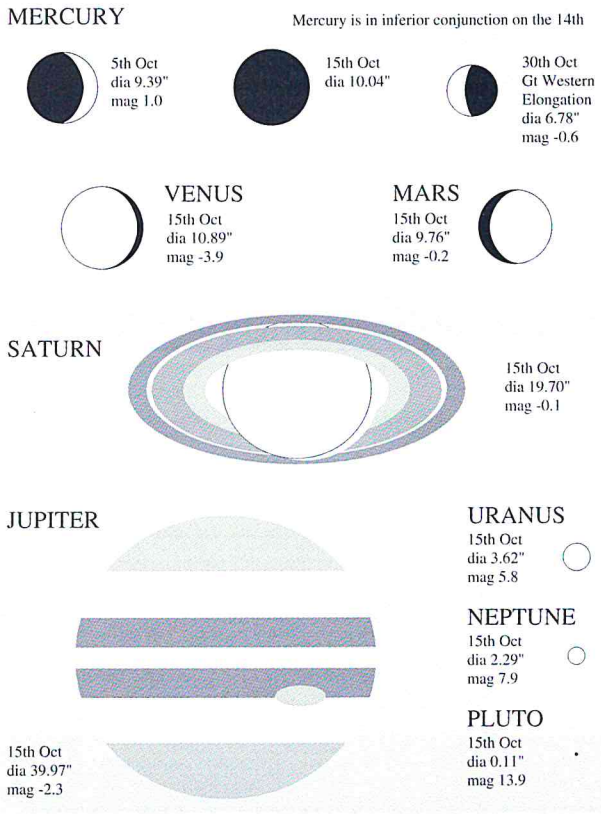
OCTOBER HIGHLIGHTS

- Early in the month is the last good opportunity to see Mercury in evening sky in 2001
- Mercury and Venus close in dawn sky (difficult observation)
- Mars at quadrature (planet is distinctly gibbous)
- Saturn and Moon close

THE MOON

2nd	Full Moon
8th	Occultation of Saturn by the Moon, not visible from Australia
10th	Last Quarter
15th	Moon at perigee (closest to Earth – 361,860 km distant, angular size 32.6°)
17th	New Moon
24th	Occultation of Mars by the Moon, not visible from Australia
24th	First Quarter
27th	Moon at apogee (furthest from Earth – 404,935 km distant, angular size 29.3°)

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is visible for the first week of October in the western evening sky, however it then rapidly loses altitude as it moves toward the Sun and inferior conjunction (between the Earth and the Sun) on the 14th. Moving into the morning sky, Mercury reaches its greatest elongation from the Sun (19°) on the 30th. This morning return is a poor one, with the Sun rising only 40 minutes after the planet. Those with a good eastern horizon may like to attempt to catch a glimpse of Mercury and Venus just 0.7° apart in the twilight from the 29th. This will be a difficult observation with the Sun rising so soon after these planets (see Sky View).

VENUS can be observed close to the horizon in the eastern morning twilight. From next month, Venus will be too close to the Sun for observation until after superior conjunction early next year. Venus is in the constellation Leo early in the month, then crossing over into Virgo. On the 15th, the thin crescent Moon will be 6° from Venus; a difficult observation in the twilight (see Sky View).

MARS is in the evening sky, setting around 1.30am (mid-month). This month, the planet moves away from the denser regions of the Milky Way in Sagittarius, on its way to Capricornus. On the 23rd, the First Quarter Moon is 4.6° from the Red Planet (see Sky View), and on the following evening 7°. Mars appears within 1° of the globular cluster M75, between the 25th and 27th, just before crossing the border into Capricornus. Now over three months past opposition, the planet has reached that part of its orbit known as quadrature, when the Sun-Earth-Mars angle is 90° (see diagram page 6). Telescopically at this time the Mars appears distinctly gibbous (egg shaped), with the Sun illuminating only 86% of the visible disc.

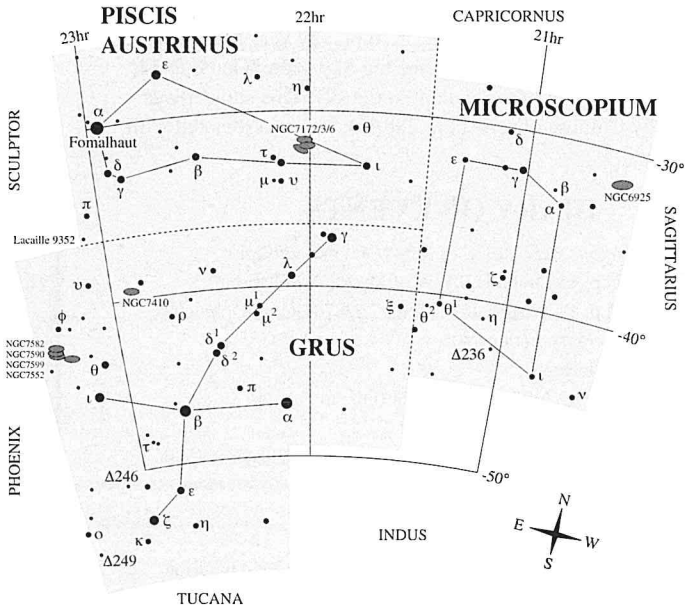
JUPITER rises in the northeastern sky around midnight above the Gemini twins Castor and Pollux. On the 10th, the 22-day old waning gibbous Moon will be 4° from the planet (see Sky View).

SATURN is in the late eastern evening sky, rising about two hours before Jupiter. This pair are now separated by 30° and it is interesting to note that just 16 months ago they were only a little over 1° apart. We will have to wait until the year 2020 before the faster moving Jupiter again catches up to, and overtakes the ringed planet. On the 8th, the 20-day old Moon is a close 1.3° from Saturn (see Sky View).

URANUS and **NEPTUNE** transit the meridian around 7.30pm mid-month. The First Quarter Moon appears 3° from Neptune on the evening of the 24th and 5° from Uranus on the following evening. Both planets end their retrograde motion this month and return to their west to east motion against the star field.

CONSTELLATIONS OF THE MONTH — GRUS (Gru) MICROSCOPIUM (Mic) and PISCIS AUSTRINUS (PsA)

Piscis Austrinus (pronounced pie-siss os-try-nus), the Southern Fish, is also referred to as Piscis Australis. Its origins go back far in time and is believed to be the parent of Pisces, the zodiac constellation of the fishes. The 'mouth of the fish' is the bright 1st magnitude star Fomalhaut; it is in this mouth that the stream of water poured from an urn by Aquarius ends up. For the galaxy hunter there are several worth investigating, three of which are grouped within the same field, NGC7172, 7173 and 7176. There are also some good binary stars within the constellation. Of note for small instruments are Beta and Gamma Piscis Austrini. Beta consists of a 4.5 yellow star with an 8th magnitude white companion 30 arc seconds away. Gamma is a little more difficult, being two yellowish suns of magnitude 4.5 and 8, separated by only 4 arc seconds. An 8th magnitude star known as Lacaille 9352 is interesting because of its large proper motion. At a distance of 10.7 light years from us, the star is moving at 6.9 arc seconds per year, this is the fourth fastest proper motion known. Even amateurs can detect this motion, either by photography or careful drawings made a few years apart. In about 130 years the star will move across the border into Sculptor.



To the east of Piscis Austrinus is the rather unremarkable Microscopium (pronounced my-krow-scop-ee-um). Lacaille introduced the Microscope in 1752. It is one of 14 minor constellations conceived by him in honour of instruments of science and the arts. The constellation does not contain any stars brighter than 5th magnitude, but several binary stars are worth a look, as is the brightest galaxy NGC6925. Alpha Microscopii is an easy pair of 5th and 10th magnitude stars 20 arc seconds apart. They are coloured yellow and grey. Dunlop 236 is another wide pair at 58 arc seconds; the yellow stars are almost matched at magnitudes 6.5 and 6.9.

To the south of Fomalhaut is Grus (pronounced groose) the Crane. To the ancient Arabs it was part of their southern fish. It first appeared in Bayer's Uranometria in 1604, but it was in existence prior to this date. Around the same time some authors referred to it as a different bird, Phoenicopterus, The Flamingo. The objects of interest in Grus are a few double stars, and for the medium to large telescope, many good galaxies. The best of Grus' doubles are Dunlop pairs. These are always good for smaller telescopes because of their brightness and generally wide separation. Dunlop 246 is a fine pair of yellow suns, 6.1 and 6.8 magnitude, separated by 8.6 arc seconds. Dunlop 249 is a good pair of blue-white stars, 6.5 and 7.3 magnitude, separated by 26 arc seconds. Grus has scores of galaxies for those interested in tracking down faint 'fuzzies'. The Grus Quartet is a must with three of the four galaxies in the same low power field: NGC7582, 7590 and 7599. The last member of the group, NGC7552 is about half a degree away. The bright edge-on galaxy NGC7410 looks like a spindle with a bright core.

OCTOBER

PLUTO, moving toward conjunction in December, sets in the evening around 10pm (mid-month).

MINOR PLANETS at opposition this month include 39 Laetitia on the 17th at magnitude 9.4 in Cetus and 89 Julia on the 30th at magnitude 9.6 in Andromeda.

COMETS

Comet 19P/Borrelly slowly fades from 9th to 10th magnitude during October. Although Borrelly is now moving away from the Sun, having passed perihelion last month, the distance between it and Earth is decreasing, and will continue to do so for the rest of the year. Consequently, its rate of fading is slower than what would have been expected. Borrelly can be found in the morning sky, moving through the constellations of Cancer and Leo.

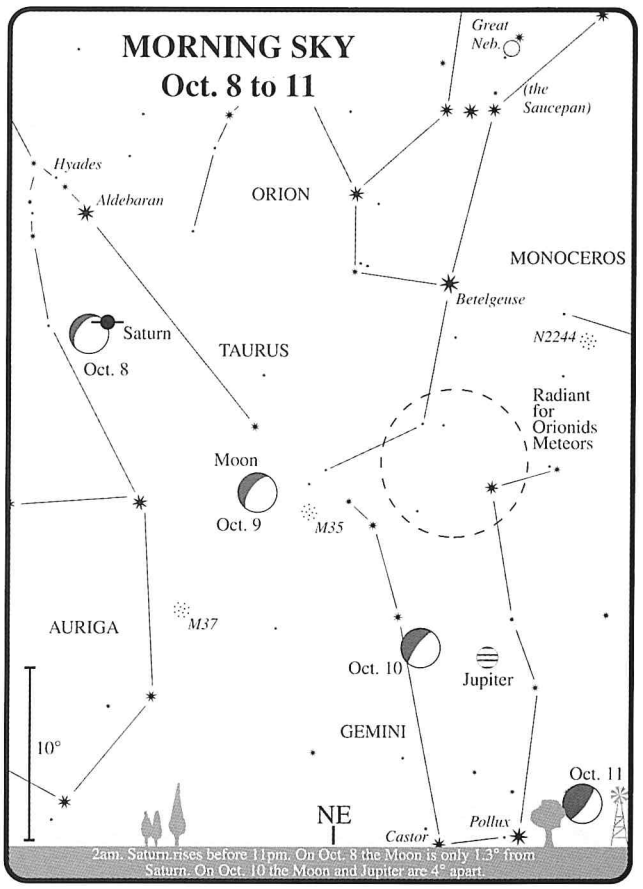
METEOR SHOWERS

The **epsilon-Geminids** are a weak minor shower that is active from the 14th to 27th October with maximum on the 18th. A low hourly rate of 2 can be expected. As this shower is near the Orionids that are active at the same time, it may be difficult to distinguish them.

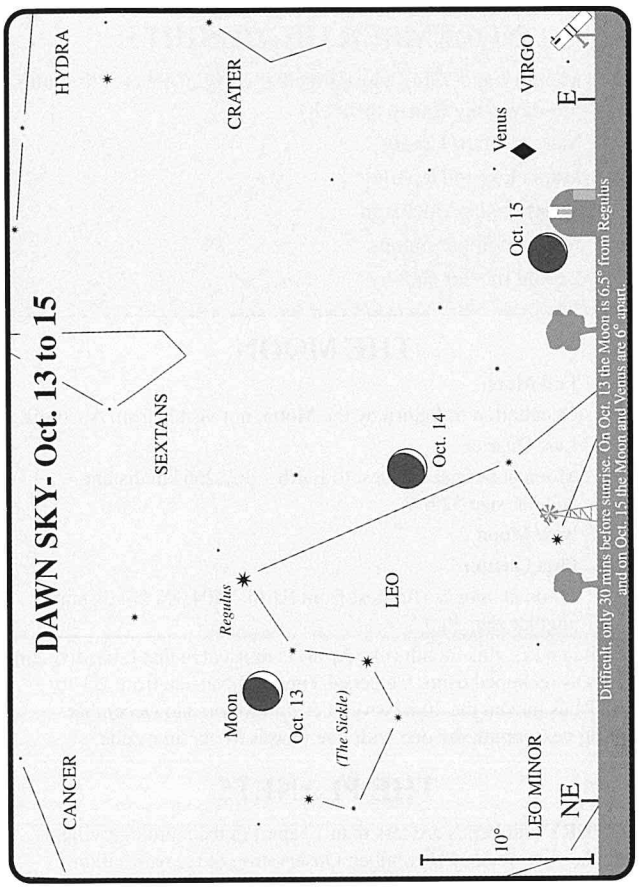
The **Orionids** are best seen from late evening until dawn and are visible from 2nd October through to 7th November. Maximum activity is on the 21st, but with many sub-maxima, good rates are observable between the 20th to 24th October. In 1993 high rates were recorded on the 17th and 18th, 4 days before the predicted peak. The Orionids provide a prominent display that generally reaches an intensity of 25 meteors per hour. They are typically very swift, often bright, and with some leaving trains. See the Sky View 'Oct. 8 to 11' which shows the position of the radiant in the sky. This shower was first recorded by Chinese observers in 288AD, and is associated with Halley's Comet.

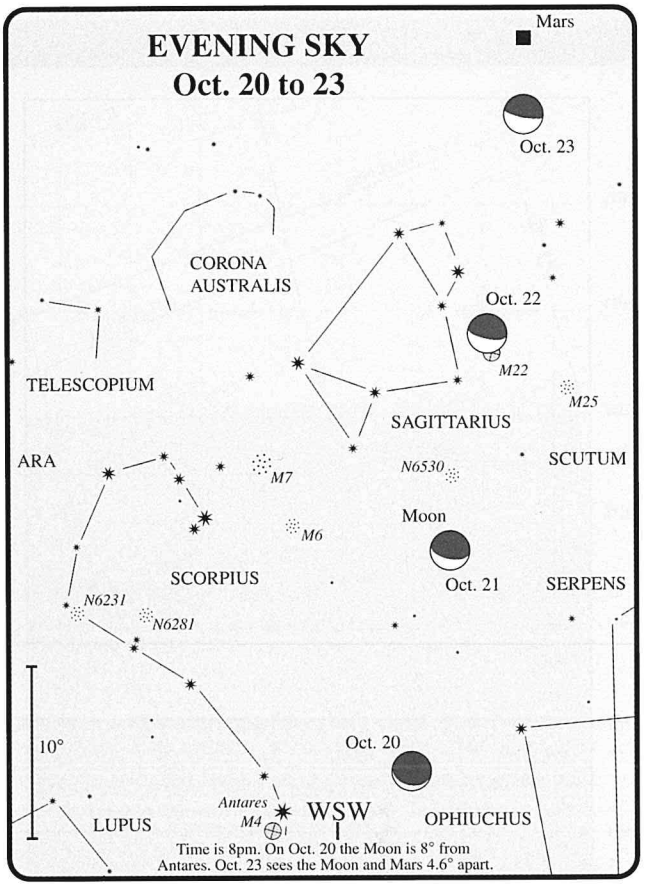
DIARY OF EVENTS

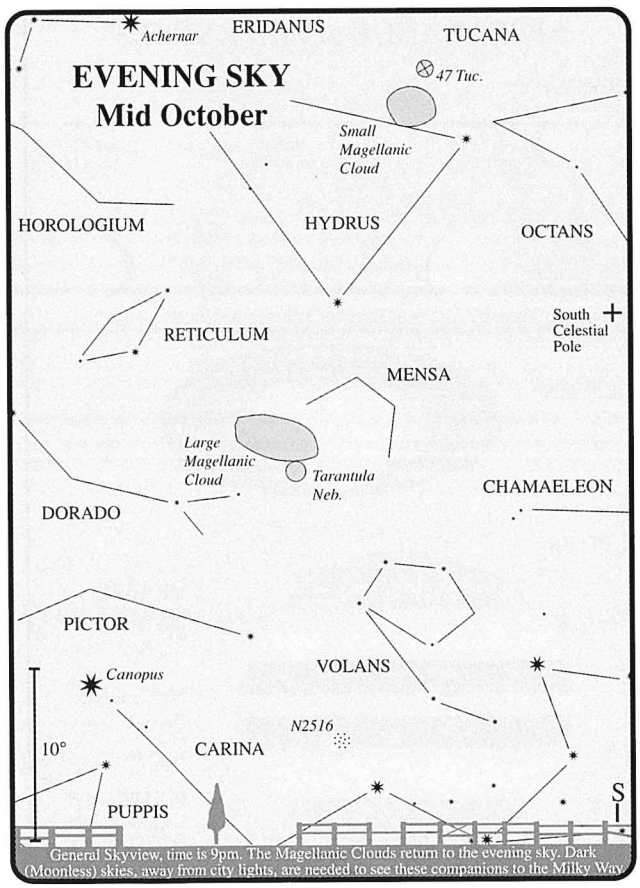
1st	7 PM	m.p. 1 Ceres 0.1°S of M54 (GC) in Sagittarius
2nd		m.p. 15 Eunomia 0.1°W of M4 (GC) in Scorpius
2nd		m.p. 43 Ariadne 1°N of NGC 6287 (GC) in Ophiuchus
2nd	4 AM	Mercury stationary
2nd	9:49 PM	Full Moon
4th		m.p. 89 Julia 1°NE of M34 (OC) in Perseus
5th		Venus at perihelion
6th		Comet 19P/Borrelly 3.5°N of Beehive Cluster (OC) in Cancer
6th		m.p. 15 Eunomia 0.1°SW of Antares
8th	3 AM	Saturn 0.5° S of Moon; occultation
10th		m.p. 40 Harmonia 0.5°N of NGC 2175 (OC) in Orion
10th	2 AM	Vesta stationary
10th	8 AM	Jupiter 1.4° S of Moon
10th	12:20 PM	Last Quarter Moon
10th	7 PM	m.p. 1 Ceres 0.4°S of star Zeta Sagittarii
12th		Mars at perihelion
13th		m.p. 42 Isis 0.9°N of star Delta Sagittarii
14th	10 AM	Mercury in inferior conjunction
15th		m.p. 7 Iris 1.2°S star Beta Scorpii
15th	7 AM	Moon at perigee
15th	10 AM	Venus 4° S of Moon
17th	3:23 AM	New Moon
18th		Venus 1°S of NGC 4179 (SG) in Virgo
18th		Mercury at ascending node
18th	7 AM	Neptune stationary
19th		m.p. 14 Irene 1°NE of NGC 6520 (OC) in Sagittarius
20th	9 PM	m.p. 89 Julia 0.1°S of NGC 956 (OC) in Andromeda
21st		m.p. 43 Ariadne 0.6°NW of NGC 6469 (OC) in Sagittarius
22nd	7 PM	Mercury stationary
23rd		Mercury at perihelion
24th	4 AM	Mars 0.1° N of Moon; occultation
24th	10:58 AM	First Quarter Moon
24th	8 PM	Neptune 3° N of Moon
26th		m.p. 43 Ariadne 0.7°N of M21 (OC) in Sagittarius
26th		Venus at greatest latitude North
26th	1 AM	Uranus 3° N of Moon
26th	7 PM	Mars 0.6°S of M75 (GC) in Sagittarius
27th	4 AM	Moon at apogee
28th		m.p. 15 Eunomia 0.3°S of M19 (GC) in Ophiuchus
29th		m.p. 43 Ariadne 0.3°SW of NGC 6568 (OC) in Sagittarius
30th		Mercury 0.6°NE of Venus
30th	1 AM	Mercury greatest elongation W (19°)
31st	Noon	Uranus stationary

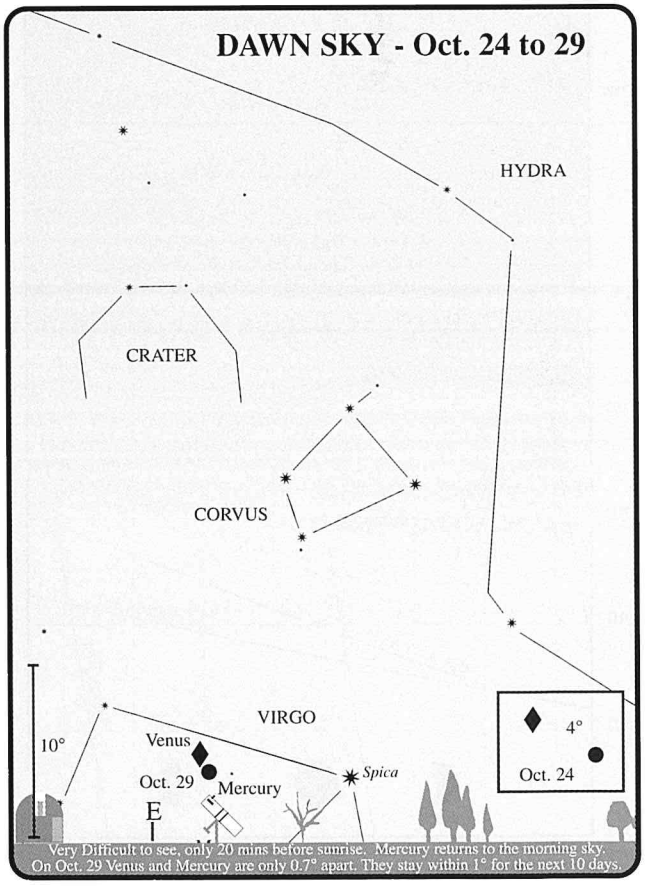


OCTOBER


DAWN SKY- Oct. 13 to 15
HYDRA
CRATER
VIRGO
Venus
E
Oct. 15
SEXTANS
Oct. 14
Regulus
LEO
Moon
Oct. 13
(The Sickle)
CANCER
LEO MINOR
NE
10°
Difficult, only 30 mins before sunrise. On Oct. 13 the Moon is 6.5° from Regulus and on Oct. 15 the Moon and Venus are 6° apart.

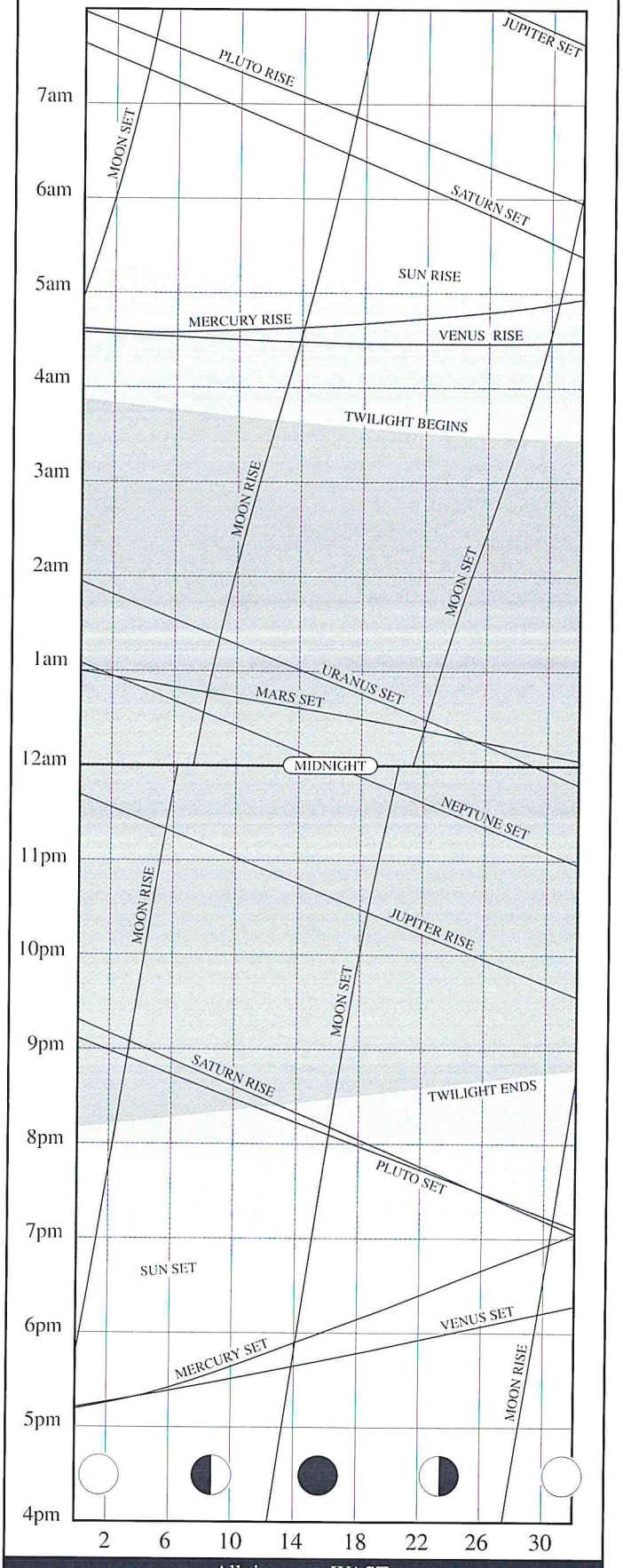

EVENING SKY
Oct. 20 to 23
Mars
Oct. 23
CORONA AUSTRALIS
Oct. 22
M22
M25
TELESCOPIUM
SAGITTARIUS
ARA
M7
N6530
SCUTUM
Moon
M6
SCORPIUS
Oct. 21
SERPENS
N6231
N6281
10°
Oct. 20
Antares
M4
WSW
LUPUS
OPHIUCHUS
Time is 8pm. On Oct. 20 the Moon is 8° from Antares. Oct. 23 sees the Moon and Mars 4.6° apart.


Achernar
ERIDANUS
TUCANA
EVENING SKY
Mid October
47 Tuc.
Small Magellanic Cloud
HOROLOGIUM
HYDRUS
OCTANS
South Celestial Pole
RETICULUM
MENSA
Large Magellanic Cloud
Tarantula Neb.
CHAMAELEON
DORADO
PICTOR
Canopus
VOLANS
10°
N2516
CARINA
PUPPIS
S
General Skyview, time is 9pm. The Magellanic Clouds return to the evening sky. Dark (Moonless) skies, away from city lights, are needed to see these companions to the Milky Way


DAWN SKY - Oct. 24 to 29
HYDRA
CRATER
CORVUS
VIRGO
10°
Venus
Oct. 29
Mercury
Spica
E
4°
Oct. 24
Very Difficult to see, only 20 mins before sunrise. Mercury returns to the morning sky. On Oct. 29 Venus and Mercury are only 0.7° apart. They stay within 1° for the next 10 days.

NOVEMBER

RISE/SET CHART



All times are WAST.

NOVEMBER HIGHLIGHTS

- Mercury and Venus close together early in the month in the pre-dawn sky (fairly difficult)
- Mars close to Uranus
- Mars close to Neptune
- Saturn visits Aldebaran
- Jupiter without moons
- Leonid meteor shower

THE MOON

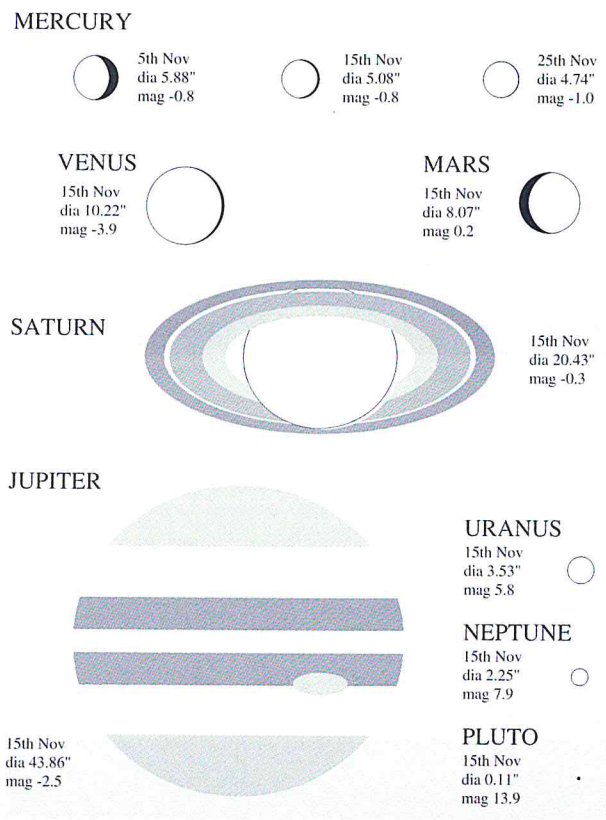
1st	Full Moon
4th	Occultation of Saturn by the Moon, not visible from Australia
8th	Last Quarter
12th	Moon at perigee (closest to Earth – 367,256 km distant, angular size 32.6°)
15th	New Moon
23rd	First Quarter
23rd	Moon at apogee (furthest from Earth – 404,394 km distant, angular size 30.0°)

For trivia buffs, this month (like April) is unusual in that it has five lunar phases as reckoned using Universal Time. Conversion from UT to WAST has moved the 30th November Full Moon into December, making next month the one with five phases in our time zone.

THE PLANETS

MERCURY and Venus are less than 1° apart in the morning twilight during the first week of November. Observation of the pair will be difficult with the Sun rising just three quarters of an hour after the planets (see 'Movement of the Planets' diagram p. 8). Mercury soon becomes lost

APPEARANCE of the PLANETS



in the glare of the Sun and remains unobservable until after superior conjunction, when it reappears in the late December evening twilight. In the course of the month Mercury moves from Virgo into Libra, and finally into Scorpius.

VENUS, low in the eastern dawn sky, follows the same fate as Mercury as it becomes lost in the Sun's glare. Venus will be in superior conjunction in January, but will remain close to the Sun until its arrival in the evening sky in late February 2002. Venus is in the constellation of Virgo for the first half of the month, and the later in Libra.

MARS is in the evening sky, setting around 12.30am (mid-month). It joins two of the Solar System's outer members, Uranus and Neptune, in Capricornus this month. The Red Planet's path takes it close to both distant worlds; on the 5th, Mars will be 2° from Neptune, and on the 26th, 0.8° from Uranus. The Mars/Uranus conjunction should show an attractive colour contrast in a low power telescope field. On the 21st, the 6-day old Moon will be 4.7° from the planet (see Sky View).

JUPITER, approaching opposition on 1st January, stands prominent above the Gemini twins Castor and Pollux, in the late eastern evening sky. On the 7th, the 20-day old waning gibbous Moon will be 6° from the planet (see Sky View). Jupiter appears stationary on the 3rd, and is subsequently in retrograde motion for the next four months.

There is a rare event involving Jupiter's four prominent moons on the early morning of the 9th. For a brief period of 16 minutes none of these moons will be visible outside of the disc of the planet. From the time that Ganymede goes into Jupiter's shadow (III Ec D) at 12.27am WAST until Io completes its transit across the face of the planet (I Tr E) at 12.43am, all of the Galilean moons will be either in transit, eclipsed or occulted (also see next page and 'Jupiter's Moons' starting on page 82). Jupiter is well placed in the sky for Australian observers although some of the events leading up to 'the no moon" period are not visible from WA. Only a small telescope is needed to see these events.

SATURN transits the meridian around 1.30am mid-month, appearing high in the northeastern evening sky near the 1st magnitude star Aldebaran. By month's end this star, the 'Eye of the Bull', and the planet will be 4° apart. With opposition early next month, the ringed planet is well placed for evening observation. The 17-day old Moon is 3.4° from Saturn on the 4th (see Sky View). Later in the month on the 30th the Full Moon will be 6° from the planet, forming a nice triangle with Aldebaran (see Sky View in December section).

The LEONID METEORS for 2001

We have all seen the occasional meteor or shooting star when out at night. Most of these are random but a number are often referred to as belonging to a shower. Scientists for many years found it strange that at some times of the year there would be a marked increase in the number of meteors and that they would seem to originate from one area of the sky (the radiant). After a very intense storm in 1833 of the Leonids, academics were at last convinced that meteors originated outside of the Earth's atmosphere. Many of the meteors are debris from comets and the showers are seen annually as the Earth passes near or through the path of a periodic comet. Occasionally we will go through the path just after or before the comet passes our planet and this is when we see a storm. In other words, the road is dirtier the closer you get to the truck.



Leonids during 1999 maximum; 5 min. exposure with a Canon T70, 28mm f/2.8, on Kodak Tri-X. Taken at Hamzeh Camp of the Jordanian Astronomical Society at Al Azraq, Jordan by Robert H. McNaught. Note this is a negative image, the Leonids are the small trails moving from top to bottom, appearing to come from a radiant above the left edge of the image. The many short lines shown running top right to bottom left are star trails.

The Leonids are associated with Comet Tempel-Tuttle, which takes 33 years to orbit the Sun. So historically we have seen impressive displays around the time of the return of this comet every 33 years. There are records of Leonid storms dating back to 899AD from Egypt. In 1833, North American observers witnessed 1,000 meteors per minute! Probably the greatest display ever was the last storm in 1966 when United States observers witnessed 40 meteors per second or 2,400 per minute!

The time of maximum for this return has a high level of uncertainty. Some experts predicted 1998, others 1999, 2000 or 2001 for the storm. Also the observer's position on Earth is critical, for the actual peak each year may last less than an hour. The time of the peak also has a high level of uncertainty. Unfortunately, the publishing deadline for this book precludes the writers from commenting on the 2000 performance, but we can comment on the 1998 and 1999 apparitions (predicted versus the actual) and the prospects for 2001.

The predicted peak time for 1998 seemed ideal to see from Western Australia with the time corresponding to 3am WAST (19 hours UT) on November 18. Unfortunately for Australia only a few fireballs were seen that morning. It appears that the Leonids had actually peaked some 12 hours earlier than expected with great shows of 500 to 1000 per hour being reported in Europe and the USA. This was good, but certainly not a storm.

In 1999 people in Europe, Africa and the Middle East witnessed one of the greatest displays in the 20th Century, but not as spectacular as 1966. This impressive maximum of 3,500 ZHR (Zenith Hourly Rate, see p. 99) lasted only a few minutes around 2:00 UT on November 18. A number of observers even reported seeing impact flashes from the Leonids on the Moon! Astronomers have continued to refine their mathematics and the model used by David Asher (Armagh Observatory) and Robert McNaught (Siding Spring Observatory, Australia) predicted the peak for 1999 to within a few minutes! These gentlemen have predicted only a moderate display for 2000 which also favours European observers on the morning of November 18 (3:44 and 7:51 UT).

So where does that leave 2001? We can only hope that Asher and McNaught's predictions for 2001 are accurate. They are talking about 2 peaks several times stronger than the impressive display of 1999. The times are ideal for Australian observers being at 1:30am WAST (9,000 ZHR) and 2:19am WAST (15,000 ZHR!) on the morning of November 19. These times couldn't be better placed for Western Australian observers (let's hope for better luck than 1998). It is just a few days past New Moon, so we will have dark skies (if you get away from the city lights). The Sky View on page 55 shows the position of the radiant.

Unfortunately, there are no guarantees in astronomy. Another astronomer, Ferrin (University of the Andes, Venezuela), who also predicted the 1999 time accurately, has totally different calculations for 2000 and 2001. He is predicting a storm for 2000 on the morning of November 17 for Central/North America (9:24UT). Like Asher and McNaught, he also favours Australia for 2001, however with only a moderate display (350 ZHR) on the morning of November 18 (12:30am WAST).

By the time you read this we will likely know if either of the above predictions were correct for 2000. In 2001 it might be a good idea to check out the morning sky of 18th and 19th. Good luck for the 2001 Leonids.

NOVEMBER

URANUS and **NEPTUNE** are both paid a visit by Mars this month, as detailed above. Our readers may recall a very similar set of circumstances in November/December 1999, when at this time Mars was a little closer to both outer worlds.

PLUTO. This is not a good time to observe this remote world. It is moving toward conjunction in December and setting in the evening twilight by mid-month.

MINOR PLANETS at opposition this month include 4 Vesta on the 28th at magnitude 6.5 in Taurus and 11 Parthenope on the 21st at magnitude 9.7 in Taurus.

COMETS

Comet 19P/Borrelly is in the late morning sky as it moves through the northern constellations of Leo Minor and Ursa Major this month. During this time, it fades from 10th to 11th magnitude.

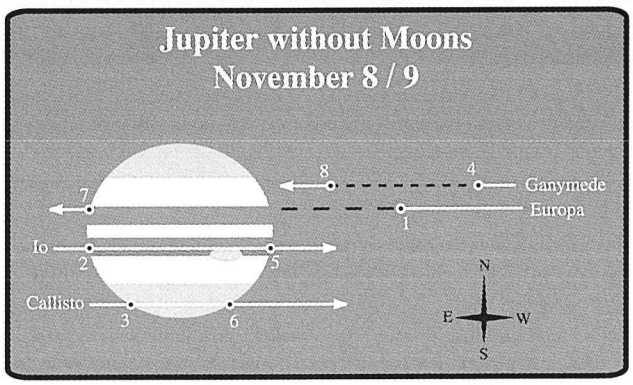
METEOR SHOWERS

The **Leonids** have received much publicity in recent years. There is a possibility this shower will put on a good display in 2001. See the feature article on the previous page for a more detailed description of this famous display of meteors and its prospects for maximum this year. There is also a Sky View showing the position of the radiant.

The **Alpha-Monocerotids** is a minor shower, with unusual short lived bursts of high rates. Active from 15th to 25th November, they peak on the 21st and are best seen during the late evening. While the zenith hourly rate is normally around 5, high rates were seen in the years 1925, 1935, 1985 and 1995. The 1995 rate reached an estimated 420, and lasted just 5 minutes, the entire shower was over in 30 minutes. There is some speculation of a 10-year cycle, but who knows what this year has in store?

DIARY OF EVENTS

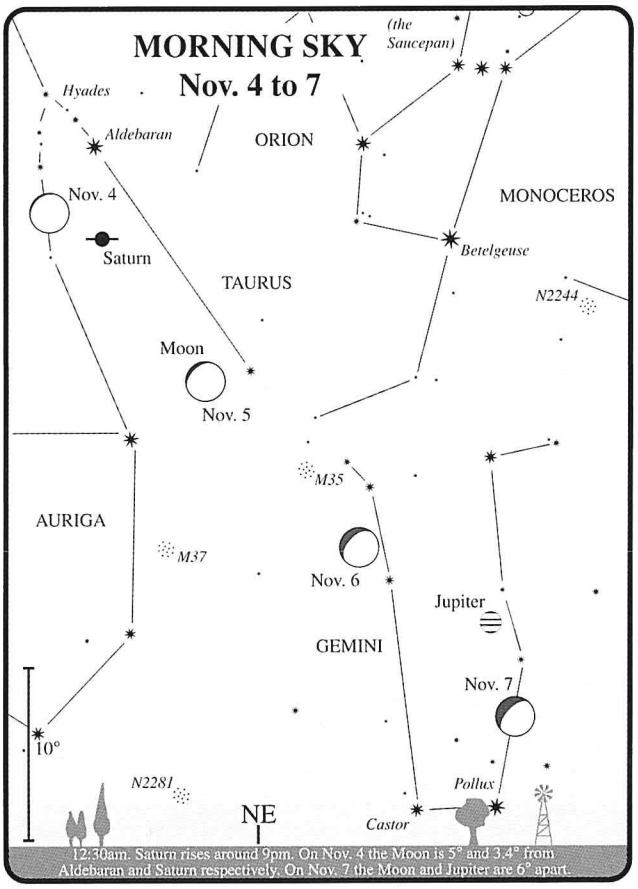
1st		m.p. 15 Eunomia 0.2°NW of NGC 6293 (GC) in Ophiuchus
1st	1:41 PM	Full Moon
2nd		m.p. 42 Isis 0.8°S of star Tau Sagittarii
2nd		Mercury at greatest latitude North
2nd	5 PM	Mercury 5° N of Spica
2nd	8 PM	Venus 4° N of Spica
3rd	1 AM	Jupiter stationary
4th	6 AM	Saturn 0.6° S of Moon; occultation
5th	2 AM	Mars 2° S of Neptune
6th	3 PM	Jupiter 1.7° S of Moon
8th	8:21 PM	Last Quarter Moon
9th		Comet 19P/Borrelly 0.3°SE of NGC 3254 (SG) in Leo Minor
9th		m.p. 2 Pallas 0.1°N of star Beta Ophiuchi
10th		m.p. 15 Eunomia 0.1°SW of NGC 6355 (GC) in Ophiuchus
11th		m.p. 2 Pallas 1°S of IC 4665 (OC) in Ophiuchus
12th		m.p. 14 Irene 0.1°NW of star Phi Sagittarii
12th	1 AM	Moon at perigee
14th		m.p. 7 Iris 0.2°S of NGC 6235 (GC) in Ophiuchus
15th	2:40 PM	New Moon
16th	7 PM	m.p. 89 Julia 0.3°NW of star Gamma Andromedae
18th		m.p. 14 Irene 0.5°S of star Sigma Sagittarii
19th		Saturn 1.4°N of NGC 1647 (OC) in Taurus
21st		m.p. 1 Ceres 1.2°S of m.p. 42 Isis
21st		m.p. 7 Iris 0.1°N of NGC 6287 (GC) in Ophiuchus
21st	5 AM	Neptune 3° N of Moon
22nd	3 AM	Mars 3° N of Moon
22nd	10 AM	Uranus 4° N of Moon
23rd	7:21 AM	First Quarter Moon
23rd	Midnight	Moon at apogee
26th		Mercury at descending node
26th	6 PM	Mars 0.8° S of Uranus
28th	1 AM	Vesta at opposition

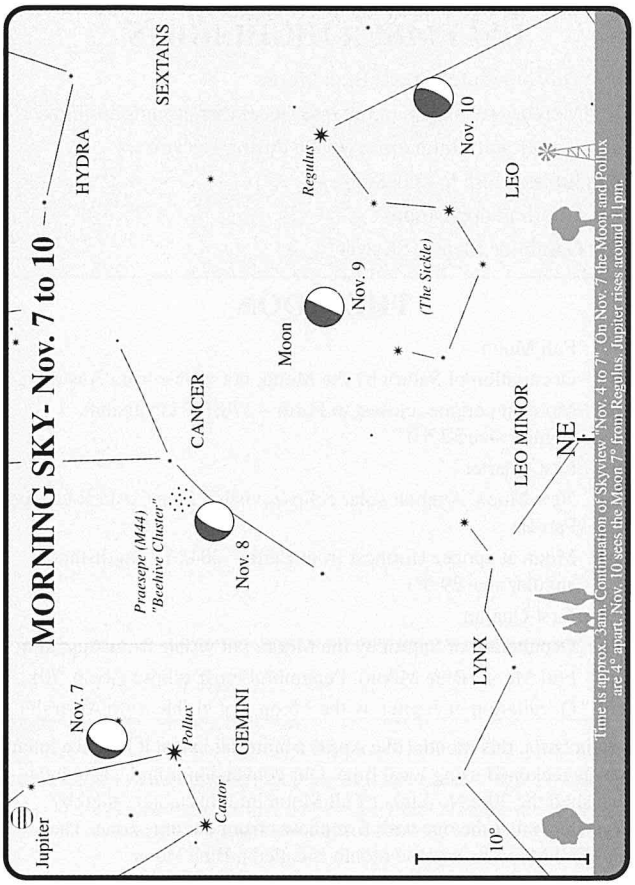


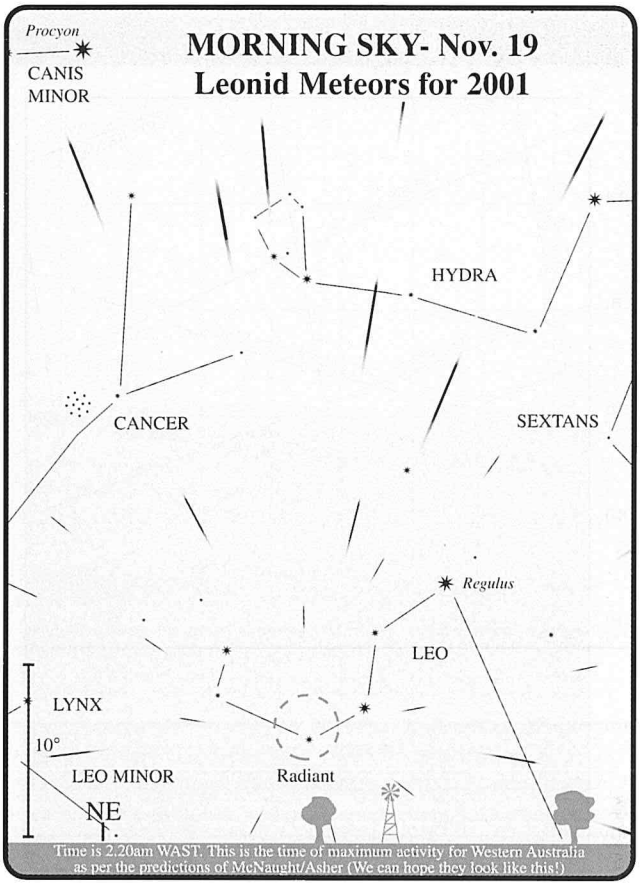
No.	Time (WAST)	Moon	Event
	9:24pm	Io	Shadow transit begin
1.	10:13pm	Europa	Eclipse disappearance
2.	10:30pm	Io	Transit begin (Ingress)
	11:10pm		*Jupiter rises (Perth)*
3.	11:21pm	Callisto	Transit begin (Ingress)
	11:37pm	Io	Shadow transit end
4	12:27am	Ganymede	Eclipse disappearance
5.	12:43am	Io	Io Transit finish (Egress)
6.	1:57am	Callisto	Transit finish (Egress)
7.	3:12am	Europa	Occultation reappearance
8.	3:23am	Ganymede	Eclipse reappearance
	3.43am		*twilight begins (Perth)*

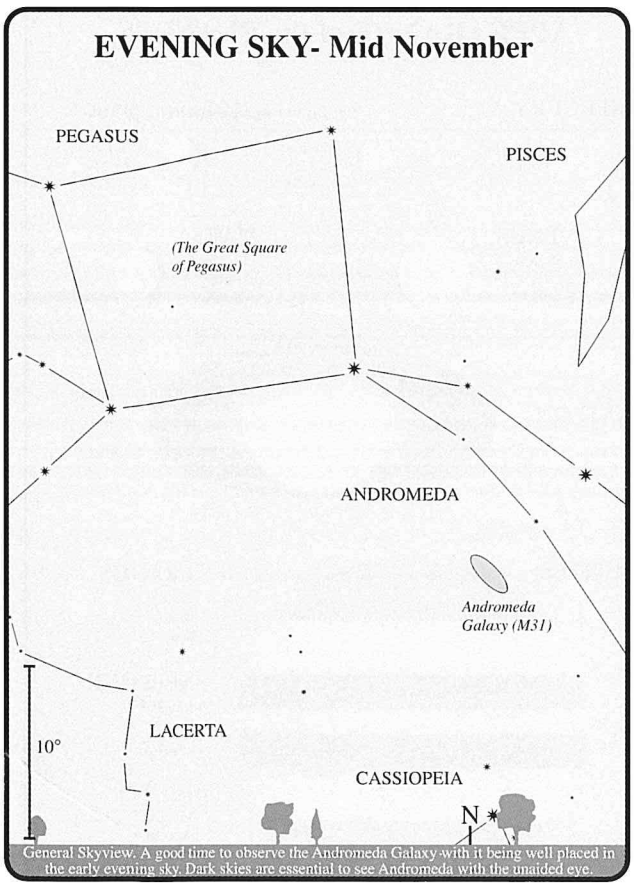
Notes

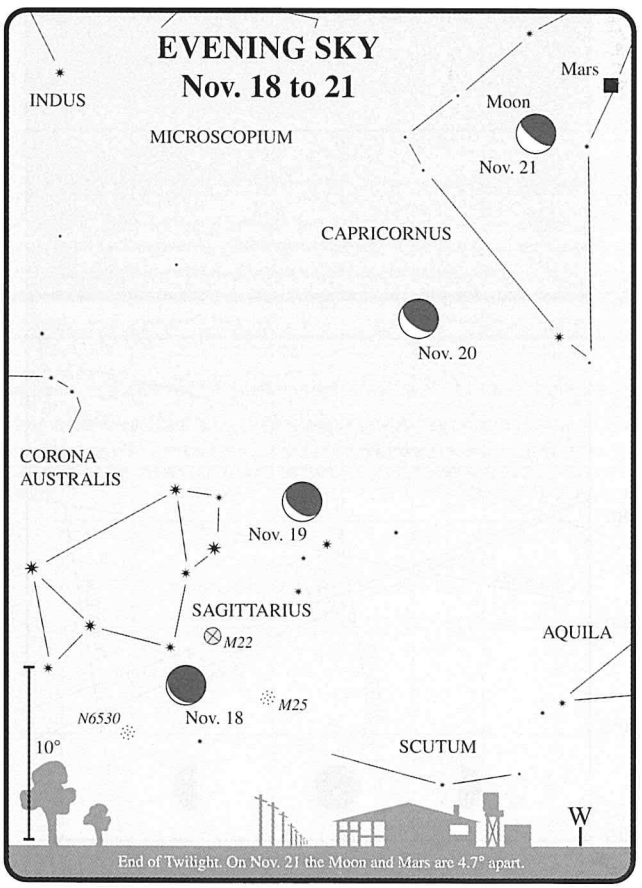
- Between events 4 and 5, no moons visible outside of Jupiter's disc
- Io shadow transit events are not marked on the diagram
- Events 1 and 2 occur before Jupiter rises (as seen from Perth)




MORNING SKY- Nov. 7 to 10
HYDRA
SEXTANS
Regulus
Nov. 10
LEO
Nov. 9
(The Sickle)
Moon
CANCER
LEO MINOR
NE
Praesepe (M44)
"Beehive Cluster"
Nov. 8
LYNX
Nov. 7
Pollux
GEMINI
Castor
Jupiter
10°
Time is approx. 3am. Continuation of Skyview "Nov. 4 to 7". On Nov. 7 the Moon and Pollux are 4° apart. Nov. 10 sees the Moon 7° from Regulus. Jupiter rises around 11pm.

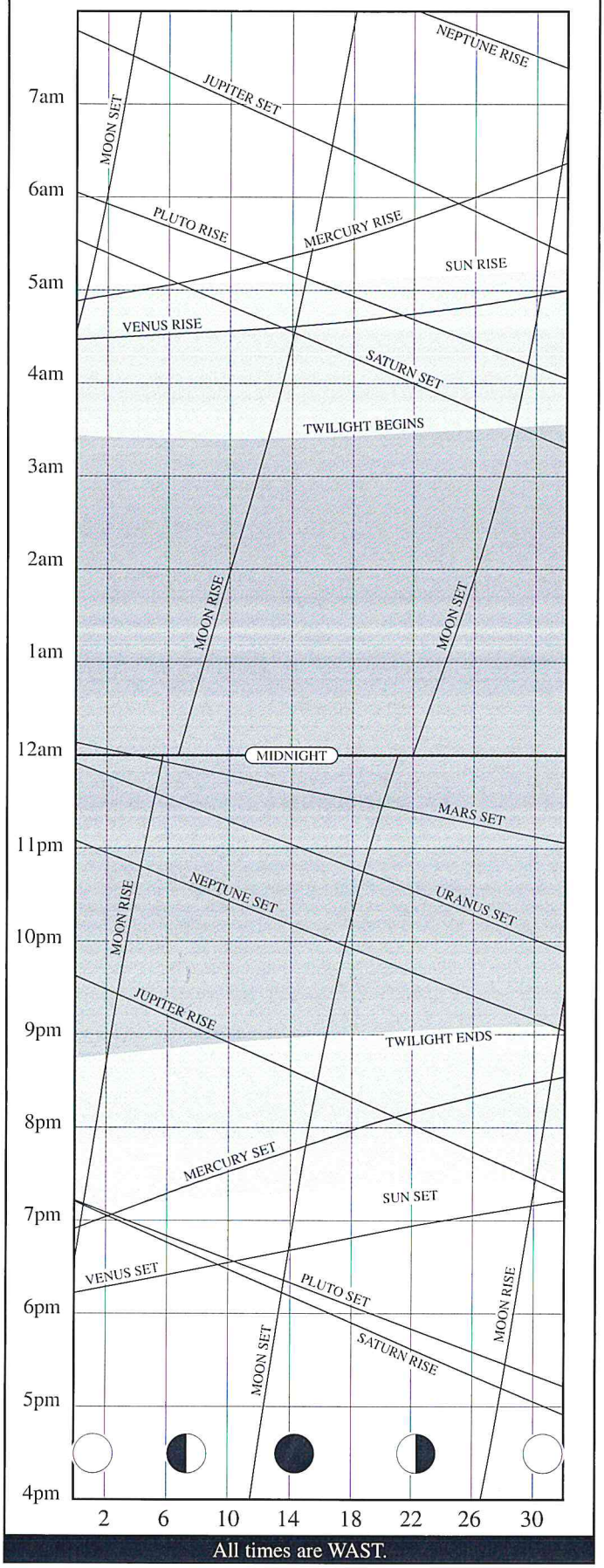

Procyon
CANIS MINOR
MORNING SKY- Nov. 19
Leonid Meteors for 2001
HYDRA
CANCER
SEXTANS
Regulus
LEO
LYNX
10°
LEO MINOR
Radiant
NE
Time is 2.20am WAST. This is the time of maximum activity for Western Australia as per the predictions of McNaught/Asher (We can hope they look like this!)


EVENING SKY- Mid November
PEGASUS
PISCES
(The Great Square of Pegasus)
ANDROMEDA
Andromeda Galaxy (M31)
LACERTA
10°
CASSIOPEIA
N
General Skyview. A good time to observe the Andromeda Galaxy with it being well placed in the early evening sky. Dark skies are essential to see Andromeda with the unaided eye.


EVENING SKY
Nov. 18 to 21
INDUS
Mars
Moon
MICROSCOPIUM
Nov. 21
CAPRICORNUS
Nov. 20
CORONA AUSTRALIS
Nov. 19
SAGITTARIUS
M22
AQUILA
M25
N6530
Nov. 18
10°
SCUTUM
W
End of Twilight. On Nov. 21 the Moon and Mars are 4.7° apart.

DECEMBER

RISE/SET CHART



All times are WAST.

DECEMBER HIGHLIGHTS

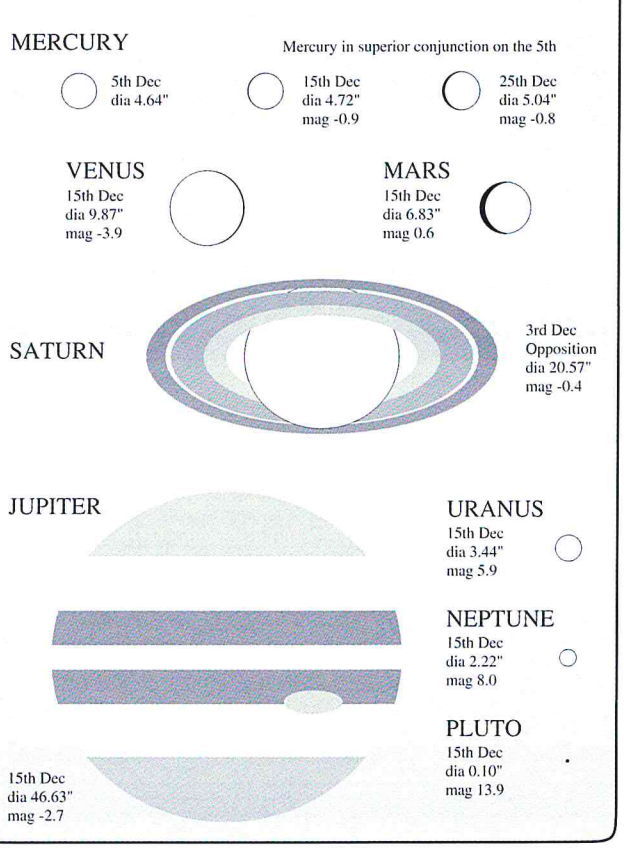
- This month features a Blue Moon
- Mercury reappears in the late December evening twilight
- Jupiter and Moon close (twice during December)
- Jupiter close to opposition
- Saturn at opposition
- Geminids Meteor Shower

THE MOON

1st	Full Moon
1st	Occultation of Saturn by the Moon, not visible from Australia
7th	Moon at perigee (closest to Earth – 370,117 km distant, angular size 32.5°)
8th	Last Quarter
15th	New Moon. Annular solar eclipse, visible from Costa Rica (see Part II)
21st	Moon at apogee (furthest from Earth – 404,633 km distant, angular size 29.6°)
23rd	First Quarter
28th	Occultation of Saturn by the Moon, not visible from Australia
30th	Full Moon (Blue Moon). Penumbral lunar eclipse (see p. 70).
30th	Occultation of Jupiter by the Moon, not visible from Australia

For trivia buffs, this month (like April) is unusual in that it has five lunar phases as reckoned using local time. Our conversion from U.T. to local time pushed the 30th November Full Moon into this month, thereby making December the one with five phases from our time zone. The second Full Moon in any one month is called a Blue Moon.

APPEARANCE of the PLANETS



THE PLANETS

MERCURY is in superior conjunction (Mercury and Earth on opposite sides of the Sun) on the 5th, and thereafter moves into the evening sky. Mercury spends half the month in Ophiuchus, and then moves into Sagittarius. The planet will only be seen in the twilight late in the month, setting about an hour after the Sun.

VENUS is too close to the Sun for observation this month. The planet will be in superior conjunction in January, remaining close to the Sun until its debut in the evening sky in late February 2002.

EARTH is at Solstice on the 22nd. At noon on this day the Sun is directly overhead at latitude 23.5° S and the days in the Southern Hemisphere are at their longest.

MARS is in the evening sky, setting around 11.30pm (mid-month). It begins the month in Capricornus, 3.3° from Uranus. The Red Planet rapidly distances itself from this outer world and moves into Aquarius early in December. On the 20th, the 5-day old crescent Moon will be 6° from Mars, and on the following evening 6.5° (see Sky View). We trust that our readers had clear weather during the June 2001 opposition, whetting the appetite for the 'big one' in August 2003. The disk has shrunk to a little over 6 arc seconds this month, compared to almost 21 arc seconds in June, the magnitude decreasing from -2.4 to 0.8.

JUPITER, at opposition on the 1st January, is visible the entire night. Although the planet is a good telescopic object at any time of the year, opposition means the planet's equatorial diameter is 50% larger than when in conjunction (compare the planet appearance diagrams for June and December). Twice this month the Moon will be close to Jupiter, on the 3rd, the 18-day old Moon is 3.3° away (see Sky View), and on the 30th, the Full Moon will be nearer at 2° (see Sky View).

SATURN reaches opposition this month on the 3rd and is visible the whole night. The summer evenings are an ideal time to observe this most exquisite planet, at its brightest and largest this year. Overall the planet's size has increased by 25% since its conjunction last May. The distance across the length of the rings is 46.7 arc seconds, and the minor axis is wide at 20.3 arc seconds, slightly broader than Saturn's polar diameter. Saturn remains within 4° of Aldebaran throughout the month, and is twice visited by the Moon. On the 1st, the Full Moon is 7° from the planet (see Sky View), and on the 28th closer at 3.2° (see Sky View).

URANUS and **NEPTUNE** are both in conjunction with the Sun early next year, and set in the mid-evening sky. The 3-day old Moon appears 3° from Neptune on the 18th and 3° from Uranus on the 19th.

PLUTO, in conjunction with the Sun on the 7th, is not visible during December. This distant world returns to the morning sky next month.

MINOR PLANET 40 Harmonia is at opposition this month on the 18th at magnitude 9.4 in Taurus.

COMETS

Comet 19P/Borrelly can be found low in the morning northern sky. As December progresses, the comet moves through Ursa Major and Canes Venatici, fading from 10th to 11th magnitude. Borrelly visits the galaxies of Canes Venatici during December and January.

Comet 96P/Machholz 1 will be difficult to observe this month as it nears perihelion in January. Although it is predicted to brighten from 15th magnitude to 8th magnitude by the end of December, the comet will be very low in the evening sky, moving through the constellations of Telescopium and Sagittarius. At month's end, it is setting just after the end of astronomical twilight.

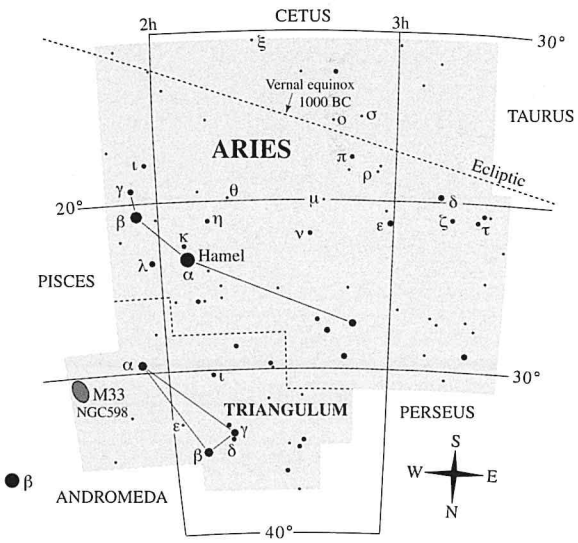
CONSTELLATIONS OF THE MONTH — ARIES (Ari) and TRIANGULUM (Tri)

Aries, a rather inconspicuous constellation, is found low in the northern evening sky this month. To find it with the unaided eye look about half way between the Great Square of Pegasus and Taurus. Of average size, the constellation has just three stars brighter than 4th magnitude; nevertheless it is a significant constellation both astrologically and astronomically. It is the first sign of the zodiac, and retains this honour even though the vernal (spring) point has now shifted into Pisces. In the period when classical mythology was evolving, the Sun's path along the ecliptic crossed the celestial equator on its journey north in Aries (marking the coming of the Northern Hemisphere spring). This point is known as the First Point of Aries, or the vernal equinox. Because the Earth's axis is slowly wobbling like a spinning top, the vernal equinox moves relative to the celestial sphere (it takes about 25,800 years for a complete revolution). This wobble, or precession, has seen the First Point of Aries move from Aries (in 27 BC) westward into Pisces. By the year 2600 AD this point will cross over into Aquarius, marking the true 'Age of Aquarius' (our new-age friends were a little out in their calculations).

Aries, the Ram, is probably best known for its association with the Greek story of the quest for the Golden Fleece by Jason and the Argonauts. Traditionally, the ram is shown reclining, with head turned to admire its own Golden Fleece. In Arabic it was recognised as Al Hamal 'the sheep', and the constellation's brightest star, Alpha Arietis, is known as Hamal. To the ancient Chinese it was 'the dog', but was a much larger figure incorporating Taurus and Gemini. An asterism known as Musca Borealis, the Northern Fly (sitting on the back of the ram), has in modern times been abandoned. We still have, in the Southern Hemisphere, a fly called Musca. Why anybody would ever want to immortalise a fly in the sky is a mystery to the authors.

For the telescope, a few good galaxies exist, but larger instruments (25cm or better) are required. There are many excellent pairs for double star enthusiasts, including one of the earliest of this class of object to be discovered. Amateur astronomer Robert Hooke, while observing a comet in 1664, came across Gamma Arietis, an excellent pair of evenly matched 4.8 magnitude suns, separated by 7.8 arc seconds.

Triangulum was known by the Greeks as Deltoton, after the triangular capital Greek letter delta, or Trigonos (triangular or three-angled). The



Romans saw the triangle of stars forming a representation of the island Sicily in the sky. Lying to the south of Aries, the constellation boasts little other than the majestic nearby face on spiral galaxy known as M33 or the Pinwheel Galaxy.

A member of the Local Group of galaxies, M33 is about 2.4 million light years away, a little more than M31, the Great Nebula in Andromeda. It is often said that M31 is the most distant thing we can see with the unaided eye, although a few keen eyed observers can see the fainter M33. The difficulty is M33 is very large (over 1°), with a low surface brightness, and when first searching for the galaxy many look for a much smaller and brighter object. Dark country skies are a must, and binoculars of any size will help locate the hazy patch. Large amateur telescopes are required to show the spiral arms.

DECEMBER

METEOR SHOWERS

The **Geminids** are one of the best annual showers observable, but for southern observers the radiant is below or low on the horizon until after midnight. Visible from the 7th to 17th, with maximum on the 13th, the Geminids produce often bright, medium speed meteors. The zenith hourly rate is variable but around 110 is normal, and worth watching for in the morning hours, even though our northern counterparts will see the best of the Geminids. The Sky View 'Dec. 4 to 7' shows the position of the radiant which is close to the star Castor.

DIARY OF EVENTS

1st	4:49 AM	Full Moon
1st	10 AM	Saturn 0.5° S of Moon; occultation
3rd	7 PM	Jupiter 1.6° S of Moon
3rd	10 PM	Saturn at opposition
5th	6 AM	Mercury in superior conjunction
6th		Mercury at aphelion
7th	7 AM	Moon at perigee
7th	Noon	Pluto in conjunction with the Sun
8th	3:52 AM	Last Quarter Moon
13th		m.p. 89 Julia 1°W of NGC 752 (OC) in Andromeda
15th	4:47 AM	New Moon; eclipse
18th		Comet 19P/Borrelly 0.4°NW of NGC 4214 (IG) in Canes Venatici
18th		Comet 96P/Machholz-1 0.3°NE of IC 4808 (SG) in Corona Australis
18th	1 AM	Saturn 4° N of Aldebaran
18th	3 PM	Neptune 4° N of Moon
19th	8 PM	Uranus 4° N of Moon
21st		Venus at descending node
21st	4 AM	Mars 4° N of Moon
21st	9 PM	Moon at apogee
22nd		Comet 19P/Borrelly 0.8°SE of NGC 4244 (SG) in Canes Venatici
22nd	3 AM	Solstice
23rd	4:56 AM	First Quarter Moon
26th		m.p. 19 Fortuna 0.2°N of NGC 128 (SG) in Pisces
26th		Mercury at greatest latitude South
26th	5 AM	Juno stationary
27th		Neptune 2°S of m.p. 43 Ariadne
28th	4 PM	Saturn 0.2° S of Moon; occultation
30th		Jupiter at ascending node
30th	6:40 PM	Full Moon; penumbral eclipse
30th	7 PM	m.p. 40 Harmonia 0.8°N of M1 (Crab Neb.) in Taurus
30th	10 PM	Jupiter 1.2° S of Moon; occultation

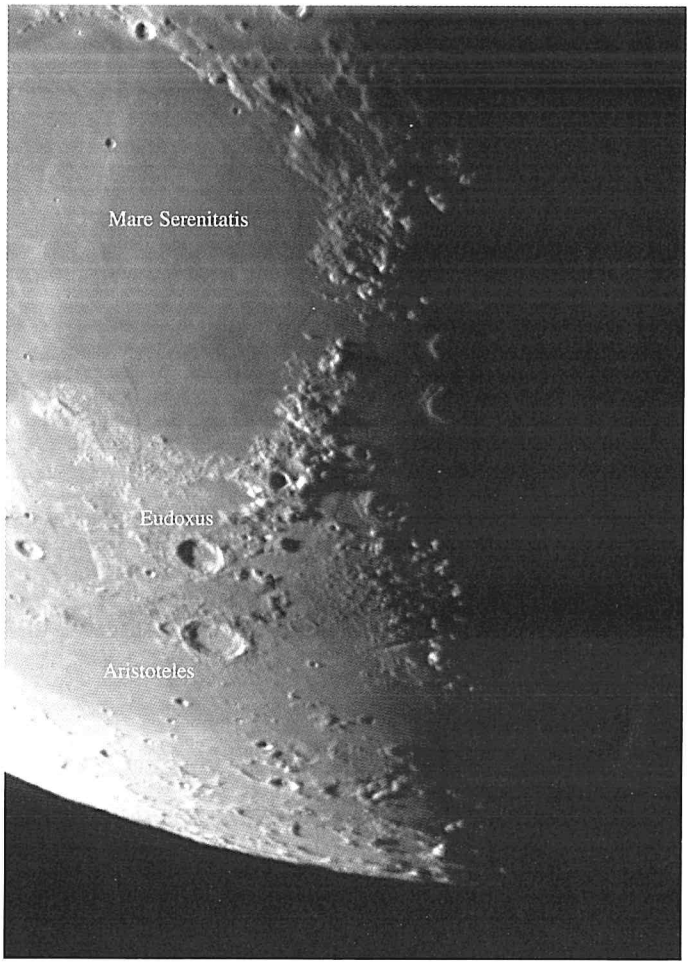
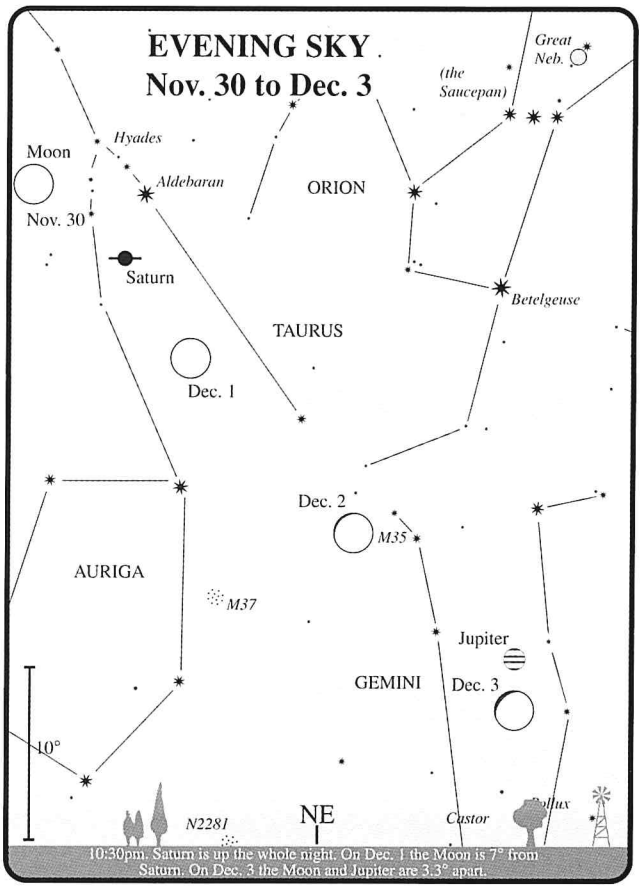
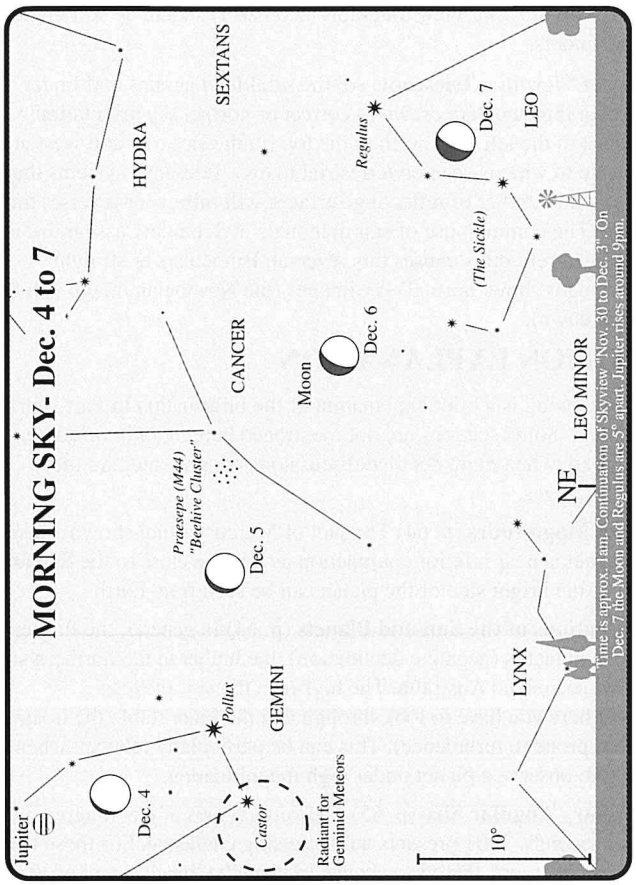
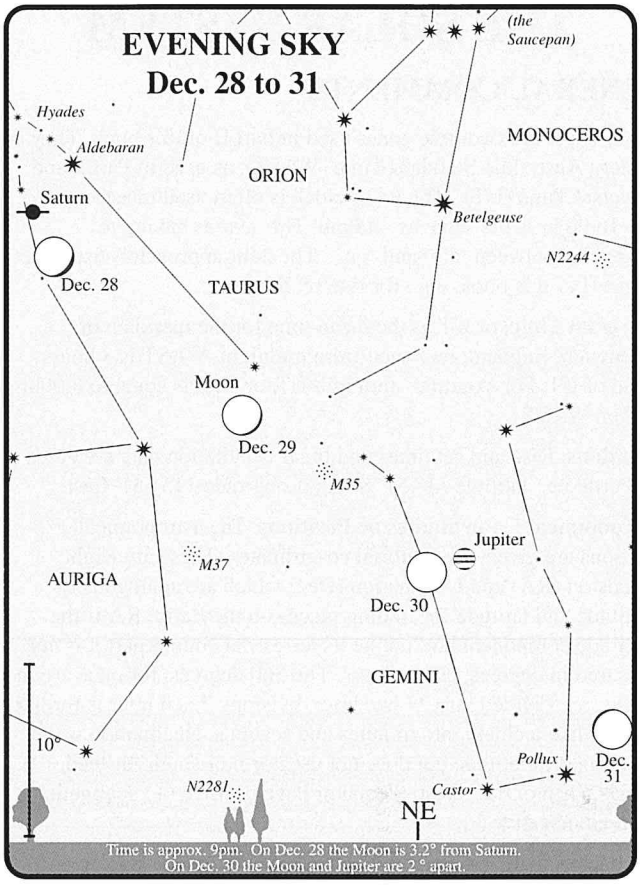


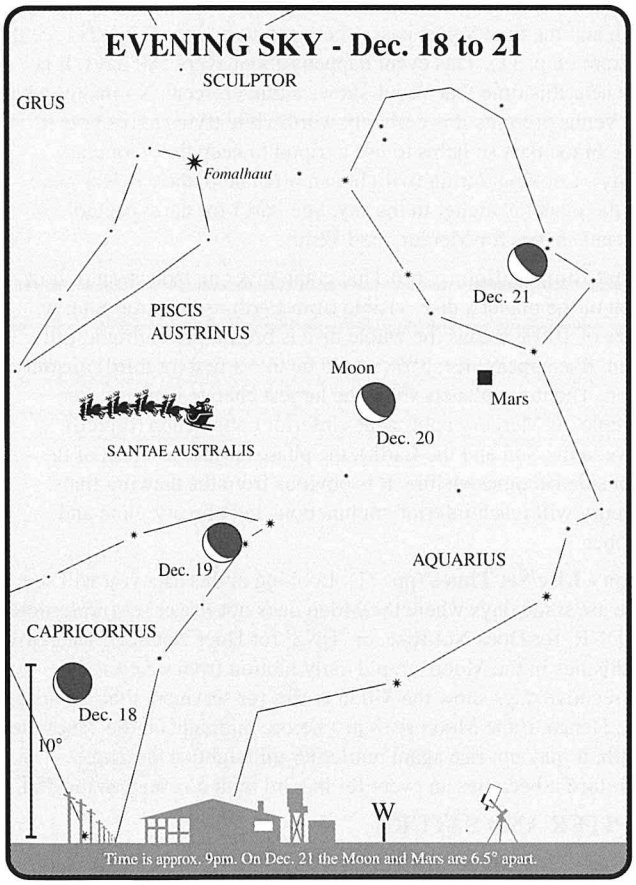
Image of the northern regions of the Moon, taken near First Quarter showing Mare Serenitatis (Sea of Serenity) and the craters Eudoxus and Aristoteles. A mosaic of several CCD images taken on an SBIG ST7 through a Celestron 11. Imaged by Robert Price.

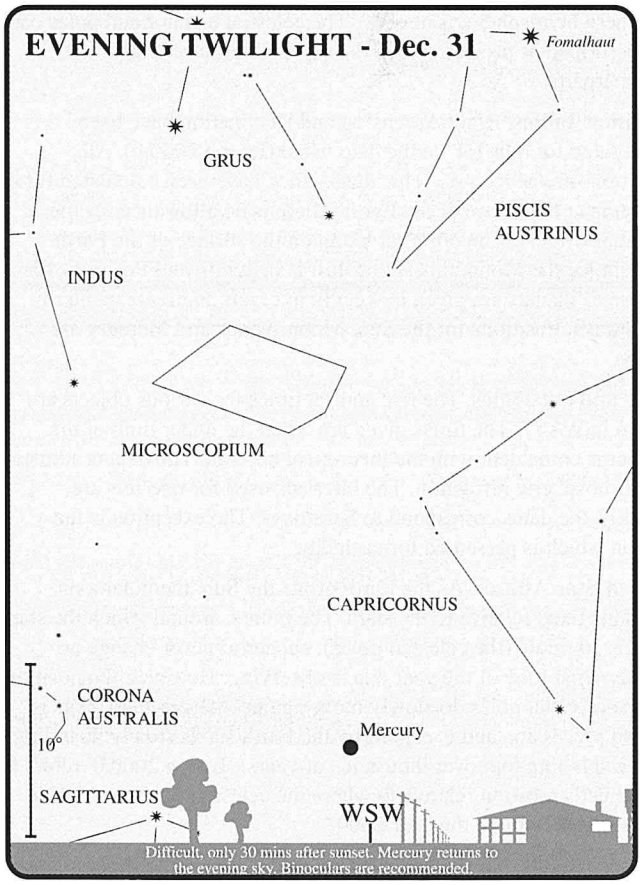


DECEMBER


MORNING SKY- Dec. 4 to 7
HYDRA
SEXTANS
LEO
Regulus
Dec. 7
(The Sickle)
CANCER
Moon
Dec. 6
LEO MINOR
Praesepe (M44)
"Beehive Cluster"
Dec. 5
NE
Pollux
GEMINI
LYNX
Jupiter
Dec. 4
Castor
Radiant for
Geminid Meteors
10°
Time is approx. 1am. Continuation of Skyview "Nov. 30 to Dec. 3". On
Dec. 7 the Moon and Regulus are 5° apart. Jupiter rises around 9pm.


EVENING SKY
Dec. 28 to 31
(the
Saucepan)
Hyades
Aldebaran
MONOCEROS
ORION
Saturn
Betelgeuse
N2244
Dec. 28
TAURUS
Moon
Dec. 29
M35
M37
Jupiter
AURIGA
Dec. 30
GEMINI
10°
Pollux
Dec.
31
N2281
Castor
NE
Time is approx. 9pm. On Dec. 28 the Moon is 3.2° from Saturn.
On Dec. 30 the Moon and Jupiter are 2 ° apart.


EVENING SKY - Dec. 18 to 21
SCULPTOR
GRUS
Fomalhaut
Dec. 21
PISCIS
AUSTRINUS
Moon
Mars
SANTAE AUSTRALIS
Dec. 20
Dec. 19
AQUARIUS
CAPRICORNUS
Dec. 18
10°
W
Time is approx. 9pm. On Dec. 21 the Moon and Mars are 6.5° apart.


EVENING TWILIGHT - Dec. 31
Fomalhaut
GRUS
PISCIS
AUSTRINUS
INDUS
MICROSCOPIUM
CAPRICORNUS
CORONA
AUSTRALIS
Mercury
10°
SAGITTARIUS
WSW
Difficult, only 30 mins after sunset. Mercury returns to
the evening sky. Binoculars are recommended.

PART II
THE SOLAR SYSTEM

GENERAL COMMENTS

Time. There are two time zones used in Part II of this book. They are Western Australian Standard Time (WAST), as used in Part I, and Universal Time (UT). The 24 hr clock is often used in astronomy e.g., 16:00 hr is the same as 4:00pm. This avoids having to distinguish between 'am' and 'pm'. The 24hr approach is used a lot in Part II of this book, e.g., for rise/set times.

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.

Locations. Rise and set times and lunar occultation data are given for Perth i.e. latitude 31° 57' South, Longitude 115° 51' East:

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

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

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

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.

Field of View in a Telescope. All the satellite diagrams and finder charts in this book are drawn to correct or normal sky orientation, i.e., east to the left, and north to the top (in the sky, east and west are opposite to what is seen on terrestrial maps). Telescope systems that use an odd number of 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 (the Newtonian image will be upside down).

SECTION EXPLANATION

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

Planet Magnitudes (p. 64) The plot of Mercury is not shown when the planet is near inferior conjunction as it is too close to the Sun and little of the bright side of the planet can be seen from Earth.

Declinations of the Sun and Planets (p. 64) In general, the further south a planet is (negative declination), the higher in the northern sky it is, as seen from Australia. The higher in the sky, the less atmosphere you have to look through and the more stable the image is (less prone to turbulence). This can be particularly relevant when trying to observe a planet under high magnification.

Planetary Angular Size (p. 65) The vertical axis of this diagram is in arc seconds. 2001 presents an interesting challenge. For those keen sighted observers, there is a chance to view the thin crescent of Venus with the unaided eye. This year Venus gets close to being 1 arc minute (actually 59 arc seconds) in size during the time of inferior conjunction in late March. This is when the planet is closest to the Earth and the time Venus passes between us and the Sun (also see the diagram on p. 11). This event happens about every 580 days. It is only near this time that Venus shows a thin crescent. No matter what size Venus presents it is certainly worthwhile trying to observe it using binoculars (it helps to use a tripod to keep the binoculars steady). 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 shapes for Mercury and Venus.

Planet Illumination (p. 65) This graph gives an indication of how much of the planet's disc, visible from Earth, is lit by the Sun. A figure of 100% means the whole disc is bright, presenting a 'full moon' like appearance; 50% would be like a first (or third) quarter Moon. The inner planets show the largest change in phase. For example, as Mercury approaches inferior conjunction (directly between the Sun and the Earth), the phase shrinks as more of the night side becomes visible. It is obvious from the drawing that Mercury will reach inferior conjunctions in February, June and October.

Moon - Rise/Set Times (pp. 71). Looking at this data you will see there are some days where the Moon does not rise or set (represented by 'DNR' for Does Not Rise, or 'DNS' for 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. Therefore it becomes an event for the 3rd with no event on the 2nd.

JUPITER AND SATURN

Jupiter - Longitudes of Central Meridian. (p. 88) Unlike Mars, Jupiter (and Saturn) are gas giants and they only allow us to view

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

The longitude can be worked out from the Longitude of Central Meridian tables (p. 88). All the times on the main tables are calculated for 0hrs UT (8:00am WAST) of date. You will need to add multiple hours and minutes from the small 'Increase in Longitude' tables. For example the longitude of central meridian for Jupiter (system I) for November 1 at 12:20am WAST would be calculated as follows. First subtract 8 hours to convert to UT i.e., 16:20 hrs on Oct. 31. From the table, the longitude on Oct. 31 is 192.7°. To this add an adjustment for the 16 hours, which is 225.3°, and finally for the 20 mins add 12.2°. These add up to 430.2°; less 360° gives a final answer of 70.2°.

Jupiter's Moons (pp. 82-87). 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 that of the Earth's orbit. Therefore, as seen from Earth, the moons appear to move from side-to-side (east-west) of Jupiter, occasionally passing across (transiting) or behind (occulted by) the planet. The diagrams on pp. 85-87 show the patterns the four major moons of Jupiter make as they move from side-to-side. Each complete period represents one orbit of the satellite. Each horizontal date line represents midnight WAST (16hr UT). The close pair of parallel vertical lines, running down the centre, represents the disc of Jupiter. It is interesting to compare the times when each moon passes over these lines, with the satellite's transit times (pp. 83-84). The same can be done with the occultation times, that is when the line disappears behind Jupiter.

The four moons Io, Europa, Ganymede and Callisto are bright enough to be seen in binoculars (7X power or greater is recommended). It may be necessary to mount the binoculars on a tripod to help keep them steady. Initially, try looking for Callisto when it is furthest from Jupiter (maximum elongation). This happens every 8 days approximately; an example would be the evening of January 6. 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. 82) shows the positions of eclipse events for each satellite for mid-month, relative to Jupiter. An eclipse is when a moon passes into (disappearance or 'd') or out of (reappearance or 'r') Jupiter's shadow.

URANUS, NEPTUNE AND PLUTO

Uranus and Neptune (p. 92). These planets should be easily visible through binoculars. The finder charts will help identify the planets from nearby stars. Under dark skies, most of the stars shown here will be visible through binoculars. It is important to let your eyes adapt to the darkness.

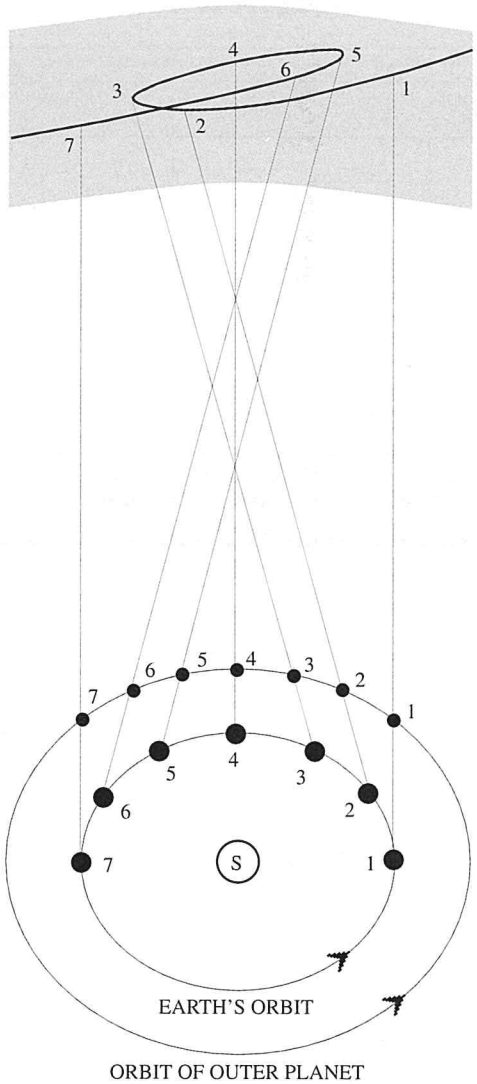
Pluto (pp. 92-93). The pointer chart (p. 92) is designed to help people find the general area for Pluto. The main finder chart shows stars down to approximately magnitude 14.5. This is necessary to pick out the faint star-like image of Pluto (magnitude 13.7) from other numerous faint stars in the field.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

RETROGRADE MOTION

The finder charts for the outer planets have one thing in common - an apparent motion with a loop shape. 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. Most of the outer planets reach opposition each year, except for Mars which is about 26 months. Mars is at opposition during 2001 and it too shows the loop. Jupiter does not reach opposition during 2001 with it slipping into 2002 on January 1.

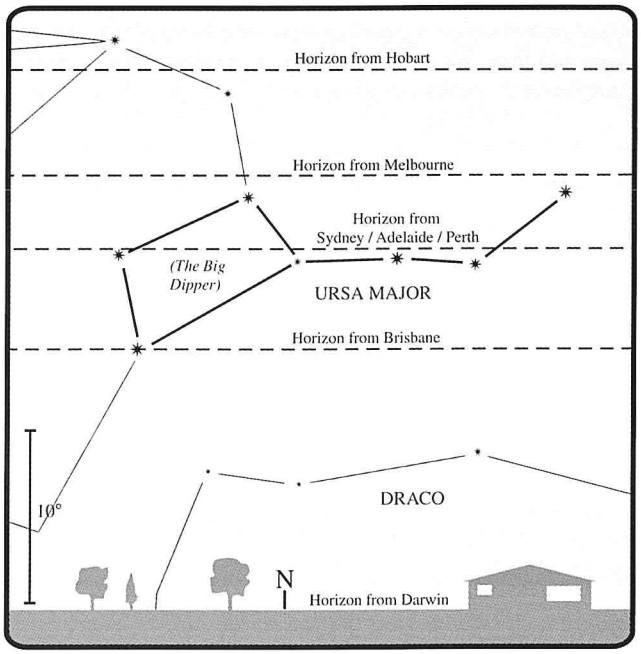
Returning to the Retrograde Motion Diagram, the shaded area represents the path of an outer planet against the celestial sphere. As the Earth moves around the Sun, faster than this outer planet (let's call it Uranus), our home planet overtakes it. The result is this loop or S-bend in the apparent path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

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



EFFECT OF LATITUDE

The Sky Views (see the monthly sections) have been drawn for a latitude of approximately 32° south of the equator. This is reasonably central for the population distribution of Australia. However, we live in a large continent which covers a wide range of latitude. The further one goes north the more stars we see familiar to our northern hemisphere friends. As an example, let's take the 'Big Dipper'. You may have first heard about this in books written in say England or America. This group of stars is part of a larger group known as the constellation Ursa Major, the Great Bear. From Darwin the group is clearly visible above the horizon (but upside down). However, from the southern states not all of it is visible. From the south we see very little of the constellation Draco. The Big Dipper is best placed in the northern sky in mid-May around 9pm (mid-June, 7pm). The diagram (right) is drawn to the same scale as a Sky View.



SOLAR SYSTEM DATA — THE PLANETS

NAME	MEAN DISTANCE FROM SUN ($x 10^3$ km)	(Earth = 1)	MAG at OPP	EQUATORIAL DIAMETER (km).	FLATTENING [1]	No of MOONS	MASS ($x10^{24}$ kg)	(Earth = 1)
Sun	-		-26.8	1392530	0	-	1989085	332946
Moon	-		-12.74 [11]	3475	0	-	0.073483	0.0123
Mercury	57856	0.387	0.16 [12]	4879	0	0	0.33022	0.055
Venus	108132	0.723	-4.07 [12]	12104	0	0	4.8690	0.816
Earth	149492	1.000	-3.5 [13]	12756	0.00335364	1	5.9742	1.000
Mars	227780	1.524	-2.01	6794	0.006476	2	0.64191	0.107
Jupiter	777776	5.203	-2.70	142984	0.064874	16	1898.8	317.900
Saturn	1425983	9.540	0.67	120536	0.097962	18	568.50	95.200
Uranus	2867760	19.180	5.52	51118	0.022927	17 [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:

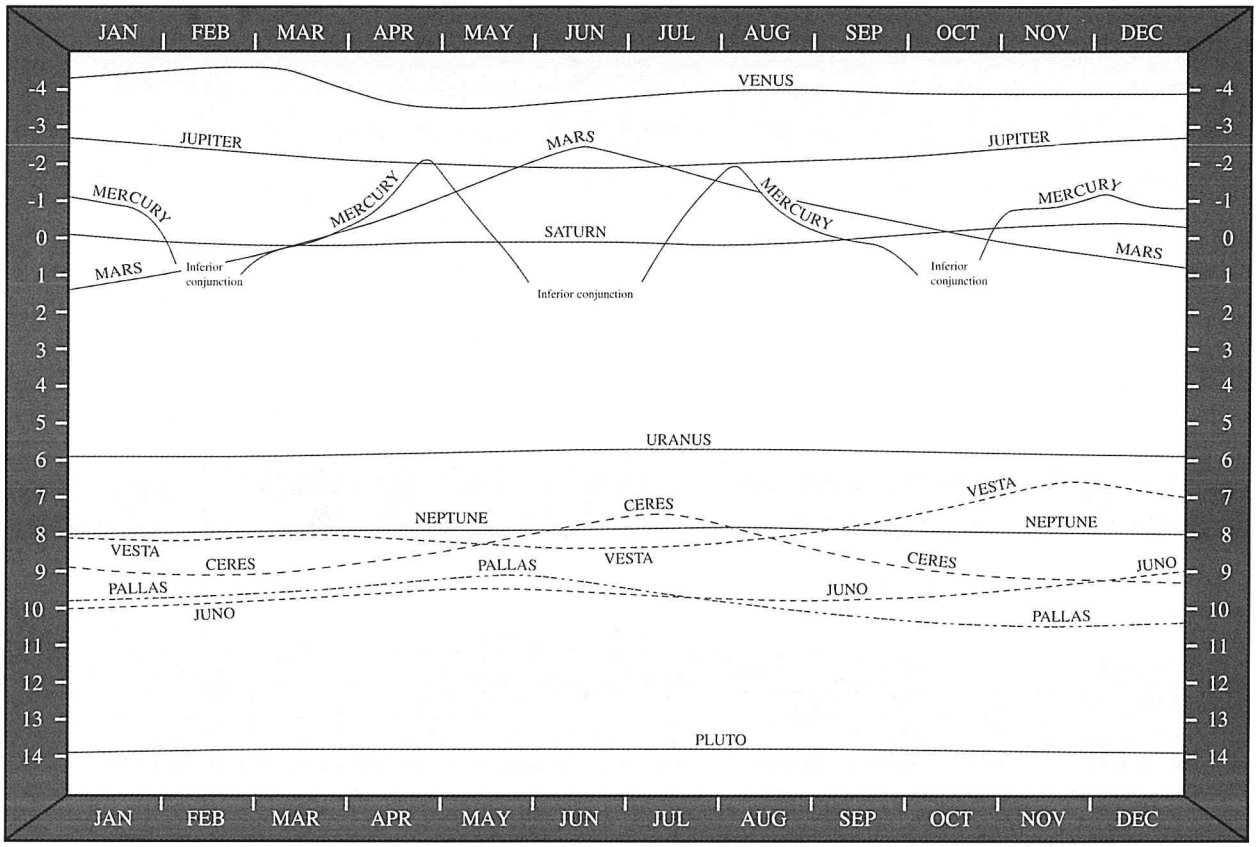
1 The ratio of the difference of equatorial and polar radii to equatorial radius.
2 The planet's year.
3 The period of the planet's orbit with respect to the Earth.
4 The planet's day. A negative sign indicates the rotation is retrograde with respect to the North pole.
5 The ratio of the sunlight reflected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

SOLAR SYSTEM DATA — SATELLITES

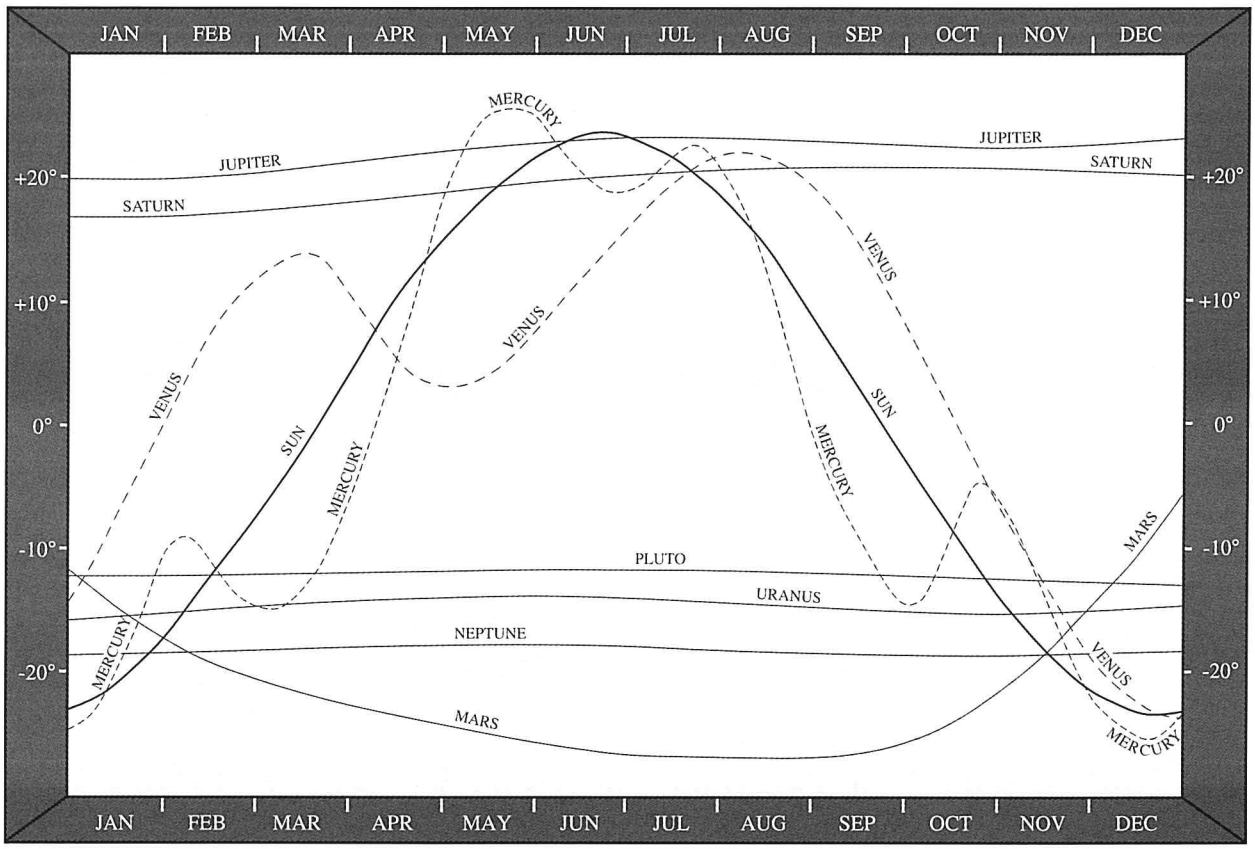
PLANET / SATELLITE		ORBITAL [1] PERIOD (days) (R=retrograde)	MAX. ELONG AT MEAN OPPOSITION	SEMIMAJOR AXIS ($x10^3$ km)	ORBITAL ECCENTRICITY	INCLINATION TO PLANET'S EQUATOR (°)	MASS (1/PLANET)	RADIUS (km)	SIDEREAL PERIOD OF ROTATION (days) [4]	MAGNITUDE AT OPPOSITION
Earth										
Moon		27.321661		384.400	0.054900489	18.28-28.58	0.01230002	1737.4	S	-12.74
Mars										
Phobos	I	0.31891023	25"	9.378	0.015	1.0	$1.65x10^{-8}$	13.4x11.2x9.2	S	11.3
Deimos	II	1.2624407	1' 02"	23.459	0.0005	0.9-2.7	$3.71x10^{-9}$	7.5x6.1x5.2	S	12.40
Jupiter										
Metis	XVI	0.294780	0' 42"	128			$0.5x10^{-10}$	20	S	17.5
Adrastea	XV	0.29826	0' 42"	129			$0.1x10^{-10}$	13x10x8	S	19.1
Amalthea	V	0.49817905	0' 59"	181	0.003	0.40	$38x10^{-10}$	131x73x67	S	14.1
Thebe	XIV	0.6745	1' 13"	222	0.015	0.8	$4x10^{-10}$	55x45	S	15.7
Io	I	1.769137786	2' 18"	422	0.004	0.04	$4.70x10^{-5}$	1830x1819x1815	S	5.02
Europa	II	3.551181041	3' 40"	671	0.009	0.47	$2.53x10^{-5}$	1565	S	5.29
Ganymede	III	7.15455296	5' 51"	1070	0.002	0.21	$7.80x10^{-5}$	2634	S	4.61
Callisto	IV	16.6890184	10' 18"	1883	0.007	0.51	$5.67x10^{-5}$	2403	S	5.65
Leda	XIII	238.72	1° 00' 39"	11094	0.14762	26.07	$0.03x10^{-10}$	5		20.2
Himalia	VI	250.5662	1° 02' 46"	11480	0.15798	27.63	$50x10^{-10}$	85	0.4	14.84
Lysithea	X	259.22	1° 04' 04"	11720	0.107	29.02	$0.4x10^{-10}$	12	0.533	18.4
Elara	VII	259.6528	1° 04' 10"	11737	0.20719	24.77	$4x10^{-10}$	40		16.77
Ananke	XII	631. R	1° 55' 52"	21200	0.16870	147	$0.2x10^{-10}$	10	0.35	18.9
Carme	XI	692. R	2° 03' 31"	22600	0.20678	164	$0.5x10^{-10}$	15	0.433	18.0
Pasiphae	VIII	735. R	2° 08' 26"	23500	0.378	145	$1x10^{-10}$	18		17.03
Sinope	IX	758. R	2° 09' 31"	23700	0.275	153	$0.4x10^{-10}$	14	0.548	18.3
Saturn										
Pan	XVIII	0.5750	0' 21"	133.583				10		
Atlas	XV	0.6019	0' 22"	137.670	0.000	0.3		18.5x17.2x13.5		18
Prometheus	XVI	0.6130	0' 23"	139.353	0.003	0.0		74x50x34		16
Pandora	XVII	0.6285	0' 23"	141.700	0.004	0.0		55x44x31		16
Epimetheus	XI	0.6942	0' 24"	151.422	0.009	0.34	$9.5x10^{-10}$	69x55x55	S	15
Janus	X	0.6945	0' 24"	151.472	0.007	0.14	$3.38x10^{-9}$	97x95x77	S	14
Mimas	I	0.942421813	0' 30"	185.52	0.0202	1.53	$6.60x10^{-8}$	209x196x191	S	12.9
Enceladus	II	1.370217855	0' 38"	238.02	0.00452	0.00	$1x10^{-7}$	256x247x245	S	11.7
Telesto	XIII	1.8878	0' 48"	294.66				15x12.5x7.5		18.5
Tethys	III	1.887802160	0' 48"	294.66	0.00000	1.86	$1.10x10^{-6}$	536x528x526	S	10.2
Calypso	XIV	1.8878	0' 48"	294.66				15x8x8		18.7
Helene	XII	2.7369	1' 01"	377.40	0.005	0.0		18x16x15		18
Dione	IV	2.736914742	1' 01"	377.40	0.002230	0.02	$1.93x10^{-6}$	560	S	10.4
Rhea	V	4.517500436	1' 25"	527.04	0.00100	0.35	$4.06x10^{-6}$	764	S	9.7
Titan	VI	15.94542068	3' 17"	1221.83	0.029192	0.33	$2.37x10^{-4}$	2575	S	8.28
Hyperion	VII	21.2766088	3' 59"	1481.1	0.104	0.43	$4x10^{-8}$	180x140x113		14.19
Iapetus	VIII	79.3301825	9' 35"	3561.3	0.02828	14.72	$2.8x10^{-6}$	718	S	11.1
Phoebe	IX	550.48 R	34' 51"	12952	0.16326	177 [2]	$7x10^{-10}$	110	0.4	16.45
Uranus										
Cordelia	VI	0.3350338	0' 04"	49.77	0.00026	0.08		13		24.1
Ophelia	VII	0.376400	0' 04"	53.79	0.0099	0.10		15		23.8
Bianca	VIII	0.43457899	0' 04"	59.17	0.009	0.19		21		23.0
Cressida	IX	0.46356960	0' 05"	61.78	0.0004	0.01		31		22.2
Desdemona	X	0.47364960	0' 05"	62.68	0.00013	0.11		27		22.5
Juliet	XI	0.49306549	0' 05"	64.35	0.00066	0.07		42		21.5
Portia	XII	0.51319592	0' 05"	66.09	0.0000	0.06		54		21.0
Rosalind	XIII	0.55845953	0' 05"	69.94	0.0001	0.28		27		22.5
Belinda	XIV	0.62352747	0' 06"	75.26	0.00007	0.03		33		22.1
Puck	XV	0.76183287	0' 07"	86.01	0.00012	0.32		77		20.2
Miranda	V	1.41347925	0' 10"	129.39	0.0027	4.2	$0.08x10^{-5}$	240x234x233	S	16.3
Ariel	I	2.52037935	0' 14"	191.02	0.0034	0.3	$1.55x10^{-5}$	581x578x578	S	14.16
Umbriel	II	4.1441772	0' 20"	266.30	0.0050	0.36	$1.35x10^{-5}$	585	S	14.81
Titania	III	8.7058717	0' 33"	435.91	0.0022	0.14	$4.06x10^{-5}$	789	S	13.73
Oberon	IV	13.4632389	0' 44"	583.52	0.0008	0.10	$3.47x10^{-5}$	761	S	13.94
Caliban	XVI	579R	8' 56"	7,169	0.082	139.7 [2]		30		22.4
Sycorax	XVII	1289R	15' 26"	12,214	0.509	152.7 [2]		60		20.9
Neptune										
Naiad	III	0.294396	0' 02"	48.23	0.000	4.74		29		24.7
Thalassa	IV	0.311485	0' 02"	50.07	0.000	0.21		40		23.8
Despina	V	0.334655	0' 02"	52.53	0.000	0.07		74		22.6
Galatea	VI	0.428745	0' 03"	61.95	0.000	0.05		79		22.3
Larissa	VII	0.554654	0' 03"	73.55	0.00139	0.20		104x89		22.0
Proteus	VIII	1.122315	0' 06"	117.65	0.0004	0.55		218x208x201	S	20.3
Triton	I	5.8768541 R	0' 17"	354.76	0.000016	157.345	$2.09x10^{-4}$	1353	S	13.47
Nereid	II	360.13619	4' 21"	5513.4	0.7512	27.6 [3]	$2x10^{-7}$	170		18.7
Pluto										
Charon	I	6.38725	<1"	19.6	<0.001	99 [3]	0.125	593	S	16.8

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

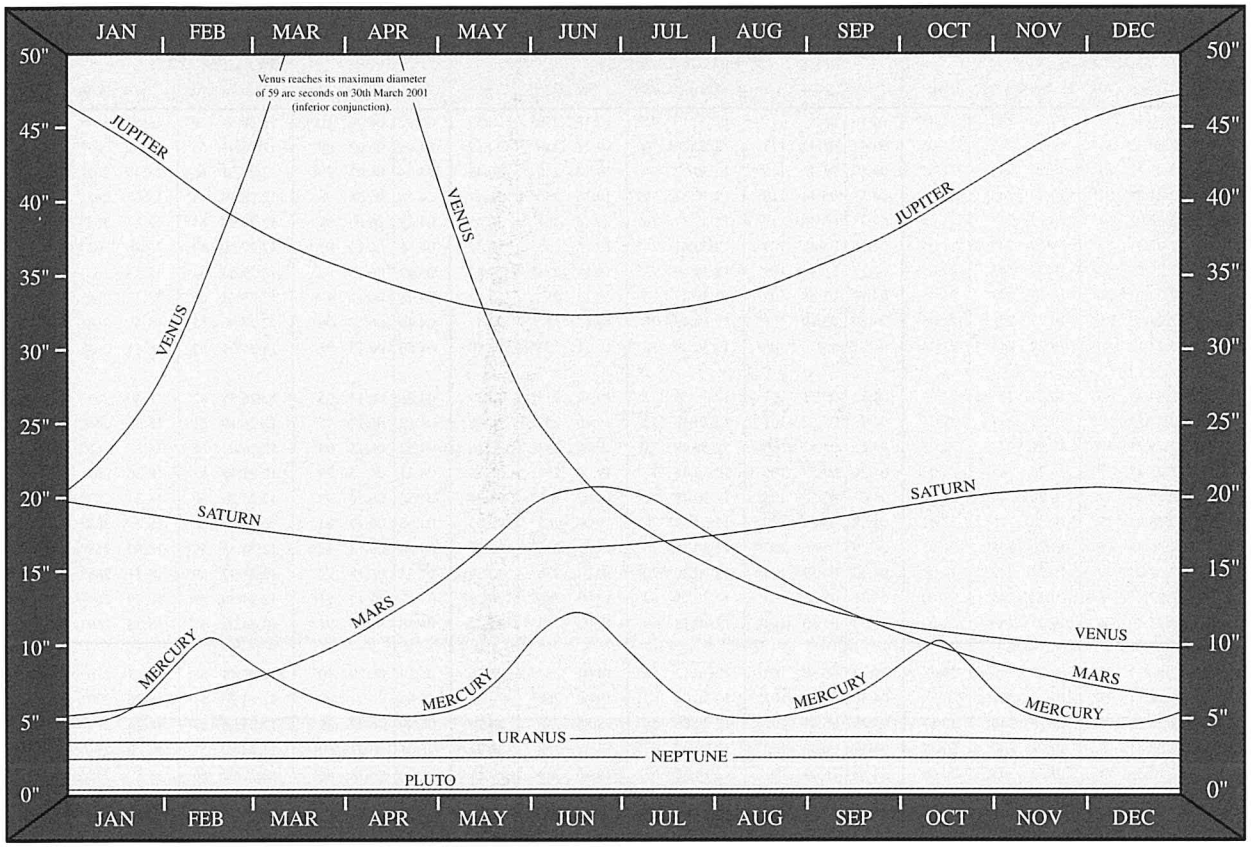
MAGNITUDES of the PLANETS and MAJOR ASTEROIDS



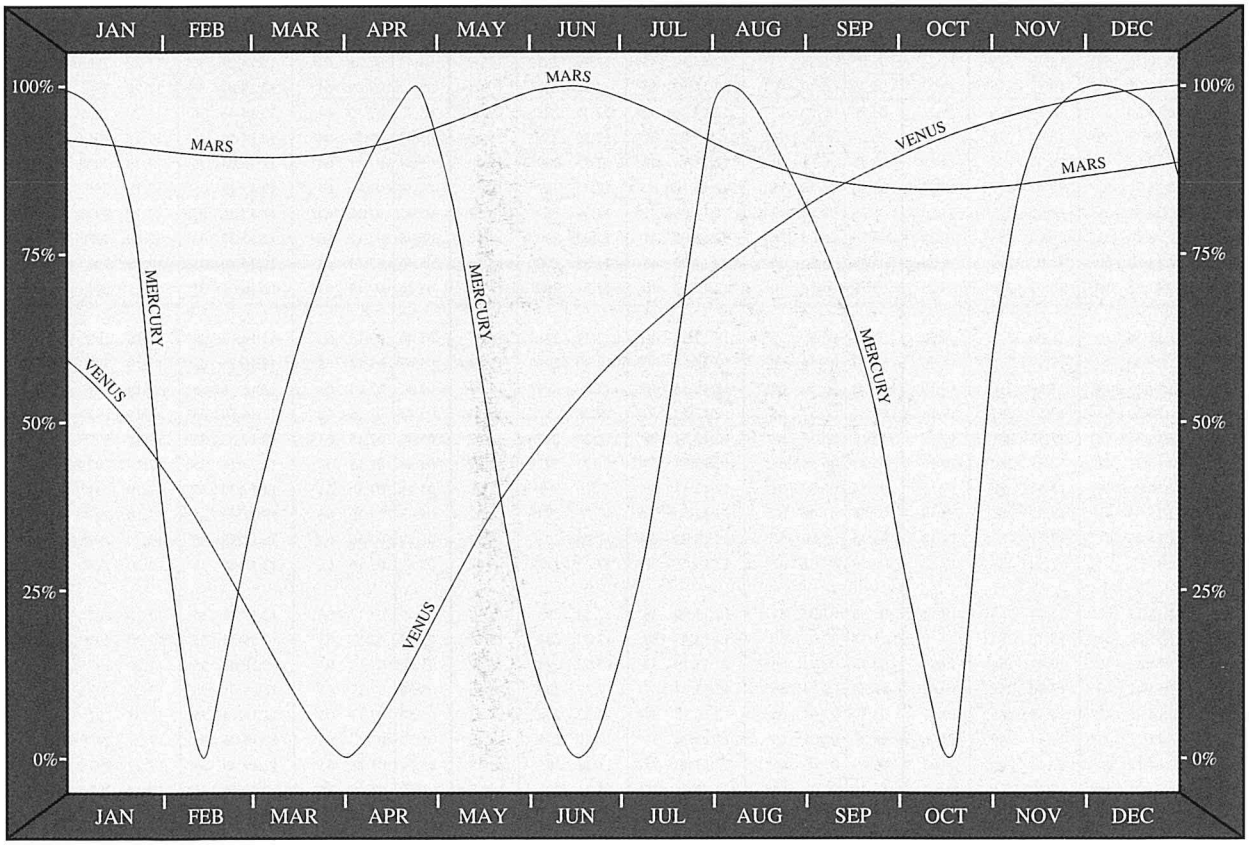
DECLINATIONS of the SUN and PLANETS



PLANETARY ANGULAR SIZE



PLANET ILLUMINATION



SUN – RISE, SET and TRANSIT (PERTH, WAST)

JANUARY

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	03:34	05:14	118°	12:20:15	81°	19:26	242°	21:05
2	03:35	05:15	118°	12:20:43	81°	19:26	242°	21:05
3	03:36	05:16	118°	12:21:11	81°	19:26	242°	21:05
4	03:37	05:16	118°	12:21:38	81°	19:27	242°	21:05
5	03:38	05:17	118°	12:22:05	81°	19:27	243°	21:05
6	03:39	05:18	117°	12:22:31	81°	19:27	243°	21:05
7	03:40	05:19	117°	12:22:57	80°	19:27	243°	21:05
8	03:41	05:20	117°	12:23:23	80°	19:27	243°	21:05
9	03:42	05:20	117°	12:23:47	80°	19:27	243°	21:05
10	03:43	05:21	117°	12:24:12	80°	19:27	243°	21:04
11	03:44	05:22	117°	12:24:35	80°	19:27	244°	21:04
12	03:46	05:23	116°	12:24:59	80°	19:27	244°	21:04
13	03:47	05:24	116°	12:25:21	80°	19:26	244°	21:03
14	03:48	05:25	116°	12:25:43	79°	19:26	244°	21:03
15	03:49	05:26	116°	12:26:04	79°	19:26	244°	21:02
16	03:50	05:27	116°	12:26:25	79°	19:26	245°	21:02
17	03:51	05:27	115°	12:26:45	79°	19:26	245°	21:01
18	03:53	05:28	115°	12:27:04	79°	19:25	245°	21:01
19	03:54	05:29	115°	12:27:22	78°	19:25	245°	21:00
20	03:55	05:30	115°	12:27:40	78°	19:25	246°	21:00
21	03:56	05:31	114°	12:27:57	78°	19:24	246°	20:59
22	03:57	05:32	114°	12:28:14	78°	19:24	246°	20:58
23	03:59	05:33	114°	12:28:29	77°	19:23	246°	20:57
24	04:00	05:34	113°	12:28:44	77°	19:23	247°	20:57
25	04:01	05:35	113°	12:28:58	77°	19:22	247°	20:56
26	04:02	05:36	113°	12:29:11	77°	19:22	247°	20:55
27	04:04	05:37	113°	12:29:23	76°	19:21	248°	20:54
28	04:05	05:38	112°	12:29:35	76°	19:21	248°	20:53
29	04:06	05:39	112°	12:29:46	76°	19:20	248°	20:52
30	04:07	05:40	112°	12:29:55	76°	19:20	249°	20:52
31	04:09	05:41	111°	12:30:05	75°	19:19	249°	20:51

FEBRUARY

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	04:10	05:42	111°	12:30:13	75°	19:18	249°	20:50
2	04:11	05:42	111°	12:30:20	75°	19:18	250°	20:49
3	04:12	05:43	110°	12:30:27	75°	19:17	250°	20:48
4	04:14	05:44	110°	12:30:32	74°	19:16	250°	20:47
5	04:15	05:45	110°	12:30:37	74°	19:16	251°	20:45
6	04:16	05:46	109°	12:30:41	74°	19:15	251°	20:44
7	04:17	05:47	109°	12:30:44	73°	19:14	251°	20:43
8	04:19	05:48	108°	12:30:47	73°	19:13	252°	20:42
9	04:20	05:49	108°	12:30:49	73°	19:12	252°	20:41
10	04:21	05:50	108°	12:30:49	72°	19:11	253°	20:40
11	04:22	05:51	107°	12:30:50	72°	19:11	253°	20:39
12	04:23	05:52	107°	12:30:49	72°	19:10	253°	20:38
13	04:25	05:52	106°	12:30:48	71°	19:09	254°	20:36
14	04:26	05:53	106°	12:30:45	71°	19:08	254°	20:35
15	04:27	05:54	106°	12:30:43	71°	19:07	255°	20:34
16	04:28	05:55	105°	12:30:39	70°	19:06	255°	20:33
17	04:29	05:56	105°	12:30:35	70°	19:05	255°	20:31
18	04:30	05:57	104°	12:30:30	70°	19:04	256°	20:30
19	04:31	05:58	104°	12:30:25	69°	19:03	256°	20:29
20	04:32	05:58	104°	12:30:18	69°	19:02	257°	20:28
21	04:33	05:59	103°	12:30:12	69°	19:01	257°	20:26
22	04:35	06:00	103°	12:30:04	68°	19:00	258°	20:25
23	04:36	06:01	102°	12:29:56	68°	18:58	258°	20:24
24	04:37	06:02	102°	12:29:47	68°	18:57	258°	20:22
25	04:38	06:03	101°	12:29:38	67°	18:56	259°	20:21
26	04:39	06:03	101°	12:29:28	67°	18:55	259°	20:20
27	04:40	06:04	100°	12:29:18	66°	18:54	260°	20:18
28	04:41	06:05	100°	12:29:07	66°	18:53	260°	20:17

MARCH

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	04:42	06:06	100°	12:28:55	66°	18:52	261°	20:16
2	04:43	06:07	99°	12:28:43	65°	18:51	261°	20:14
3	04:44	06:07	99°	12:28:31	65°	18:49	262°	20:13
4	04:45	06:08	98°	12:28:18	64°	18:48	262°	20:12
5	04:45	06:09	98°	12:28:04	64°	18:47	262°	20:10
6	04:46	06:10	97°	12:27:50	64°	18:46	263°	20:09
7	04:47	06:10	97°	12:27:36	63°	18:44	263°	20:07
8	04:48	06:11	96°	12:27:21	63°	18:43	264°	20:06
9	04:49	06:12	96°	12:27:06	63°	18:42	264°	20:05
10	04:50	06:13	95°	12:26:51	62°	18:41	265°	20:03
11	04:51	06:13	95°	12:26:35	62°	18:40	265°	20:02
12	04:52	06:14	95°	12:26:19	61°	18:38	266°	20:00
13	04:52	06:15	94°	12:26:02	61°	18:37	266°	19:59
14	04:53	06:15	94°	12:25:46	61°	18:36	267°	19:58
15	04:54	06:16	93°	12:25:29	60°	18:34	267°	19:56
16	04:55	06:17	93°	12:25:12	60°	18:33	268°	19:55
17	04:56	06:18	92°	12:24:55	59°	18:32	268°	19:54
18	04:57	06:18	92°	12:24:37	59°	18:31	268°	19:52
19	04:57	06:19	91°	12:24:20	59°	18:29	269°	19:51
20	04:58	06:20	91°	12:24:02	58°	18:28	269°	19:50
21	04:59	06:20	90°	12:23:44	58°	18:27	270°	19:48
22	05:00	06:21	90°	12:23:26	57°	18:26	270°	19:47
23	05:00	06:22	89°	12:23:08	57°	18:24	271°	19:46
24	05:01	06:22	89°	12:22:50	57°	18:23	271°	19:44
25	05:02	06:23	88°	12:22:32	56°	18:22	272°	19:43
26	05:03	06:24	88°	12:22:14	56°	18:20	272°	19:42
27	05:03	06:24	88°	12:21:56	55°	18:19	273°	19:40
28	05:04	06:25	87°	12:21:38	55°	18:18	273°	19:39
29	05:05	06:26	87°	12:21:20	55°	18:17	274°	19:38
30	05:05	06:26	86°	12:21:02	54°	18:15	274°	19:36
31	05:06	06:27	86°	12:20:44	54°	18:14	275°	19:35

APRIL

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	05:07	06:28	85°	12:20:26	54°	18:13	275°	19:34
2	05:07	06:28	85°	12:20:08	53°	18:12	275°	19:32
3	05:08	06:29	84°	12:19:50	53°	18:10	276°	19:31
4	05:09	06:30	84°	12:19:33	52°	18:09	276°	19:30
5	05:09	06:31	83°	12:19:15	52°	18:08	277°	19:29
6	05:10	06:31	83°	12:18:58	52°	18:07	277°	19:28
7	05:11	06:32	83°	12:18:41	51°	18:05	278°	19:26
8	05:11	06:33	82°	12:18:24	51°	18:04	278°	19:25
9	05:12	06:33	82°	12:18:08	50°	18:03	279°	19:24
10	05:13	06:34	81°	12:17:52	50°	18:02	279°	19:23
11	05:13	06:35	81°	12:17:36	50°	18:00	279°	19:22
12	05:14	06:35	80°	12:17:20	49°	17:59	280°	19:20
13	05:14	06:36	80°	12:17:05	49°	17:58	280°	19:19
14	05:15	06:37	80°	12:16:50	49°	17:57	281°	19:18
15	05:16	06:37	79°	12:16:35	48°	17:56	281°	19:17
16	05:16	06:38	79°	12:16:21	48°	17:55	282°	19:16
17	05:17	06:39	78°	12:16:07	48°	17:53	282°	19:15
18	05:18	06:39	78°	12:15:53	47°	17:52	282°	19:14
19	05:18	06:40	77°	12:15:40	47°	17:51	283°	19:13
20	05:19	06:41	77°	12:15:28	47°	17:50	283°	19:12
21	05:19	06:41	77°	12:15:15	46°	17:49	284°	19:11
22	05:20	06:42	76°	12:15:04	46°	17:48	284°	19:10
23	05:21	06:43	76°	12:14:52	46°	17:47	284°	19:09
24	05:21	06:43	75°	12:14:42	45°	17:46	285°	19:08
25	05:22	06:44	75°	12:14:31	45°	17:45	285°	19:07
26	05:22	06:45	75°	12:14:21	45°	17:44	286°	19:06
27	05:23	06:45	74°	12:14:12	44°	17:43	286°	19:05
28	05:24	06:46	74°	12:14:03	44°	17:42	286°	19:04
29	05:24	06:47	73°	12:13:55	44°	17:41	287°	19:03
30	05:25	06:47	73°	12:13:47	43°	17:40	287°	19:03

MAY

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	05:25	06:48	73°	12:13:39	43°	17:39	287°	19:02
2	05:26	06:49	72°	12:13:32	43°	17:38	288°	19:01
3	05:26	06:50	72°	12:13:26	42°	17:37	288°	19:00
4	05:27	06:50	72°	12:13:20	42°	17:36	288°	18:59
5	05:28	06:51	71°	12:13:15	42°	17:35	289°	18:59
6	05:28	06:52	71°	12:13:10	42°	17:34	289°	18:58
7	05:29	06:52	71°	12:13:06	41°	17:34	289°	18:57
8	05:29	06:53	70°	12:13:03	41°	17:33	290°	18:57
9	05:30	06:54	70°	12:13:00	41°	17:32	290°	18:56
10	05:30	06:54	70°	12:12:57	40°	17:31	290°	18:55
11	05:31	06:55	69°	12:12:55	40°	17:31	291°	18:55
12	05:32	06:56	69°	12:12:54	40°	17:30	291°	18:54
13	05:32	06:56	69°	12:12:53	40°	17:29	291°	18:53
14	05:33	06:57	68°	12:12:53	39°	17:28	292°	18:53
15	05:33	06:58	68°	12:12:54	39°	17:28	292°	18:52
16	05:34	06:58	68°	12:12:55	39°	17:27	292°	18:52
17	05:34	06:59	68°	12:12:57	39°	17:26	292°	18:51
18	05:35	07:00	67°	12:12:59	39°	17:26	293°	18:51
19	05:35	07:00	67°	12:13:02	38°	17:25	293°	18:50
20	05:36	07:01	67°	12:13:05	38°	17:25	293°	18:50
21	05:36	07:02	67°	12:13:09	38°	17:24	293°	18:50
22	05:37	07:02	66°	12:13:13	38°	17:24	294°	18:49
23	05:38	07:03	66°	12:13:18	37°	17:23	294°	18:49
24	05:38	07:04	66°	12:13:24	37°	17:23	294°	18:48
25	05:39	07:04	66°	12:13:30	37°	17:22	294°	18:48
26	05:39	07:05	65°	12:13:36	37°	17:22	295°	18:48
27	05:40	07:06	65°	12:13:43	37°	17:22	295°	18:48
28	05:40	07:06	65°	12:13:51	37°	17:21	295°	18:47
29	05:41	07:07	65°	12:13:58	36°	17:21	295°	18:47
30	05:41	07:07	65°	12:14:07	36°	17:21	295°	18:47
31	05:42	07:08	65°	12:14:15	36°	17:20	296°	18:47

JUNE

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	05:42	07:08	64°	12:14:24	36°	17:20	296°	18:47
2	05:42	07:09	64°	12:14:34	36°	17:20	296°	18:46
3	05:43	07:10	64°	12:14:43	36°	17:20	296°	18:46
4	05:43	07:10	64°	12:14:54	36°	17:19	296°	18:46
5	05:44	07:11	64°	12:15:04	36°	17:19	296°	18:46
6	05:44	07:11	64°	12:15:15	35°	17:19	296°	18:46
7	05:45	07:12	63°	12:15:26	35°	17:19	297°	18:46
8	05:45	07:12	63°	12:15:37	35°	17:19	297°	18:46
9	05:45	07:12	63°	12:15:49	35°	17:19	297°	18:46
10	05:46	07:13	63°	12:16:01	35°	17:19	297°	18:46
11	05:46	07:13	63°	12:16:13	35°	17:19	297°	18:46
12	05:47	07:14	63°	12:16:25	35°	17:19	297°	18:46
13	05:47	07:14	63°	12:16:38	35°	17:19	297°	18:46
14	05:47	07:15	63°	12:16:50	35°	17:19	297°	18:46
15	05:48	07:15	63°	12:17:03	35°	17:19	297°	18:46
16	05:48	07:15	63°	12:17:16	35°	17:19	297°	18:47
17	05:48	07:16	63°	12:17:29	35°	17:19	297°	18:47
18	05:48	07:16	63°	12:17:42	35°	17:19	297°	18:47
19	05:49	07:16	63°	12:17:55	35°	17:20	297°	18:47
20	05:49	07:16	63°	12:18:08	35°	17:20	297°	18:47
21	05:49	07:17	63°	12:18:22	35°	17:20	297°	18:47
22	05:49	07:17	63°	12:18:35	35°	17:20	297°	18:48
23	05:50	07:17	63°	12:18:48	35°	17:20	297°	18:48
24	05:50	07:17	63°	12:19:01	35°	17:21	297°	18:48
25	05:50	07:17	63°	12:19:14	35°	17:21	297°	18:48
26	05:50	07:17	63°	12:19:26	35°	17:21	297°	18:49
27	05:50	07:18	63°	12:19:39	35°	17:22	297°	18:49
28	05:50	07:18	63°	12:19:51	35°	17:22	297°	18:49
29	05:50	07:18	63°	12:20:03	35°	17:22	297°	18:50
30	05:50	07:18	63°	12:20:15	35°	17:23	297°	18:50

SUN – RISE, SET and TRANSIT (PERTH, WAST)

JULY

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	05:51	07:18	63°	12:20:27	35°	17:23	297°	18:50
2	05:51	07:18	63°	12:20:38	35°	17:24	297°	18:51
3	05:51	07:18	63°	12:20:49	35°	17:24	297°	18:51
4	05:51	07:18	63°	12:21:00	35°	17:24	297°	18:51
5	05:51	07:18	63°	12:21:10	35°	17:25	297°	18:52
6	05:51	07:17	64°	12:21:20	35°	17:25	296°	18:52
7	05:50	07:17	64°	12:21:30	35°	17:26	296°	18:53
8	05:50	07:17	64°	12:21:39	36°	17:26	296°	18:53
9	05:50	07:17	64°	12:21:48	36°	17:27	296°	18:53
10	05:50	07:17	64°	12:21:57	36°	17:27	296°	18:54
11	05:50	07:16	64°	12:22:05	36°	17:28	296°	18:54
12	05:50	07:16	64°	12:22:13	36°	17:28	296°	18:55
13	05:50	07:16	65°	12:22:20	36°	17:29	295°	18:55
14	05:49	07:16	65°	12:22:27	36°	17:29	295°	18:56
15	05:49	07:15	65°	12:22:33	37°	17:30	295°	18:56
16	05:49	07:15	65°	12:22:39	37°	17:31	295°	18:57
17	05:49	07:14	65°	12:22:44	37°	17:31	295°	18:57
18	05:48	07:14	66°	12:22:49	37°	17:32	294°	18:58
19	05:48	07:14	66°	12:22:53	37°	17:32	294°	18:58
20	05:48	07:13	66°	12:22:57	37°	17:33	294°	18:59
21	05:47	07:13	66°	12:23:00	38°	17:34	294°	18:59
22	05:47	07:12	66°	12:23:02	38°	17:34	293°	19:00
23	05:46	07:12	67°	12:23:04	38°	17:35	293°	19:00
24	05:46	07:11	67°	12:23:06	38°	17:35	293°	19:01
25	05:45	07:10	67°	12:23:06	38°	17:36	293°	19:01
26	05:45	07:10	67°	12:23:07	39°	17:37	292°	19:02
27	05:44	07:09	68°	12:23:06	39°	17:37	292°	19:02
28	05:44	07:09	68°	12:23:05	39°	17:38	292°	19:03
29	05:43	07:08	68°	12:23:03	39°	17:39	292°	19:03
30	05:43	07:07	69°	12:23:01	40°	17:39	291°	19:04
31	05:42	07:06	69°	12:22:58	40°	17:40	291°	19:04

AUGUST

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	05:42	07:06	69°	12:22:54	40°	17:40	291°	19:05
2	05:41	07:05	69°	12:22:50	40°	17:41	290°	19:05
3	05:40	07:04	70°	12:22:45	41°	17:42	290°	19:06
4	05:40	07:03	70°	12:22:40	41°	17:42	290°	19:06
5	05:39	07:03	70°	12:22:34	41°	17:43	289°	19:07
6	05:38	07:02	71°	12:22:27	41°	17:44	289°	19:07
7	05:37	07:01	71°	12:22:20	42°	17:44	289°	19:08
8	05:37	07:00	71°	12:22:12	42°	17:45	288°	19:08
9	05:36	06:59	72°	12:22:04	42°	17:46	288°	19:09
10	05:35	06:58	72°	12:21:55	43°	17:46	288°	19:09
11	05:34	06:57	72°	12:21:46	43°	17:47	287°	19:10
12	05:33	06:56	73°	12:21:36	43°	17:48	287°	19:10
13	05:32	06:55	73°	12:21:25	43°	17:48	287°	19:11
14	05:32	06:54	73°	12:21:14	44°	17:49	286°	19:11
15	05:31	06:53	74°	12:21:02	44°	17:49	286°	19:12
16	05:30	06:52	74°	12:20:50	44°	17:50	286°	19:13
17	05:29	06:51	75°	12:20:38	45°	17:51	285°	19:13
18	05:28	06:50	75°	12:20:24	45°	17:51	285°	19:14
19	05:27	06:49	75°	12:20:11	45°	17:52	284°	19:14
20	05:26	06:48	76°	12:19:57	46°	17:53	284°	19:15
21	05:25	06:47	76°	12:19:42	46°	17:53	284°	19:15
22	05:24	06:46	77°	12:19:27	46°	17:54	283°	19:16
23	05:23	06:45	77°	12:19:12	47°	17:54	283°	19:16
24	05:22	06:43	77°	12:18:56	47°	17:55	282°	19:17
25	05:21	06:42	78°	12:18:39	47°	17:56	282°	19:17
26	05:20	06:41	78°	12:18:22	48°	17:56	282°	19:18
27	05:18	06:40	79°	12:18:05	48°	17:57	281°	19:18
28	05:17	06:39	79°	12:17:48	48°	17:58	281°	19:19
29	05:16	06:37	79°	12:17:30	49°	17:58	280°	19:20
30	05:15	06:36	80°	12:17:11	49°	17:59	280°	19:20
31	05:14	06:35	80°	12:16:53	49°	17:59	280°	19:21

SEPTEMBER

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	05:13	06:34	81°	12:16:34	50°	18:00	279°	19:21
2	05:11	06:33	81°	12:16:14	50°	18:01	279°	19:22
3	05:10	06:31	82°	12:15:55	51°	18:01	278°	19:22
4	05:09	06:30	82°	12:15:35	51°	18:02	278°	19:23
5	05:08	06:29	82°	12:15:15	51°	18:02	277°	19:24
6	05:06	06:28	83°	12:14:55	52°	18:03	277°	19:24
7	05:05	06:26	83°	12:14:34	52°	18:04	277°	19:25
8	05:04	06:25	84°	12:14:13	52°	18:04	276°	19:25
9	05:03	06:24	84°	12:13:53	53°	18:05	276°	19:26
10	05:01	06:22	85°	12:13:32	53°	18:05	275°	19:27
11	05:00	06:21	85°	12:13:11	54°	18:06	275°	19:27
12	04:59	06:20	85°	12:12:50	54°	18:07	274°	19:28
13	04:57	06:18	86°	12:12:28	54°	18:07	274°	19:28
14	04:56	06:17	86°	12:12:07	55°	18:08	273°	19:29
15	04:55	06:16	87°	12:11:46	55°	18:08	273°	19:30
16	04:53	06:15	87°	12:11:25	55°	18:09	272°	19:30
17	04:52	06:13	88°	12:11:03	56°	18:10	272°	19:31
18	04:51	06:12	88°	12:10:42	56°	18:10	272°	19:32
19	04:49	06:11	89°	12:10:21	57°	18:11	271°	19:32
20	04:48	06:09	89°	12:09:59	57°	18:11	271°	19:33
21	04:47	06:08	90°	12:09:38	57°	18:12	270°	19:34
22	04:45	06:07	90°	12:09:17	58°	18:13	270°	19:34
23	04:44	06:05	91°	12:08:56	58°	18:13	269°	19:35
24	04:42	06:04	91°	12:08:35	59°	18:14	269°	19:36
25	04:41	06:03	91°	12:08:14	59°	18:15	268°	19:36
26	04:40	06:01	92°	12:07:54	59°	18:15	268°	19:37
27	04:38	06:00	92°	12:07:33	60°	18:16	267°	19:38
28	04:37	05:59	93°	12:07:13	60°	18:16	267°	19:39
29	04:35	05:57	93°	12:06:53	60°	18:17	267°	19:39
30	04:34	05:56	94°	12:06:33	61°	18:18	266°	19:40

OCTOBER

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	04:33	05:55	94°	12:06:14	61°	18:18	266°	19:41
2	04:31	05:53	95°	12:05:55	62°	18:19	265°	19:42
3	04:30	05:52	95°	12:05:36	62°	18:20	265°	19:42
4	04:28	05:51	96°	12:05:17	62°	18:20	264°	19:43
5	04:27	05:50	96°	12:04:59	63°	18:21	264°	19:44
6	04:26	05:48	96°	12:04:41	63°	18:22	263°	19:45
7	04:24	05:47	97°	12:04:24	64°	18:22	263°	19:46
8	04:23	05:46	97°	12:04:07	64°	18:23	262°	19:46
9	04:21	05:45	98°	12:03:50	64°	18:24	262°	19:47
10	04:20	05:43	98°	12:03:34	65°	18:24	262°	19:48
11	04:18	05:42	99°	12:03:19	65°	18:25	261°	19:49
12	04:17	05:41	99°	12:03:04	65°	18:26	261°	19:50
13	04:16	05:40	100°	12:02:49	66°	18:27	260°	19:51
14	04:14	05:39	100°	12:02:35	66°	18:27	260°	19:52
15	04:13	05:37	100°	12:02:22	67°	18:28	259°	19:53
16	04:12	05:36	101°	12:02:09	67°	18:29	259°	19:54
17	04:10	05:35	101°	12:01:57	67°	18:30	258°	19:55
18	04:09	05:34	102°	12:01:45	68°	18:30	258°	19:56
19	04:07	05:33	102°	12:01:34	68°	18:31	258°	19:57
20	04:06	05:32	103°	12:01:23	68°	18:32	257°	19:58
21	04:05	05:30	103°	12:01:14	69°	18:33	257°	19:59
22	04:03	05:29	103°	12:01:04	69°	18:33	256°	20:00
23	04:02	05:28	104°	12:00:56	69°	18:34	256°	20:01
24	04:01	05:27	104°	12:00:48	70°	18:35	255°	20:02
25	04:00	05:26	105°	12:00:41	70°	18:36	255°	20:03
26	03:58	05:25	105°	12:00:35	71°	18:37	255°	20:04
27	03:57	05:24	106°	12:00:29	71°	18:37	254°	20:05
28	03:56	05:23	106°	12:00:24	71°	18:38	254°	20:06
29	03:54	05:22	106°	12:00:20	72°	18:39	253°	20:07
30	03:53	05:21	107°	12:00:16	72°	18:40	253°	20:08
31	03:52	05:20	107°	12:00:14	72°	18:41	253°	20:09

NOVEMBER

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	03:51	05:19	108°	12:00:12	72°	18:42	252°	20:10
2	03:50	05:19	108°	12:00:11	73°	18:42	252°	20:12
3	03:48	05:18	108°	12:00:10	73°	18:43	252°	20:13
4	03:47	05:17	109°	12:00:11	73°	18:44	251°	20:14
5	03:46	05:16	109°	12:00:12	74°	18:45	251°	20:15
6	03:45	05:15	109°	12:00:14	74°	18:46	250°	20:16
7	03:44	05:14	110°	12:00:17	74°	18:47	250°	20:17
8	03:43	05:14	110°	12:00:21	75°	18:48	250°	20:19
9	03:42	05:13	110°	12:00:26	75°	18:48	249°	20:20
10	03:41	05:12	111°	12:00:32	75°	18:49	249°	20:21
11	03:40	05:11	111°	12:00:38	75°	18:50	249°	20:22
12	03:39	05:11	111°	12:00:46	76°	18:51	248°	20:23
13	03:38	05:10	112°	12:00:54	76°	18:52	248°	20:25
14	03:37	05:10	112°	12:01:03	76°	18:53	248°	20:26
15	03:36	05:09	112°	12:01:13	77°	18:54	247°	20:27
16	03:35	05:08	113°	12:01:24	77°	18:55	247°	20:28
17	03:34	05:08	113°	12:01:36	77°	18:56	247°	20:29
18	03:34	05:07	113°	12:01:48	77°	18:57	247°	20:31
19	03:33	05:07	114°	12:02:01	78°	18:57	246°	20:32
20	03:32	05:06	114°	12:02:16	78°	18:58	246°	20:33
21	03:31	05:06	114°	12:02:30	78°	18:59	246°	20:34
22	03:31	05:06	114°	12:02:46	78°	19:00	245°	20:35
23	03:30	05:05	115°	12:03:03	78°	19:01	245°	20:37
24	03:29	05:05	115°	12:03:20	79°	19:02	245°	20:38
25	03:29	05:05	115°	12:03:38	79°	19:03	245°	20:39
26	03:28	05:04	115°	12:03:56	79°	19:04	244°	20:40
27	03:28	05:04	116°	12:04:16	79°	19:05	244°	20:41
28	03:27	05:04	116°	12:04:36	79°	19:05	244°	20:42
29	03:27	05:04	116°	12:04:57	80°	19:06	244°	20:43
30	03:26	05:04	116°	12:05:18	80°	19:07	244°	20:45

DECEMBER

	Twi	Rise	Azm	Transit	Alt	Set	Azm	Twi
1	03:26	05:03	116°	12:05:40	80°	19:08	243°	20:46
2	03:26	05:03	117°	12:06:03	80°	19:09	243°	20:47
3	03:25	05:03	117°	12:06:26	80°	19:10	243°	20:48
4	03:25	05:03	117°	12:06:50	80°	19:10	243°	20:49
5	03:25	05:03	117°	12:07:15	80°	19:11	243°	20:50
6	03:25	05:03	117°	12:07:40	81°	19:12	243°	20:51
7	03:25	05:03	117°	12:08:06	81°	19:13	242°	20:52
8	03:24	05:03	118°	12:08:32	81°	19:14	242°	20:53
9	03:24	05:04	118°	12:08:59	81°	19:14	242°	20:54
10	03:24	05:04	118°	12:09:26	81°	19:15	242°	20:55
11	03:24	05:04	118°	12:09:53	81°	19:16	242°	20:55
12	03:25	05:04	118°	12:10:21	81°	19:17	242°	20:56
13	03:25	05:04	118°	12:10:50	81°	19:17	242°	20:57
14	03:25	05:05	118°	12:11:18	81°	19:18	242°	20:58
15	03:25	05:05	118°	12:11:47	81°	19:19	242°	20:59
16	03:25	05:05	118°	12:12:17	81°	19:19	242°	20:59
17	03:25	05:06	118°	12:12:46	81°	19:20	242°	21:00
18	03:26	05:06	118°	12:13:15	81°	19:20	242°	21:01
19	03:26	05:06	119°	12:13:45	81°	19:21	241°	21:01
20	03:27	05:07	119°	12:14:15	81°	19:21	241°	21:02
21	03:27	05:07	119°	12:14:45	81°	19:22	241°	21:02
22	03:27	05:08	119°	12:15:15	81°	19:22	241°	21:03
23	03:28	05:08	119°	12:15:45	81°	19:23	241°	21:03
24	03:29	05:09	119°	12:16:14	81°	19:23	241°	21:04
25	03:29	05:09	119°	12:16:44	81°	19:24	242°	21:04
26	03:30	05:10	118°	12:17:14	81°	19:24	242°	21:04
27	03:30	05:11	118°	12:17:43	81°	19:25	242°	21:05
28	03:31	05:11	118°	12:18:13	81°	19:25	242°	21:05
29	03:32	05:12	118°	12:18:42	81°	19:25	242°	21:05
30	03:33	05:12	118°	12:19:11	81°	19:25	242°	21:05
31	03:33	05:13	118°	12:19:39	81°	19:26	242°	21:05

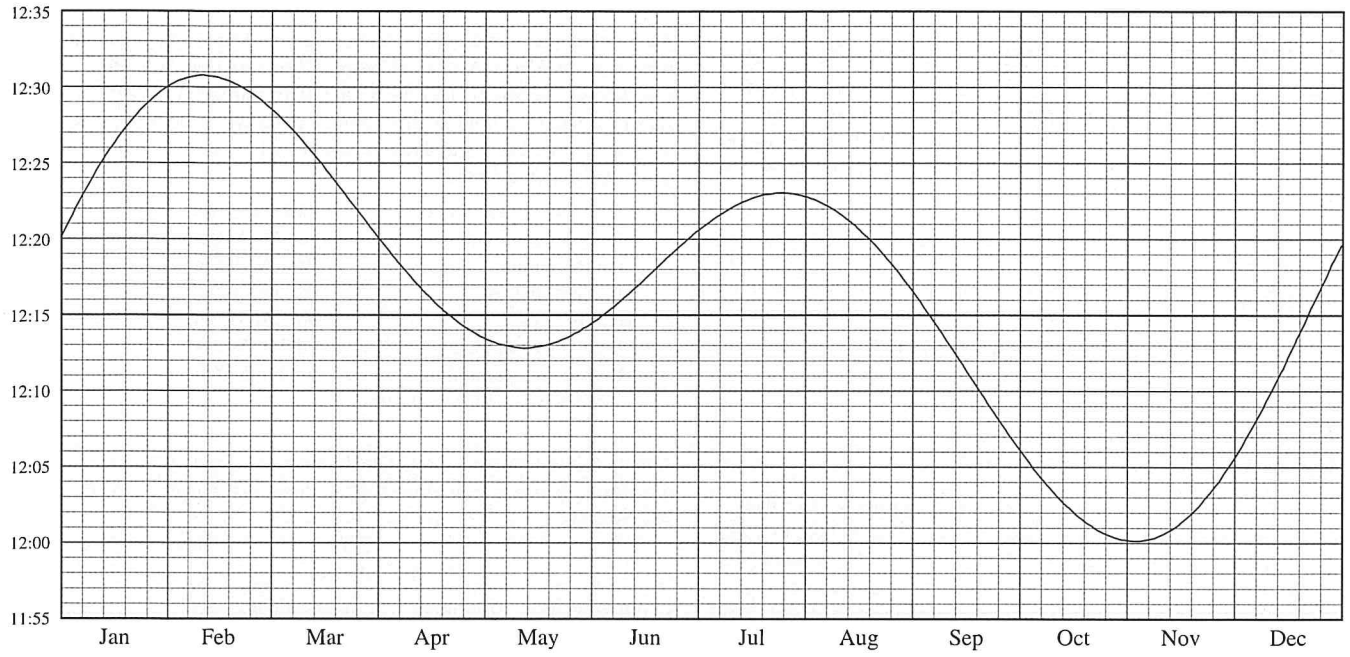
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GEOCENTRIC POSITION (0hr UT, Epoch 2000.0)

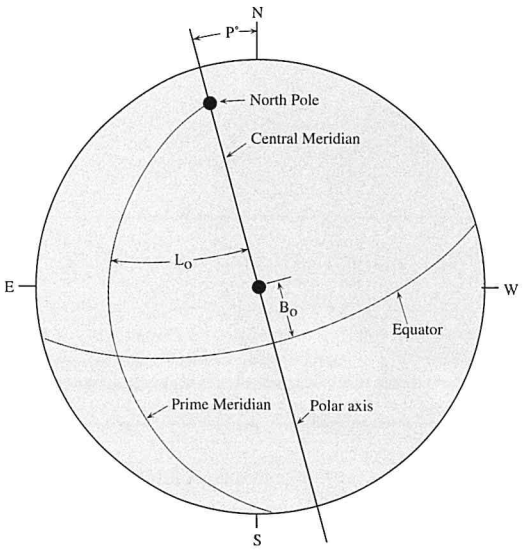
	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	R.A. hh mm ss	Dec. ° ' "	R.A. hh mm ss	Dec. ° ' "	R.A. hh mm ss	Dec. ° ' "	R.A. hh mm ss	Dec. ° ' "	R.A. hh mm ss	Dec. ° ' "	R.A. hh mm ss	Dec. ° ' "
1	18 46 15	- 23 00 49	20 58 35	- 17 08 32	22 47 51	- 07 38 44	00 41 38	+ 04 28 42	02 33 02	+ 15 01 39	04 35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

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

TRANSIT TIME OF THE SUN AT PERTH (WAST)



ORIENTATION OF THE SUN



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.

DATE (0hr UT)		P°	B_o°	L_o°
Jan	6	- 0.41	- 3.61	151.43
	13	- 3.77	- 4.37	059.25
	20	- 7.02	- 5.05	327.08
	27	- 10.12	- 5.66	234.91
Feb	3	- 13.02	- 6.18	142.75
	10	- 15.68	- 6.60	050.58
	17	- 18.09	- 6.92	318.40
	24	- 20.21	- 7.13	226.22
Mar	3	- 22.04	- 7.24	134.02
	10	- 23.56	- 7.24	041.79
	17	- 24.75	- 7.13	309.53
	24	- 25.61	- 6.91	217.24
	31	- 26.13	- 6.59	124.92
Apr	7	- 26.29	- 6.18	032.56
	14	- 26.10	- 5.68	300.16
	21	- 25.55	- 5.10	207.72
	28	- 24.64	- 4.46	115.24
May	5	- 23.37	- 3.75	022.72
	12	- 21.76	- 2.99	290.17
	19	- 19.82	- 2.20	197.59
	26	- 17.57	- 1.37	104.98
Jun	2	- 15.05	- 0.53	012.36
	9	- 12.30	+ 0.31	279.71
	16	- 9.36	+ 1.15	187.05
	23	- 6.28	+ 1.97	094.40
	30	- 3.13	+ 2.77	001.74
Jul	7	+ 0.05	+ 3.53	269.09
	14	+ 3.19	+ 4.24	176.45
	21	+ 6.26	+ 4.90	083.83
	28	+ 9.22	+ 5.49	351.23
Aug	4	+ 12.01	+ 6.00	258.65
	11	+ 14.62	+ 6.44	166.09
	18	+ 17.01	+ 6.78	073.56
	25	+ 19.17	+ 7.04	341.06
Sep	1	+ 21.08	+ 7.20	248.58
	8	+ 22.72	+ 7.25	156.12
	15	+ 24.07	+ 7.21	063.70
	22	+ 25.11	+ 7.06	331.29
	29	+ 25.84	+ 6.81	238.91
Oct	6	+ 26.23	+ 6.46	146.54
	13	+ 26.26	+ 6.01	054.19
	20	+ 25.94	+ 5.48	321.86
	27	+ 25.24	+ 4.86	229.54
Nov	3	+ 24.15	+ 4.17	137.23
	10	+ 22.68	+ 3.41	044.94
	17	+ 20.83	+ 2.60	312.66
	24	+ 18.63	+ 1.75	220.39
Dec	1	+ 16.09	+ 0.87	128.13
	8	+ 13.26	- 0.02	035.88
	15	+ 10.19	- 0.92	303.65
	22	+ 6.94	- 1.80	211.43
	29	+ 3.58	- 2.66	119.23

VARIATION OF L_o

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

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

SYNODIC ROTATION NUMBERS (UT)

		d.dd
1972	Jan	17.50
1973	Feb	13.84
1974	Mar	13.17
1975	Apr	9.47
1976	May	6.72
1977	Jun	2.94
1978	Jun	30.13
1979	Jul	27.34
1980	Aug	23.57
1981	Sep	19.83
1982	Oct	17.11
1983	Nov	13.41
1984	Dec	10.73

SOLAR AND LUNAR ECLIPSES

During the year 2001 there are five eclipses, two of the Sun and three of the Moon. One solar eclipse is total and the other annular. One of each type of lunar eclipse is represented, total, partial and penumbral.

The partial lunar eclipse of July 6th will be visible in its entirety across Australia. The penumbral eclipse of 30th December is not observable from most of Australia. From Perth, during the first half of the eclipse the moon is below the horizon. The latter half, (after moonrise and sunset) is severely effected by twilight.

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

Please note all times listed in the tables below are in U.T.

TOTAL LUNAR ECLIPSE – 9th January 2001

The first eclipse of the twenty-first century will be visible in its entirety from most of Africa, Asia and Europe. Observers from Western Australia will witness the Moon enter the umbra, with astronomical twilight starting around the time totality begins. As the Moon does not penetrate deep within the Earth's umbral shadow it will, in all probability, not be a particularly dark eclipse.

Moon enters penumbra	9d 17h 43.5m	U.T.
Moon enters umbra	9d 18h 42.0m	
Totality begins	9d 19h 49.5m	
Middle of eclipse	9d 20h 20.5m	
Totality ends	9d 20h 51.6m	
Moon leaves umbra	9d 21h 59.1m	
Moon leaves penumbra	9d 22h 57.6m	

Magnitude of eclipse = 1.195

TOTAL SOLAR ECLIPSE – 21st June 2001

The path of the first solar eclipse of the year begins in the South Atlantic Ocean near the coast of Uruguay. The shadow first contacts land in South Africa, moving across Angola, Zambia, Zimbabwe and Mozambique. Leaving the Mozambique coast the shadow again crosses water before landfall in Madagascar, finally ending at sunset in the Indian Ocean. The greatest eclipse time (totality) of 4 minutes 56.6 seconds occurs in the Atlantic off the African coast. The duration over land ranges from 4 minutes 35 seconds at Sumbe, Angola, down to 2 minutes at Manja, Madagascar.

	U.T.	Long	Lat
Eclipse begins	21d 09h 32.9m	-41°05.5'	-25°04.8'
Centre of eclipse, local noon	21d 11h 57.8m	+00°59.9'	-11°35.7'
Eclipse ends	21d 14h 34.3m	+45°12.9'	-14°57.5'

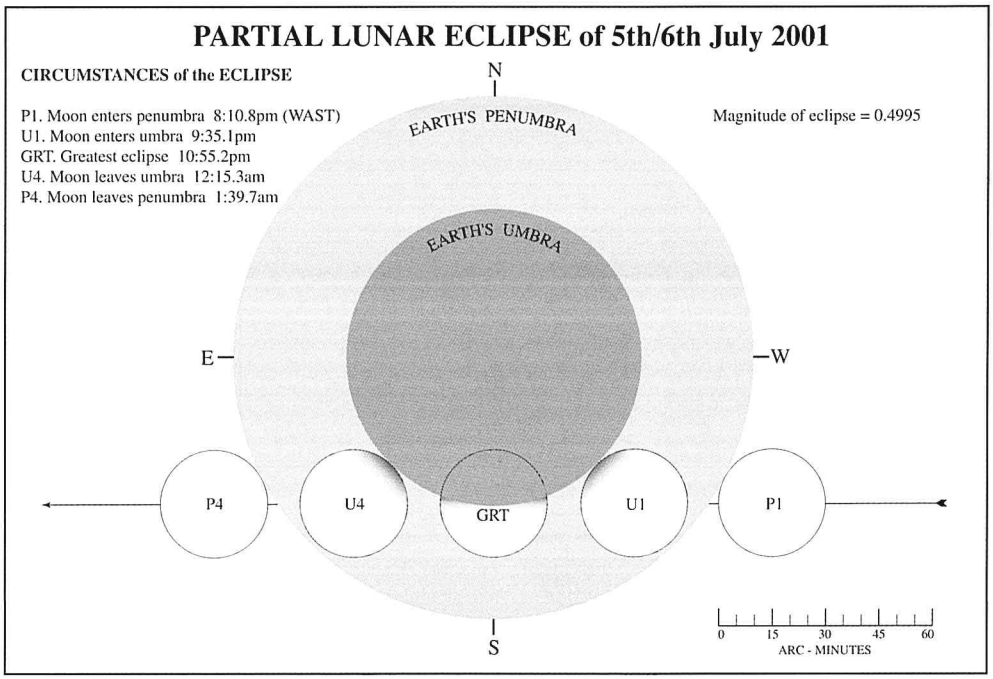
PARTIAL LUNAR ECLIPSE 5th July 2001

The second lunar eclipse this year is visible from Australia and New Zealand. In Western Australia the eclipse begins at 8:11pm local time and continues until 1:40 am on the 6th July. The umbral magnitude at mid-eclipse will be 0.4995 with the edge of the Earth's umbral shadow neatly situated at the Moon's centre. See also the Sky View for July 2 to 5 on page 38.

Moon enters penumbra	5d 12h 10.8m UT
Moon enters umbra	5d 13h 35.1m
Middle of eclipse	5d 14h 55.2m
Moon leaves umbra	5d 16h 15.3m
Moon leaves penumbra	5d 17h 39.7m

Magnitude of eclipse = 0.4995

The diagram (right) shows the position of the Moon in relation to the Earth's shadow. The contact times listed are in WAST.



ANNULAR SOLAR ECLIPSE – 14th December 2001

Like the first solar eclipse this year, the path of this annular is mostly over water. Beginning northwest of the Hawaiian Islands, the shadow sweeps southeast to the equator where greatest eclipse time of 3 minutes and 53 seconds occurs. From the equator the shadow begins a northeasterly curve, finally making landfall in the central American country of Costa Rica. On dry land, the eclipse duration is just over 3 minutes at the cities of Santa Cruz and Las Canas, which are near the centre line. San Jose (the capital city of Costa Rica) would be the place to be for those seeking Baily's Beads; it is near the southern limit of the annular stage, with a duration of 1 minute 17 seconds.

	U.T.	Long	Lat
Eclipse begins	14d 18h 03.3m	-172°05.6'	+22°02.7'
Centre of Eclipse, local noon	14d 20h 44.8m	-132°29.3'	+1°11.3'
Eclipse ends	14d 23h 40.6m	-89°01.1'	+6°00.0'

PENUMBRAL LUNAR ECLIPSE 30th December 2001

This eclipse will be visible from parts of eastern Australia, and begins with the Moon still below the horizon. Twilight will interfere with observation from Perth.

Moon enters penumbra	30d 08h 25.4m UT
Middle of eclipse	30d 10h 29.2m
Moon leaves penumbra	30d 12h 33.2m

Penumbral magnitude of eclipse = 0.919

MOON RISE & SET

PERTH, WAST

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

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

Note: DNR means Moon does not rise on that day, DNS means Moon does not set. See explanation p. 60.

MOON DISTANCE (WAST)

APOGEE	d hh	PERIGEE	d hh
Jan	25 03	Jan	10 17
Feb	21 06	Feb	8 06
Mar	20 19	Mar	8 17
Apr	17 14	Apr	5 18
May	15 09	May	2 12
Jun	12 04	May	27 15
Jul	9 19	Jun	24 01
Aug	6 05	Jul	22 05
Sep	2 07	Aug	19 14
Sep	29 14	Sep	17 00
Oct	27 04	Oct	15 07
Nov	24 00	Nov	12 01
Dec	21 21	Dec	7 07

MOON PHASES (WAST)

Lunation	New Moon d	New Moon h m	First Quarter d	First Quarter h m	Full Moon d	Full Moon h m	Last Quarter d	Last Quarter h m
965			Jan 03	06:31	Jan 10	04:24	Jan 16	20:35
966	Jan 24	21:07	Feb 01	22:02	Feb 08	15:12	Feb 15	11:23
967	Feb 23	16:21	Mar 03	10:03	Mar 10	01:23	Mar 17	04:45
968	Mar 25	09:21	Apr 01	18:49	Apr 08	11:22	Apr 15	23:31
969	Apr 23	23:26	May 01	01:08	May 07	21:52	May 15	18:11
970	May 23	10:46	May 30	06:09	Jun 06	09:39	Jun 14	11:28
971	Jun 21	19:58	Jun 28	11:19	Jul 05	23:04	Jul 14	02:45
972	Jul 21	03:44	Jul 27	18:08	Aug 04	13:56	Aug 12	15:53
973	Aug 19	10:55	Aug 26	03:55	Sep 03	05:43	Sep 11	02:59
974	Sep 17	18:27	Sep 24	17:31	Oct 02	21:49	Oct 10	12:20
975	Oct 17	03:23	Oct 24	10:58	Nov 01	13:41	Nov 08	20:21
976	Nov 15	14:40	Nov 23	07:21	Dec 01	04:49	Dec 08	03:52
977	Dec 15	04:47	Dec 23	04:56	Dec 30	18:40		

LUNAR OCCULTATIONS 2001

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 does the Sun.
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°. 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 table presents the easier to observe occultations for 2001 as predicted for **Perth**. Both events, the disappearance and reappearance, are not necessarily included. An event may not be present because:-

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

THE TIMING OF OCCULTATIONS.

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

TIMING EQUIPMENT. For a single event, such as a normal occultation, a stop-watch and the telephone time signal as a reference are required. For multiple events, the amateur may tape record simultaneously a shortwave radio time signal with his own voice calling out the events (e.g., star gone ... now!). The tape would be later played back (often at a slower speed) and the precise times determined. An accuracy of within 0.2 seconds is not unusual for the experienced observer.

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

For further information on timing methods for occultations it would be worthwhile contacting your local astronomical society (p. 109).

LUNAR OCCULTATION TABLES

The faintest stars, which have occultation predictions on the following pages, are approximately 7th magnitude. The criteria for selection are complex involving the Sun and Moon altitude, star magnitude and whether it is a bright or dark limb event.

EXPLANATION

WAST	the date and time of the occultation, hr & min are in WAST	
OBJECT	n, nn, nnn, nnnn	ZC catalogue number
	nnnnn or nnnnnn	SAO catalogue number
	X nnnnn	USNO XZ catalogue number
	name of planet, satellite or Messier (Mnnn) object.	
PD	event, consisting of two letters.	
	The first letter is the type of Event: 'D' = Disappearance and 'R' = Reappearance. The second letter represents: 'D' = Dark limb, 'B' = a bright limb event. A 'G' indicates a graze at or near the location.	
Mag	magnitude of the star.	
Elg	elongation or separation of the Moon from the Sun as measured in degrees.	
Alt.	altitude of the Moon during the occultation.	
P.A.	position angle is the position the event occurs on the limb of the Moon (measured as degrees east of true north).	
A	coefficient of longitude (see below)	
B	coefficient of latitude (see below)	
	**** NB. For some stars, close to 'grazing', A and B values become useless, and no values are recorded.	

CALCULATING EVENT TIME FOR OTHER LOCATIONS

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

Predicted Time at your location

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

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

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

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

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

WORKED EXAMPLE

An observer wishes to calculate a more accurate time for the disappearance of ZC 1544 on January 13 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 03:50 WAST and the values of A and B are 1.8 and –0.8 respectively.

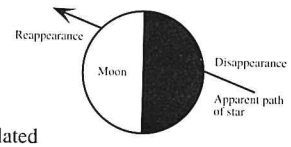
Therefore the equation becomes :-

03:50 + (1.8 × 1°.48) + (–0.8 × –1°.37)

= 03:50 + (2.7) + (1.1)

= 03:50 + 3.8 = 03:54

The event will be visible from Wagin approximately 4 mins later than Perth, i.e., about 3:54am (WAST) on January 13th.



Lunar occultation predictions were calculated using Occult version 4 by D.Herald, PO Box 254 Woden ACT 2606.

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LUNAR OCCULTATION TABLE

PERTH (31° 57' S, 115° 51'E)

WAST	OBJECT	PD	Mag	Elg	Alt	PA	A	B
Jan 04 21:11	322	DD	5.6	109	43	78	+2.2	+1.1
Jan 04 22:25	327	DD	4.4	109	32	66	+1.5	+1.6
Jan 04 22:29	322	RB	5.6	109	31	226	+1.3	+2.1
Jan 04 23:39	327	RB	4.4	110	18	245	+0.9	+1.7
Jan 05 23:06	93261	DD	7.4	122	30	350	+0.2	+8.1
Jan 08 00:31	755	DD	6.2	149	27	41	+1.9	+2.2
Jan 09 00:59	929	DD	5.8	163	29	67	+2.1	+1.2
Jan 09 01:21	931	DD	6.9	164	27	91	+1.8	+0.6
Jan 09 02:17	78094	DD	7.2	164	20	41	+2.1	+2.7
Jan 09 02:18	942	DD	6.5	164	20	108	+1.2	+0.4
Jan 11 01:32	1253	RD	7.3	168	36	281	+2.1	-0.2
Jan 11 22:39	98510	RD	7.2	154	18	247	+1.0	-0.3
Jan 12 01:47	98567	RD	7.5	153	39	318	+1.7	-1.5
Jan 12 22:50	1514	RD	6.2	140	12	239	+0.6	0.0
Jan 12 23:01	99091	RD	7.3	140	14	336	+1.1	-2.9
Jan 13 02:29	1532	RD	7.6	139	42	318	+1.6	-1.6
Jan 13 02:55	1535	RD	6.8	139	44	244	+3.3	+1.1
Jan 13 03:50	1544	DB	5.4	138	43	122	+1.8	-0.8
Jan 19 02:24	159398	RD	7.4	63	12	302	-0.1	-1.7
Jan 19 02:34	2231	RD	6.8	63	14	316	-0.1	-2.0
Jan 20 02:55	159935	RD	7.2	51	11	267	+0.1	-1.0
Jan 21 04:00	185318	RD	7.0	40	15	241	+0.6	-0.2
Jan 22 04:30	2635	RD	5.5	28	12	291	-0.2	-1.5
Feb 03 19:49	668	RB	3.5	114	39	217	+1.7	+1.6
Feb 03 23:12	691	DD	6.3	115	20	58	+1.5	+1.8
Feb 03 23:21	94021	DD	7.2	115	19	36	+1.7	+2.7
Feb 03 23:35	94031	DD	7.4	115	17	91	+1.1	+1.0
Feb 04 23:47	843	DD	7.0	129	22	166	-0.7	-6.2
Feb 05 22:10	1017	DD	6.8	142	34	38	+2.3	+2.0
Feb 06 20:26	1161	DD	5.9	155	25	83	+1.6	-0.6
Feb 06 21:01	79621	DD	7.4	155	29	101	+1.9	-0.9
Feb 06 22:40	79663	DD	7.5	156	35	73	+2.3	+0.4
Feb 09 23:51	1586	RD	7.5	160	37	273	+1.9	-0.8
Feb 10 03:20	1598	RD	6.5	159	42	287	+1.8	-0.1
Feb 19 03:36	2736	RD	6.3	48	16	288	0.0	-1.5
Mar 04 19:59	929	DD	5.8	108	35	111	+2.4	-0.5
Mar 04 20:45	931	DD	6.9	108	33	149	+1.9	-2.4
Mar 04 21:16	78094	DD	7.2	108	30	96	+2.0	+0.4
Mar 06 22:53	1253	DD	7.3	136	34	105	+1.9	0.0
Mar 07 20:52	98510	DD	7.2	149	33	153	+1.7	-2.5
Mar 08 20:51	1514	DD	6.2	163	29	147	+1.4	-2.3
Mar 09 00:55	1535	DD	6.8	165	40	112	+1.8	-0.3
Mar 09 02:59	1544	DD	5.4	165	24	54	+2.6	+3.7
Mar 11 23:08	1897	RD	7.1	153	37	237	+2.6	+0.8
Mar 13 22:19	2133	RD	5.5	128	13	339	-0.3	-2.5
Mar 14 05:06	2158	RD	7.5	125	65	302	+2.0	-1.0
Mar 16 00:49	2408	RD	6.6	103	27	308	+0.2	-2.0
Mar 17 02:44	2547	DB	4.9	90	41	115	+0.8	-1.8
Mar 17 04:03	2547	RD	4.9	90	58	280	+1.8	-1.2
Mar 19 02:27	188112	RD	6.8	68	18	219	+1.2	+1.1
Mar 20 04:01	2964	RD	6.8	57	26	297	+0.3	-2.1
Mar 28 19:14	93261	DD	7.4	40	13	120	+0.8	+0.1
Apr 01 19:05	1050	DD	5.7	90	34	142	+2.1	-1.7
Apr 01 20:02	1050	RB	5.7	90	30	226	+2.7	+2.3
Apr 05 01:44	1479	DD	6.4	133	13	186	-1.4	-4.7
Apr 05 19:37	1586	DD	7.5	144	32	146	+1.3	-2.3
Apr 05 23:06	1598	DD	6.5	145	45	135	+1.5	-1.1
Apr 10 02:13	2089	RD	6.7	159	68	314	+1.7	-1.6
Apr 10 21:07	2200	RD	7.5	148	16	239	+0.8	0.0
Apr 13 01:20	2498	DB	4.4	122	50	80	+1.9	-0.6
Apr 13 02:33	2498	RD	4.4	122	65	318	+1.3	-2.8
Apr 13 03:52	2509	DB	5.8	121	78	91	+2.6	-0.2
Apr 13 05:25	2509	RD	5.8	121	71	294	+2.4	-0.8
Apr 15 00:14	2777	RD	6.9	100	17	217	+1.3	+1.3
Apr 18 03:50	164583	RD	7.2	66	29	263	+0.9	-0.9
Apr 20 04:30	3425	DB	4.4	43	15	355	+1.0	+7.5
Apr 20 04:47	3425	RD	4.4	43	19	325	+0.2	-8.6
Apr 30 21:00	1308	DD	4.7	87	25	89	+1.7	+0.9
Apr 30 22:05	1308	RB	4.7	87	15	314	+0.4	-0.4
May 03 23:54	1689	DD	5.2	128	34	95	+1.6	+0.7
May 06 01:56	139336	DD	7.1	155	38	150	+0.9	-1.5
May 07 01:10	2043	DD	6.5	168	58	170	+0.7	-3.5
May 08 04:48	2180	RD	6.8	175	28	219	+0.5	+5.6
May 10 04:41	184944	RD	7.6	153	54	329	+2.1	-2.7
May 10 20:40	2547	RD	4.9	144	10	316	-0.5	-2.0
May 11 04:30	185961	RD	7.5	141	67	301	+2.4	-1.1
May 13 04:25	2884	RD	7.5	118	80	209	+2.3	+4.4
May 16 04:50	164948	RD	7.2	85	57	263	+2.2	-0.5
May 18 04:47	3506	DB	6.1	62	34	21	+0.8	+2.2
May 18 05:47	3506	RD	6.1	62	46	283	+2.3	-1.9
May 19 03:48	66	RD	7.1	51	11	321	+0.7	-8.2
May 20 04:48	109805	RD	7.5	39	11	289	+0.7	-2.2
May 21 05:56	322	DB	5.6	27	13	64	+0.4	-0.2
May 28 20:20	98567	DD	7.5	71	23	144	+0.5	-0.9
May 29 19:08	99091	DD	7.3	83	41	118	+1.8	-0.5
Jun 01 20:55	139139	DD	7.2	124	59	97	+2.6	-0.2
Jun 02 23:46	2005	DD	7.0	137	50	139	+1.4	-1.3
Jun 04 00:09	158835	DD	7.1	150	58	157	+1.3	-2.7
Jun 04 23:30	159453	DD	6.9	162	73	95	+2.6	-0.1
Jun 05 18:49	2361	RB	4.2	173	22	320	-0.1	-2.1
Jun 06 03:24	2401	DD	5.5	176	43	118	+1.5	-0.2
Jun 06 19:03	2498	RD	4.4	174	16	296	-0.1	-1.6
Jun 06 20:58	2509	RD	5.8	174	40	287	+0.9	-1.5
Jun 07 04:05	2529	RD	6.5	172	46	277	+1.5	+0.7
Jun 07 05:49	2535	RD	6.3	171	24	309	+1.0	-0.4
Jun 07 22:37	2661	RD	7.3	162	50	284	+1.4	-1.5
Jun 07 22:37	2661	RD	7.0	162	50	284	+1.4	-1.5
Jun 08 02:40	2675	RD	7.0	160	74	310	+2.7	-2.0
Jun 08 04:21	2682	RD	7.0	160	54	243	+1.4	+2.1
Jun 09 04:46	188098	RD	7.6	148	59	257	+1.8	+1.4
Jun 10 04:52	2961	RD	5.9	137	67	250	+2.0	+1.5
Jun 10 23:59	3078	DB	4.9	127	34	85	+1.0	-0.9
Jun 11 01:21	3078	RD	4.9	127	52	258	+1.9	-0.4
Jun 11 23:24	3197	RD	6.4	117	17	299	0.0	-2.4
Jun 15 03:16	25	RD	7.4	82	31	274	+1.4	-1.4
Jun 16 04:56	150	DB	6.1	70	38	79	+1.7	-0.5
Jun 16 06:12	150	RD	6.1	69	50	212	+1.2	+1.8
Jun 28 23:22	1854	DD	6.8	96	17	86	+0.7	+1.3
Jun 29 22:44	1965	DD	6.5	108	37	187	0.0	-5.9
Jul 01 00:55	2089	DD	6.7	121	23	64	+0.7	+2.6
Jul 01 20:08	159219	DD	7.6	132	69	90	+2.7	-0.4
Jul 01 20:43	2200	DD	7.5	132	72	55	+4.7	+3.4
Jul 01 23:20	2208	DD	7.2	133	55	107	+1.9	0.0
Jul 02 23:35	2345	DD	7.1	145	64	167	+1.6	-5.0
Jul 04 18:33	186069	DD	7.4	167	25	126	0.0	-2.0
Jul 04 19:48	2595	DD	5.7	168	41	155	-0.2	-3.6
Jul 04 20:10	2604	DD	6.7	168	45	120	+0.9	-2.0
Jul 04 20:50	2608	DD	7.1	168	54	135	+0.9	-2.7
Jul 04 20:59	186216	DD	7.1	168	55	48	+3.1	+1.9
Jul 07 03:55	2916	RD	6.8	167	54	276	+1.9	+0.7
Jul 09 04:47	164583	RD	7.2	144	60	309	+4.7	-2.8
Jul 11 04:02	146587	RD	7.5	123	68	303	+5.5	-4.1
Jul 11 06:07	3425	DB	4.4	122	56	5	0.0	+4.1
Jul 17 04:24	593	RD	5.9	52	11	316	+2.8	-5.5
Jul 18 05:58	752	DB	4.6	39	15	71	+0.8	-0.4
Jul 24 18:32	1689	DD	5.2	50	34	133	+0.9	-0.6
Jul 24 19:37	1689	RB	5.2	51	22	289	+0.8	+0.3
Jul 25 20:08	119485	DD	7.0	64	30	89	+1.3	+1.1
Jul 26 20:16	139336	DD	7.1	78	41	196	-1.3	-8.8
Jul 28 22:54	159111	DD	7.5	104	35	133	+1.2	-0.8
Jul 30 19:05	2425	DD	5.9	127	66	117	+1.8	-1.7
Jul 31 19:40	2557	DD	6.2	139	64	120	+1.7	-2.0
Jul 31 22:58	185877	DD	7.5	140	69	119	+2.5	-1.0
Aug 01 01:25	185961	DD	7.5	140	39	68	+0.8	+1.9
Aug 01 02:50	2588	DD	7.0	141	21	89	+0.3	+1.1
Aug 01 03:05	186053	DD	7.5	141	18	79	+0.1	+1.3
Aug 01 03:21	186069	DD	7.4	141	15	100	+0.2	+0.8
Aug 01 20:04	187156	DD	7.6	150	59	109	+1.7	-1.7
Aug 06 03:50	164948	RD	7.2	163	55	215	+0.9	+2.7
Aug 06 05:42	3271	RD	7.2	162	31	242	+0.6	+1.8
Aug 08 05:34	3506	RD	6.1	140	46	190	+0.2	+3.5
Aug 09 04:41	66	RD	7.1	129	56	214	+1.4	+2.4
Aug 10 00:00	170	RD	6.0	120	21	303	+1.6	-4.2
Aug 10 01:25	178	RD	6.5	119	37	238	+1.3	+0.4
Aug 10 05:09	192	DB	5.1	118	53	16	+0.9	+3.0
Aug 11 04:23	298	RD	7.1	107	49	223	+1.6	+1.5
Aug 11 05:52	110316	RD	7.2	106	48	193	+0.8	+3.0
Aug 12 02:29	93098	RD	7.5	96	26	267	+1.5	-1.0
Aug 13 03:40	527	RD	6.2	83	27	226	+0.8	+0.6
Aug 14 05:24	700	DB	5.8	70	30	53	+1.3	+0.4
Aug 24 22:28	2135	DD	7.1	74	14	44	-0.2	+4.1
Aug 26 21:25	2401	DD	5.5	98	51	69	+1.6	+2.1
Aug 26 22:33	2401	RB	5.5	98	37	309	+1.4	-0.6
Aug 27 21:21	2529	DD	6.5	110	63	41	+1.9	+4.4
Aug 28 21:58	2682	DD	7.0	121	66	78	+2.2	+1.3
Aug 29 02:27	187078	DD	7.3	123	12	94	0.0	+0.9
Aug 29 22:52	188098	DD	7.6	133	66	65	+1.9	+1.8
Aug 30 23:19	2961	DD	5.9	144	69	77	+2.3	+1.2
Aug 31 19:59	3078	DD	4.9	154	52	74	+1.9	-0.2
Aug 31 21:32	3078	RB	4.9	155	70	258	+2.5	+0.1
Sep 02 03:10	3225	DD	7.2	167	38	14	-0.2	+3.4
Sep 04 05:07	3478	RD	6.4	169	28	206	+0.2	+2.7
Sep 04 23:34	25	RD	7.4	160	50	193	+0.8	+3.0
Sep 05 05:23	128698	RD	7.0	158	30	272	+1.3	+1.1
Sep 06 22:06	249	RD	4.5	138	12	192	-0.1	+2.3
Sep 08 03:39	376	RD	7.0	125	47	271	+3.0	-0.1
Sep 09 00:04	478	RD	7.4	115	12	269	+0.8	-1.1
Sep 10 04:32	93840	RD	7.2	101	37	258	+2.3	+0.1
Sep 10 04:44	93844	RD	7.6	101	38	221	+1.6	+1.3
Sep 21 21:17	2210	DD	6.8	55	14	158	+0.8	-1.9
Sep 22 19:18	2345	DD	7.1	67	50	31	+1.4	+8.3
Sep 23 20:06	185220	DD	7.5	79	52	99	+1.8	+0.5
Sep 24 21:22	186478	DD	7.1	91	48	46	+0.8	+3.1
Sep 25 22:40	2793	DD	6.7	103	42	10	-1.1	+6.2
Sep 26 22:20	2921	DD	6.0	114	57	149	+6.4	-8.1
Sep 27 00:01	188878	DD	7.5	115	36	59	+0.5	+2.0
Sep 30 21:38	146587	DD	7.5	158	62	32	+1.5	+2.3
Oct 01 00:28	3425	DD	4.4	159	59	41	+1.4	+2.4
Oct 01 01:48	3425	RB	4.4	159	44	250	+1.4	+1.7
Oct 01 02:59	3434	DD	7.5	159	30	46	+0.5	+2.2
Oct 11 04:24	1195	RD	6.8	81	24	217	+1.0	+1.3
Oct 11 04:31	79804	RD	7.4	81	25	237	+1.5	+0.2
Oct 21 20:20	2567	DD	7.2	60	34	55	+0.4	+2.4
Oct 23 20:42	2875	RB	6.0	83	51	228	+0.9	+2.6
Oct 23 22:25	2884	DD	7.5	84	30	35	-0.2	+2.7
Oct 23 22:31	188511	DD	7.3	84	29	149	+3.4	-3.8
Oct 24 23:29	3014	DD	7.2	95	26	32	-0.3	+2.6
Oct 26 22:23	164948	DD	7.2	117	55	41	+1.0	+2.5
Oct 27 00:23	3271	DD	7.2	117	31	12	-0.4	+3.3
Oct 28 01:49	3392	DD	7.3	129	20	77	+0.5	+1.5
Oct 29 00:20	3506	DD	6.1	139	44	125	+4.1	-1.6
Oct 29 22:54	66	DD	7.1	150	59	126	+7.4	-4.8
Oct 30 23:37	192	DD	5.1	161	53	76	+2.5	+0.9
Oct 31 00:57	192	RB	5.1	162	45	212	+1.2	+2.5
Nov 01 19:42	404	RD	5.2	175	11	263	+0.6	-0.9
Nov 07 03:08	1155	RD	6.4	112	29	243	+1.9	+0.2
Nov 07 03:16	1157	RD	6.2	112	30	195	+0.8	+5.9
Nov 19 20:27	188005	DD	7.5	51	28	81	+0.5	+1.3
Nov 21 20:31	3081	DD	6.5	74	46	101	+1.8	+0.6
Nov 28 01:58	110154	DD	7.4	142	17	88	+0.9	+1.2
Nov 28 23:51	376	DD	7.0	153	41	120	+3.7	-1.1
Nov 30 03:05	505	DD	7.0	166	16	86	+1.1	+1.2
Dec 02 22:25	936	RD	5.8	158	17	233	+0.7	+0.2
Dec 03 03:24	78231	RD	7.5	156	29	306	+1.8	-0.5
Dec 03 23:11	1097	RD	6.9	144	15	241	+0.8	-0.2
Dec 03 23:23	1099	RD	5.8	144	16	278	+1.4	-1.1
Dec 04 03:19	1117	DB	5.0	143	33	45	+2.8	+2.0
Dec 09 03:21	1751	RD	5.7	77	23	6	+0.2	-4.6
Dec 21 22:40	146587	DD	7.5	76	16	55	+0.1	+1.9
Dec 30 03:13	898	DD	6.0	171	14	112	+0.9	+0.4

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

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

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

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

MERCURY RISE AND SET TIMES FOR PERTH (WAST) VENUS

MERCURY

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

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

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

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

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

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

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

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

MARS

RISE & SET

Perth, WAST

POSITION

(0hrs UT Epoch 2000.0)

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

OPPOSITION OF MARS 2001

On the 14th June 2001, Mars will be at opposition, providing the best view of the planet since September 1988. Oppositions of Mars are not all favourable, some giving a better perspective than others. When the Earth passes Mars in its orbit every 26 months we get a close view of the planet. When Mars is also at perihelion, we get a particularly good view. The reason for this is the elliptical orbit of Mars. On average the planet is 228 million km from the Sun, but this varies by a considerable 42 million km. At an aphelic (Mars furthest from the Sun) opposition, Mars is 99 million km from the Earth. When at a perihelic opposition, it will be only 57 million km from us. The favourable perihelic oppositions are rare, occurring only once every 15 to 17 years. There is considerable excitement building for this opposition, leading up to the grand apparition of 2003 (figs. 3 & 4).

Oppositions in the early months of the year are always unfavourable because Mars is at aphelion. Perihelic oppositions occur around August, and fortunately for Southern Hemisphere observers, the planet is also at its greatest southerly declination at that time. When Mars is at conjunction, its disc is only 3.5 arc seconds (") in diameter, smaller than distant Uranus. At a poor opposition the diameter is 14", increasing to 25" at a perihelic opposition. During the 2001 opposition the disc steadily grows from 5.2" at the beginning of the year to 20.8" at opposition, then decreases to 6.3" by year's end (see fig. 1). This opposition will be a good practice run for the 2003 opposition, and a chance to sharpen up on those observing and drawing skills.

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 this delay is 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. The Martian dust storms, which can be global and last for months, may well obscure some surface features or even create a total block-out. The study of these storms is still important.

The iron-rich soils of Mars (which give the Red Planet its colour) were shown by the Viking landers to be much lighter in colour than the rocks underneath. High velocity winds can lift the soil and transport it around the planet. Sometimes the rocky surface is uncovered, showing a darker area; and conversely dark areas can be covered by lighter dust as storms deposit millions of tonnes of material over the landscape.

Even with the constant movement of dust around the planet, there are several easily recognisable regions that can be seen and identified from opposition to opposition. It will be interesting to compare this year's observable features with the ALPO map (fig. 5). The most prominent of the dark areas is Syrtis Major, a wedge shaped region just north of the equator. Directly below Syrtis Major in the south is a light contrasting area known as Hellas, a depression that when covered in light dust is very conspicuous. The mysterious Eye of Mars or Solis Lacus (Lake of the Sun) is also located in the Southern Hemisphere; a small dark region ringed by lighter material. At some oppositions this feature is outstanding, at others difficult because of the shifting sands.

Mars can certainly be enjoyed at any opposition through a telescope in normal white light, however the view can be enhanced dramatically by the use of filters. The improvement in contrast by using various coloured filters brings hard to detect areas into prominence. A red or orange filter will highlight dark features. Green and red filters are best for detecting the projections and boundaries of the polar caps. Yellow and green filters can distinguish surface frost and fog from lower level cloud and blue or violet filters will show the higher level clouds. Dust storms are best seen through yellow, orange and red filters.

There are many Martian myths and enigmas that have fired the imagination over the past century or so, irrigation canals constructed by a dying Martian race trying to save their arid planet, and the more recent Face on Mars. The 'face' is a mountain that vaguely resembles a humanoid face if lit by the Sun in

just the right way. Like the canals, the face is just another example of seeing what some would like to see or believe.

There are many unsolved mysteries of the Red Planet, and in a scientific light the amateur can still contribute. Monitoring the Martian atmosphere and surface features will assist in our understanding of the geological and atmospheric mechanics of this strange planet.

For up to date news and observations, and how the amateur can contribute, the Web has several good sites. Recommended are the Association of Lunar and Planetary Observers (ALPO) home page at www.lpl.arizona.edu/alpo and the International Marswatch (IMW) at www.astroleague.org/marswatch/

Ephemeris for Physical Observations (0hr UT)

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

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.

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.

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

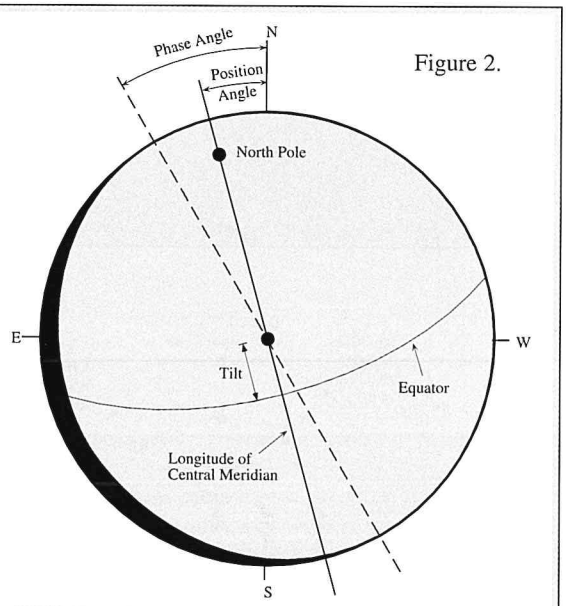


Figure 2.

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

Central Meridian — Increase in Longitude

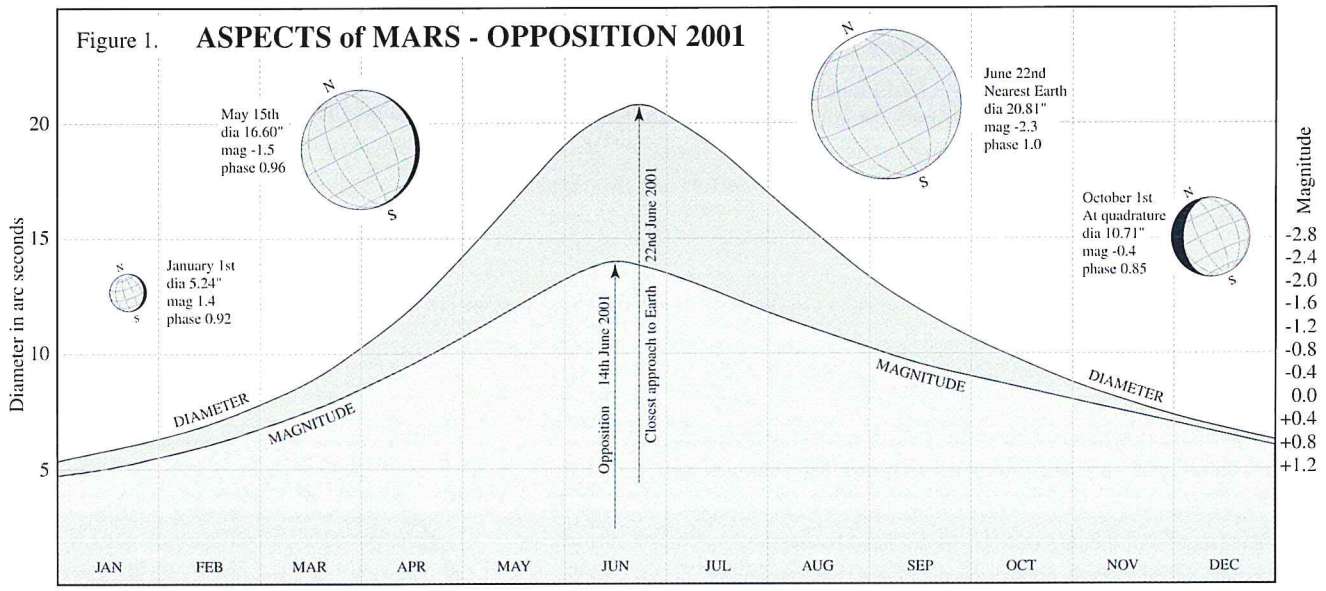
hr	deg°	hr	deg°	hr	deg°	min	deg°
01	014.6	09	131.6	17	248.6	10	002.4
02	029.2	10	146.2	18	263.2	20	004.9
03	043.9	11	160.8	19	277.8	30	007.3
04	058.5	12	175.5	20	292.4	40	009.7
05	073.1	13	190.1	21	307.0	50	012.2
06	087.7	14	204.7	22	321.7		
07	102.3	15	219.3	23	336.3		
08	117.0	16	233.9	24	350.9		

Calculating longitude of central meridian for a particular observation date and time. First convert your local time to UT. Next, from the main table select the central meridian figure for the date. Now take the hour and minute and look them up in the 'Increase in Longitude' table. Add these three numbers. If the result is greater than 360° subtract 360 from it.

For example an observation at 12:20am on June 11 WAST, converts to 16:20 UT on June 10. From the tables below our calculation is 206.8 + 233.9 + 4.9 = 445.6 Subtract 360 gives us a longitude of central meridian of 85.6°.

The longitudes are shown on the map (fig. 5)

	MAY 2001, 0 hr UT					JUNE 2001, 0 hr UT					JULY 2001, 0 hr UT				
	Cent Mer°	Tilt°	Phase	Phase Angle	P.A.°	Cent Mer°	Tilt°	Phase	Phase Angle	P.A.°	Cent Mer°	Tilt°	Phase	Phase Angle	P.A.°
1	207.8	-1.8	0.936	29.2	27.3	286.7	+0.6	0.991	10.9	28.2	020.9	+6.1	0.982	15.3	32.3
2	198.6	-1.8	0.938	28.8	27.3	277.8	+0.8	0.992	10.1	28.3	012.0	+6.2	0.980	16.1	32.4
3	189.4	-1.9	0.940	28.4	27.2	268.9	+1.0	0.993	09.3	28.5	003.0	+6.3	0.979	16.9	32.5
4	180.2	-1.9	0.942	28.0	27.2	260.0	+1.2	0.994	08.5	28.6	354.1	+6.5	0.976	17.6	32.6
5	171.0	-1.8	0.943	27.5	27.1	251.2	+1.4	0.995	07.7	28.7	345.2	+6.6	0.974	18.4	32.6
6	161.8	-1.8	0.945	27.1	27.1	242.3	+1.5	0.996	07.0	28.9	336.2	+6.7	0.972	19.2	32.7
7	152.7	-1.8	0.947	26.6	27.1	233.4	+1.7	0.997	06.2	29.0	327.3	+6.8	0.970	19.9	32.8
8	143.5	-1.8	0.949	26.1	27.0	224.5	+1.9	0.998	05.4	29.1	318.3	+6.9	0.968	20.7	32.9
9	134.4	-1.8	0.951	25.7	27.0	215.7	+2.1	0.998	04.6	29.3	309.3	+7.0	0.965	21.4	32.9
10	125.2	-1.7	0.953	25.2	27.0	206.8	+2.3	0.999	03.9	29.4	300.3	+7.0	0.963	22.1	33.0
11	116.1	-1.7	0.954	24.6	27.0	198.0	+2.5	0.999	03.2	29.6	291.3	+7.1	0.961	22.9	33.0
12	107.0	-1.6	0.956	24.1	27.0	189.1	+2.7	0.999	02.7	29.7	282.3	+7.2	0.958	23.6	33.1
13	097.8	-1.6	0.958	23.6	27.0	180.3	+2.9	1.000	02.3	29.9	273.3	+7.2	0.956	24.2	33.1
14	088.7	-1.5	0.960	23.0	27.0	171.4	+3.1	1.000	02.3	30.0	264.3	+7.3	0.953	24.9	33.2
15	079.7	-1.5	0.962	22.5	27.0	162.6	+3.3	0.999	02.6	30.2	255.2	+7.3	0.951	25.6	33.2
16	070.6	-1.4	0.964	21.9	27.0	153.8	+3.5	0.999	03.1	30.3	246.2	+7.4	0.949	26.2	33.2
17	061.5	-1.3	0.966	21.3	27.1	144.9	+3.7	0.999	03.7	30.5	237.1	+7.4	0.946	26.8	33.2
18	052.5	-1.2	0.968	20.7	27.1	136.1	+3.9	0.998	04.5	30.6	228.0	+7.4	0.944	27.5	33.3
19	043.4	-1.1	0.970	20.1	27.1	127.2	+4.1	0.998	05.3	30.7	218.9	+7.4	0.941	28.1	33.3
20	034.4	-1.0	0.972	19.4	27.2	118.4	+4.3	0.997	06.1	30.9	209.8	+7.4	0.939	28.7	33.3
21	025.3	-0.9	0.973	18.8	27.2	109.6	+4.4	0.996	06.9	31.0	200.7	+7.4	0.936	29.3	33.3
22	016.3	-0.8	0.975	18.1	27.3	100.7	+4.6	0.995	07.8	31.2	191.5	+7.4	0.934	29.8	33.3
23	007.3	-0.7	0.977	17.5	27.4	091.9	+4.8	0.994	08.6	31.3	182.4	+7.4	0.931	30.4	33.2
24	358.3	-0.6	0.979	16.8	27.4	083.0	+5.0	0.993	09.4	31.4	173.2	+7.3	0.929	30.9	33.2
25	349.4	-0.4	0.980	16.1	27.5	074.2	+5.2	0.992	10.3	31.6	164.1	+7.3	0.927	31.4	33.2
26	340.4	-0.3	0.982	15.4	27.6	065.3	+5.3	0.991	11.1	31.7	154.9	+7.3	0.924	32.0	33.2
27	331.4	-0.2	0.984	14.7	27.7	056.4	+5.5	0.989	12.0	31.8	145.7	+7.2	0.922	32.5	33.1
28	322.5	+0.0	0.985	13.9	27.8	047.5	+5.6	0.988	12.8	31.9	136.5	+7.2	0.920	33.0	33.1
29	313.5	+0.2	0.987	13.2	27.9	038.7	+5.8	0.986	13.6	32.1	127.3	+7.1	0.917	33.4	33.0
30	304.6	+0.3	0.988	12.4	28.0	029.8	+5.9	0.984	14.4	32.2	118.0	+7.0	0.915	33.9	33.0
31	295.7	+0.5	0.990	11.7	28.1						108.8	+7.0	0.913	34.4	32.9



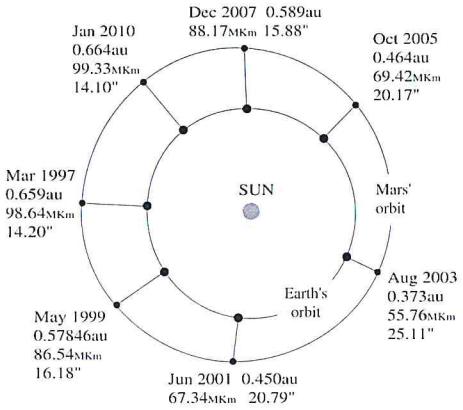
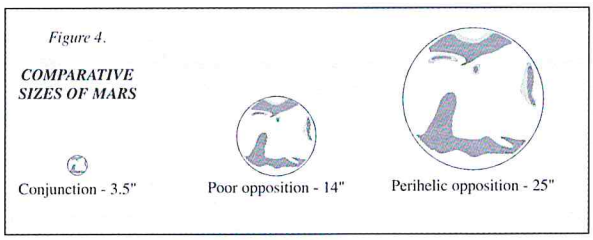


Figure 3 (left)
Oppositions from 1997 to 2010
Shown under each date is the Earth/Mars distance in astronomical units and millions of kilometres (MKm), plus the angular diameter in seconds of arc.



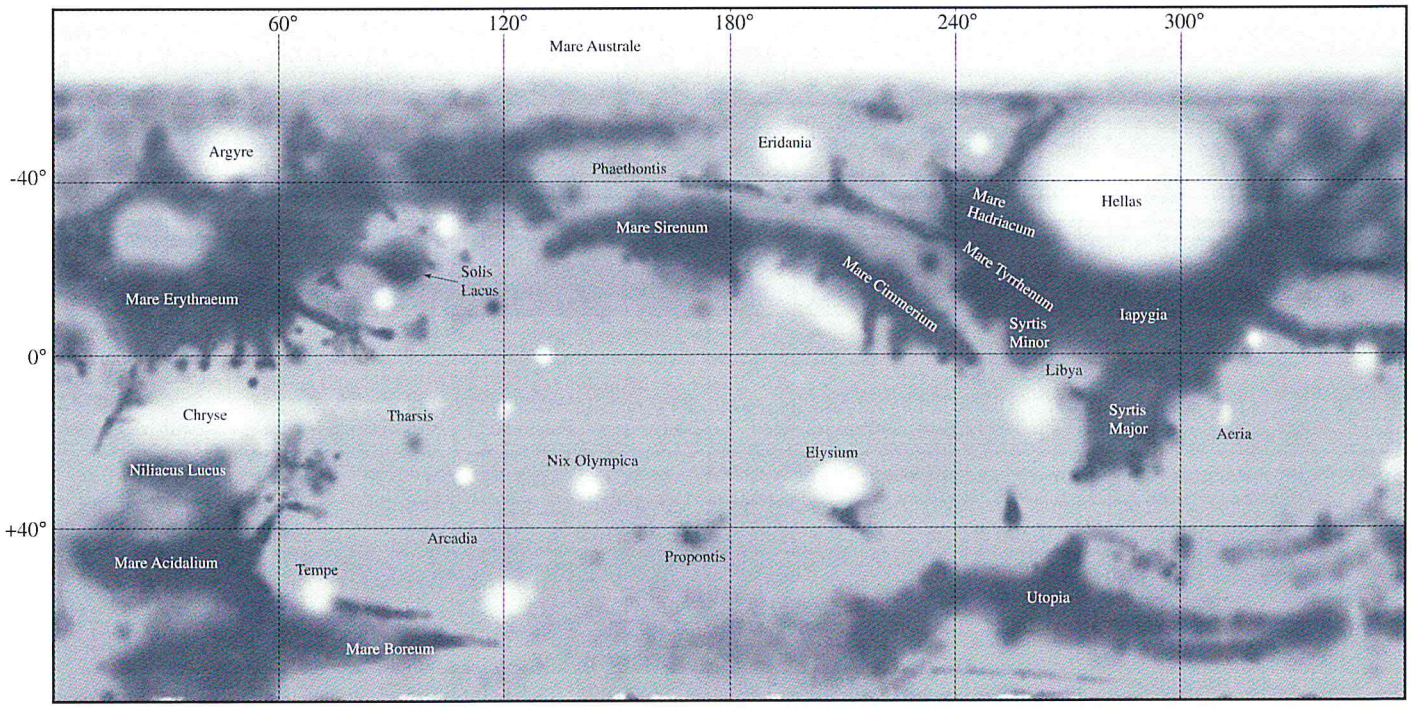
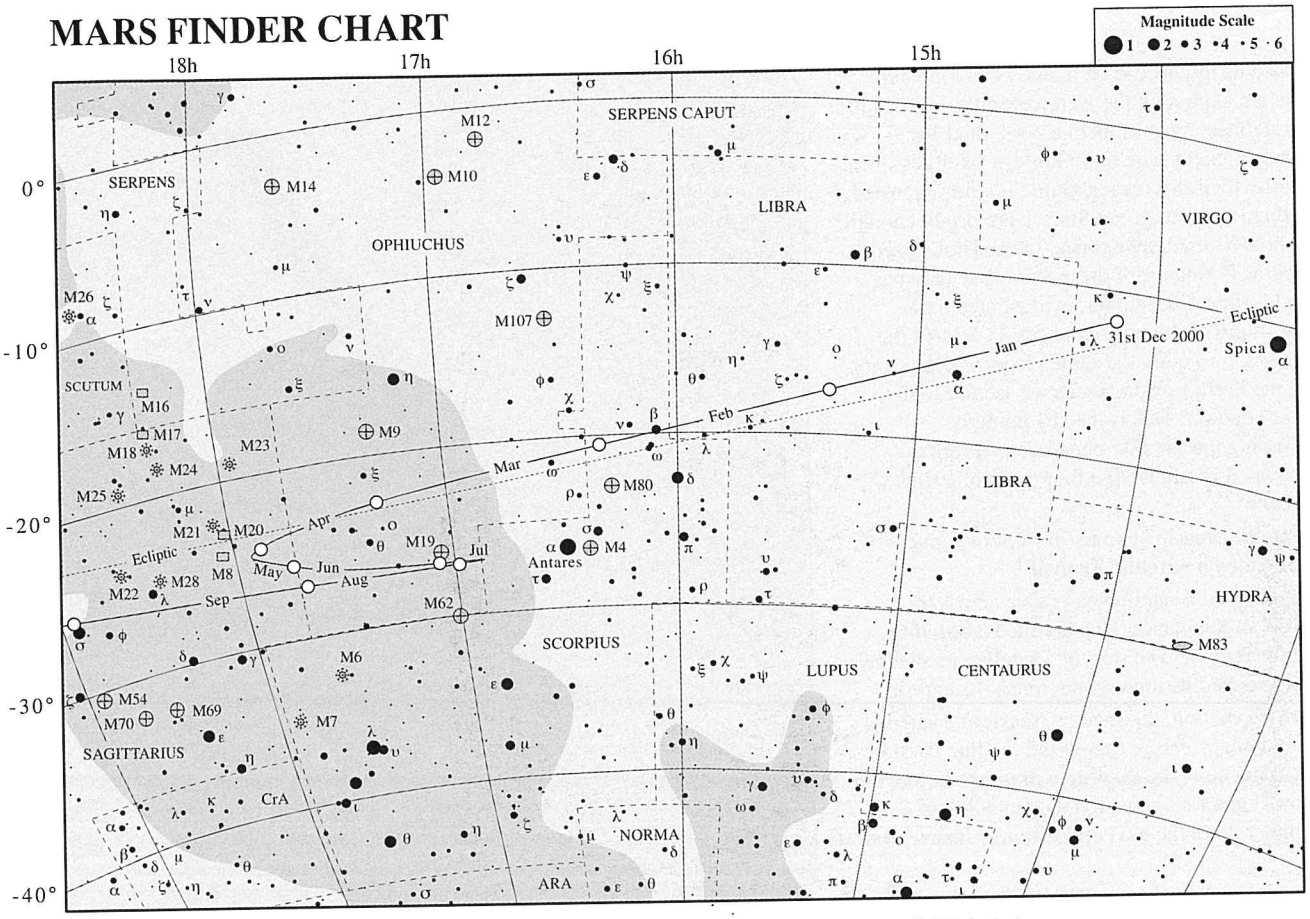
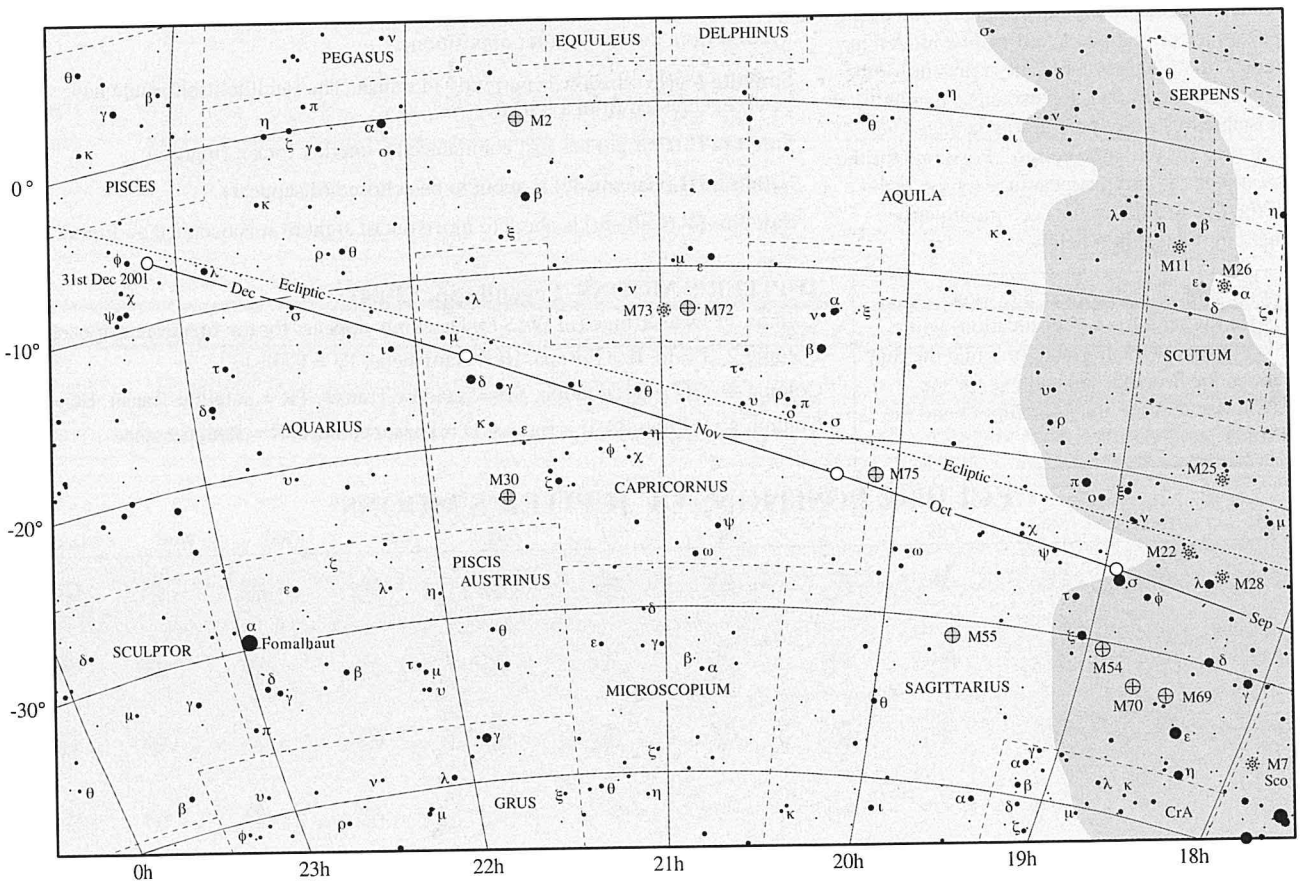


Figure 5. Mars map courtesy of Dan Troiani, Association of Lunar & Planetary Observers, Mars Section Head Coordinator. The map was assembled using CCD images, videos, drawings and photographs taken during the 1997 apparition by observers of the ALPO International Mars Patrol and MarsWatch '97. Dan used over 1,700 observations to create the map. The white areas are where clouds are frequently observed.

MARS FINDER CHART



Opposition 14th June, Stationary 12th May and 20th July.



JUPITER'S MOONS 2001

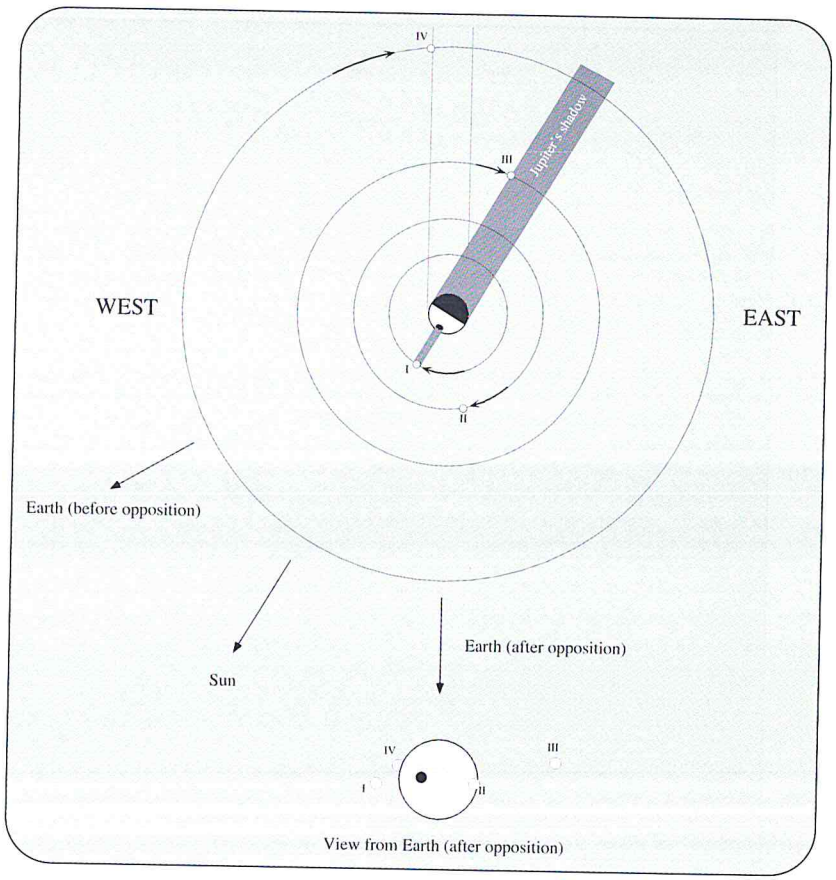
Jupiter and its moons can be likened to a miniature solar system. Although there are currently 16 known Jovian satellites, most of them are too faint for amateur equipment. The four Galilean satellites, named after their discoverer, Galileo (who suggested calling them the 'Medicean Stars'), are bright 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 85-87. All the moons orbit in roughly the same plane, which is very close to the Earth's orbit. Hence we see the Jovian system as edge-on. This is the key point to understanding the satellite phenomena. From our perspective on Earth, we see four types of events. They are:-

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

2 The shadow of a satellite can move across the 'surface' of the planet. This is called a **Satellite Shadow Transit.** The start of a satellite or shadow transit is called its ingress, the finish, its egress. Before opposition, the shadow transit of a satellite will commence before that of the satellite itself. After opposition, the satellite will transit before the shadow. Jupiter's opposition date in 2000 was November 28th, the next opposition is January 1st, 2002.

3 A satellite can go into **occultation** i.e., pass behind the disc of Jupiter.

4 A satellite can be **eclipsed** as it passes into Jupiter's shadow. The closer Jupiter is to opposition, the more likely the eclipse events, or at least one event (disappearance or reappearance) will be hidden by the planet's disc. This is especially relevant for the close-in satellites. In fact, Io is so close to Jupiter, it is impossible to see both the disappearance and reappearance for the same eclipse. Positions for the disappearance (d) and reappearance (r) for each moon, relative to Jupiter, for each month, are presented in the diagram below.



The diagram above illustrates all of the Jupiter satellite events. It is only an example and does not represent any particular date.
Viewed from the Earth (after opposition):-

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

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

Satellite III (Ganymede) is about to be eclipsed (disappear).

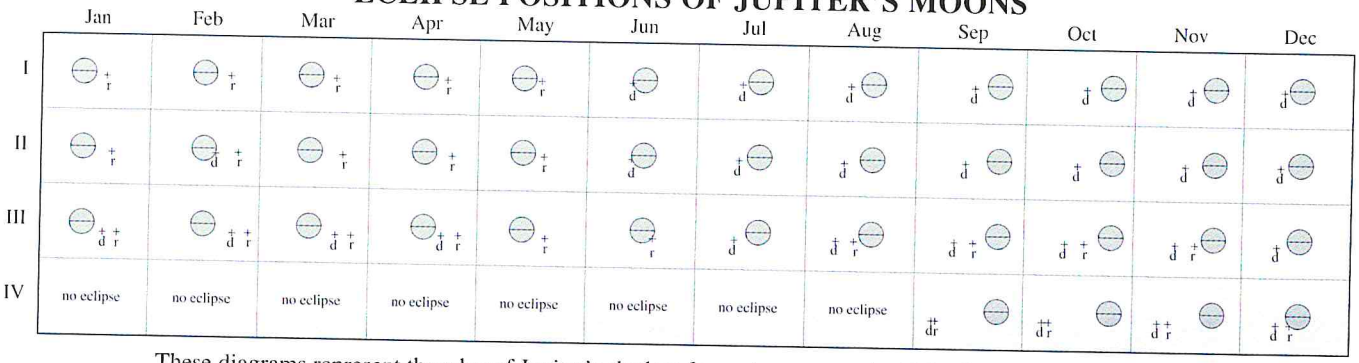
Satellite IV (Callisto) is about to move out of sight as it is occulted by Jupiter's disc.

Note: In the table on pages 83 - 84, some events may happen (as seen from your location) while Jupiter is just below the horizon, or while the Sun is just above the horizon. This allows for the variation in rise and set times for Jupiter and the Sun across Australia.

JUPITER'S MOONS Legend (pp. 83-84)

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

ECLIPSE POSITIONS OF JUPITER'S MOONS



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

JUPITER'S MOONS (WAST)

January

1	21:02	II	TRI
	22:40	II	SHI
	23:36	II	TRE
2	01:16	II	SHE
3	19:28	II	ECR
4	00:16	I	OCD
	19:04	III	OCR
	20:34	III	ECD
	21:23	I	TRI
	22:16	I	SHI
	22:44	III	ECR
	23:33	I	TRE
5	00:27	I	SHE
	21:48	I	ECR
8	23:23	II	TRI
9	01:16	II	SHI
	01:57	II	TRE
10	22:06	II	ECR
11	02:03	I	OCD
	20:31	III	OCD
	22:36	III	OCR
	23:12	I	TRI
12	00:12	I	SHI
	00:35	III	ECD
	01:22	I	TRE
	20:31	I	OCD
	23:43	I	ECR
13	19:49	I	TRE
	20:51	I	SHE
17	19:53	II	OCD
18	00:44	II	ECR
19	00:05	III	OCD
	01:01	I	TRI
	19:46	II	SHE
	22:20	I	OCD
20	19:28	I	TRI
	20:36	I	SHI
	21:39	I	TRE
	22:47	I	SHE
21	20:07	I	ECR
22	20:49	III	SHE
24	22:20	II	OCD
26	19:47	II	SHI
	20:00	II	TRE
	22:22	II	SHE
27	00:10	I	OCD
	21:20	I	TRI
	22:32	I	SHI
	23:30	I	TRE
28	00:42	I	SHE
	22:02	I	ECR
29	19:11	I	SHE
	19:52	III	TRE
	22:40	III	SHI

February

2	19:54	II	TRI
	22:23	II	SHI
	22:29	II	TRE
3	23:12	I	TRI
4	00:27	I	SHI
	19:20	II	ECR
	20:30	I	OCD
	23:58	I	ECR
5	18:56	I	SHI
	19:50	I	TRE
	21:07	I	SHE
	21:31	III	TRI
	23:42	III	TRE
9	18:52	III	ECR
	22:26	II	TRI
11	19:18	II	OCR
	19:19	II	ECD
	21:59	II	ECR
	22:23	I	OCD
12	19:34	I	TRI
	20:52	I	SHI
	21:44	I	TRE
	23:03	I	SHE
13	20:22	I	ECR
16	20:39	III	ECD
	22:55	III	ECR
18	19:15	II	OCD
	21:55	II	OCR
	21:58	II	ECD
19	21:29	I	TRI
	22:48	I	SHI
20	18:46	I	OCD
	19:28	II	SHE
	22:17	I	ECR
21	19:28	I	SHE
23	19:15	III	OCD
	21:34	III	OCR
25	21:54	II	OCD
27	19:28	II	SHI
	19:29	II	TRE
	20:42	I	OCD
	22:04	II	SHE
28	19:13	I	SHI
	20:05	I	TRE
	21:24	I	SHE

March

1	18:41	I	ECR
6	18:45	III	SHI
	19:31	II	TRI
	21:01	III	SHE
	22:04	II	SHI
	22:08	II	TRE
7	19:51	I	TRI
	21:09	I	SHI
	22:02	I	TRE
8	19:15	II	ECR
	20:36	I	ECR
13	19:59	III	TRE
	22:11	II	TRI
14	21:49	I	TRI
15	19:05	I	OCD
	21:54	II	ECR
16	18:30	I	TRE
	19:44	I	SHE
22	19:24	II	OCD
	21:04	I	OCD
23	18:18	I	TRI
	19:29	I	SHI
	20:29	I	TRE
24	18:56	I	ECR
	19:03	III	ECR
	19:10	II	SHE
30	20:17	I	TRI
31	18:34	III	OCR
	19:08	II	SHI
	19:35	II	TRE
	20:43	III	ECD
	20:51	I	ECR

April

1	18:05	I	SHE
7	19:32	I	OCD
	19:41	II	TRI
	20:29	III	OCD
8	17:49	I	SHI
	19:00	I	TRE
	20:01	I	SHE
9	19:09	II	ECR
15	18:48	I	TRI
	19:45	I	SHI
16	19:09	I	ECR
18	17:36	III	TRE
	18:51	III	SHI
23	18:03	I	OCD
24	17:32	I	TRE
	18:22	I	SHE
25	17:16	II	TRE
	18:51	II	SHE
	19:34	III	TRI

May

1	17:21	I	TRI
	18:05	I	SHI
2	17:24	II	TRI
	17:28	I	ECR
	18:47	II	SHI
6	19:12	III	ECR
13	18:33	III	OCD
16	18:36	I	OCD
17	18:09	I	TRE
	18:37	I	SHE
18	18:01	II	OCD
24	17:22	III	SHE
	17:58	I	TRI
	18:19	I	SHI
25	17:41	I	ECR
27	17:55	II	TRE
31	17:53	III	TRI

June

1	17:10	I	OCD
2	16:56	I	SHE
20	07:30	I	SHI
	07:35	I	TRI
21	06:57	I	OCR
22	07:22	III	TRI

July

2	07:30	II	SHE
9	07:24	II	SHI
11	06:09	II	OCR
13	07:42	I	SHI
14	07:32	I	OCR
21	06:43	I	ECD
22	06:18	I	SHE
	06:54	I	TRE
27	06:00	II	TRE
28	05:28	III	SHE
	05:37	III	TRI
29	05:59	I	SHI
	06:41	I	TRI
30	06:04	I	OCR

August

3	06:04	II	TRI
	07:12	II	SHE
4	06:49	III	SHI
6	05:00	I	ECD
7	05:24	I	TRE
10	07:05	II	SHI
12	06:44	II	OCR
13	06:54	I	ECD
14	05:10	I	TRI
	06:28	I	SHE
	07:24	I	TRE
15	04:28	III	OCD
	04:34	I	OCR
	07:19	III	OCR
17	04:20	IV	TRI
	05:23	IV	TRE
19	04:45	II	ECD
21	06:09	I	SHI
	07:09	I	TRI

JUPITER'S MOONS (WAST)

22	04:39	III	ECD
	06:34	I	OCR
23	03:52	I	TRE
28	03:47	II	TRI
	04:19	II	SHE
	06:33	II	TRE
29	05:10	I	ECD
30	03:37	I	TRI
	04:44	I	SHE
	05:50	I	TRE

September

2	03:18	III	TRI
	06:09	III	TRE
4	04:11	II	SHI
	06:32	II	TRI
	06:55	II	SHE
6	04:16	II	OCR
	04:25	I	SHI
	05:34	I	TRI
	06:37	I	SHE
7	05:00	I	OCR
9	05:27	III	SHE
11	06:48	II	SHI
13	06:18	I	SHI
14	03:27	I	ECD
15	02:59	I	SHE
	04:13	I	TRE
16	06:42	III	SHI
20	04:18	II	ECD
	04:41	III	OCR
21	05:21	I	ECD
22	02:40	I	SHI
	03:55	I	TRI
	04:04	II	TRE
	04:52	I	SHE
	06:08	I	TRE
23	03:22	I	OCR
27	03:23	III	ECR
	05:49	III	OCD
28	02:22	IV	OCD
	04:36	IV	OCR
29	03:57	II	TRI
	04:03	II	SHE
	04:33	I	SHI
	05:50	I	TRI
30	01:43	I	ECD
	05:18	I	OCR

October

1	02:31	I	TRE
4	04:32	III	ECD
6	01:24	IV	SHI
	02:26	IV	SHE
	03:55	II	SHI
7	03:37	I	ECD
8	02:12	I	TRI
	02:49	III	TRE
	03:07	I	SHE
	04:04	II	OCR
	04:25	I	TRE
9	01:41	I	OCR
14	05:31	I	ECD
15	01:16	II	ECD
	01:26	III	SHE
	02:48	I	SHI
	03:47	III	TRI
	04:04	I	TRI
	05:01	I	SHE
16	03:34	I	OCR
17	00:46	I	TRE
	01:14	II	TRE
22	02:34	III	SHI
	03:49	II	ECD
	04:41	I	SHI
	05:25	III	SHE
	05:56	I	TRI
23	01:53	I	ECD
	05:26	I	OCR
24	00:24	I	TRI
	00:59	II	TRI
	01:11	II	SHE
	01:22	I	SHE
	02:37	I	TRE
	03:46	II	TRE
26	00:35	III	OCR
30	03:47	I	ECD
31	01:02	II	SHI
	01:03	I	SHI
	02:14	I	TRI
	02:20	IV	ECD
	03:16	I	SHE
	03:29	II	TRI
	03:48	II	SHE
	04:04	IV	ECR
	04:27	I	TRE

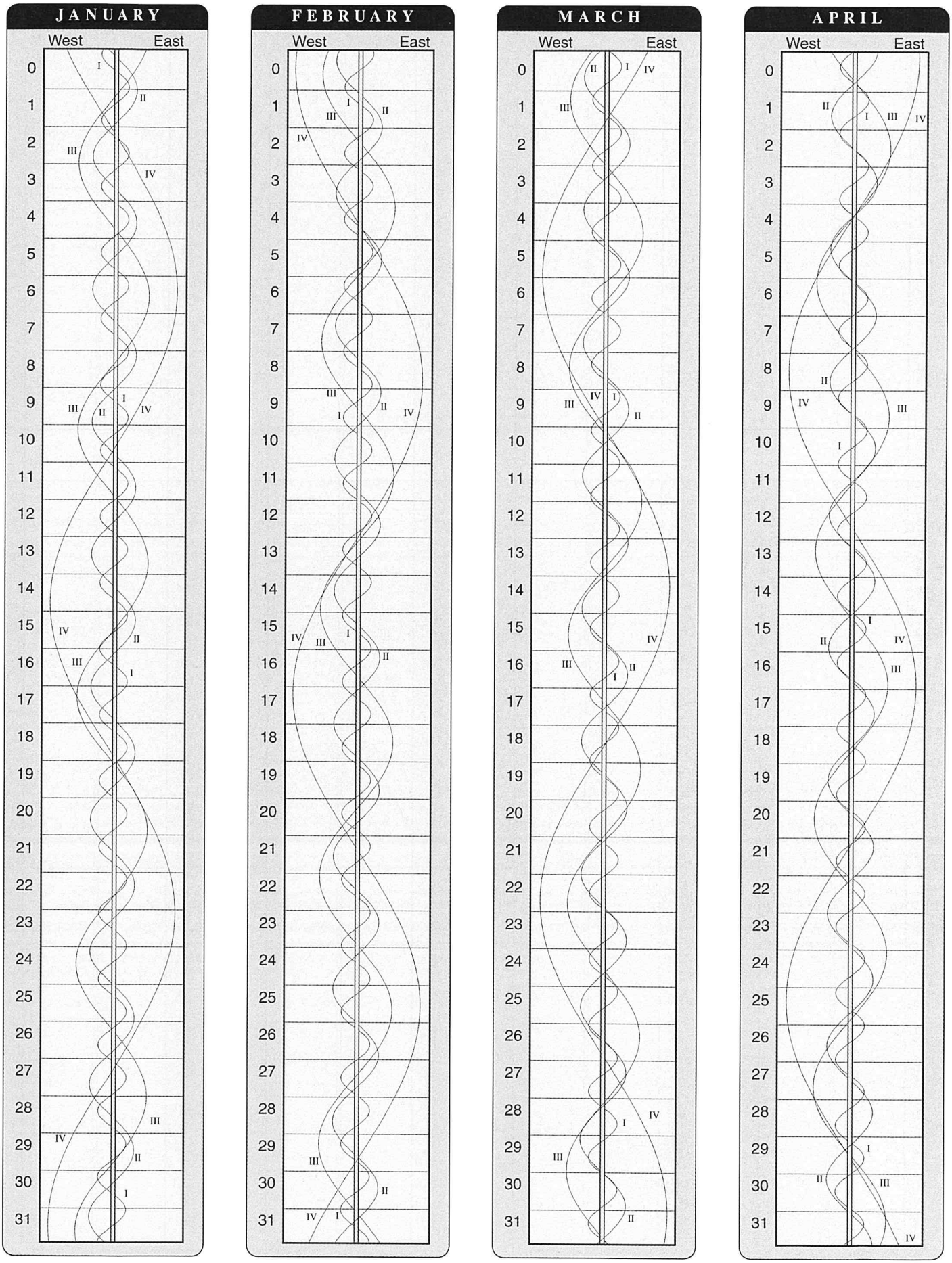
November

1	01:44	I	OCR
2	00:47	II	OCR
	01:17	III	OCD
	04:20	III	OCR
6	05:41	I	ECD
7	02:56	I	SHI
	03:38	II	SHI
	04:03	I	TRI
	05:09	I	SHE
8	00:10	I	ECD
	03:34	I	OCR
	23:21	IV	TRI
	23:37	I	SHE
9	00:27	III	ECD
	00:43	I	TRE
	01:57	IV	TRE
	03:12	II	OCR
	03:23	III	ECR
	04:57	III	OCD
14	04:49	I	SHI
15	02:04	I	ECD
	05:22	I	OCR
	23:17	I	SHI
16	00:17	I	TRI
	00:46	II	ECD
	01:31	I	SHE
	02:31	I	TRE
	04:25	III	ECD
	05:34	II	OCR
	23:49	I	OCR
17	05:31	IV	OCD
18	00:22	II	TRE
20	01:18	III	TRE
22	03:58	I	ECD
23	01:11	I	SHI
	02:04	I	TRI
	03:20	II	ECD
	03:24	I	SHE
	04:18	I	TRE
	22:26	I	ECD
24	01:36	I	OCR
	22:10	II	SHI
	22:45	I	TRE
	23:56	II	TRI
25	00:57	II	SHE
	02:44	II	TRE
26	22:26	III	SHI
27	01:22	III	SHE
	01:45	III	TRI
	04:46	III	TRE
30	03:04	I	SHI
	03:50	I	TRI
	05:18	I	SHE

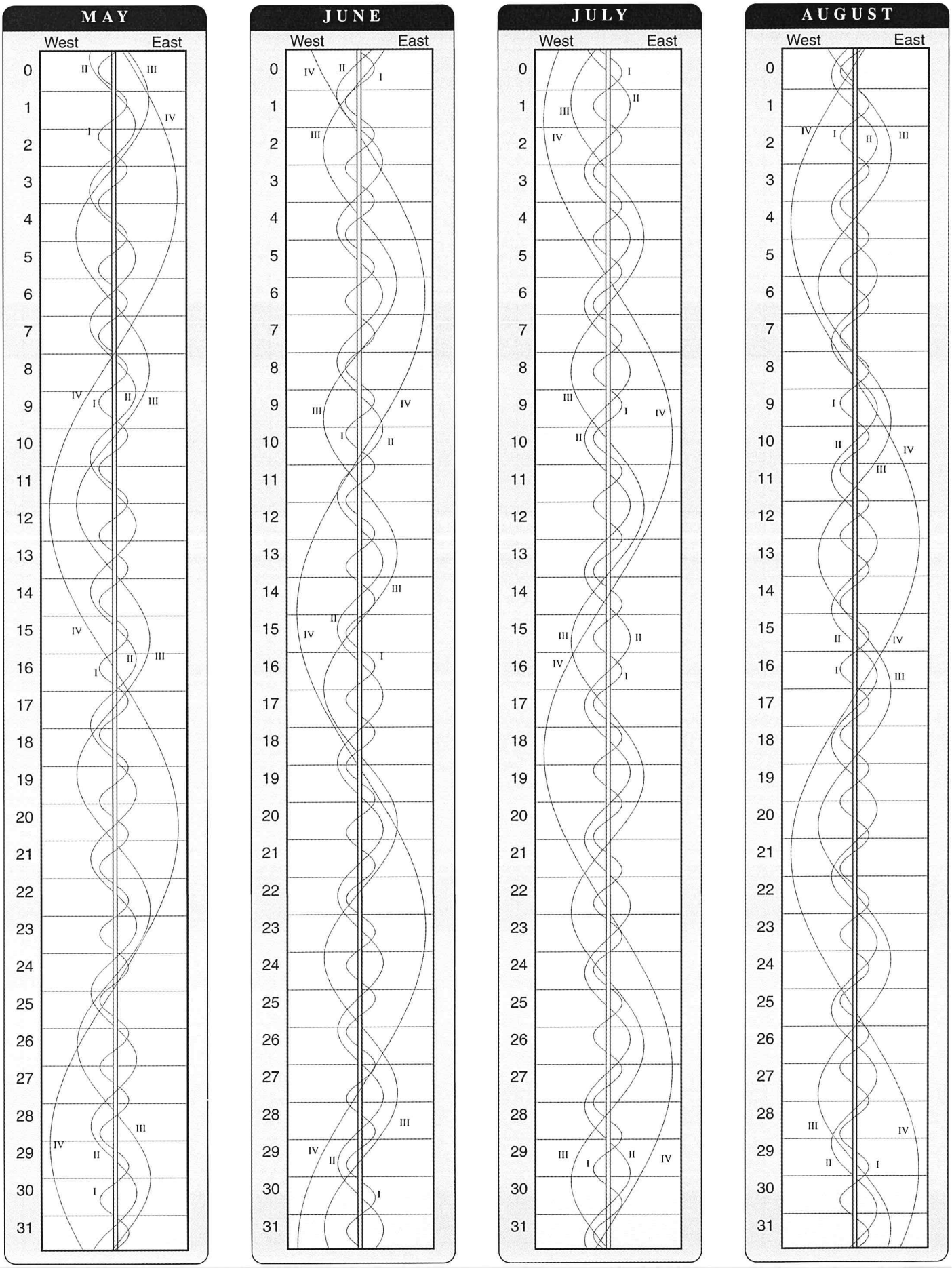
December

1	00:20	I	ECD
	03:22	I	OCR
	22:16	I	TRI
	23:46	I	SHE
2	00:30	I	TRE
	00:46	II	SHI
	02:15	II	TRI
	03:34	II	SHE
	05:03	II	TRE
	21:48	I	OCR
3	23:20	II	OCR
	23:23	IV	OCR
4	02:24	III	SHI
	05:08	III	TRI
	05:22	III	SHE
7	04:57	I	SHI
	21:54	III	OCR
8	02:15	I	ECD
	05:07	I	OCR
	23:26	I	SHI
9	00:00	I	TRI
	01:40	I	SHE
	02:15	I	TRE
	03:23	II	SHI
	04:33	II	TRI
	23:33	I	OCR
10	21:45	II	ECD
11	01:35	II	OCR
12	01:02	IV	SHI
	03:27	IV	SHE
15	01:13	III	OCR
	04:09	I	ECD
16	01:20	I	SHI
	01:44	I	TRI
	03:34	I	SHE
	03:59	I	TRE
	22:38	I	ECD
17	01:17	I	OCR
	22:03	I	SHE
	22:25	I	TRE
18	00:19	II	ECD
	03:50	II	OCR
19	22:05	II	SHE
	22:45	II	TRE
22	00:22	III	ECD
	04:30	III	OCR
23	03:13	I	SHI
	03:28	I	TRI
	05:28	I	SHE
24	00:32	I	ECD
	03:01	I	OCR
	21:42	I	SHI
	21:54	I	TRI
	23:57	I	SHE
25	00:08	I	TRE
	02:54	II	ECD
	21:27	I	OCR
26	21:54	II	SHI
	22:12	II	TRI
27	00:42	II	SHE
	01:00	II	TRE
28	19:54	IV	TRI
	21:39	IV	SHE
	22:34	IV	TRE
29	04:21	III	ECD
30	05:07	I	SHI
	05:11	I	TRI
31	02:27	I	ECD
	04:44	I	OCR
	23:36	I	SHI
	23:37	I	TRI

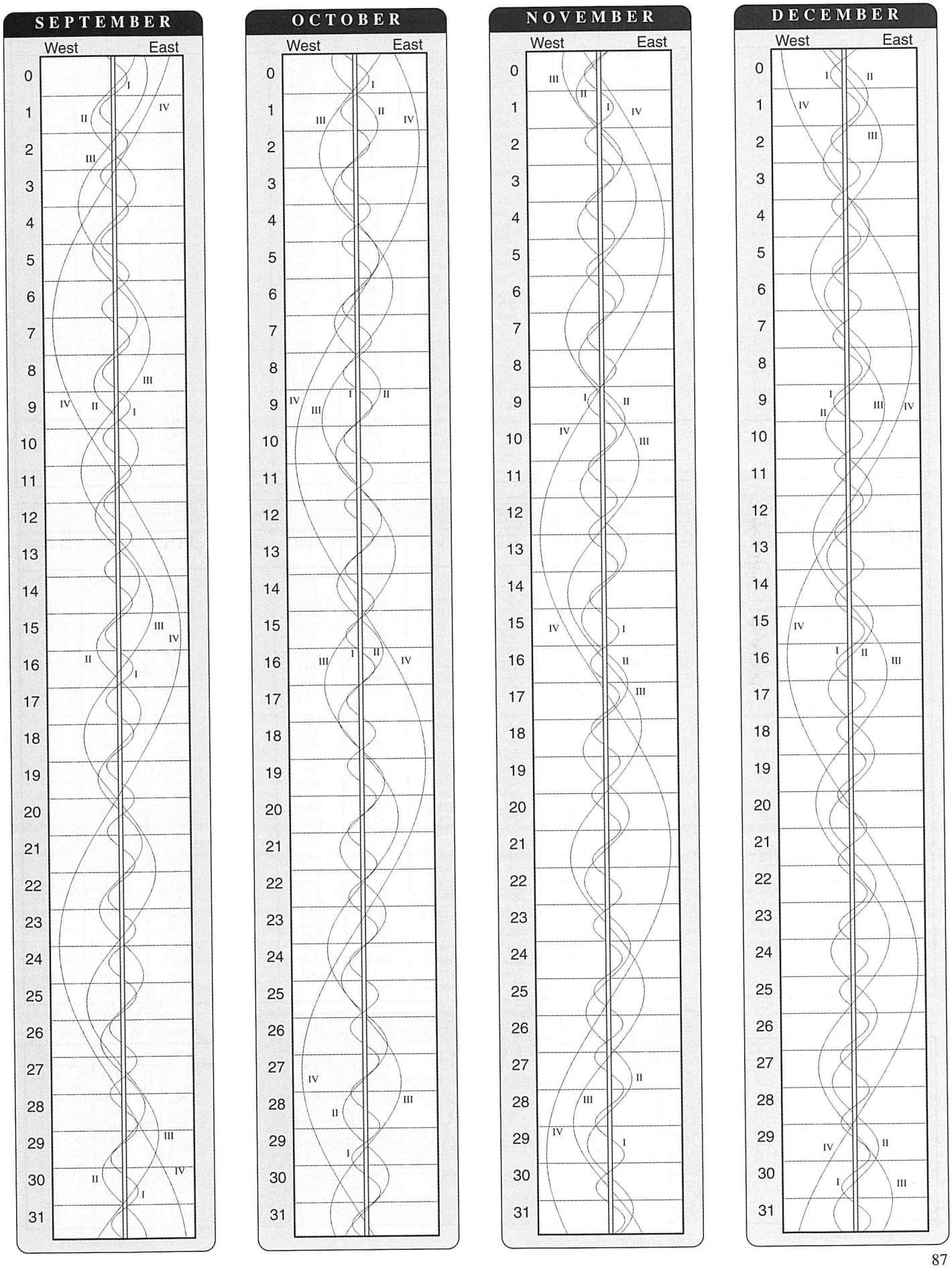
JUPITER'S MOONS (WAST)



JUPITER'S MOONS (WAST)



JUPITER'S MOONS (WAST)



JUPITER — LONGITUDE OF CENTRAL MERIDIAN

SYSTEM I (0hr UT)

DATE	JAN °	FEB °	MAR °	APR °	MAY °	JUN °	JUL °	AUG °	SEP °	OCT °	NOV °	DEC °	DATE
1	274.8	128.5	225.6	073.7	123.1	330.1	020.2	229.2	079.9	135.1	350.6	050.8	1
2	072.7	286.3	023.3	231.3	280.7	127.7	177.8	026.9	237.7	292.9	148.6	208.8	2
3	230.6	084.1	181.0	029.0	078.3	285.4	335.5	184.6	035.5	090.8	306.6	006.8	3
4	028.6	241.9	338.7	186.6	236.0	083.1	133.2	342.4	193.3	248.7	104.6	164.9	4
5	186.5	039.7	136.4	344.3	033.6	240.7	290.9	140.1	351.1	046.6	262.5	322.9	5
6	344.4	197.5	294.1	141.9	191.3	038.4	088.6	297.9	149.0	204.5	060.5	120.9	6
7	142.3	355.3	091.8	299.6	348.9	196.0	246.3	095.6	306.8	002.4	218.5	279.0	7
8	300.2	153.1	249.5	097.2	146.5	353.7	044.0	253.4	104.6	160.3	016.5	077.0	8
9	098.1	310.8	047.2	254.9	304.2	151.3	201.7	051.1	262.4	318.2	174.5	235.1	9
10	256.0	108.6	204.9	052.5	101.8	309.0	359.4	208.9	060.2	116.1	332.5	033.1	10
11	053.9	266.4	002.6	210.2	259.5	106.7	157.1	006.6	218.1	274.0	130.4	191.2	11
12	211.7	064.1	160.3	007.8	057.1	264.3	314.8	164.4	015.9	071.9	288.4	349.2	12
13	009.6	221.9	318.0	165.5	214.8	062.0	112.5	322.1	173.7	229.8	086.4	147.3	13
14	167.5	019.6	115.6	323.1	012.4	219.7	270.2	119.9	331.5	027.7	244.4	305.3	14
15	325.4	177.4	273.3	120.8	170.1	017.3	067.9	277.6	129.4	185.6	042.4	103.3	15
16	123.2	335.1	071.0	278.4	327.7	175.0	225.6	075.4	287.2	343.5	200.4	261.4	16
17	281.1	132.9	228.7	076.1	125.3	332.7	023.3	233.2	085.0	141.5	358.4	059.4	17
18	079.0	290.6	026.4	233.7	283.0	130.3	181.0	030.9	242.9	299.4	156.5	217.5	18
19	236.8	088.4	184.0	031.3	080.6	288.0	338.7	188.7	040.7	097.3	314.5	015.5	19
20	034.7	246.1	341.7	189.0	238.3	085.7	136.5	346.5	198.6	255.3	112.5	173.6	20
21	192.5	043.8	139.4	346.6	035.9	243.4	294.2	144.3	356.4	053.2	270.5	331.6	21
22	350.4	201.6	297.0	144.3	193.6	041.0	091.9	302.0	154.3	211.1	068.5	129.7	22
23	148.2	359.3	094.7	301.9	351.2	198.7	249.6	099.8	312.1	009.1	226.5	287.7	23
24	306.0	157.0	252.4	099.6	148.9	356.4	047.3	257.6	110.0	167.0	024.6	085.8	24
25	103.9	314.7	050.0	257.2	306.5	154.1	205.1	055.4	267.8	324.9	182.6	243.8	25
26	261.7	112.5	207.7	054.8	104.2	311.7	002.8	213.2	065.7	122.9	340.6	041.8	26
27	059.5	270.2	005.4	212.5	261.8	109.4	160.5	011.0	223.6	280.8	138.6	199.9	27
28	217.3	067.9	163.0	010.1	059.5	267.1	318.2	168.7	021.4	078.8	296.7	357.9	28
29	015.1		320.7	167.8	217.1	064.8	116.0	326.5	179.3	236.8	094.7	156.0	29
30	172.9		118.3	325.4	014.8	222.5	273.7	124.3	337.2	034.7	252.7	314.0	30
31	330.7		276.0		172.4		071.4	282.1		192.7		112.0	31

SYSTEM II (0hr UT)

DATE	JAN °	FEB °	MAR °	APR °	MAY °	JUN °	JUL °	AUG °	SEP °	OCT °	NOV °	DEC °	DATE
1	342.4	319.7	203.1	174.6	355.1	325.7	146.8	119.3	093.5	279.7	258.8	090.0	1
2	132.7	109.8	353.2	324.7	145.2	115.7	296.9	269.4	243.7	070.0	049.1	240.4	2
3	283.0	260.0	143.2	114.7	295.2	265.7	086.9	059.5	033.9	220.2	199.4	030.8	3
4	073.3	050.1	293.3	264.7	085.2	055.7	237.0	209.6	184.0	010.5	349.8	181.2	4
5	223.6	200.3	083.4	054.7	235.2	205.8	027.1	359.7	334.2	160.7	140.1	331.6	5
6	013.8	350.5	233.5	204.8	025.2	355.8	177.1	149.8	124.4	311.0	290.5	122.0	6
7	164.1	140.6	023.5	354.8	175.2	145.8	327.2	300.0	274.6	101.3	080.8	272.4	7
8	314.4	290.8	173.6	144.8	325.2	295.8	117.3	090.1	064.8	251.5	231.2	062.8	8
9	104.7	080.9	323.7	294.8	115.2	085.9	267.3	240.2	214.9	041.8	021.5	213.2	9
10	254.9	231.0	113.7	084.8	265.3	235.9	057.4	030.3	005.1	192.1	171.9	003.6	10
11	045.2	021.2	263.8	234.9	055.3	025.9	207.5	180.4	155.3	342.3	322.3	154.1	11
12	195.4	171.3	053.8	024.9	205.3	176.0	357.5	330.6	305.5	132.6	112.6	304.5	12
13	345.7	321.4	203.9	174.9	355.3	326.0	147.6	120.7	095.7	282.9	263.0	094.9	13
14	135.9	111.6	353.9	324.9	145.3	116.0	297.7	270.8	245.9	073.2	053.4	245.3	14
15	286.2	261.7	144.0	114.9	295.3	266.1	087.8	061.0	036.1	223.5	203.7	035.7	15
16	076.4	051.8	294.0	264.9	085.3	056.1	237.8	211.1	186.3	013.8	354.1	186.1	16
17	226.6	201.9	084.1	055.0	235.4	206.2	027.9	001.2	336.5	164.0	144.5	336.6	17
18	016.9	352.0	234.1	205.0	025.4	356.2	178.0	151.4	126.7	314.3	294.9	127.0	18
19	167.1	142.1	024.2	355.0	175.4	146.2	328.1	301.5	277.0	104.6	085.2	277.4	19
20	317.3	292.2	174.2	145.0	325.4	296.3	118.2	091.6	067.2	254.9	235.6	067.8	20
21	107.5	082.4	324.3	295.0	115.4	086.3	268.2	241.8	217.4	045.2	026.0	218.2	21
22	257.8	232.5	114.3	085.0	265.4	236.4	058.3	031.9	007.6	195.5	176.4	008.6	22
23	048.0	022.6	264.4	235.0	055.5	026.4	208.4	182.1	157.8	345.9	326.8	159.0	23
24	198.2	172.6	054.4	025.1	205.5	176.5	358.5	332.2	308.1	136.2	117.2	309.5	24
25	348.4	322.7	204.4	175.1	355.5	326.5	148.6	122.4	098.3	286.5	267.6	099.9	25
26	138.6	112.8	354.5	325.1	145.5	116.6	298.7	272.5	248.5	076.8	058.0	250.3	26
27	288.8	262.9	144.5	115.1	295.5	266.6	088.8	062.7	038.8	227.1	208.4	040.7	27
28	078.9	053.0	294.5	265.1	085.6	056.7	238.9	212.9	189.0	017.4	358.8	191.1	28
29	229.1		084.6	055.1	235.6	206.7	029.0	003.0	339.2	167.8	149.2	341.5	29
30	019.3		234.6	205.1	025.6	356.8	179.1	153.2	129.5	318.1	299.6	131.9	30
31	169.5		024.6		175.6		329.2	303.3		108.4		282.3	31

SYSTEM I

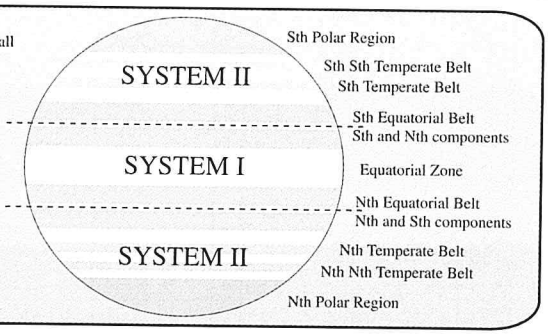
Rotation: 9h 50m 30.003s

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 Equatorial 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 page 60

JUPITER

RISE & SET

Perth, WAST

POSITION

(0hrs UT Epoch 2000.0)

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

SATURN

RISE & SET

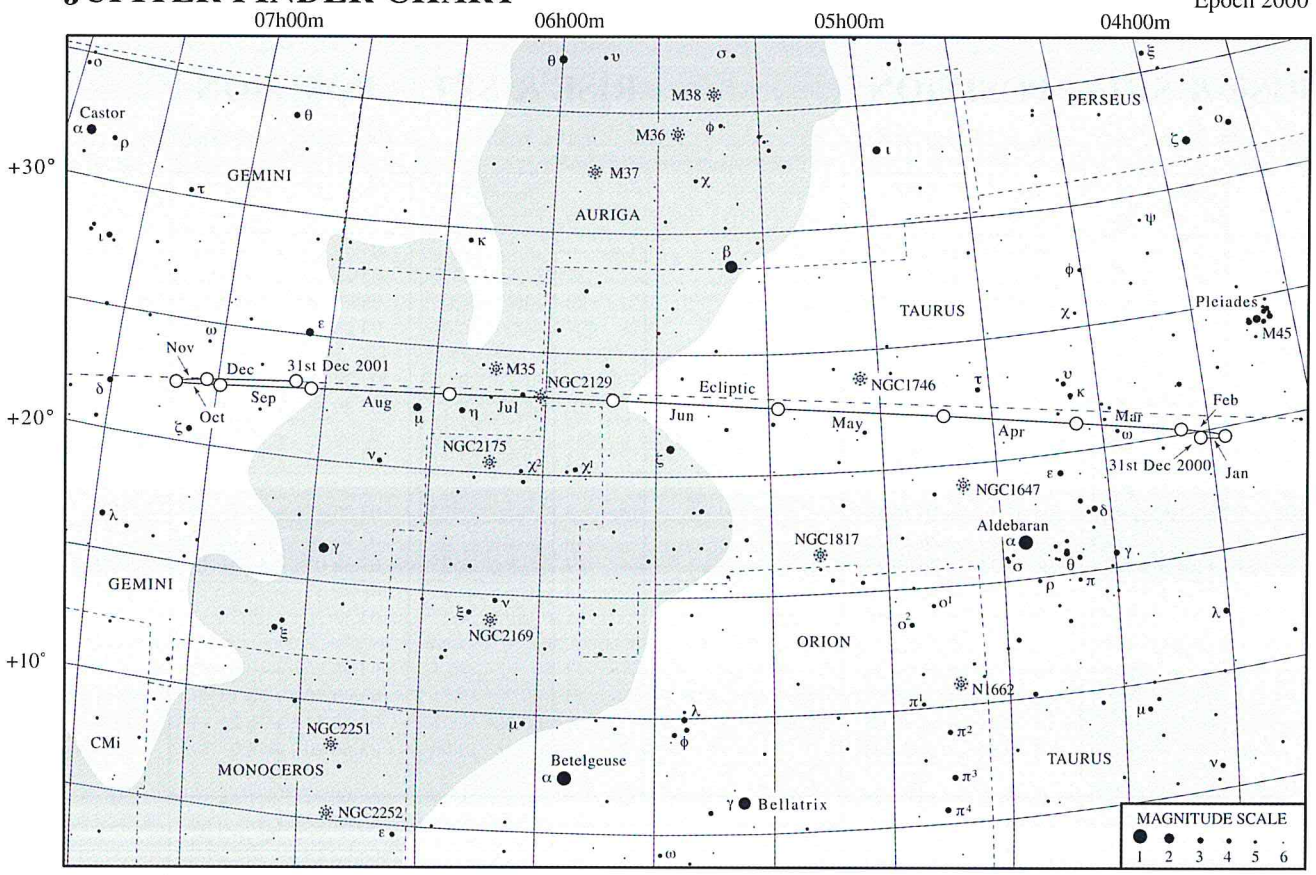
Perth, WAST

POSITION

(0hrs UT Epoch 2000.0)

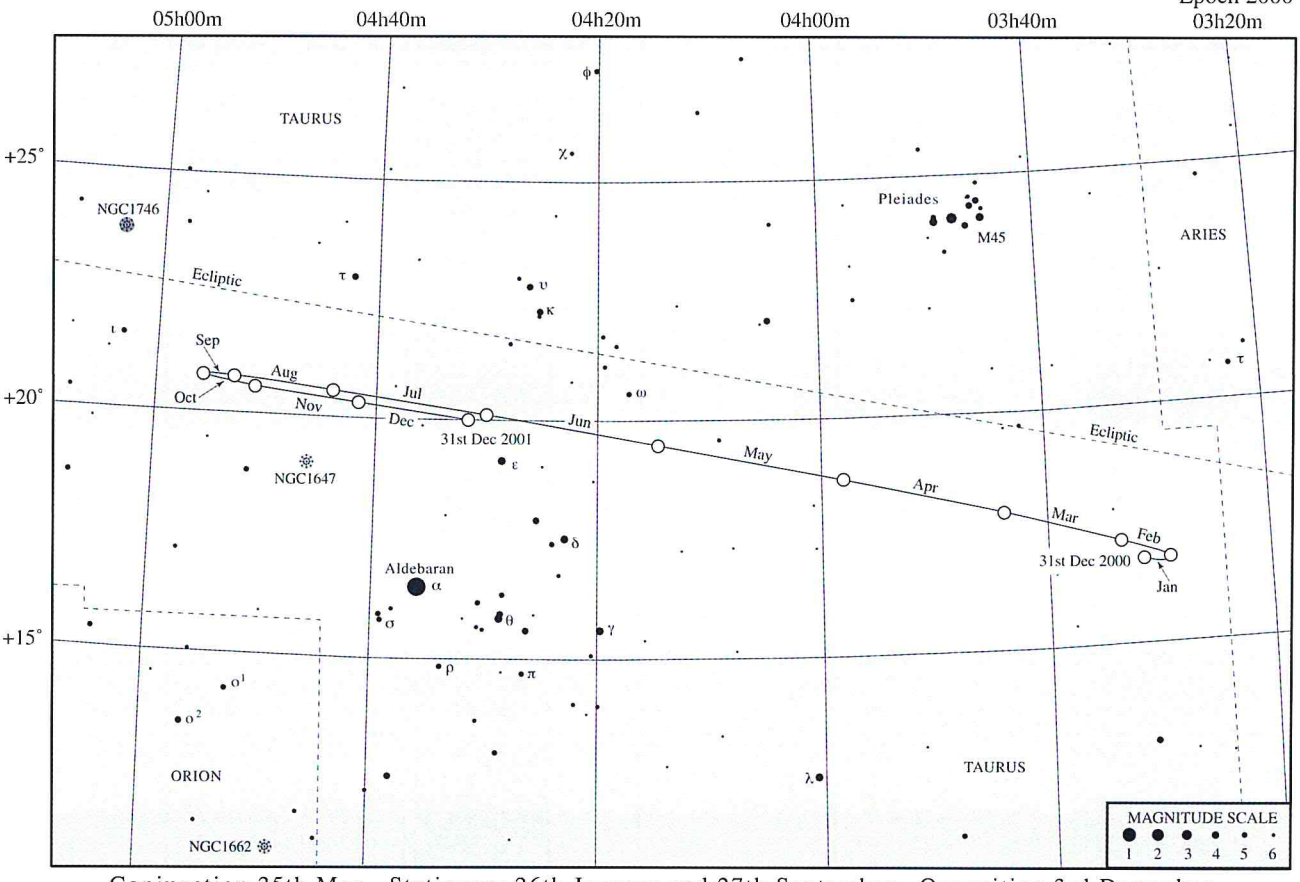
	Rise hh mm	Set hh mm	RA h m s	DEC ° ' "
Jan 6	15:24	02:05	03 30 17	+ 16 45 21
13	14:55	01:37	03 29 27	+ 16 44 16
20	14:27	01:09	03 28 58	+ 16 44 32
27	14:00	00:41	03 28 51	+ 16 46 11
Feb 3	13:33	00:13	03 29 07	+ 16 49 12
10	13:06	23:43	03 29 45	+ 16 53 32
17	12:40	23:16	03 30 44	+ 16 59 06
24	12:14	22:49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

JUPITER FINDER CHART



Conjunction 14th June, Stationary 26th January and 3rd November, Opposition 1st January 2002.

SATURN FINDER CHART



Conjunction 25th May, Stationary 26th January and 27th September, Opposition 3rd December.

URANUS, NEPTUNE AND PLUTO

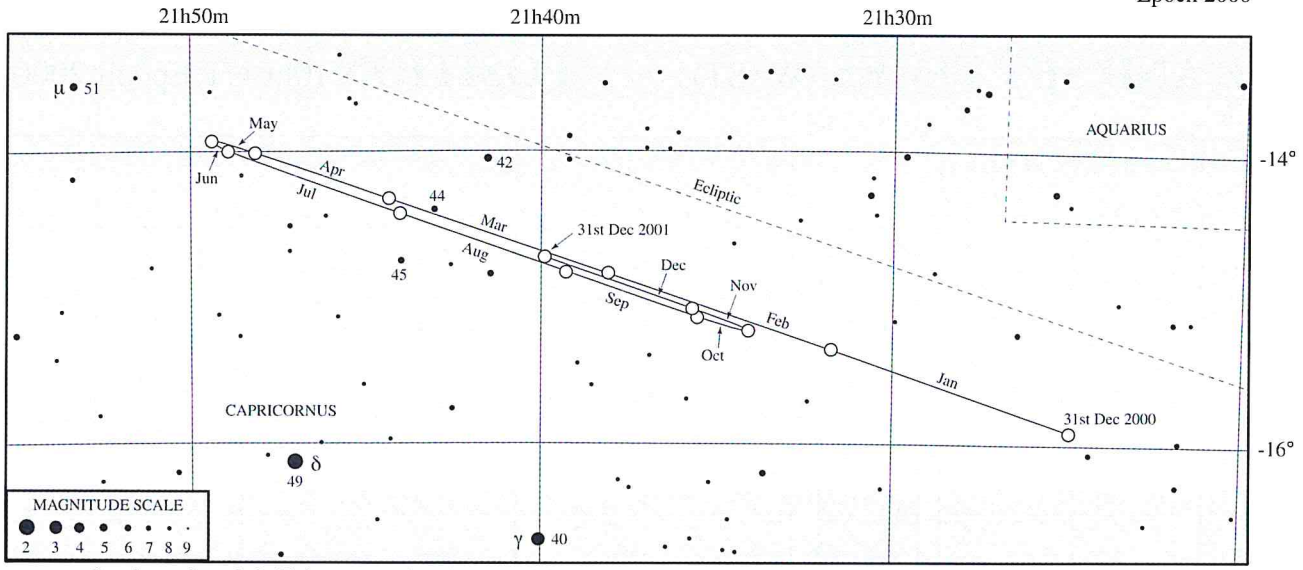
RISE AND SET TIMES (WAST)

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

POSITION (0hr UT Epoch 2000.0)

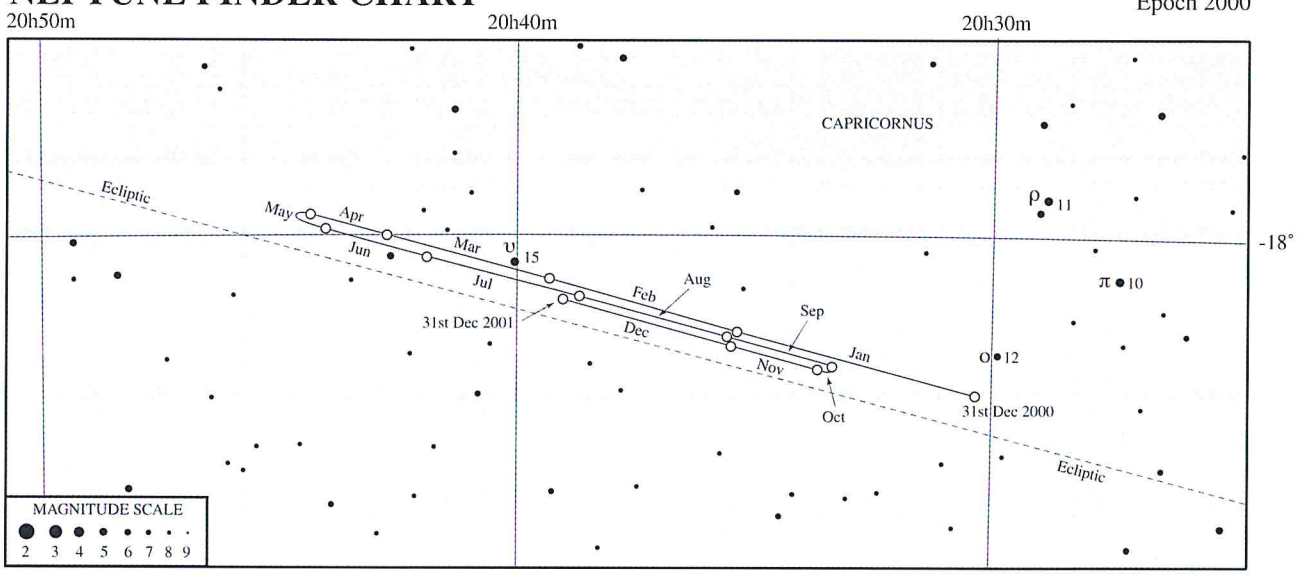
URANUS RA h m s	URANUS DEC ° ' "	NEPTUNE RA h m s	NEPTUNE DEC ° ' "	PLUTO RA h m s	PLUTO DEC ° ' "
21 26 10	- 15 48 25	20 31 17	- 18 43 50	16 55 19	- 12 13 11
21 27 36	- 15 41 30	20 32 20	- 18 40 09	16 56 14	- 12 13 57
21 29 06	- 15 34 15	20 33 25	- 18 36 21	16 57 06	- 12 14 22
21 30 39	- 15 26 46	20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

URANUS FINDER CHART



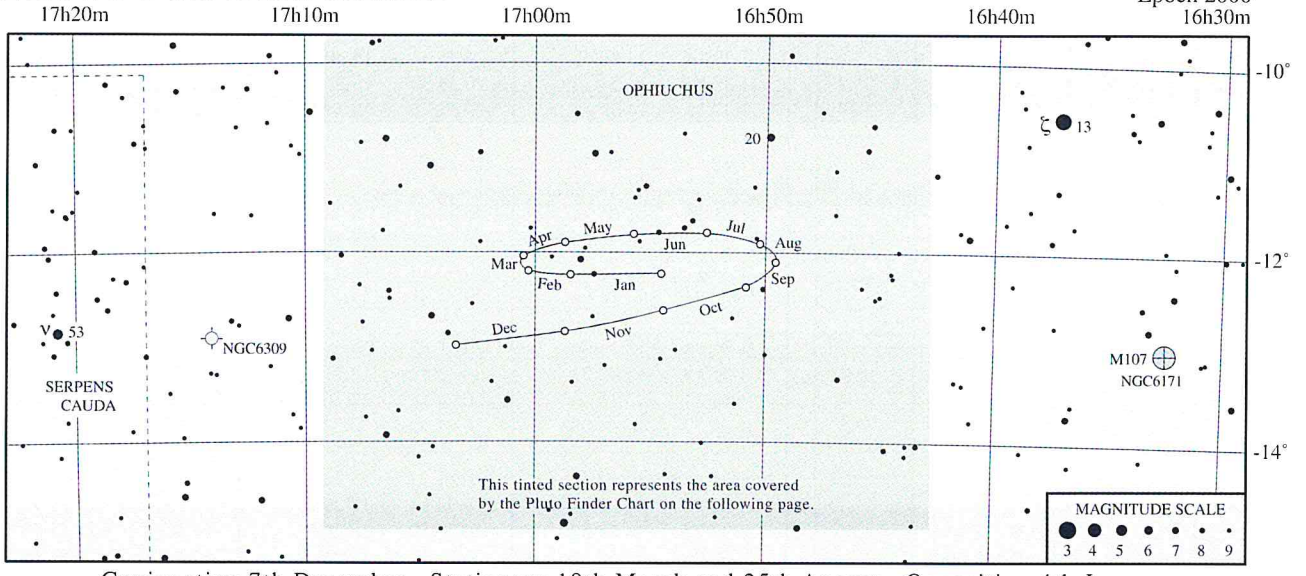
Conjunction 9th February, Stationary 30th May and 31st October, Opposition 16th August.

NEPTUNE FINDER CHART



Conjunction 26th January, Stationary 11th May and 18th October, Opposition 30th July.

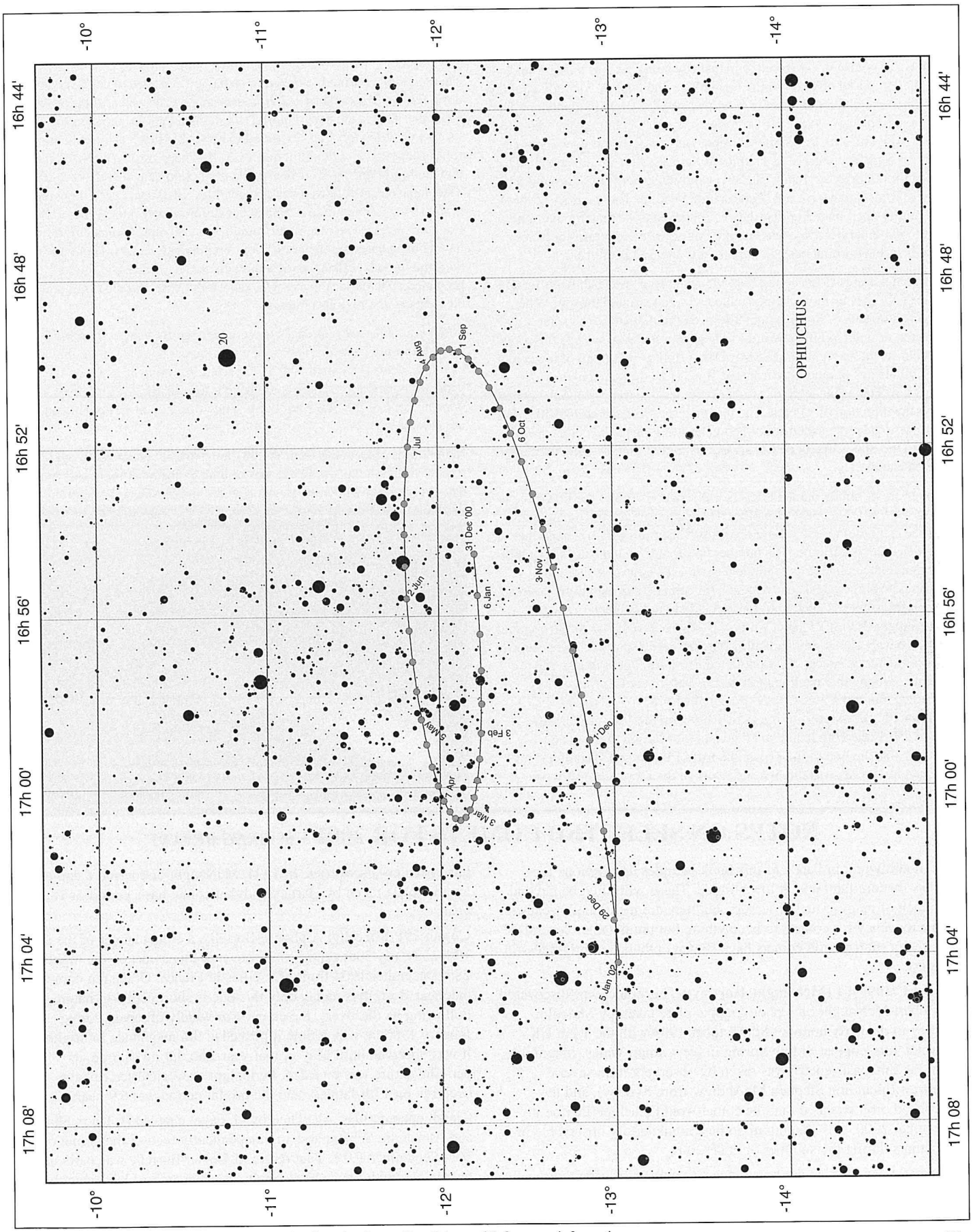
PLUTO POINTER CHART



Conjunction 7th December, Stationary 19th March and 25th August, Opposition 4th June.

PLUTO FINDER CHART 2001

Epoch 2000.0



See introduction to Part II (page 61) for more information.

COMETS FOR 2001

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 one with the shortest period, Encke, takes just over 3 years to orbit the Sun. There are also a number of comets that are not expected to return for hundreds of years. Each year sees the discovery of around 5 to 10 new comets that have not been recorded before. The majority of these have either open-ended orbits (they are believed to be making their only visit to the inner Solar System and are not expected to return) or have extremely long orbital periods measured in thousands of years.

As a comet draws closer to the Sun, the nucleus or snowball heats up and the ice sublimes forming a cloud called a 'coma' around the core. The coma can be tens of thousands of kilometres in diameter. The solar radiation or wind, on its outward journey from the Sun, sweeps the coma cloud of its lightweight ionized particles forming the ion tail of the comet. This tail always points away from the Sun. The other tail that can form is a dust tail. This is made up of heavier particles that trail behind the comet along the direction of its path. The lost material from the coma will continue to be replenished from the nucleus as long as the comet stays close to the Sun. Comets do not always have tails. In fact some may only show the coma.

Comets are normally named after their discoverers (up to the first three to report the find). There are also other designations given to comets (you will see examples on the following pages). The prefix 'P/' refers to the fact the comet is periodic. The number before the 'P' indicates the number of the periodic comet. For example Comet 47P/Ashbrook-Jackson indicates Ashbrook-Jackson was the 47th comet confirmed to be periodic. The prefix is not assigned until the comet is found on a later return. Interestingly, Halley's Comet's prefix is 1P/ because it was the first comet shown to be periodic. In fact Halley did not find the comet. It was named after him after he successfully predicted its return. You will also see references to another naming system. It is best to explain this with an example. You will notice Comet McNaught-Hartley is referred to as 'C/1999 T1'. 1999 refers to the year, T refers to the 19th half month period ('T' is the 20th letter but 'I' is not used) during the year and 1 shows it was the first discovery in this half of the month. Therefore McNaught-Hartley was the first discovery in the first half of October 1999.

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 and from even return to return. To watch one brighten, develop a tail and then fade away over a period of a few weeks, can be a fascinating experience.

This section is devoted to the comets that are expected to be observable during 2001. The table (p. 96) lists these objects as well as their orbital elements. This is the data required to calculate their locations in the sky. It lists all the known comets expected to be visible that reach perihelion (closest approach to the Sun) during 2001. There are also a few included that are bright during 2001 but have a perihelion date in 2000 or 2002. The elements are followed by 'ephemerides' (a list of expected positions in the sky and magnitude estimates for different dates) for some of the brighter comets. The magnitude parameters can often be inaccurate, having been based on their behaviour on previous returns. There are also non-gravitational effects associated with comets, which can render predicted ephemerides inaccurate, especially when extrapolating orbital elements from previous returns.

Often you will read references to a comet's return being favourable (well placed) or unfavourable. There are a few factors that determine this. For example, when the comet is at its expected maximum brightness, its apparent position in the sky could have it too close to the Sun or on the opposite side of the Sun from Earth. This would likely be considered unfavourable.

Many of the comets expected in 2001 are extremely faint and would require professional size telescopes or long exposure astrophotographs to detect them. But who knows what new discoveries lie in the future!



NOTES ON SELECTED COMETS FOR 2001 - *BY GREG BRYANT*

The monthly text in Part 1 of this book includes descriptions for comets that are faint and at low altitude. These will often be beyond the reach of many visual observers, but they are mentioned because of the tendency for comets to be anything but predictable. Several of this year's short-period comets have shown outbursts in brightness in the past.

Comet C/1999 T1 (McNaught-Hartley): This comet was discovered by Robert McNaught on a photographic plate taken by Malcolm Hartley in the early hours of 8th October 1999 with the 1.2m UK Schmidt Telescope at Siding Spring in New South Wales. Magnitude 15 at the time, astrometry was taken by observers from several countries (including Stephen McAndrew from Sydney), and the calculated orbit revealed that the comet would reach perihelion in December 2000. It is shaping up to be a comet easily observable in binoculars during the summer of 2000/2001.

McNaught and Hartley are no strangers to comets bearing their names. McNaught has twelve comets with his name; eleven of them have been co-discoveries. Hartley has thirteen comets, of which nine have been co-discoveries. In 1994, McNaught discovered a comet on another plate taken by Hartley and that comet has a period of 18 years.

Comet 19P/Borrelly: Alphonse Borrelly, a comet hunter of the late 19th and early 20th centuries, discovered this comet on the night of 28th December 1904 from Marseilles in France. Of the ten comets that bear Borrelly's name, only this one is short period in nature. Following its discovery, the comet was widely observed during January 1905, at which time it peaked at 9th magnitude in brightness. It was observed until May of that year, and during its time, its periodic nature was revealed. Perihelion was calculated to have occurred on 17th January and the orbital period was 6.9 years.

Search ephemerides calculated by G. Fayet enabled H. Knox Shaw and Alexandre Schaumasse to independently recover the comet on 20th September 1911. That return of Comet Borrelly was particularly favourable, with the comet's brightness approaching 8th magnitude. Since then, the apparitions of Borrelly have been good and bad, with an approach near Jupiter slightly altering its orbit, and locking it into

a set of bad returns (period of 7 years) in the mid 20th Century. Another Jupiter encounter caused Borrelly's period to be shortened from 7 to 6.8 years, enabling better apparitions to occur. In 1987, the comet peaked at magnitude 7.5, catching the attention of Australian supernova hunter Reverend Robert Evans who came across it whilst supernova hunting in the constellation of Fornax. While at its last return, in 1994, it reached 8th magnitude.

During the 1994 return, the Hubble Space Telescope obtained images of the comet, and the nucleus was measured to be 8.3 x 3.3 km. Comet Borrelly is the target of the Deep Space 1 mission, which was launched in October 1998 and will encounter the comet in September 2001.

Comet 24P/Schaumasse: Discovered from Nice, France, by Alexandre Schaumasse on 1st December 1911, the 12th magnitude comet brightened by one magnitude before fading from view in February 1912. During the months that it was visible, orbit calculations revealed the periodic nature of the comet. Perihelion occurred on 14th November and the period was about 8 years.

Astronomers were aware that the comet would pass just 0.37 AU from Jupiter in May 1937, and so careful predictions were made for the next return in 1943. However, it wasn't until March 1944, four months after perihelion, that the comet was found, detected on large-field photographic plates taken by Henry Giclas at Lowell Observatory. The position was seven degrees away from prediction, and it remained a mystery until the 1960s when the variance was explained in terms of non-gravitational forces. The comet's return in 1952 was intriguing, with a prolonged outburst causing the comet to reach a peak magnitude of 4.9. The comet was brighter than 7th magnitude for several months. The comet's return in 1960 was also favourable, reaching 9th magnitude, but the apparitions of 1968 and 1976 went unheralded. Although a photograph taken in 1976 revealed a faint cometary object, it wasn't confirmed as being Schaumasse until the comet's recovery in 1984. The comet was well observed at its return in 1993, reaching a peak of 8th magnitude.

Comet 41P/Tuttle-Giacobini-Kresak: The American comet hunter Horace Tuttle discovered this comet on 3rd May 1858. Tenth magnitude at the time of discovery, the comet was only observed for one month. However, astronomers were still able to calculate it was periodic, although estimates of the comet's period ranged from 5.8 to 7.5 years. On 1st June 1907, an astronomer by the name of Giacobini came across a 13th magnitude comet. A parabolic orbit was assumed for the comet, but in 1914 it was suggested that the comet might be related to Tuttle's comet of 1858. Crommelin mathematically linked the two in 1928. He predicted that the comet would next return in November 1928, but no searches were conducted. Crommelin revisited the enigma of Tuttle-Giacobini in 1933 and found that perihelion was next expected to occur in March 1934, but searches revealed nothing, and the comet was assumed to be lost. On 24th April 1951, Lubor Kresak discovered a 10th magnitude comet. The comet was well placed for observation and not only was the comet found to be of short-period, but it was soon identified as a recovery of the lost Comet Tuttle-Giacobini. Kresak's name was added to the comet.

In 1973, the comet's character forever changed. On 20th May, ten days before perihelion, it was estimated at 13th magnitude. Six days later, S. Ako from Japan photographed an unknown comet of 8th magnitude, and the following day another Japanese astronomer independently detected the comet at 5th magnitude. The comet was actually Tuttle-Giacobini-Kresak in a major outburst, and a photograph of the comet later that day saw the comet at around 4th magnitude! The comet's outburst declined after a few days, but in the first week of July, the comet jumped again from 14th to 5th magnitude. Since then, the comet has been relatively well behaved, although at its last return, the comet did undergo a small outburst in brightness to 9th magnitude in August 1995. Obviously, this is a comet that can surprise and is well worth keeping an eye on.

Comet 45P/Honda-Mrkos-Pajdusakova: Famed Japanese comet hunter Minora Honda discovered this comet just before dawn on 3rd December 1948. At the time, he reported the comet to be 9th magnitude in brightness. Three days later, Ludmilla Pajdusakova (Skalnate Pleso Observatory) independently found the comet. However, twilight intervened and she could not confirm it until the following day. By this time, her colleague, Antonin Mrkos, had independently found the comet. It was soon recognised that the comet was periodic, and that a close approach to Jupiter in 1935 had placed the comet in its current orbit. Its return in 1974/75 was very favourable. After reaching perihelion on 28th December, 1974, and shining slightly better than 8th magnitude for a few days, it passed Earth on 5th February, 1975 at a distance of 0.23 AU and came within one degree of the South Celestial Pole.

A better appearance was to come at its most recent return in 1995/96. Reaching perihelion on Christmas Day of 1995, Honda-Mrkos-Pajdusakova brightened to nearly 6th magnitude at the time before being lost in the Sun's glare. Emerging from the glare in January 1996, the comet approached Earth to about 0.17 AU in early February. On 2nd February, Queensland amateur Terry Lovejoy reported the comet to be 7th magnitude using 15x80 binoculars, two magnitudes brighter than predicted, with a coma diameter of 30 arc minutes. One wonders how the comet will look at its returns in 2011 and 2017, when it will pass Earth at distances of 0.06 and 0.08 AU respectively.

In February 1996, during Honda-Mrkos-Pajdusakova's close approach, the orbiting Hubble Space Telescope imaged the comet, and it was discovered that its nucleus is a mere 0.7km in diameter!

Comet 73P/Schwassmann-Wachmann 3: There's plenty of interest in the return of this comet. Not much was expected for the last return of Schwassmann-Wachmann 3 in 1995. It was recovered in late 1994, and an observation of the comet in August 1995 showed it to be about 13th magnitude, as predicted. In September, however, observations made at radio wavelengths revealed that there was an outburst occurring on the comet. This was soon backed up by visual observations, which saw the comet as bright as 8th magnitude. In early October, many observers, including this writer, saw the comet brighter than 6th magnitude, with a dust tail in excess of one degree in length. Many amateurs, not expecting such a bright comet in the western evening sky, reported independent discoveries of a "new" comet. At this time, the comet was nearly seven magnitudes brighter than predicted. Observations made at the European Southern Observatory in Chile showed that the comet had split into several pieces.

The return of Schwassmann-Wachmann 3 in 2001 is very poor, but it is highlighted because of the uncertainty in the predicted brightness of the comet. Will there be any pieces left? If so, will they be showing enhanced activity? The showing in 2001 will give us a guide to what we can expect in 2006, when the comet will pass 0.074 AU from Earth on 13th May, nearly as close as in its discovery apparition in 1930 when it reached 6th magnitude.

Comet 96P/Machholz 1: Donald Machholz was one of the top comet discoverers of the 1980s and 1990s, discovering nine in total, two of which were short-period in nature. This comet, his first periodic, was discovered on 12th May 1986. A parabolic orbit was calculated from observations over the first few days. In June, astronomers were very surprised to learn that the comet was in fact short period in nature, orbiting the Sun every 5.2 years. Studies of the comet's orbit showed that it had been relatively stable for many centuries, so it became apparent that the most likely conclusion was that the comet, after having been dormant and thus undetectable for some time, had just become active. Modelling also showed that the comet's perihelion distance 1,300 years ago was 0.9 AU. Today, it is

0.12 AU, and by 2450 it will be as close as 0.03 AU to the Sun. Should the comet survive those increasingly close passages to the Sun, the perihelion distance will begin to move out again.

Another surprise came when the comet was observed in 1988 and 1989, around the time of aphelion when the comet was 5.9 AU from the Sun. The images of the stellar nucleus were brighter than expected, leading some to believe that the comet was still showing some activity.

The observing window for Comet Machholz 1 is very short at each return, and this return is less favourable than most. At its last return in 1996, the comet was not visually observed by amateurs but it was captured by the orbiting SOHO spacecraft around the time of perihelion - its images showed the comet at between 3rd and 4th magnitude.

Greg Bryant has been an astronomy writer and active observer for over ten years. He is publisher of the quarterly newsletter Comet Tales (p. 108) and has headed the ASNSW's Solar System Section since 1990. In 2000, he was honoured by the International Astronomical Union with the naming of minor planet (9984) Gregbryant.

EXPLANATION OF COMET ELEMENTS TABLE

Perihelion Date Date of closest approach to the Sun.

q The perihelion distance, in AU (Astronomical units)

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

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

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

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

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

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

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

The mathematics used to calculate the ephemerides from these elements is complex (but not difficult, 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 2000.0

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

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

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

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

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

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

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

COMETS FOR 2001 — ORBITAL ELEMENTS (EQUINOX 2000.0)

Comet Name	Perihelion Date yy mm d.dd	q A.U.	e	Period years	ω deg	Ω deg	i deg	H1	K1
C/1999 T2 (LINEAR)	2000 11 24.4693512	3.037150	1.002076		104.673365	014.879056	111.000429	5.0	10.0
C/1999 T1 (McNaught-Hartley)	2000 12 13.4878492	1.171663	0.999932		344.760880	182.482386	079.975040	5.0	10.0
47P/Ashbrook-Jackson	2001 01 06.4950175	2.305363	0.396093	7.46	348.884439	002.602137	012.513396	4.5	18.0
41P/Tuttle-Giacobini-Kresak	2001 01 06.9862053	1.052243	0.659279	5.43	062.178274	141.104029	009.225624	10.0	40.0
74P/Smirnova-Chernykh	2001 01 15.6301153	3.545796	0.148323	8.50	086.654104	077.155644	006.652375	4.5	15.0
73P/Schwassmann-Wachmann 3	2001 01 27.7225825	0.937379	0.693811	5.36	198.774624	069.921761	011.405925	12.0	15.0
P/1992 G3 (Mueller 4)	2001 02 07.8574264	2.646960	0.388511	9.01	043.674871	145.365441	029.747490	11.5	10.0
44P/Reinmuth 2	2001 02 19.9912311	1.889724	0.464518	6.63	046.103146	296.068461	006.981768	8.3	15.0
113P/Spitaler	2001 02 25.8704151	2.127265	0.423545	7.09	050.064835	014.524923	005.776568	13.5	10.0
75P/Kohoutek	2001 02 27.3457813	1.787300	0.496163	6.68	175.694923	269.682964	005.909929	10.5	10.0
110P/Hartley 3	2001 03 21.4159607	2.478316	0.314650	6.88	167.939036	287.752676	011.688802	3.0	25.0
C/1999 Y1 (LINEAR)	2001 03 24.1229954	3.091173	1.000553		184.285972	188.882977	134.787175	5.5	10.0
107P/Wilson-Harrington	2001 03 26.6340666	1.000752	0.621419	4.30	091.090702	270.827204	002.784117	n/a	n/a
45P/Honda-Mrkos-Pajdusakova	2001 03 29.914968	0.528414	0.825089	5.25	326.132118	089.082768	004.255601	13.5	20.0
97P/Metcalf-Brewington	2001 04 10.0726378	2.605198	0.457164	10.50	229.586260	186.434530	017.953060	4.0	20.0
P/1993 X1 (Kushida-Muramatsu)	2001 04 29.5490937	2.752592	0.277428	7.44	347.567545	093.691848	002.367296	5.5	20.0
24P/Schaumasse	2001 05 02.657582	1.205005	0.704809	8.25	057.873804	079.831171	011.751484	7.0	30.0
61P/Shajn-Schaldach	2001 05 09.0081086	2.330101	0.389477	7.46	216.623724	166.880423	006.084449	6.0	25.0
51P/Harrington	2001 06 05.8893215	1.568128	0.561847	6.77	233.604674	119.180714	008.656220	11.0	20.0
86P/Wild 3	2001 06 18.6022271	2.310287	0.364477	6.93	179.161984	072.612914	015.438587	11.0	15.0
C/2000 CT54 (LINEAR)	2001 06 19.5263212	3.156387	0.998658		272.646188	018.965233	049.207130	n/a	n/a
P/1994 A1 (Kushida)	2001 06 27.7939181	1.431270	0.629003	7.58	216.021763	245.624853	004.118846	10.0	12.0
16P/Brooks 2	2001 07 19.8247257	1.834897	0.491928	6.86	198.108378	176.914065	005.548170	7.5	25.0
82P/Gehrels 3	2001 09 03.0682299	3.626624	0.125676	8.45	227.948657	239.689301	001.127166	5.0	20.0
19P/Borrelly	2001 09 14.7322896	1.358203	0.623896	6.86	353.375907	075.424845	030.324672	5.0	25.0
P/1987 Q3 (Helin)	2001 09 26.34971	2.530729	0.565755	14.10	215.409828	143.537267	004.717123	10.0	15.0
C/1999 U4 (Catalina-Skiff)	2001 10 28.355774	4.914142	1.008144		077.523084	032.288324	051.923965	4.5	10.0
133P/Elst-Pizarro	2001 11 23.6765583	2.635406	0.165362	5.61	133.000739	160.229723	001.385487	n/a	n/a
96P/Machholz 1	2002 01 08.6339396	0.124105	0.958811	5.23	014.580743	094.608469	060.186666	13.0	12.0

COMET EPHEMERIDES FOR 2001

Comet 73P/Schwassmann-Wachmann 3

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
2000 Dec 9	15 19.7	-13 45	1.975	1.178	26	14.5
2000 Dec 16	15 48.6	-16 10	1.920	1.122	26	14.2
2000 Dec 23	16 19.6	-18 25	1.874	1.072	25	13.8
2000 Dec 30	16 52.6	-20 25	1.838	1.027	25	13.5
2001 Jan 6	17 27.4	-22 04	1.814	0.990	23	13.2
2001 Jan 13	18 03.6	-23 16	1.800	0.962	22	13.0
2001 Jan 20	18 40.7	-23 56	1.798	0.944	21	12.9
2001 Jan 27	19 18.0	-24 02	1.807	0.937	19	12.9
2001 Feb 3	19 54.7	-23 35	1.826	0.942	18	12.9
2001 Feb 10	20 30.2	-22 38	1.853	0.958	17	13.1
2001 Feb 17	21 04.0	-21 14	1.888	0.984	17	13.3
2001 Feb 24	21 35.7	-19 31	1.930	1.019	16	13.5
2001 Mar 3	22 05.3	-17 33	1.977	1.062	16	13.9
2001 Mar 10	22 32.8	-15 28	2.028	1.111	16	14.2
2001 Mar 17	22 58.3	-13 18	2.081	1.166	17	14.6

Comet 45P/Honda-Mrkos-Pajdusakova

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
2001 Feb 17	21 58.6	-14 13	1.950	0.964	02	14.6
2001 Feb 24	22 28.0	-11 32	1.851	0.863	02	13.6
2001 Mar 3	23 00.1	-08 20	1.754	0.764	02	12.4
2001 Mar 10	23 35.1	-04 34	1.661	0.673	04	11.2
2001 Mar 17	00 13.4	+00 15	1.572	0.595	07	10.0
2001 Mar 24	00 55.3	+04 33	1.486	0.543	11	9.1
2001 Mar 31	01 40.4	+09 34	1.405	0.529	16	8.7
2001 Apr 7	02 28.4	+14 26	1.334	0.556	22	9.0
2001 Apr 14	03 18.6	+18 46	1.282	0.617	28	9.8
2001 Apr 21	04 10.3	+22 13	1.255	0.700	34	10.9
2001 Apr 28	05 02.2	+24 33	1.257	0.794	39	12.0
2001 May 5	05 52.3	+25 43	1.287	0.894	44	13.1
2001 May 12	06 38.8	+25 50	1.343	0.995	48	14.1
2001 May 19	07 20.7	+25 08	1.419	1.095	50	15.1

Comet 96P/Machholz 1

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
2001 Dec 1	18 23.0	-48 06	1.743	1.091	35	14.7
2001 Dec 8	18 38.2	-47 07	1.637	0.949	32	13.8
2001 Dec 15	18 54.9	-45 49	1.508	0.795	28	12.7
2001 Dec 22	19 12.7	-43 50	1.353	0.624	25	11.2
2001 Dec 29	19 30.4	-40 19	1.163	0.430	21	8.9
2002 Jan 5	19 38.3	-31 37	0.932	0.206	12	4.6
2002 Jan 12	19 04.4	-12 29	0.976	0.197	12	4.5
2002 Jan 19	19 04.4	-09 31	1.230	0.422	18	9.0
2002 Jan 26	19 12.7	-09 22	1.415	0.617	22	11.2
2002 Feb 2	19 21.7	-09 35	1.556	0.788	25	12.7
2002 Feb 9	19 30.3	-09 50	1.665	0.943	30	13.8
2002 Feb 16	19 38.0	-10 03	1.750	1.086	34	14.6

Comet 47P/Ashbrook-Jackson

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
2000 Dec 2	21 23.9	-19 57	2.518	2.319	67	13.1
2000 Dec 9	21 35.4	-18 28	2.589	2.314	63	13.1
2000 Dec 16	21 47.1	-16 57	2.657	2.310	59	13.2
2000 Dec 23	21 59.1	-15 23	2.724	2.308	55	13.2
2000 Dec 30	22 11.3	-13 47	2.789	2.306	51	13.3
2001 Jan 6	22 23.6	-12 09	2.852	2.305	48	13.3
2001 Jan 13	22 35.9	-10 29	2.912	2.306	44	13.4
2001 Jan 20	22 48.4	-08 48	2.970	2.307	40	13.4
2001 Jan 27	23 01.0	-07 05	3.025	2.310	37	13.4
2001 Feb 3	23 13.5	-05 21	3.077	2.314	33	13.5
2001 Feb 10	23 26.1	-03 36	3.126	2.318	30	13.5
2001 Feb 17	23 38.8	-01 51	3.171	2.324	26	13.6
2001 Feb 24	23 51.5	+00 05	3.214	2.331	23	13.7
2001 Mar 3	00 04.1	+01 40	3.252	2.339	19	13.7
2001 Mar 10	00 16.8	+03 24	3.288	2.348	16	13.8
2001 Mar 17	00 29.5	+05 08	3.319	2.358	13	13.8
2001 Mar 24	00 42.3	+06 50	3.347	2.368	09	13.9
2001 Mar 31	00 55.0	+08 31	3.371	2.380	06	13.9
2001 Apr 7	01 07.8	+10 10	3.391	2.393	04	14.0
2001 Apr 14	01 20.5	+11 47	3.407	2.406	03	14.0
2001 Apr 21	01 33.3	+13 22	3.419	2.420	06	14.1
2001 Apr 28	01 46.1	+14 54	3.426	2.435	09	14.1
2001 May 5	01 58.9	+16 23	3.429	2.451	12	14.2
2001 May 12	02 11.6	+17 49	3.429	2.468	15	14.2
2001 May 19	02 24.4	+19 12	3.423	2.485	19	14.3
2001 May 26	02 37.1	+20 32	3.414	2.504	22	14.3

Comet C/1999T2 (LINEAR)

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
2000 Dec 2	16 53.9	+27 06	3.588	3.038	49	12.6
2000 Dec 9	16 56.2	+26 19	3.592	3.041	49	12.6
2000 Dec 16	16 58.5	+25 42	3.585	3.045	50	12.6
2000 Dec 23	17 00.6	+25 15	3.568	3.050	51	12.6
2000 Dec 30	17 02.5	+24 57	3.541	3.057	53	12.6
2001 Jan 6	17 04.0	+24 50	3.503	3.066	56	12.6
2001 Jan 13	17 05.0	+24 52	3.456	3.076	60	12.6
2001 Jan 20	17 05.5	+25 03	3.400	3.088	63	12.6
2001 Jan 27	17 05.2	+25 24	3.335	3.101	68	12.5
2001 Feb 3	17 04.1	+25 54	3.264	3.116	73	12.5
2001 Feb 10	17 01.9	+26 32	3.187	3.132	78	12.5
2001 Feb 17	16 58.5	+27 18	3.107	3.149	83	12.4
2001 Feb 24	16 53.8	+28 10	3.025	3.168	89	12.4
2001 Mar 3	16 47.4	+29 09	2.944	3.188	95	12.4
2001 Mar 10	16 39.1	+30 10	2.865	3.210	101	12.4
2001 Mar 17	16 29.0	+31 11	2.793	3.232	107	12.3
2001 Mar 24	16 16.8	+32 10	2.729	3.256	113	12.3
2001 Mar 31	16 02.5	+33 00	2.677	3.281	119	12.3
2001 Apr 7	15 46.3	+33 38	2.640	3.307	124	12.3
2001 Apr 14	15 28.7	+33 58	2.620	3.335	128	12.3
2001 Apr 21	15 10.1	+33 57	2.618	3.363	131	12.4
2001 Apr 28	14 51.2	+33 33	2.637	3.393	132	12.4
2001 May 5	14 32.9	+32 46	2.677	3.423	131	12.5
2001 May 12	14 15.6	+31 39	2.737	3.454	128	12.6
2001 May 19	14 00.0	+30 14	2.816	3.487	124	12.7
2001 May 26	13 46.3	+28 37	2.913	3.520	119	12.8
2001 Jun 2	13 34.6	+26 52	3.025	3.554	114	12.9
2001 Jun 9	13 24.8	+25 02	3.150	3.589	108	13.0
2001 Jun 16	13 16.9	+23 11	3.284	3.625	101	13.2
2001 Jun 23	13 10.6	+21 21	3.427	3.661	95	13.3
2001 Jun 30	13 05.9	+19 33	3.575	3.698	89	13.4
2001 Jul 7	13 02.4	+17 48	3.727	3.736	83	13.6
2001 Jul 14	12 60.0	+16 06	3.879	3.775	77	13.7
2001 Jul 21	12 58.5	+14 29	4.031	3.814	71	13.8
2001 Jul 28	12 57.9	+12 55	4.180	3.853	65	14.0
2001 Aug 4	12 58.0	+11 26	4.325	3.894	59	14.1
2001 Aug 11	12 58.7	+09 59	4.465	3.934	53	14.2
2001 Aug 18	12 59.9	+08 37	4.598	3.976	47	14.3
2001 Aug 25	13 01.5	+07 17	4.724	4.017	41	14.4
2001 Sep 1	13 03.4	+06 01	4.840	4.060	35	14.5

Comet 19P/Borrelly

Date	R.A. h m	Dec ° '	Δ AU	R AU	Elg	Mag
2001 May 5	01 10.4	-16 45	2.635	1.985	41	14.6
2001 May 12	01 27.0	-15 02	2.555	1.936	43	14.2
2001 May 19	01 43.9	-13 16	2.476	1.887	44	13.9
2001 May 26	02 01.1	-11 27	2.398	1.839	46	13.5
2001 Jun 2	02 18.5	-09 36	2.322	1.791	47	13.2
2001 Jun 9	02 36.3	-07 44	2.247	1.745	48	12.8
2001 Jun 16	02 54.5	-05 49	2.176	1.699	49	12.4
2001 Jun 23	03 13.0	-03 53	2.107	1.656	50	12.1
2001 Jun 30	03 31.9	-01 55	2.040	1.614	51	11.7
2001 Jul 7	03 51.2	+00 03	1.977	1.574	52	11.4
2001 Jul 14	04 10.8	+02 03	1.916	1.537	53	11.1
2001 Jul 21	04 30.9	+04 02	1.859	1.502	54	10.8
2001 Jul 28	04 51.5	+06 01	1.805	1.470	55	10.5
2001 Aug 4	05 12.4	+07 59	1.753	1.441	55	10.2
2001 Aug 11	05 33.8	+09 56	1.705	1.417	56	9.9
2001 Aug 18	05 55.7	+11 51	1.660	1.396	57	9.7
2001 Aug 25	06 17.9	+13 43	1.618	1.379	58	9.5
2001 Sep 1	06 40.7	+15 32	1.578	1.368	59	9.4
2001 Sep 8	07 03.8	+17 18	1.542	1.360	60	9.3
2001 Sep 15	07 27.3	+18 59	1.508	1.358	62	9.2
2001 Sep 22	07 51.0	+20 35	1.477	1.361	63	9.2
2001 Sep 29	08 15.0	+22 05	1.449	1.368	65	9.2
2001 Oct 6	08 39.0	+23 31	1.423	1.381	67	9.3
2001 Oct 13	09 02.9	+24 51	1.400	1.397	69	9.4
2001 Oct 20	09 26.6	+26 07	1.380	1.418	71	9.5
2001 Oct 27	09 49.9	+27 19	1.362	1.443	74	9.7
2001 Nov 3	10 12.6	+28 28	1.345	1.472	76	9.8
2001 Nov 10	10 34.6	+29 36	1.331	1.504	79	10.1
2001 Nov 17	10 55.7	+30 44	1.319	1.539	82	10.3
2001 Nov 24	11 15.7	+31 55	1.308	1.577	86	10.5
2001 Dec 1	11 34.4	+33 09	1.299	1.617	89	10.8
2001 Dec 8	11 51.7	+34 29	1.292	1.659	93	11.1
2001 Dec 15	12 07.5	+35 54	1.286	1.703	96	11.3
2001 Dec 22	12 21.5	+37 26	1.282	1.748	100	11.6
2001 Dec 29	12 33.6	+39 06	1.281	1.795	104	11.9

COMET EPHEMERIDES FOR 2001

Comet C/1999T1 (McNaught-Hartley)

Date	R.A. h m	Dec ° ′	Δ AU	R AU	Elg	Mag
2000 Nov 4	12 05.8	-38 12	1.914	1.326	40	7.6
2000 Nov 11	12 28.4	-36 27	1.877	1.279	40	7.4
2000 Nov 18	12 50.2	-34 25	1.834	1.239	39	7.2
2000 Nov 25	13 11.3	-32 04	1.784	1.208	40	7.1
2000 Dec 2	13 31.8	-29 22	1.729	1.186	41	6.9
2000 Dec 9	13 51.9	-26 16	1.669	1.174	44	6.8
2000 Dec 16	14 11.6	-22 45	1.605	1.172	47	6.7
2000 Dec 23	14 31.3	-18 45	1.540	1.181	50	6.7
2000 Dec 30	14 50.8	-14 12	1.475	1.201	54	6.6
2001 Jan 6	15 10.4	-09 05	1.415	1.229	58	6.7
2001 Jan 13	15 29.9	-03 22	1.362	1.267	63	6.7
2001 Jan 20	15 49.5	+02 53	1.322	1.312	68	6.8
2001 Jan 27	16 09.1	+09 35	1.295	1.364	72	6.9
2001 Feb 3	16 28.5	+16 33	1.286	1.421	76	7.1
2001 Feb 10	16 47.6	+23 34	1.296	1.483	80	7.3
2001 Feb 17	17 06.3	+30 24	1.325	1.549	83	7.5
2001 Feb 24	17 24.4	+36 51	1.372	1.618	85	7.8
2001 Mar 3	17 41.7	+42 46	1.434	1.689	86	8.1
2001 Mar 10	17 57.9	+48 07	1.509	1.763	87	8.4
2001 Mar 17	18 12.8	+52 51	1.594	1.838	87	8.7
2001 Mar 24	18 26.1	+57 03	1.686	1.914	87	9.0
2001 Mar 31	18 37.5	+60 44	1.784	1.991	87	9.2
2001 Apr 7	18 46.6	+63 58	1.886	2.069	86	9.5
2001 Apr 14	18 53.1	+66 48	1.988	2.147	85	9.8
2001 Apr 21	18 56.4	+69 16	2.092	2.225	84	10.1
2001 Apr 28	18 56.1	+71 24	2.194	2.304	83	10.3
2001 May 5	18 51.6	+73 12	2.295	2.382	82	10.6
2001 May 12	18 42.7	+74 40	2.394	2.461	82	10.8
2001 May 19	18 29.4	+75 48	2.491	2.539	81	11.0
2001 May 26	18 12.1	+76 33	2.584	2.618	81	11.2
2001 Jun 2	17 52.3	+76 56	2.674	2.696	80	11.4
2001 Jun 9	17 31.8	+76 55	2.762	2.774	80	11.6
2001 Jun 16	17 12.7	+76 34	2.846	2.851	80	11.8
2001 Jun 23	16 56.4	+75 53	2.927	2.928	80	12.0
2001 Jun 30	16 43.7	+74 57	3.006	3.005	80	12.2
2001 Jul 7	16 34.7	+73 49	3.082	3.082	81	12.3
2001 Jul 14	16 29.1	+72 31	3.156	3.158	81	12.5
2001 Jul 21	16 26.5	+71 06	3.229	3.234	81	12.6
2001 Jul 28	16 26.4	+69 35	3.300	3.309	82	12.8
2001 Aug 4	16 28.4	+68 01	3.370	3.384	82	12.9
2001 Aug 11	16 32.0	+66 24	3.439	3.459	83	13.1
2001 Aug 18	16 37.0	+64 45	3.509	3.533	83	13.2
2001 Aug 25	16 43.1	+63 06	3.579	3.607	84	13.3
2001 Sep 1	16 50.2	+61 27	3.651	3.681	84	13.5
2001 Sep 8	16 58.0	+59 49	3.723	3.754	84	13.6
2001 Sep 15	17 06.3	+58 13	3.797	3.826	84	13.7
2001 Sep 22	17 15.2	+56 39	3.873	3.899	84	13.8
2001 Sep 29	17 24.4	+55 08	3.952	3.971	84	14.0
2001 Oct 6	17 34.0	+53 40	4.032	4.042	84	14.1
2001 Oct 13	17 43.8	+52 17	4.115	4.113	83	14.2
2001 Oct 20	17 53.8	+50 59	4.201	4.184	82	14.3
2001 Oct 27	18 04.0	+49 46	4.289	4.255	81	14.5

Comet 24P/Schaumasse

Date	R.A. h m	Dec ° ′	Δ AU	R AU	Elg	Mag
2001 Feb 3	02 05.6	+10 07	1.523	1.642	79	14.4
2001 Feb 10	02 15.8	+11 57	1.536	1.587	74	14.0
2001 Feb 17	02 27.6	+13 52	1.545	1.534	71	13.5
2001 Feb 24	02 41.1	+15 51	1.550	1.484	67	13.1
2001 Mar 3	02 56.1	+17 52	1.552	1.435	64	12.7
2001 Mar 10	03 12.8	+19 54	1.551	1.390	62	12.2
2001 Mar 17	03 31.3	+21 55	1.547	1.348	59	11.8
2001 Mar 24	03 51.6	+23 53	1.541	1.311	58	11.5
2001 Mar 31	04 13.8	+25 44	1.533	1.278	56	11.1
2001 Apr 7	04 37.9	+27 27	1.525	1.251	55	10.8
2001 Apr 14	05 04.0	+28 56	1.517	1.230	54	10.6
2001 Apr 21	05 32.0	+30 08	1.510	1.215	53	10.4
2001 Apr 28	06 01.7	+30 58	1.506	1.207	53	10.3
2001 May 5	06 32.7	+31 22	1.505	1.205	53	10.3
2001 May 12	07 04.6	+31 19	1.509	1.211	53	10.4
2001 May 19	07 36.8	+30 45	1.520	1.224	53	10.5
2001 May 26	08 08.9	+29 42	1.536	1.243	54	10.8
2001 Jun 2	08 40.1	+28 12	1.561	1.269	54	11.1
2001 Jun 9	09 10.2	+26 19	1.593	1.300	55	11.4
2001 Jun 16	09 38.9	+24 06	1.633	1.335	55	11.8
2001 Jun 23	10 05.9	+21 39	1.683	1.376	55	12.3
2001 Jun 30	10 31.4	+19 03	1.740	1.420	55	12.8
2001 Jul 7	10 55.3	+16 21	1.805	1.467	54	13.3
2001 Jul 14	11 17.8	+13 39	1.877	1.517	54	13.8
2001 Jul 21	11 39.0	+10 58	1.956	1.569	53	14.3
2001 Jul 28	11 59.0	+08 21	2.041	1.623	52	14.9

Comet C/1999Y1 (LINEAR)

Date	R.A. h m	Dec ° ′	Δ AU	R AU	Elg	Mag
2000 Nov 4	00 45.9	+35 53	2.497	3.377	148	12.8
2000 Nov 11	00 32.1	+32 26	2.512	3.351	142	12.8
2000 Nov 18	00 20.5	+28 55	2.553	3.326	135	12.8
2000 Nov 25	00 11.0	+25 30	2.616	3.301	127	12.8
2000 Dec 2	00 03.6	+22 16	2.698	3.278	118	12.8
2000 Dec 9	23 58.0	+19 17	2.796	3.256	109	12.9
2000 Dec 16	23 54.1	+16 36	2.906	3.236	101	12.9
2000 Dec 23	23 51.6	+14 13	3.023	3.216	92	13.0
2000 Dec 30	23 50.4	+12 07	3.144	3.198	84	13.0
2001 Jan 6	23 50.2	+10 16	3.266	3.182	76	13.1
2001 Jan 13	23 50.9	+08 40	3.386	3.166	69	13.2
2001 Jan 20	23 52.3	+07 17	3.502	3.152	61	13.2
2001 Jan 27	23 54.3	+06 04	3.611	3.140	54	13.3
2001 Feb 3	23 56.9	+05 01	3.712	3.128	47	13.3
2001 Feb 10	23 59.9	+04 05	3.803	3.119	40	13.3
2001 Feb 17	00 03.2	+03 15	3.883	3.110	34	13.4
2001 Feb 24	00 06.8	+02 31	3.951	3.103	27	13.4
2001 Mar 3	00 10.7	+01 50	4.005	3.098	21	13.4
2001 Mar 10	00 14.7	+01 12	4.046	3.094	14	13.4
2001 Mar 17	00 18.8	+00 36	4.074	3.092	08	13.5
2001 Mar 24	00 23.0	+00 00	4.086	3.091	03	13.5
2001 Mar 31	00 27.2	+00 35	4.085	3.092	05	13.5
2001 Apr 7	00 31.4	-01 12	4.069	3.094	11	13.5
2001 Apr 14	00 35.6	-01 51	4.040	3.098	17	13.4
2001 Apr 21	00 39.6	-02 33	3.997	3.103	24	13.4
2001 Apr 28	00 43.5	-03 18	3.942	3.110	30	13.4
2001 May 5	00 47.1	-04 09	3.874	3.118	36	13.4
2001 May 12	00 50.6	-05 06	3.796	3.128	43	13.3
2001 May 19	00 53.7	-06 10	3.707	3.139	49	13.3
2001 May 26	00 56.4	-07 23	3.610	3.152	56	13.3
2001 Jun 2	00 58.7	-08 46	3.505	3.166	62	13.2
2001 Jun 9	01 00.4	-10 20	3.396	3.181	69	13.2
2001 Jun 16	01 01.5	-12 07	3.283	3.198	76	13.1
2001 Jun 23	01 01.8	-14 08	3.169	3.216	84	13.1
2001 Jun 30	01 01.2	-16 25	3.056	3.235	91	13.0
2001 Jul 7	00 59.5	-18 59	2.948	3.256	98	13.0
2001 Jul 14	00 56.5	-21 50	2.848	3.277	106	12.9
2001 Jul 21	00 52.0	-24 57	2.758	3.300	114	12.9
2001 Jul 28	00 45.8	-28 18	2.683	3.325	121	12.9
2001 Aug 4	00 37.7	-31 50	2.626	3.350	128	12.8
2001 Aug 11	00 27.5	-35 26	2.590	3.376	134	12.9
2001 Aug 18	00 14.9	-38 59	2.576	3.404	139	12.9
2001 Aug 25	00 00.2	-42 21	2.587	3.432	141	12.9
2001 Sep 1	23 43.4	-45 23	2.622	3.462	141	13.0
2001 Sep 8	23 25.0	-47 58	2.682	3.492	138	13.1
2001 Sep 15	23 05.8	-50 02	2.763	3.524	133	13.2
2001 Sep 22	22 46.6	-51 35	2.864	3.556	127	13.3
2001 Sep 29	22 28.3	-52 38	2.981	3.589	120	13.4
2001 Oct 6	22 11.6	-53 16	3.111	3.623	113	13.6
2001 Oct 13	21 57.1	-53 33	3.251	3.657	106	13.7
2001 Oct 20	21 44.9	-53 34	3.399	3.693	99	13.8
2001 Oct 27	21 35.1	-53 24	3.550	3.729	93	14.0
2001 Nov 3	21 27.5	-53 08	3.703	3.766	86	14.1
2001 Nov 10	21 21.9	-52 46	3.855	3.803	80	14.2
2001 Nov 17	21 18.2	-52 23	4.005	3.841	73	14.4
2001 Nov 24	21 16.0	-51 59	4.149	3.880	68	14.5

Comet 41P/Tuttle-Giacobini-Kresak

Date	R.A. h m	Dec ° ′	Δ AU	R AU	Elg	Mag
2000 Nov 18	12 29.0	-01 51	1.654	1.245	49	14.9
2000 Nov 25	12 57.4	-04 05	1.603	1.199	48	14.2
2000 Dec 2	13 26.9	-06 19	1.563	1.158	48	13.5
2000 Dec 9	13 57.5	-08 28	1.533	1.123	47	12.9
2000 Dec 16	14 29.0	-10 29	1.514	1.094	46	12.5
2000 Dec 23	15 01.0	-12 18	1.505	1.072	45	12.1
2000 Dec 30	15 33.2	-13 52	1.505	1.058	45	11.9
2001 Jan 6	16 05.3	-15 08	1.514	1.052	44	11.8
2001 Jan 13	16 37.0	-16 04	1.530	1.055	43	11.9
2001 Jan 20	17 07.8	-16 42	1.551	1.067	43	12.1
2001 Jan 27	17 37.5	-17 01	1.577	1.087	43	12.4
2001 Feb 3	18 05.9	-17 03	1.605	1.114	43	12.9
2001 Feb 10	18 32.8	-16 51	1.634	1.147	44	13.5
2001 Feb 17	18 58.1	-16 27	1.664	1.187	45	14.1

METEOR SHOWERS

WHAT is a METEOR SHOWER?

A meteor shower is no more than the leftover debris from comets. A comet has been best described as a 'dirty snowball', a conglomerate of ice, frozen gases, dust, and larger particles that become meteoroids when freed from the nucleus. When a comet is near perihelion, very fine dust particles are released from the nucleus as it is warmed by the Sun (by the process of sublimation). These particles are then pushed away by solar radiation or wind to form the classical dust tail of a comet. Pieces that are too large to be blown away end up strewn along the comet's orbit to become meteoroids.

Ultimately the meteoroids spread out over the comet's orbit, somewhat like an elliptical shaped donut, the effects of solar radiation and the slight gravity tugs from the planets will over time break up the stream. If the Earth passes through a meteoroid stream we will experience a meteor shower. A typical meteor of visual magnitude may be as small as a grain of sand up to the size of a small pea. Particles in space that strike the Earth's atmosphere will have a minimum speed of 11 km/s (if the body is at rest when swept up by the Earth), and an upper limit of 73 km/s. The Leonid stream, at 71 km/s, makes it the fastest of the showers.

Incredible velocities such as these (a bullet from a rifle travels at about 1 km per second) result in the meteor's kinetic energy being converted to heat when it strikes the atmosphere at an altitude of about 100 km. The surrounding air is heated to incandescence by friction and as a consequence we can observe these tiny bodies as they self-destruct in our atmosphere.

SHOWER NAME	MOON PHASE	ACTIVITY DURATION	MAX ACT	RADIANT		DIA	VEL km/s	ZHR
				R.A.	Dec			
Quadrantids	FQ	Jan 01-Jan 05	Jan 04	230°	+49°	5°	41	120
delta-Cancrids	LQ	Jan 01-Jan 24	Jan 17	130°	+20°	10°-5°	28	4
alpha-Centaurids	FM	Jan 28-Feb 21	Feb 08	210°	-59°	4°	56	6
delta-Leonids	NM	Feb 15-Mar 10	Feb 25	168°	+16°	5°	23	2
gamma-Normids	FM	Feb 25-Mar 22	Mar 13	249°	-51°	5°	56	8
Virginids	NM	Jan 25-Apr 15	Mar 24	195°	-04°	15°-10°	30	5
Lyrids	NM	Apr 16-Apr 25	Apr 21	271°	+34°	5°	49	15
pi-Puppids*	NM	Apr 15 - Apr 28	Apr 23	110°	-45°	5°	18	*
eta-Aquarids	FM	Apr 19-May 28	May 05	338°	-01°	4°	66	60
Sagittarids	LQ	Apr 15-Jul 15	May 19	247°	-22°	15°-10°	30	5
Bootids (June)*	FQ	Jun 26 - Jul 02	Jun 27	224°	+48°	5°	18	*
Pegasids	FM	Jul 07-Jul 13	Jul 09	340°	+15°	5°	70	3
Phoenicids (July)*	LQ	Jul 10 - Jul 16	Jul 13	032°	-48°	7°	47	*
Pisces Austrinids	FQ	Jul 15-Aug 10	Jul 27	341°	-30°	15°-10°	35	5
Southern delta-Aquarids	FQ	Jul 12-Aug 19	Jul 27	339°	-16°	5°	41	20
alpha-Capricornids	FQ	Jul 03-Aug 15	Jul 29	307°	-10°	8°	23	4
Southern iota-Aquarids	FM	Jul 25-Aug 15	Aug 04	334°	-15°	5°	34	2
Northern delta-Aquarids	LQ	Jul 15-Aug 25	Aug 08	335°	-05°	5°	42	4
Perseids	LQ	Jul 17-Aug 24	Aug 12	046°	+58°	5°	59	140
kappa-Cygnids	NM	Aug 03-Aug 25	Aug 17	286°	+59°	6°	25	3
Northern iota-Aquarids	NM	Aug 11-Aug 31	Aug 19	327°	-06°	5°	31	3
alpha-Aurigids	FM	Aug 25-Sep 05	Aug 31	084°	+42°	5°	66	10
delta-Aurigids	LQ	Sep 05-Oct 10	Sep 08	060°	+47°	5°	64	6
Piscids	NM	Sep 01-Sep 30	Sep 19	005°	-01°	5°	26	3
Draconids*	LQ	Oct 06 - Oct 10	Oct 08	262°	+54°	2°	20	*
Epsilon Geminids	NM	Oct 14-Oct 27	Oct 18	102°	+27°	5°	70	2
Orionids	FQ	Oct 02-Nov 07	Oct 21	095°	+16°	10°	66	20
Southern Taurids	LQ	Oct 01-Nov 25	Nov 05	052°	+13°	10°-5°	27	5
Northern Taurids	NM	Oct 01-Nov 25	Nov 12	058°	+22°	10°-5°	29	5
Leonids	NM	Nov 14-Nov 21	Nov 17	153°	+22°	5°	71	100+
alpha-Monocerotids	FQ	Nov 15-Nov 25	Nov 21	117°	+01°	5°	65	Var
chi-Orionids	FM	Nov 26-Dec 15	Dec 01	082°	+23°	8°	28	3
Phoenicids	LQ	Nov 28-Dec 09	Dec 06	018°	-53°	5°	18	Var
Puppid-Velids	LQ	Dec 01-Dec 15	Dec 07	123°	-45°	10°	40	10
Monocerotids (Dec)	LQ	Nov 27-Dec 17	Dec 09	100°	+08°	5°	42	3
sigma-Hydrids	LQ	Dec 03-Dec 15	Dec 11	127°	+02°	5°	58	2
Geminids	NM	Dec 07-Dec 17	Dec 13	112°	+33°	5°	35	120
Coma Berenicids	FQ	Dec 12-Jan 23	Dec 19	175°	+25°	5°	65	5
Ursids	FQ	Dec 17-Dec 26	Dec 22	217°	+76°	5°	33	10

Individual meteors during a shower appear to originate from a common point in the sky known as the radiant. This focal point is named after the constellation in which the meteors appear or the comet that is associated with the shower. Members of meteoroid streams travel though space in parallel paths. The apparent divergence from the radiant is only an illusion, due simply to the effect of perspective. The way that trees and buildings converge on either side of a long straight road, is the same effect that is seen when a meteor shower occurs far above an observer.

The table of Meteor Showers has been compiled from the 'Meteor Shower Calendar' produced by the International Meteor Organisation (IMO). It is the most accurate listing for naked-eye meteor observing available today. The table is complete in that both northern and southern showers are listed. Serious meteor observing should be carried out under dark skies, and preferably without the Moon. The best showers for this year, taking into consideration the lunar phase, are summarised in the monthly section.

In addition to the showers catalogued, an average of about 5 to 10 sporadic meteors (originating from random points in the sky) are visible per hour under dark sky conditions. More meteors are seen in the morning sky than in the evening; as the morning sky is facing the Earth's motion in space we tend to 'run into' and 'sweep up' meteors, whereas evening meteors must have sufficient velocity to catch up to the speeding Earth. Amateurs wishing to follow up an interest in meteors, and even make a contribution to meteor science, should contact the International Meteor Organisation. They can be reached on the Web: www.imo.net/ or by writing to Ina Rendtel, IMO Treasurer, Mehlbeerenweg 5, D-14469 Potsdam, Germany. You can also email to treasurer@imo.net for details on IMO membership. Please enclose return postage if writing. International Reply Coupons are available from Australia Post outlets.

NOTES ON THE TABLE ABOVE

SHOWER NAME The shower is named after the constellation that the radiant appears in or a bright star near that point. A shower marked with an asterisk (*) is only occasionally active.

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

ACTIVITY DURATION The approximate dates when the shower is active.

MAX ACT The date when maximum activity can be expected.

RADIANT, 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 11km/s (very slow) to 71km/s (very fast), medium speed is about 40km/s.

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 - APPENDICES

BRIGHTEST AND NEARER STARS (opposite page)

The column descriptions are:

Designation The name of the star in the system created by Bayer. He numbered the stars in the constellations using Greek letters (p. inside back cover). They were ordered by their brightness, alpha being the brightest in most cases.
Name Common names for the stars.
Constellation The star's constellation.
RA and Dec. The position of the star, epoch 2000.0.
Magnitude App. The apparent magnitude as seen in the sky.
Magnitude Abs. The absolute magnitude. This is a good indication of how the stars' true luminosities compare. It is the brightness of the star if placed at a distance of 10 parsecs (approximately 32.6 light years) from Earth.
Spectral Type The spectral classification of the star (see below).
Parallax see glossary.
ly is light year and **pc** is parsec (see glossary).

The spectral type of a star gives a broad indication of its temperature and colour. The primary classes are **O**, **B**, **A**, **F**, **G**, **K** and **M**, remembered by the mnemonic **O**h **B**e **A** **F**ine **G**irl(Guy) **K**iss **M**e. There are also now the 'colder' star classes, **L** and **T**. The classes are then broken down into ten subclasses (1 to 10) and then even further subdivided into I, II, III, IV, etc. A discussion of these is beyond this publication.

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

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

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

NON-STELLAR OBJECTS (p. 102)

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

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

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

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

The column descriptions are:-

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

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

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

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

TYPE. Is the broad classification as discussed above.

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

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

CONSTELLATIONS - Abbreviations and Culmination at 9pm.

Name	Genitive	Abr.	Cul.
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

THE BRIGHTEST STARS

See introduction to Part III (p. 100) for more information.

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

THE NEARER STARS

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

NON-STELLAR OBJECTS (Epoch 2000.0)

See introduction to Part III (p. 100) for more information.

CAT	NUM	R.A.	DEC	SIZE	CON	TYPE	MAG	DESCRIPTION
NGC	55	00 14.9	-39° 11'	30'x6.3'	Scl	Spiral galaxy	8.1	A bright galaxy in the Sculptor Group
NGC	104	00 24.1	-72° 05'	30.9'	Tuc	Globular cluster	3.8	47 Tucanae, one of the finest globulars
NGC	224	00 42.7	+41° 16'	185'x75'	And	Spiral galaxy	3.4	M31, The 'Andromeda Galaxy'
NGC	253	00 47.6	-25° 17'	30'x6.9'	Scl	Spiral galaxy	7.6	'Silver Coin' galaxy. Large, bright edge-on spiral
	SMC	00 52.7	-72° 30'	5°x4°	Tuc	Galaxy	2.3	Small Magellanic Cloud. Visible to unaided eye from dark sky
	Pleiades	03 47.0	+24° 07'	2°	Tau	Open cluster	1.2	M45 or 'Seven Sisters'. Naked eye cluster, the brighter stars mag. 2
	Hyades	04 27.0	+16° 00'	6°	Tau	Open cluster	0.5	A naked eye, 'V' shaped cluster. 28 stars, the brighter mag. 3 and 4
	LMC	05 23.6	-69° 45'	9°x10°	Dor	Galaxy	0.1	Large Magellanic Cloud. Visible to unaided eye from dark sky
NGC	1976	05 35.4	-05° 27'	65'x60'	Ori	Gaseous nebula	4.0	M42, 'Orion Nebula', emission and reflection nebula
NGC	2070	05 38.6	-69° 05'	30'x20'	Dor	Emission nebula	8.3	30 Doradus, 'Tarantula Nebula', bright complex looped structure
NGC	2169	06 08.4	+13° 57'	6'	Ori	Open cluster	5.9	Rich loose cluster, 30 stars magnitude 7 and fainter
NGC	2168	06 08.9	+24° 20'	28'	Gem	Open cluster	5.3	M35, 200 stars, magnitude range 9 to16, no central concentration
NGC	2244	06 32.4	-04° 52'	23'	Mon	Open cluster	4.8	Rich cluster of 100 stars, with nebulosity (Rosette Nebula)
NGC	2264	06 41.1	+09° 53'	20'	Mon	Open cluster	3.9	40 stars, large brightness range, involved in nebulosity (Cone Nebula)
NGC	2287	06 47.0	-20° 44'	38'	CMa	Open cluster	4.5	M41, 80 stars 7th magnitude and fainter with 6.9 mag. red star near centre
NGC	2301	06 51.8	+00° 28'	12'	Mon	Open cluster	6.0	Rich cluster, 80 stars, large magnitude range, central concentration
NGC	2362	07 18.8	-24° 57'	8'	CMa	Open cluster	4.1	60 stars, large brightness range (4th mag. down), concentrated centre
NGC	2422	07 36.6	-14° 30'	29'	Pup	Open cluster	4.4	M47, large coarse cluster with 30 bright and faint stars
NGC	2437	07 41.8	-14° 49'	27'	Pup	Open cluster	6.1	M46, rich open cluster, 100 stars, planetary nebula NGC2438 in same field
NGC	2447	07 44.6	-23° 52'	22'	Pup	Open cluster	6.2	M93, 80 stars magnitude 8 to 13 with strong central concentration
NGC	2451	07 45.4	-37° 58'	45'	Pup	Open cluster	2.8	Rich in stars with slight central concentration
NGC	2477	07 52.3	-38° 33'	27'	Pup	Open cluster	5.8	160 stars around 10 - 12th magnitude, strong central concentration
NGC	2516	07 58.3	-60° 52'	29'	Car	Open cluster	3.8	80 stars 6th magnitude and fainter, strong central concentration
NGC	2547	08 10.7	-49° 16'	74'	Vel	Open cluster	4.7	Rich in stars with strong central concentration. Brightest stars mag. 6
NGC	2548	08 13.8	-05° 48'	54'	Hya	Open cluster	5.8	M48, Large cluster of 80 stars 8 to 13th magnitude, central concentration
NGC	2632	08 40.1	+19° 59'	95'	Cnc	Open cluster	3.1	M44, 'Praesepe' or 'Beehive Cluster', very large cluster, 50 stars
IC	2391	08 40.2	-53° 04'	50'	Vel	Open cluster	2.5	Moderately rich in bright (about mag. 3) and faint stars
IC	2395	08 41.1	-48° 12'	7'	Vel	Open cluster	4.6	40 stars 6th magnitude and fainter
NGC	2808	09 12.0	-64° 52'	13.8'	Car	Globular cluster	6.1	Large and rich, compressed centre, stars 13 to 15th magnitude
NGC	3114	10 02.7	-60° 07'	35'	Car	Open cluster	4.2	Rich cluster, stars 9 to 14th magnitude, slight central concentration
NGC	3132	10 07.1	-40° 26'	30"	Vel	Planetary nebula	9.7	The 'Eight Burst Nebula', ring and disk, 10th magnitude central star
IC	2602	10 43.2	-64° 24'	50'	Car	Open cluster	1.9	Rich in stars, strong central concentration, brightest stars mag. 3
NGC	3372	10 43.8	-59° 52'		Car	Emission nebula		The 'Eta Carinae Nebula', very bright, prominent dark lanes
NGC	3532	11 06.4	-58° 40'	55'	Car	Open cluster	3.0	Rich and large, slight central concentration, 150 stars 7 to 12th magnitude
NGC	3766	11 36.1	-61° 37'	12'	Cen	Open cluster	5.3	Rich cluster, 100 stars magnitude range 7 to 12th
NGC	4755	12 53.6	-60° 20'	10'	Cru	Open cluster	4.2	The 'Jewel Box', rich in stars, large brightness range
NGC	4945	13 05.4	-49° 28'	23'x5.9'	Cen	Spiral galaxy	9.0	Large edge on spiral, good field, another small galaxy in same field
NGC	5128	13 25.5	-43° 01'	31'x23'	Cen	Galaxy	6.7	'Centaurus A', bright sphere crossed by dark lane, radio source
NGC	5139	13 26.8	-47° 29'	36'	Cen	Globular cluster	3.5	Omega Centauri, perhaps the finest example of a globular cluster
NGC	5272	13 42.2	+28° 23'	16.2'	CVn	Globular cluster	5.9	M3, large bright globular, brightens suddenly towards the middle
NGC	5281	13 46.6	-62° 54'	5'	Cen	Open cluster	5.9	40 stars, moderately rich in bright and faint stars, magnitudes 6 to 12
NGC	5617	14 29.8	-60° 43'	10'	Cen	Open cluster	6.3	80 stars, large brightness range, strong central concentration
NGC	5904	15 18.6	+02° 05'	17.4'	Ser	Globular cluster	5.7	M5, bright, large very compressed in middle, slightly oval in shape
NGC	6025	16 03.7	-60° 30'	12'	TrA	Open cluster	5.1	60 stars, large brightness range, slight central concentration
NGC	6067	16 13.2	-54° 13'	12'	Nor	Open cluster	5.6	100 stars, large brightness range, strong central concentration
NGC	6087	16 18.9	-57° 54'	12.5'	Nor	Open cluster	5.4	40 stars, moderate brightness range, slight central concentration
NGC	6121	16 23.6	-26° 32'	26.3'	Sco	Globular cluster	5.8	M4, conspicuous globular near Antares
NGC	6124	16 25.6	-40° 40'	29'	Sco	Open cluster	5.8	100 stars, large brightness range, strong central concentration
NGC	6193	16 41.3	-48° 46'	14'	Ara	Open cluster	5.2	Few stars, large brightness range, slight central concentration
NGC	6205	16 41.7	+36° 28'	16.6'	Her	Globular cluster	5.7	M13, the 'Great Hercules Cluster', showpiece of northern skies
NGC	6231	16 54.0	-41° 48'	14'	Sco	Open cluster	2.6	A few stars with strong central concentration. Brightest stars mag. 5
NGC	6405	17 40.1	-32° 13'	33'	Sco	Open cluster	4.2	M6, the 'Butterfly Cluster', 80 stars, large brightness range
NGC	6397	17 40.7	-53° 40'	25.7'	Ara	Globular cluster	5.8	Loose, scattered structure, possibly the nearest of the globulars
NGC	6475	17 53.9	-34° 49'	80'	Sco	Open cluster	3.2	M7, 80 stars brighter than 10th magnitude, large brightness range
NGC	6494	17 56.8	-19° 01'	27'	Sgr	Open cluster	5.5	M23, 150 stars, moderate brightness range, lies in good star field
NGC	6514	18 02.3	-23° 02'	20'	Sgr	Gaseous nebula	5.0	M20, 'Trifid Nebula', emission and reflection nebulosity cut by dark lanes
NGC	6523	18 03.8	-24° 23'	45'x30'	Sgr	Emission nebula	5.0	M8, 'Lagoon', densest section known as the 'Hourglass', dark lane
NGC	6611	18 18.8	-13° 47'	21'	Ser	Open cluster	6.0	M16, 100 bright and faint stars, involved in the 'Eagle Nebula'
IC	4725	18 31.6	-19° 15'	32'	Sgr	Open cluster	4.6	M25, 30 stars loosely scattered
NGC	6656	18 36.4	-23° 54'	24'	Sgr	Globular cluster	5.1	M22. Fine globular, only Omega Centauri and 47 Tucanae are brighter
NGC	6705	18 51.1	-06° 16'	13'	Sct	Open cluster	5.8	M11, the 'Wild Duck Cluster', rich and compact open cluster
NGC	7009	21 04.2	-11° 22'	25"	Aqr	Planetary nebula	8.5	The 'Saturn Nebula', ring structure in a larger and fainter halo
NGC	7078	21 30.0	+12° 10'	12.3'	Peg	Globular cluster	6.0	M15, bright, irregularly round, well resolved into faint stars
NGC	7293	22 29.6	-20° 48'	12'	Aqr	Planetary nebula	7.3	The 'Helix Nebula', ring structure involved in larger and fainter disk

RISE/SET TIME CORRECTIONS FOR OTHER LOCATIONS

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.

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

Example of rise/set time corrections.

Calculate the rise/set times for the Sun on Jan 16 for Kalgoorlie (30° 45'S, 121° 28'E)

	Rise	Set
From page 66 the rise/set values are:-	5:27	19:26
Adjust for longitude (115.85 - 121.47) x 4	- :22	- :22
(or see table 1 opposite. The value is negative due to Kalgoorlie being east of Perth.)		
Adjust for latitude & declination of Sun from table 2	+:04	- :04
(Dec. = -20° 58' see page 68)		
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 — 2001

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 2452090.5
Add the day of month, 17 gives us 2452107.5

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 2001 WAST is 2452108.042

JULIAN DATE at 0hrs UT		
Month		Julian Date
Jan	0	2451909.5
Feb	0	2451940.5
Mar	0	2451968.5
Apr	0	2451999.5
May	0	2452029.5
Jun	0	2452060.5
Jul	0	2452090.5
Aug	0	2452121.5
Sep	0	2452152.5
Oct	0	2452182.5
Nov	0	2452213.5
Dec	0	2452243.5

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 — 2001

Greenwich mean sidereal time at 0hrs UT

Jan	0	6.6486	Jul	0	18.5421
Feb	0	8.6856	Aug	0	20.5791
Mar	0	10.5255	Sep	0	22.6161
Apr	0	12.5625	Oct	0	0.5874
May	0	14.5338	Nov	0	2.6244
Jun	0	16.5708	Dec	0	4.5957

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 (WAST) on 17th July 2001.

21:00 WAST = 13:00 UT

GMST for July 0 is 18.5421 hours.

GMST = 18.5421 + (0.06571 x 17) + (1.00274 x 13) = 32.6948

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

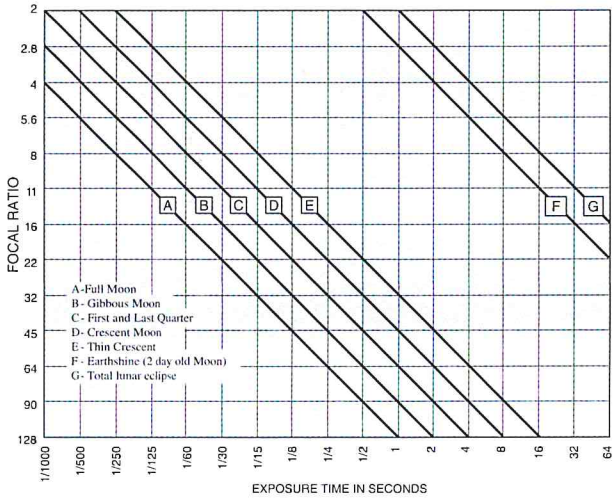
LMST = 32.6948 + 7.7233 = 40.4181

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

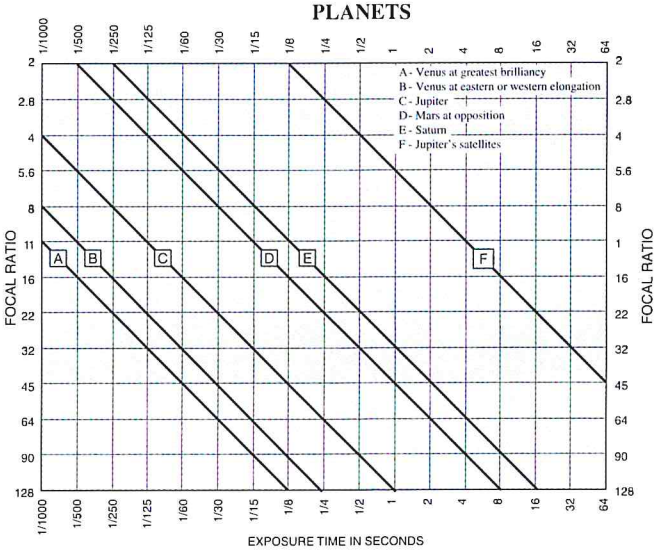
40.4181 - 24 = 16.4181 hrs or 16h 25m 5s

PHOTOGRAPHIC EXPOSURE GUIDES

MOON



PLANETS



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

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

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

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

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

PLACES OF ASTRONOMICAL INTEREST

Following is a list of places of astronomical interest. These cater to the public in regards to tours and/or displays. Some costs may change due to GST.

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. As part of the Observatory public education program, several telescopes with mirrors ranging from 10" to 16" are used to delight night visitors with the splendour of the rich southern skies. Observatory astronomers also take telescopes to conduct Astronomy Field Nights at various locations, and are in great demand for astronomy talks. A portable display is often used at public libraries and schools. A museum, displaying instruments from the old Observatory (founded in 1896), paintings and current photographs has been established, and a well equipped shop sells all sorts of astronomical memorabilia.

Volunteer Programme

Perth Observatory is keen to get the public more involved in its activities. One way to directly participate and assist is to join our volunteer program. Current projects involve assisting permanent staff with the public star viewing sessions, assisting at open days, and preserving historical documents. Those interested should send a written application to the Perth Observatory volunteer coordinator, Dr James Biggs. The applicant should outline why they wish to become part of the program, what skills, qualifications or experience they possess, what realistic amount of time they can contribute and anything else that they think is relevant. Please note that the qualification requirement is not really very stringent - what is really important is simply the desire to assist the Perth Observatory. Interviews are conducted in September most years. Vast astronomical knowledge is not required as successful applicants are trained shortly thereafter for the project (or projects) in which they wish to participate.

Hours: Normal office hours : 8am - 5pm
Night Tour: Times vary during the year. No tours May - September inclusive
Bookings essential. Tour lasts 1.5 hours approx.
Costs: Adult $15, Child & Concession $10
Complete session booking $360 (max of 36 people)
Day Tours: 10am, 12:30pm, or by appointment - bookings essential
Sunday: 2pm, no booking necessary
Costs: Day & Sunday - Adults $6.50, Child & Concession $4.50

Astronomy Field Night at remote location:

Costs: Standard rate $500 plus expenses, Schools $350 plus expenses
Phone: (08) 9293-8255 Fax: (08) 9293-8138 Info Line: (08) 9293-8109
WWW: http://www.wa.gov.au/perthobs email: perthobs@iinet.net.au

PINGELLY HEIGHTS OBSERVATORY (Astro Ventures)

Treat your family to a pleasant drive through the beautiful Western Australian country-side and marvel at the night sky through astronomical telescopes

Located at *"Sunarise"*, Lot 11 Pingelly Heights (off Aldersyde Road) Pingelly, just one and a half hours drive from the Perth Metropolitan area. Follow the Brookton Highway from Kelmscott to Brookton then turn right for Pingelly

Open Friday night and Saturday and Sunday day and night, other nights by appointment. Advance bookings preferred, light refreshments available.

Guided tours of space and the heavens through astronomical telescopes.

Experience the magnificence of the Night Sky and journey through our own Milky Way Galaxy and marvel at:

- The awesome Great Orion Nebulae
- The spectacular Jewel Box
- Saturn with its incredible rings
- Jupiter's magnificent Moons
- The Magellanic Clouds

The **Night**, at 7pm on Friday, Saturday & Sunday nights, has audio-visual presentations and displays with telescope viewing. The **Day** program, 2-4pm Saturday &Sundays, has audio-visual presentations and displays.

Costs	Day	Night
Adults	$8.80 (inc GST)	$17.60 (inc GST)
Children, Pensioner & Concession	$4.40 (inc GST)	$8.80 (inc GST)
Family (2 adults & 2 children)	$22.00 (inc GST)	$44.00 (inc GST)
Teachers!!! - (per student, max 30)	only $3.85	only $7.15

ASTRO VENTURES caters especially for:

- Primary and secondary schools
- Scout and Guide units
- Community organisations
- Youth groups
- Recreational and sporting groups
- Private parties and others on request

For further information and reservations ring Susie or Trevor on (08) 9887 0088, mobile 0407 380 922 or write to Astro Ventures, PO Box 512 Pingelly WA. 6308, email: astroventures@telstra.easymail.com.au

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 hours drive from Perth. Equipment includes a Meade 16DS, a Celestron CG-14, two Meade LX200 12" and a Meade 8" S/C. This dark sky site has been designed with the amateur astronomer in mind and has a library and computer facilities.

Hours: Open Wed., Fri. and Saturday nights, 7pm to 10pm (weather and Moon permitting). Other nights for special events/groups can be arranged. Closed from May to September inclusive.
Costs: Adults $20, children of school age $10 and family tickets, $50. Special group rates are available on request.
Contacts: Phone Meg or David on (08) 9448 4987, fax (08) 9243 0203
email: astro@iinet.net.au
Web: http://www.iinet.net.au/~astro/

NEW SOUTH WALES & ACT

THE AUSTRALIA TELESCOPE - NARRABRI ARRAY The Australia Telescope operates in the radio region of the spectrum. It essentially uses high technology to combine the signals from a number of dishes, or elements, to obtain the performance of a single theoretical dish a number of kilometres in diameter. The Compact Array, located at the CSIRO's Paul Wild Observatory near Narrabri, is the heart of the telescope. It consists of six 22m dishes five of which are spaced along a 3km track with the sixth a further 3 km to the west. A 7th dish, forming part of the long baseline 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 long baseline array.

A visit to the Australia Telescope Compact Array web site (see below) will show what is happening at the telescope including up to the minute observation updates from the 'ATCA Live' page.

Also on the ATNF site at Narrabri is the Sydney University Stellar Interferometer (SUSI), an optical interferometer that measures diameters of stars and separation of close binary stars. Although not normally open to visitors, SUSI is described in the display at the visitor's centre.

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 a n excellent display and video tape presentation which explains the concepts behind the telescope and radio astronomy in general.

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

GROVE CREEK OBSERVATORY This observatory is located 60km south of Bathurst. The facility caters for amateur astronomers and groups who are looking to use large aperture telescopes under very dark skies and excellent seeing conditions. The facility boasts a Celestron C-14, two 12.5" Newtonians and a Meade 10" LX-200 which include full astrophotography and CCD equipment. The instruments are located in three observatories, a 4m dome and two slide off roof buildings. Grove Creek Observatory has modern on-site accommodation, sleeping up to 10 people with full facilities available.

cost: $120 per person/per night all inclusive (conditions apply).
contact: Steven Williams on (02)6368-8611 or (02)9438-1757
Email: info@gco.org.au
Web: www.gco.org.au

PARKES RADIO TELESCOPE The observatory is located on the western plains of NSW, twenty kilometres north of Parkes (just off the Newell Highway). This landmark radio telescope is almost 40 years old, but after the most recent upgrades it is arguably, once again, the best single dish radio telescope in the world. It also functions as part of the CSIRO Australia Telescope array. At the observatory, public education has a high priority, hence their recently extended visitor's centre. As well as a great view of the telescope, the centre has displays, interactives and an informed and friendly staff. There is a freely available public picnic area, with a large shelter and gas barbecue facility. Souvenirs and educational material, on-hand or mail-order, are available.

Hours: 8:30am to 4:30pm - daily except Christmas and Boxing Day.
Cost: Admission to the visitor's centre is free. A modest charge is made for the audio visual presentation.
Contact: (02) 6861-1777
Email: rtwardy@atnf.csiro.au
Web: www.parkes.atnf.csiro.au/visitors_centre/

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

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

GILGANDRA OBSERVATORY This observatory is located in central NSW, 60 km north of Dubbo. It is in the centre of town, just off the Newell Highway, opposite the Three Ways Motel. It has operated since 1975 providing a 12.5 inch newtonian reflector ($f6$) for the public to view the heavens. When it was built it was one of the largest telescopes open to the public. Jack Esten's original 8 inch newtonian telescope he built around 1947 out of old farm machinery with its hand ground mirror, can be found downstairs. It is still used on very busy nights! Guided tours of the night sky are held each night except Sundays (during school holidays it is also open Sunday nights and during the days, noon till 4pm). It pays to book ahead to avoid disappointment.

Times: 7pm to 10pm (daylight saving 8:30pm to 10pm)
Cost: Adults $8, pensioners $6, children $5, family $20.
Contact: (02) 6847-2646 fax:(02) 6847-2845
Email: mail@gilobs.com.au
Web: www.gilobs.com.au

THE CANBERRA SPACE DOME & OBSERVATORY A virtual reality star theatre, the Canberra Space Dome offers multimedia shows featuring magnificent star fields, video projection and awesome digital sound. The 11m planetarium seats up to 70 in relaxed comfort. The telescopes of the Canberra Observatory are world class and include a 41cm Newtonian-cassegrain IK6 with 17.5 cm Astro-Physics Starfire refractor (in a 5.2 metre dome), an Astro Physics 15 cm $f12$ planetary refractor (in a 2 metre dome) and a Celestron 14 (in a 4.2 metre dome). Professional astronomers and explainers are on hand to conduct the sessions and answer questions. Astronomy and space-related books, souvenirs and novelties are available from a well-stocked gift shop. As this unique astronomy complex is located at the Downer Club in Canberra, visitors to the planetarium and observatory may also enjoy the club's full amenities, including the bistro.

Address: Hawdon Place, Dickson (off Antil Street).
Hours: From 6:00 pm Tuesday to Saturday (phone for session times)
Cost: $6.00 conc., $8.50 adult each facility. Groups over 10 must book
Contact: (02) 6249-7817, fax (02) 6248-7238
Email: planetarium@ctuc.asn.au
Web: www.ctuc.asn.au/planetarium/

KOOLANG OBSERVATORY AND SPACE SCIENCE CENTRE

Located on the border of the Central Coast, Lower Hunter and Wyong, the centre is just an hour from Hornsby, Gosford, Cessnock and Wyong and no more than 2 hours from most Sydney and Newcastle suburbs. At an altitude of 300 metres and surrounded by national park, Koolang's 0.5 metre and other telescopes are in operation 7 days and nights a week. Bookings are essential. Koolang has received 'designated observatory' status from the ASA and the site benefits from a lighting policy implemented by the local council (Cessnock) to protect the dark sky environment.

Hours: Daytime solar viewing shows and display centre visits: 7 days, 10am to 5pm. Night shows (2 hours) - 7 nights starting about an hour after sunset. Starting times vary, booking is essential.
Cost: Night shows: adults $10; concession; $8.50; children $7. Day shows: adults $5; concession $4; children $3; group (15 or more) discounts available. Special prices and hours for schools. These prices may change slightly during 2001.
Contact: (02) 4998 8216, fax (02) 4998 8580
Email: koolang@hunterlink.net.au
Web: users.hunterlink.net.au/koolang

BIG BADJA OBSERVATORY (NUMERALLA) Situated on a dark site 20 km east of Cooma, the 3.4m domed observatory houses a 25cm Meade SC telescope on a Losmandy mount. Year 2001 objectives include developing CCD imaging skills and expanding community awareness about current astronomical events. Instruction is freely offered in the use of telescopes and accessories. Small groups are welcome by appointment and asked to make a donation direct to the Fred Hollows Foundation. Open most suitable evenings throughout the year.

Contact: Robert McDonald (02) 6453-3221

DUBBO OBSERVATORY is located next to the world renowned Western Plains Zoo. Instruments include, 3 x 300 mm Schmidt Cassegrain telescopes and 2 pairs of 30 x 70 binoculars. At this dark site, scanning the Milky Way through these binoculars or touring the skies with the computerised telescopes completes the perfect double of touring the exotic animals by day and the exotic galaxies by night.

Cost: Adults $13.50; family of four $38.50 concession, school groups, tour groups and interested amateur astronomers.
Address: 13L Camp Rd. P.O.Box 308 Dubbo NSW 2830.
Email: EyeSky@bigpond.com.au.
Hours. Open daily (except Christmas) from 10 a.m. until late. Bookings essential for night sessions.
Contact: Peter Neilson (manager) (02) 6885 3022 Fax (02) 6885 3012.

CANBERRA DEEP SPACE COMMUNICATION COMPLEX (TIDBINBILLA) is located 40km southwest of Canberra (Tourist Route 5). The Tidbinbilla Complex is a major link in NASA's Deep Space Network. It has played a large role in nearly all of NASA's lunar and planetary probes. The Complex receives faint signals from distant spacecraft as they make their historic flybys of the planets. The Space Centre concentrates on both NASA's manned and robotic probes. The Centre incorporates audio and visual displays, interactives, models and images from Mars spacecraft. The Space Centre offers an excellent view of the 70m antenna dish.

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

WOLLONGONG SCIENCE CENTRE AND PLANETARIUM Operated by the University of Wollongong, the centre includes a planetarium, laser light shows, observatory, extensive indoor and outdoor hands-on exhibition areas, demonstration theatre, and a gift /resource shop, retailing astronomical materials as well as general science items. The Zeiss planetarium seats 70 and has a state of the art ZKP3 star projector. The public observatory houses a computer controlled DFM telescope, used for solar and stellar observations.

Cost: Child $5, concession $6, adult $8
Hours: 10 am to 4 pm, 7 days. Bookings are also available out of hours and there are scheduled astronomy evenings.
Address: Science Centre, Squires Way, Wollongong NSW 2522
Contact: (02) 4286-5000, fax: (02) 4283-6665
Web: www.uow.edu.au/science_centre

KINGS TABLELAND OBSERVATORY (BLUE MOUNTAINS) is located at Wentworth Falls. It is at an altitude of 930 metres which makes it a high and dark site, while still close to Sydney. The facility is open to any interested people or groups. Two modern telescopes are available for use; all housed in a 4.5 metre dome. There is now a flat screen planetarium.

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

NEPEAN OBSERVATORY is on the Werrington North campus of the University of Western Sydney Nepean, near Penrith. The main telescope is a 24 inch (600 mm) used for both public viewing and research. The Observatory is open every Friday night (except between Christmas and New Year) for star gazing, astronomy talks and slide shows. Sessions commence at 7pm (7.30pm during daylight saving). Group bookings are taken for other nights of the week.

Cost: Adults $8, child/concession $4, family $18
Contact: Maria Hunt (02) 9678 7336 or 0407 239 601
Email: mp.hunt@uws.edu.au
Web: www.nepean.uws.edu.au/astronomy/observatory/observatory.htm

SYDNEY 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 and modern telescopes. There is also a major exhibition called 'By the light of the Southern Stars'.

Hours: 10am to 5pm, except Christmas Day. Night sessions are held every night of the week. Bookings required for evening tours.
Cost: Evening sessions - $10 adults, $5 students or concession and $25 for families. There is no charge for daytime visits.
Contact: (02) 9217-0485.
Web: www.phm.gov.au/observe/

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 situated 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). The 3.9 metre instrument is still the 'flag-ship' for optical astronomy in this country. Siding Spring Mountain is also 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 there is a viewing gallery for the AAT which 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: $5.50 adults, $3.30 children/concession and $13.20 family. Special tours can be arranged for buses or school groups. During NSW school holidays a 2 hour tour is available, conducted by an astronomer. They run 3 times per day, ring for details. Cost is $8.80 seniors/children, $11 adult, $27.50 family.
Contact: (02) 6842-6211.
Web: www.aao.gov.au/

SETTLERS FLAT LODGE - COUNTRY RETREAT & OBSERVATORY is a four star guesthouse situated 14km east of Braidwood. The lodge features 7 ensuited rooms, tennis court, full size billiard table and an observatory facility. The observatory instruments include Celestron C14 and C8 instruments, plus an 8" *f*7 Dobsonian. Prices for accommodation include dinner, bed & breakfast, with sky tour (weather permitting). Sunday - Thursday $90 per person twin share. Friday - Saturday $120 per person twin share. Please inquire about our introductory discount. Bookings essential.

Address: 112 Charleys Forest Road, Mongarlowe Via Braidwood
Contact: Carolyn or Noel Matthews (02) 4842 8085, fax (02) 4842 8003
Email: settlers@sci.net.au

MAGELLAN OBSERVATORY is situated on 120 acres at Lake Bathurst (see photo on back cover) which is in the Southern Tablelands of NSW, 30km south of Goulburn. It is 2.5 hours south of Sydney or 1 hour north of Canberra. This well equipped observatory has accommodation and a variety of telescopes including a computerised 46cm New Generation Telescope (NGT18) housed in a 4.5m dome, 30cm & 25cm dobsonian reflectors, a 10cm Genesis refractor, a 9cm Questar Maksutov and giant 11 x 80 binoculars. An astrophotography rig is available for hire which is a Losmandy G11 with 200mm Vixen cassegrain, a 160mm Schmidt camera and a 100mm F5 APO refractor. The NGT18 can also be hired. The accommodation is a two bedroom house which is a short walk from the observatory. The property has many kangaroos, wombats, deer & birds to see. For those travelling by train, your hosts Zane & Fiona Hammond will even pick you up from Goulburn station.

Address: Lot 48 Covan Creek Rd Lake Bathurst 2580
Contact: (02) 4849-4489
Email: magellan@goulburn.net.au
Web: www.goulburn.net.au/~magellan

SKYWATCH OBSERVATORY AND ASTRO GOLF This public observatory is located in Coonabarabran, which is also the home of the Siding Spring Observatory. Skywatch is one of the largest established public observatories in the country, recently making it all the way to the finals of the 'Explorer Country' tourism awards. It is located along Timor Rd, 2km west of the clock tower in the centre of town. During the day the large exhibition is open featuring hands on activities, a theatrette, puzzles, computers and a huge display of pictures and information boards. At night time there is guided telescope viewing of the dark Coonabarabran skies. Also at Skywatch is Astro Golf, a popular 18 hole mini golf course with astronomical themes on each hole. A great family activity, open day and night. Light refreshments are available.

Hours: 2pm to 5pm (closed during the day in February) Night-time hours vary throughout the year as the daylight hours change, so it is always a good idea to call ahead. Bookings not required, but appreciated. Groups welcome but please book ahead. Open every day of the year except Christmas day.

Cost Adult $12.10 child/pensioner $7.15 family $33.00
Contact: Karl Rafferty (02) 6842-3303 fax: (02) 6842-2978
Email: astro@skywatch.cx
Web: www.skywatch.cx

MT. STROMLO OBSERVATORY For many years, Mt Stromlo was largely responsible for the excellent worldwide reputation of Australian optical astronomical research, and now operates as the Research School of Astronomy and Astrophysics for the Australian National University. Since the establishment of Siding Spring Observatory many of the astronomical breakthroughs are now being made in the dark, clear skies over the Warrumbungles. Ever-increasing light pollution over Canberra is also restricting the type of research that can be conducted at Mt. Stromlo. The observatory is home to a multitude of telescopes. When first visiting, the number of domes, of all sizes, can be quite fascinating. Guided tours of the 74" and Yale-Columbia telescopes leave from the Exploratory every hour. The 74" was the largest (most light gathering power) optical telescope in Australia before the Anglo Australian Telescope (AAT) and the Advanced Technology Telescope (ATT) at Siding Springs Observatory.

The Stromlo Exploratory is an exciting interactive astronomy education and tourist centre, which was opened in July 1997. There is a heliostat built into the Exploratory so visitors can see what the Sun really looks like! Telescope tours and slide shows run every hour. The centre has certainly been designed for both adults and children, with numerous exhibits, telescopes, a souvenir shop and the excellent Red Belly Black Cafe which caters for day and night functions. There is also a large interactive sundial and outdoor barbecue area.

From March 2001 Stromlo will be introducing their 'Capital Astronomy Nights' which will include public viewing on the 74" telescope.

Cost: Admission fees apply. There are different packages for concession, children and family.
Address: 15 minutes from Canberra City, Mt Stromlo Observatory, off Cotter Road, Weston Creek, ACT
Hours: The Exploratory is open daily (except Christmas) 9:30am-4:30pm (night visits are available by appointment).
Contact: Exploratory (02) 6249 0232
Red Belly Black Cafe (02) 6287 1518
Email: exploratory@mso.anu.edu.au
Web: http://www.mso.anu.edu.au/exploratory

QUEENSLAND

THE GREAT BARRIER REEF OBSERVATORY Situated on Hamilton Island, the observatory is open to the public during the dry months from April to November. Sessions are held on Tuesday, Thursday and Sunday evenings at 8:15 pm. Special openings on request. The island enjoys dark skies, and operates three telescopes, a 30cm SCT, and 20cm and 15cm Newtonians. The Observatory is staffed by members of the island's astronomical group and viewing is complimentary.

Contact: (07) 4946-8686
Address: PO Box 40 Hamilton Island Qld 4803
Email: star@whitsunday.net.au

OUTBACK QUEENSLAND SKYWATCH This public observatory is located in Charleville on Cunnamulla Road, near the airport. By June 2001, it should become the 'Charleville Cosmos Centre', which is a project funded by Federal and State Governments and the Murweh Shire Council. It will be a hands-on look at astronomy with special features such as the Dreamtime Theatre, which will be dreamtime stories from the aborigines on how they believed the world was created.

Contact: Visitor Information Centre (07) 4654-3057
Email: tourismcharleville@esprov.com.au

www.action-graphics.com.au/matilda_country/html_pages/charleville/charlevilleskywatch.html

SPRINGBROOK MOUNTAIN OBSERVATORY Springbrook National Park is World Heritage listed and has four major waterfalls. As it is only a 45 minute drive from Surfers Paradise it is the perfect setting for Springbrook Observatory which is non profit, and open to the general public, astronomical groups, and researchers. This facility has a C14, C11, 4.5" refractor, 8" reflector, and CCD equipment. Also adaptive optics and two Pentium 3 computers with astronomical based programs. Next to the observatory is a fully licensed restaurant, and two double room homestay accommodation.

An interactive web site http://www.maguires.com/astronomy allows an ftp link for ON LINE ASTRONOMY. Our visitors can always be in touch with Springbrook Observatory.

Contact: Andre Clayden (07)5533-5200, fax (07)5533-5457
Email: springbrook@one.net.au

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 artifacts related to astronomy. The planetarium also has an observatory with a 15cm refractor and a 41cm reflector. Observatory sessions must be pre-booked.

Shows are 3:30pm & 7:30pm, Wednesday to Friday (also 1:30pm during Qld school holidays). Weekend shows are 1:30pm, 3:30pm and 7:30pm on Saturday and 1:30pm and 3:30pm on Sunday. Visitors are requested to arrive at least 15 minutes before the starting time and bookings are advisable. Not recommended for children under 6.

Skydome: $10 adult, $6 child (under 15), $8.50 for concessions, $28 for a family pass, group rates apply.
Observatory: $10 adult, $6 child (under 15)
Bookings: (07) 3403-2578
Web: www.powerup.com.au/~stbp/

SOUTH AUSTRALIA

UNIVERSITY OF SOUTH AUSTRALIA PLANETARIUM was originally installed to teach surveying to students at the university. It is now available to the public. There is a regular show on the 1st Saturday of each month at 3pm. Other sessions are available for groups via bookings.

Address: University of South Australia, Levels Campus (Mowson Lakes)
Contact: (08) 8302-3138

INTERNATIONAL CANGAROO PROJECT, WOOMERA Although the telescope is inside the Woomera Security Area, afternoon site visits can be arranged for small groups about a week either side of New Moon, by applying in advance, giving names and addresses. This information is needed to gain access to the range. There is a display in the Woomera Heritage Centre. An idea of the activities, including a picture gallery, is available on the web site.

Contact: Dr John Patterson (08) 8303-5291 or 8396-1004 (ah)
Fax (08) 8673-7033 Email: jpatters@physics.adelaide.edu.au.
Web: http://www.physics.adelaide.edu.au/astrophysics/cangaroo.html

TASMANIA

LAUNCESTON PLANETARIUM is in the Queen Victoria Museum, Wellington St. Show Times: Tuesday to Friday 3:00pm, Saturday 2:00pm and 3:00pm. During government school holidays, shows run Monday to Saturday 2:00pm and 3:00pm. Group bookings by arrangement.

Cost: $2 Children (under 15), $3 adults and $7 family (children under 5 years old are not admitted)
Contact: (03) 6323-3777
Web: www.vision.net.au/~peter/AST/launplan/launplan.htm

PLANETARIUM IN HOBART This is a lesser known planetarium being tucked away in the centre of Hobart within Dreamworld Antarctic Adventure, located in Salamanca Square. This consists of a modest 5 to 6 metre diameter geodesic dome decked out so that about 15 people can sit around the inside equator of the dome. There are no age limits. The planetarium projector is a Starlab SL-220 of cylindrical design.

Hours: Open every day (except Christmas Day) from 10am to 5pm
Shows are hourly and run for about 40 minutes.
Contact: 1800 350 028
Web: www.antarctic.com.au

VICTORIA

BALLARAT MUNICIPAL OBSERVATORY The observatory contains three historic telescopes: the Jelbart - a 5" refractor, the Oddie - an 8" Newtonian, and the Baker Great Equatorial Telescope - a 26" Newtonian, which was commissioned in 1888. This observatory is open most Friday nights (perhaps not during Christmas or Easter) by the Ballarat Astronomical Society. Daytime tours can also be arranged by appointment.

Contact: John Hastie (03) 5332-7526 Email: bas@cbl.com.au
Web: www.giant.net.au/astronomy

MELBOURNE PLANETARIUM Australia's newest and first digital planetarium has opened at Scienceworks in Spotswood. The theatre seats 150, has surround sound and produces shows for all ages including those for amateur astronomers and tertiary students. The planetarium is open 7 days a week from 10:00am. Bookings are essential.

Contact: (03) 9392-4800
Web: www.mov.vic.gov.au/planetarium/index.html

MELBOURNE OBSERVATORY The historic Old Melbourne Observatory is located in the Royal Botanic Gardens Melbourne. A daytime walk of the historic buildings is offered together with the Night Sky experience which includes viewing through historic telescopes. Bookings are essential for both programs. The Royal Botanic Gardens Melbourne has a visitor centre, function rooms, Observatory Cafe and a Gardens' Shop on the Observatory site.

Bookings: Visitor Centre, Observatory Gate (03) 9252-2300
Web: www.rbgmelb.org.au

ASTRONOMICAL COURSES, SOURCES OF INFORMATION

The following lists astronomy courses, events, magazines and radio programs known to the authors for 2001. This list is by no means intended to be exhaustive. Across the country there are no doubt many other evening courses held at various Universities and Colleges. Enquiries from the general public are most welcome.

A number of the amateur astronomical societies also provide an invaluable service to public education by their lectures and open nights. You will need to contact the societies for further details. Costs given are subject to change. The Internet should also not be overlooked as a valuable source of information.

FUNDING FOR ASTRONOMICAL RESEARCH 2001

The Edward Corbould Research Fund has been established to encourage and assist astronomical research by Australian amateur astronomers and students. Funds will generally be available annually and disbursed with advice from a research committee appointed with the approval of CSIRO Australia. A sum of $5,000 will be available from 1 July 2001.

Applications are invited from amateur astronomers and postgraduate students at tertiary educational institutions before 28 February 2001. Application forms and further information concerning eligibility of applicants and obligations of successful applicants are available from:

The General Secretary, Astronomical Association of Queensland,
PO Box 6101, St. Lucia. Qld 4067.

GENERAL PUBLICATIONS

ASTROCARDS The Astronomical Society of NSW runs an information service called 'Astrocards'. This service quickly alerts subscribers to any new observable discoveries such as comets, novae, supernovae, bright near-Earth asteroids, or unusual planetary phenomena. The service is available via email or by letter.

Cost: $10 for 10 - cheques (payable to ASNSW) or credit card
Contact: Greg Bryant (as per 'Comet Tales' below)

SKY & SPACE MAGAZINE This astronomy and space exploration magazine is produced for enthusiasts in Australia and New Zealand. SKY & SPACE has a wide range of astronomy related topics and products, catering to both the novice and the very experienced. This full-colour magazine is bi-monthly and available through newsagencies or by subscription. Sky & Space also produce a magazine called SOUTHERN ASTRONOMY. It is a no frills magazine designed specifically for the needs of amateur astronomers covering such topics as: ATM, deep sky, observatories and CCD imaging. It is available only by subscription.

Contact: (02) 9369-3344, fax (02) 9369-3366.
Address: Sky & Space Publishing, PO Box 1690, Bondi Junction NSW 1355

COMET TALES This quarterly publication for amateur astronomers has a strong focus on providing the latest information on comets. Meteor showers, planetary and deep-sky observing, monthly sky highlights, and astronomy news are broadly covered. Events of interest for amateur astronomers are also listed.

Cost $10 for 4 issues (payable to G. Bryant)
Address: 2/100-104 Kissing Point Rd, Dundas NSW 2117
Email: gchbryant@hotmail.com
Web: http://gchbryant.tripod.com

PERIHELION A bulletin for comet observers. This newsletter, published by David Seargent, is specifically designed for the Australian observer. David is an author and contributor to Sky & Space magazine.

Cost: $12 (for 4 issues per year), $15 also includes special mail notices for new discoveries (cheques payable to Karagi Publication).
Address: PO Box 204, The Entrance NSW 2261

WESTERN AUSTRALIA

BROOME - ASTRO TOURS OF THE KIMBERLEY

The unspoiled Kimberley sky presents one of the most impressive starscapes in the world. Take advantage!

Night Sky Tour departs Broome Monday, Wednesday, Friday & Saturday 7.45pm – 10:00pm. School and private groups Tuesday and Thursday.

Spend a delightful guided evening exploring the wonders of the universe with spectacular telescopic views of the moon, planets, stars and more... We introduce you to the stars by name to orientate you with the rolling action of our own planet by using them as guideposts. Learn constellations, the zodiac and see for yourself the Earth's own journey through space. Tours include transfers to our Starlight Site, refreshments, info-folder and astro-photograph.

Outback Stargazing Adventures Exotic stargazing locations, good food, comfy swags, class telescopes and a Kimberley bush guide combine to make these remote area adventure tours an unforgettable experience.

Your choice of 4wd Safari- Great Sandy Desert Spectacular; or Camel Safaris on the mighty Fitzroy River. We cater for scientific expeditions, educational and school groups.

Dinner and Stars for Conferences and Meetings

Astro Tours guides are selected for their ability to enthusiastically pass on complex ideas in simple ways to trigger your own 'aha's', as much as for their astronomical knowledge. Giving people a living breathing conscious experience of being on a planet that is hurtling through space is our most profound task with Astro Tours. For bookings contact Greg Quicke below.

Phone: 0500 831 111 Fax (08) 9193 5362
Address: PO Box 2537 Broome 6725

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- Build a home for your telescope in the backyard

Costs: Courses from $80
Viewing nights at your location from $250 (up to 40 people in Perth Metro area) - larger groups by arrangement
Scope and viewing packages from $950
Observatories from $995

Country: All services available outside the metro area by arrangement

Contact: Keith Galbraith Phone/Fax (08) 9307 1353

NEW SOUTH WALES & ACT

ASTROFEST (COONABARABRAN) This event has been held annually for a number of years. Activities include: observing, lectures, tour of Siding Spring and Skywatch Observatories the Bart Bok annual lecture, Science in the Pub (subject to availability) and the Siding Spring Open day (check beforehand to confirm). This jam-packed weekend, usually held in October, is hosted by the Warrumbungle Mountain Motel, phone Mark Boyd (02) 6842-1832.

SOUTH PACIFIC STAR PARTY An annual national gathering of amateurs for observing under country skies. This is held at the Astronomical Society of NSW's property at Ilford, NSW. This major event now attracts over 400 people from all over Australia and overseas. The 2001 SPSP will be held from March 23rd to 26th. Contact the ASNSW for details (p. 110).

QUEENSLAND

ASTROFEST The Queensland AstroFest has been held annually since 1993 at the Lions Camp, Duckadang, about 2 hours drive northwest of Brisbane. It is held at a site with superb living conditions, a Celestron-14 telescope (the Stewart Observatory) and a very dark sky. The event is held over six nights, with main events held on Thursday, Friday and Saturday nights. Activities include: presentations from guest professional astronomers, awards in amateur astronomy, swap & sell, barbecue, smorgasboard, slide shows and light sports. The event usually attracts over 100 people. The Astrofest is normally held around new Moon in August each year.

Contact: Glenn Lang 0418 169 547
Email: info@aaq.org.au
Web: www.ozemail.com.au/~mhorn2/afest.html

BRISBANE FIELD NIGHTS The Brisbane Astronomical Society (BAS) holds a free Public Field Night on the Saturday nearest to the First Quarter Moon, weather permitting at Mt Cootha Lookout, beginning around 6:30 pm. See the next section for contact details for the BAS.

STARGAZERS WEEK 2001 O'Reilly's Rainforest Guesthouses will run its annual Stargazers Week from July 22nd to July 26th 2001. Guests will be treated to spectacular dark skies with telescopic views of winter Milky Way objects, instructional programmes, solar observing and slide shows combined with O'Reillys fine fare and friendly staff.

Contact: Tony Surma (07) 3274 5073.
Web: www.uq.net.au/~zzasurma/nightfall/stargazers.html

VICTORIA

VASTROC Victorian Amateur Astronomical Society's Conventions (VASTROC's) are held every second year (alternating 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 and 1999 VASTROCs were held by the Astronomical Society of Frankston. The host society for the 2001 VASTROC is yet to be announced.

AMATEUR ASTRONOMY SHORTWAVE STATION (VK3 EKH)

The Astronomical Society of Victoria has its own amateur radio callsign, VK3EKH. Using this callsign, Russell Ward has been conducting an amateur radio net for hams and shortwave listeners on the subject of astronomy since August 1989. The net commences each Friday evening at 10pm AEST on 3.543 MHz. Russell lists astronomical news for the week and invites stations to call in. There are a few regular stations that call in each Friday and over the years, over a hundred stations have taken part. A wide range of astronomy topics are discussed including those of interest to the radio amateur such as meteor scatter propagation, sunspot and auroral activity, satellite communications and meteor showers. New stations and shortwave listeners are most welcome.

ASTRONOMICAL SOCIETIES

The following is a list of the amateur societies in Australia. A common philosophy within 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 (especially now with GST). The authors of this publication are keen to keep the information in this section 'evergreen'. It would be appreciated if any significant change occurs (especially new organisations) that the society contact Quasar Publishing (p. 2). The deadline for ASTRONOMY 2002 will be July 1, 2001.

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

WESTERN AUSTRALIA

ASTRONOMICAL SOCIETY OF WA meets at 8pm on the second Monday of every month at the South Perth Bridge Club, cnr Brittain Street and Barker Avenue, Como. The Society conducts regular 'Astro-camps' at remote locations with good accommodation and very dark skies. It also promotes public awareness of astronomy by holding regular viewing nights for the public, and by providing speakers to schools, clubs and community groups. The Society owns a wealth of astronomical apparatus for use by members. They also publish a bi-monthly journal "The Sidereal Times".

Fees: Ordinary Member: $10 Nomination $36 Subscription
Associate Member:$6 Nomination $18 Subscription
Junior Member (U18):$6 Nomination $18 Subscription
Address: P.O. Box 421 Subiaco WA 6008
Contact: (08) 9299 6347
E-mail: aswa@cleo.murdoch.edu.au
Web: http://cleo.murdoch.edu.au/gen/aswa/

ASTRONOMICAL GROUP OF WESTERN AUSTRALIA (AGWA) was formed to provide activity and networking for amateur astronomers and people interested in the wonders of the night sky, with or without their own telescopes. Activities throughout the year include: Field trips, seminars by noted astronomers, workshops and special events and an Annual Astro-Fest. The group meets at 7pm on the first Tuesday of every month at 159A Scarborough Beach Rd, Mt Hawthorn. Everybody is welcome to attend the meetings. AGWA is proudly sponsored by York Optical.

Address: 159A Scarborough Beach Rd Mount Hawthorn WA 6016
Contact: (08) 9201 1967

MURDOCH ASTRONOMICAL SOCIETY is an active body based at Murdoch University. Membership is open to the general public and no extensive knowledge of astronomy is required, only an interest and lots of enthusiasm. Meetings are conducted each month at the University and usually consist of informal talks, occasional guest speakers, slide shows and

observation reports. A small library is available for loans to members. There is deep sky viewing away from the lights of Perth every new moon and activities at the Murdoch Observatory during the warmer months. Other activities include: star parties with the Astronomical Society of the South West, an annual public viewing night around February and viewing nights on request from school and other community groups. The society owns a 44cm, a 20cm and a 15cm Newtonian telescope for members use.

Address: c/- Murdoch Uni. Physics $ Energy Studies, Murdoch WA 6150
Contact: Graham Clements (08) 9227 0923 (after 12)

ASTRONOMICAL SOCIETY OF THE SOUTH WEST Membership is open to anyone interested in basic astronomy. Observing nights at their observatory south of Bunbury on the two Fridays before the new moon. There is an active junior group which meets twice monthly. Astronomy camps in good cottage accommodation are held during the year at dark sky sites. Other observing at nearby dark sky sites occurs on an informal basis. A six evenings astronomy course for beginners is conducted each year in March/April. Nights for the general public are held during school holidays on three occasions through the year. Community groups are welcome to book for special nights.

Fees : Ordinary $25, Junior/Concession $10, Family $40.
Address : PO Box 1100, Bunbury, WA 6231 Phone: (08) 9721 1586
Email : dodong@gateway.net.au

NEW SOUTH WALES & ACT

Astronomical Society Of Coonabarabran meets on the 3rd Thursday each month at 7:30pm at Coonabarabran High School. Paul Cass (02) 6842-2994.

Astronomical Society Of The Hunter meets at Keay Southern Cross Observatory (near Kurri Kurri) on the 1st Friday of each month at 7:30pm. Contact Col Maybury (02) 4937-4664.

Astronomical Society Of NSW meets twice monthly at CSIRO, Div. of Radio Physics, Pembroke Rd. (cnr. Vimera Rd), Marsfield. Max Gardner 02 9337-3371.

Shoalhaven Astronomers meets at the library, Falls Creek Public School, 3rd Friday each month at 7:30pm. Jack Apfelbaum (president) (02) 4423-2255.

The Newcastle Astronomical Society meets last Friday each month (except Dec), at the Uni. of Newcastle, Lecture Theatre GP, 1st flr Linguistics Bld at 7:30pm. Alan Meehan (02) 4929-6600 or George Barnes (02) 4967-1057.

British Astronomical Association - NSW Branch meets at Sydney Observatory on the third Wednesday of each month, commencing at 7:30pm. Contact Elizabeth Cocking (02) 9398-9705.

Canberra Astronomical Society meets at the Duffield Building, Mt Stromlo, 3rd Thursday each month (except Dec/Jan) at 8pm. John Howard 02 6248-0552.

Hawkesbury Astronomical Association meets once a month on the 2nd Wednesday, commencing 7:45pm, in the Tebbutt Rooms at the Windsor Library, Dight St. Windsor. Contact Adrian Saw (02) 4572-1568.

Illawarra Astronomical Society meets at the Wollongong Science Centre and Planetarium, 2nd Tuesday each month at 8pm. Darren Corbett 02 4271-1734.

Macarthur Astronomical Society meets on the 3rd Monday each month at 7.30pm at the University of Western Sydney, Macarthur, Building 22, Room 5. Contact Pete & Bobbie Elston (02) 4647-4491.

Northern Sydney Astronomical Society Inc meets at St. Ignatius College, Lane Cove, 3rd Tuesday each month at 7:30pm. David Hoffman 02 9449-3440.

Port Macquarie Astronomical Association Inc. meets at Port Macquarie Observatory, 2nd Sunday of each month at 6pm. Jim Daniel (02) 6583-1933.

Sutherland Astronomical Society operates from Green Point Observatory near Sutherland. They meet every Thursday at 8pm. Contact (02) 9589-1014.

Western Sydney Amateur Astronomy Group Inc meets 3rd Wednesday of the month at the Nepean Astronomy Centre, University of Western Sydney, Werrington Campus. Contact Peter Nakitch (02) 9835-1824.

Wollongong Amateur Astronomy Club holds New Moon observing nights at Cataract Scout Park, off Appin Road, about 10 km west of Bulli, north of Wollongong. Contact Andrew Wood (02) 4272-4505.

Taree Astronomical Society meets at Taree High School on the 2nd Thursday each month at 7pm. Contact Richard Mozejko rmozejk@tpgi.com.au

University Of New England And Northern Tablelands Astronomical Society (UNENTAS) meets monthly (except Dec/Jan) at 6:30pm on a Thursday at Kirby Observatory. Contact Vernie Everett (02) 6773-3118 (W).

QUEENSLAND

Astronomical Association Of Queensland meets 2nd Saturday each month at 8pm at Balmoral Park, Morningside. Bill Oliver (07) 3391-4587.

Astronomy 20 South, a Hamilton Island based group, meets on the 4th Wednesday of each month. Contact Ray Johnston (07) 4946-8686.

Bundaberg Astronomical Society meets at Alloway Observatory each Friday at 7:30pm. Contact Bill Fielding, Don Gray or Mac Jonsen (07) 4159-7232.

Bundy Skywatchers (Bundaberg) meets every Friday, two nights a month being field nights. Contact Karlene Galway (07) 4159-9674.

Brisbane Astronomical Society meet on 2nd Friday each month at 7:30pm at Kelvin Grove State High School library. Call David Durham (07) 3321-8511.

Cairns Astronomy Group have monthly meetings from June to November at 18 Yurongi St, Caravonica. Contact Bob Dollery (07) 4058-1180.

Central Queensland Astronomy Club is based in Rockhampton. They meet on the New Moon Friday each month. Contact Ron Inslay (07) 4926-2156.

Redlands Astronomical Society meets at Ormiston College, Ormiston (27km SE of Brisbane) on 2nd and last Tuesdays. Peter Adam (07) 3207-2630

South East Queensland Astronomical Society meets 3rd Monday each month at Kedron High School, Feb - Nov at 7.30pm. Patrick Scharf (07) 3314-0659.

Southern Astronomical Society meets at Ormeau State School on Saturdays, at 7pm (depends on moon phase). Contact Kevin Dixon (07) 5537-3852.

Sun Coast Astronomical Society meets 3rd Friday each month at 7pm at Beerwah Field Study Centre, Roys Road, Beerwah. Contact Terry O'Keefe (07) 5491-5257 or Glen Lang (07) 5496-0310.

Townsville Astronomy Group observe on 2 Saturdays closest to New Moon at Alligator Creek (20km S of Townsville). Contact Richard Free (07) 4789-2214

SOUTH AUSTRALIA

Astronomical Society Of South Australia meet on the 1st Wednesday each month (except Jan.) at Uni. of Adelaide, North Terrace campus, 08 8338-1231.

TASMANIA

Astronomical Society Of Tasmania meets at the Hutchins School, Sandy Bay, on the last Tuesday of each month except December. Contact Karenne Barnes (03) 6344-7100 (northern Tasmania) or John Smythe (03) 6234-3033 (Hobart)

VICTORIA

The Astronomical Society of East Gippsland operates in Bairnsdale and the surrounding districts. Contact Mike Finn (03) 5156-0676.

Astronomical Society Of Melbourne has public viewing nights, at their meeting place (Melbourne) or their dark sky site south of Cranbourne. Contact Chris Ellis 0412 318 125 (recorded info line (03) 9517-9250).

Astronomical Society Of Victoria meets at 8pm on the 2nd Wednesday of each month, except January, at the National Herbarium, Birdwood Ave, South Yarra. Contact Linda Mockridge (03) 9888-7130.

Astronomical Society Of Albury Wodonga meets regularly on the first Wednesday of each month (except January) at Victory Primary School, Drages Road, Wodonga at 8pm. Contact John Hills (02) 6024-7255

Astronomical Society Of Geelong meets every Friday at 8:30 pm at Geelong Showgrounds, Rest Room, Geelong. Contact Frank Baker 0407 345 070

Latrobe Valley Astronomical Society meets at Monash University, Room 2E-201, Switchback Rd, Churchill, on the second Tuesday of each month (except December and January). Contact Rob Read (03) 5176-1560.

Oasis Stargazers Club Mildura Inc conduct regular viewing nights open to the public and once a month, an activity night for members and the public. Contact Kerry Needs (03) 5021-1330 or David Martin (03) 5023-3931

Astronomical Society Of Frankston (ASF) meets 3rd Wednesday each month (except Dec) at 8pm, at Peninsula School, Wooralla Dr, Mt.Eliza. Contact Richard Pollard 0419 253 252

Ballarat Astronomical Society holds a general meeting on the second Friday of each month, contact (03) 5332-7526

Bendigo District Astronomical Society meets at BRiT (3rd Flr McCrae St Campus) at 7:30pm, 4th Wednesday each month (except Dec). Contact Neil Linton (03) 5448-8352

NORTHERN TERRITORY

Alice Springs Astronomical Society meets on the 2nd Monday of each month at the Motor Registry Office, METEL Centre. Contact Annette Green (08) 8952-9817 or Mark Sugars (08) 8953-3689

Darwin Astronomy Group has monthly viewing nights during the dry season plus special astronomical events. Contact Phillip Smith (08) 8945-9450.

GLOSSARY

Albedo The ratio of light reflected from a Solar System object to that received by it. (A complete reflection gives an albedo of 1.0 or 100%).

Algol A variable star of a class known as eclipsing variables. Algol's brightness fluctuates every 69 hours as it is eclipsed by its invisible companion.

Almanac A set of tables giving positions of Sun, Moon & planets at various times, plus other astronomical information; an Ephemeris.

Altazimuth co-ordinates The angular height (altitude) of an object above or below the horizon and its angular direction (azimuth) from north measured towards the east.

Altitude The angular elevation of an object above or below the horizon.

Angular diameter The apparent diameter of an object measured in degrees or radians.

Angular separation The angular distance between two celestial bodies measured in degrees.

Aphelion The point in an orbit of a comet, planet or minor planet most distant from the Sun. It is the opposite to ***perihelion***.

Apogee The point at which a body in orbit around the Earth reaches its farthest distance from the Earth. It is the opposite to ***perigee***

Asterism A recognisable grouping of visible stars. The stars may belong to one or more constellations. The grouping will have a name, for example 'The Teapot' in Sagittarius.

Asteroid See ***Minor Planet***.

Astronomical unit The average distance from Earth to the Sun, approximately 149.6 million km, which equals 1 AU.

Azimuth Horizontal co-ordinate of an object's position in the sky. Derived by drawing an imaginary vertical line from the object to the horizon below. The position is then expressed in degrees east from the north point.

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

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

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

Circumpolar stars Stars which never set. To determine which stars are circumpolar from a particular place, subtract the observer's latitude from 90°. This provides the minimum declination a star must have to be considered circumpolar.

Colour index The difference in the magnitudes of an object measured at two different wavelengths. It is a measure of the colour (temperature) of a star.

Coma The head of a comet, usually the brightest part.

Comet Small icy body that orbits the Sun and produces tails of gas and dust when approaching the Sun.

Conjunction An alignment of two bodies; their least angular separation as seen from Earth. When a superior planet is said to be in conjunction it is with the Sun (unless stated otherwise).

Conjunction - Inferior When the Earth, an inferior planet (Mercury or Venus) and the Sun are in a line in that order.

Conjunction - Superior When the Earth and an inferior planet (Mercury or Venus) are situated on opposite sides of the Sun.

Constellation A pattern of stars identified by name, usually of mythological gods, people, animals, or objects.

Cosmology The study of the large-scale structure and evolution of the whole Universe.

Culmination The instant when a celestial body crosses the ***meridian***; an object culminates when it reaches its highest point above the observers horizon.

Declination (Dec) One part of the equatorial co-ordinate system used to specify the location of an object in the sky. It is the angular distance of a body north (+) or south (-) of the celestial equator and is similar to lines of latitude on the Earth.

Diurnal motion The daily motion of the sky produced by rotation of the Earth, causing the rising and setting of the Sun, Moon, planets and stars.

Eccentricity A measure of how 'long or thin' an ellipse is. If the eccentricity equals zero, you have a circle.

Eclipse When one object passes into the shadow of another.

Eclipse of the Moon When the Moon passes into the shadow cone of the Earth. It is a total eclipse when the Moon is immersed in the umbral shadow, partial if only partly covered by the umbra, and penumbral if the Moon passes only through the penumbra of the Earth's shadow.

Eclipse of the Sun When the Moon passes in front of the Sun. Total when the Moon has a larger angular diameter than the Sun and completely covers the disc, annular if smaller (leaving a ring of sunlight surrounding the Moon), and partial if only partly covered.

Ecliptic The plane of the Earth's orbit projected onto the celestial sphere. It can also be defined as the Sun's path against the stars.

Ellipse An oval. The shape of the orbit of the planets. The axes of an ellipse are called the minor axis and major axis.

Elongation The angular separation of two bodies. The greatest elongation of Mercury and Venus occur when the planets are at their most angular distance from the Sun, as viewed from the Earth.

Emission nebula A cloud of glowing gas excited by ultraviolet radiation from hot stars.

Ephemeris (plural ephemerides) A tabulated list of positions for an object calculated from its orbital elements.

Epoch A date chosen as a reference point for observations. This book uses Epoch 2000.0 for all co-ordinate data and is compatible with modern star atlases.

Equation of Time The difference between apparent and mean solar time.

Equinox The two times of the year when the Sun crosses the ***celestial equator***; vernal or spring equinox occurs about March 21st, and autumnal or fall equinox about September 22nd (northern hemisphere seasons).

Galactic equator The great circle along the line of the Milky Way, marking the central plane of our ***galaxy***.

Galaxy A large disk or ball of billions of stars and ***nebulae***. They are the largest individual structures in the Universe.

Galilean satellites The four brightest satellites of Jupiter; Io, Europa, Ganymede, and Callisto, named after their discoverer, Galileo Galilei (also known as the Jovian satellites).

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

Gibbous Phase of a planet or the Moon more than fifty percent illuminated. For example, the Moon is gibbous between first and last quarter.

Globular Cluster A huge sphere containing thousands of stars. They surround our galaxy and other nearby galaxies.

Heliocentric As viewed or measured from the centre of the Sun.

Hour Angle The angular measure of the distance of an object from the local ***meridian***.

Inclination The angle that the plane of the orbit of one astronomical body makes with the plane of the orbit of another. Usually the reference is the *ecliptic*.

Inferior planet A planet orbiting the Sun inside Earth's orbit. That is Mercury and Venus.

Julian date The number of days since noon on 1st January 4713 B.C. It is useful for astronomical observations as it saves confusion with other calendars. The starting date chosen was arbitrary but far enough back in time for there to be no astronomical records prior to then.

Large Magellanic Cloud (LMC) Satellite ***galaxy*** to our own Milky Way system, appearing to the unaided eye as a large nebulous patch situated in the ***constellation*** of Dorado. From mid-southern latitudes the LMC is ***circumpolar***.

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

Lunation The period of time between two consecutive New Moons.

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

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

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

Meteor (also Shooting or Falling Star) A small particle striking the Earth's atmosphere that is heated to incandescence by friction with air molecules.

Meteor shower A group of ***meteors*** that appear to originate from a small region of the sky (the radiant).

Meteor swarm (or stream) Meteoroids grouped in a localised region of an orbit around the Sun (the source of ***meteor showers***).

Meteorite A ***meteor*** that survives its trip through the atmosphere and reaches the ground.

Meteoroid A small solid particle moving in orbit about the Sun.

Minor planet Small rocky objects which revolve around the Sun. Most lie between the orbits of Mars and Jupiter in the asteroid belt.

Minute of arc An angular measure (each degree is divided in 60 minutes of arc).

Mira A variable star in the constellation of Cetus, with a range in brightness from 2nd to 10th magnitude, and a mean period of 331 days. Known as Mira the Wonderful, it is the brightest and most famous of the long period pulsating variables.

Nadir The point on the ***celestial sphere*** directly opposite the ***zenith.***

Nebula A cloud of interstellar gas and dust. See also ***emission, reflection*** and ***planetary nebula.***

Node One of two points at which an orbit passes through a reference plane (usually the ***ecliptic***).

Oblateness The ratio of a planet's polar to its equatorial diameter.

Obliquity The degree of inclination (or tilt) of a planet's equator to its orbital plane.

Occultation The disappearance of one celestial body behind another.

Omega Centauri A globular star cluster in the constellation of Centaurus. Globulars are made up of tens of thousands of stars and form a shell around our galaxy. Omega Centauri and 47 Tucanae are two of the finest examples of these objects.

Open star cluster A loose association of stars numbering from a few dozen to hundreds.

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

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

Parallax An apparent shift in the positions of nearby stars (relative to more distant ones) from the changing position of the Earth in its orbit around the Sun. The size of the shift can be used to measure the distances to the nearer stars.

Parsec A unit of distance used by astronomers which is equal to 3.26 ***light years***. A parsec is defined as the distance to a celestial body whose ***parallax*** is one arc second.

Penumbra Area of partial illumination in the shadow of a planet surrounding the Umbra. Also zone of intermediate brightness between a sunspot and the solar photosphere.

Perigee The point at which a body in orbit around the Earth most closely approaches the Earth.

Perihelion The point in an orbit closest to the Sun, of a comet, planet or minor planet. It is opposite to ***aphelion***.

Perturbation Small changes in the motion of a body caused by the gravitational effects of another body.

Planetary nebula An expanding shell of gas ejected from a star. Thought to be the outer layers of a red giant during its latter stages of evolution, the core of which becomes a white dwarf.

Planisphere A handheld aid used to identify which constellations are visible to an observer on any particular date and time.

Polar axis The axis around which a celestial body rotates.

Proper motion The small change in position of nearby stars due to motion across the line of sight (measured in seconds of arc per year).

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

Reflection nebula. A gas cloud illuminated by a nearby star.

Retrograde motion 1. An actual motion contrary to the general direction of the bodies in the Solar System. An example of actual retrograde motion is Neptune's satellite Triton.

2. Apparent retrograde motion is the westward motion of a planet with respect to the stars which occurs near opposition (outer planets) or near inferior conjunction (inner planets).

Right ascension (R.A.) Part of the equatorial co-ordinate system used to specify the location of an object in the sky. It is the angular distance of an object from an imaginary line in the sky. It is similar to lines of longitude on the Earth but is measured in hours (24hrs = 360°).

Second of arc An angular measure. Each degree contains 3600 seconds of arc, and each ***minute of arc*** contains 60 seconds.

Sidereal time A method of keeping time which uses the motion of the stars rather than the Sun. One sidereal day is equal to 23hrs56m4s of normal solar time.

Small Magellanic Cloud (SMC) Satellite ***galaxy*** to our own Milky Way system, appearing to the unaided eye as a nebulous patch in the constellation of Tucana. From mid-southern latitudes the SMC is circumpolar.

Solstice The time when the Sun is farthest from the ***celestial equator***. In the southern hemisphere around June 21st marks the shortest day of the year, and around December 21st marks the longest day.

Spectral type A star's spectral classification determined by its ***spectrum***.

Spectrum The light of an object spread out like a rainbow. As well as this continuous spectrum, a star normally shows a distinctive set of dark and light lines which are characteristic of its composition.

Superior planet A planet orbiting the Sun outside Earth's orbit.

Synodic period The period of a planet's orbit with respect to the Earth.

Transit The passage of Mercury or Venus in front of the Sun's disc or the passage of a satellite or its shadow across the face of its primary.

Transit the meridian or meridian passage The passage of a heavenly body across the ***meridian***.

Twilight The short period of time before sunrise and after sunset during which there is not complete darkness.

Twilight - astronomical Astronomical twilight ends (in the evening sky) or begins (in the morning sky) when the Sun is 18° below the horizon.

Twilight - civil Civil twilight ends or begins when the Sun is 6° below the horizon.

Twilight - nautical Nautical twilight ends or begins when the Sun is 12° below the horizon.

Umbra Zone of maximum darkness in the shadow of a planet. Also the darkest part of a sunspot.

Universal time A time system measured on the Meridian of Greenwich, it is 8 hours less than Western Australian Standard Time (WAST).

WAST Western Australian Standard Time.

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

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

Zodiac The traditional twelve constellations that lie across the *ecliptic* (astrologers ignore Ophiuchus, which is very much a part of the Zodiac).

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GREEK ALPHABET

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



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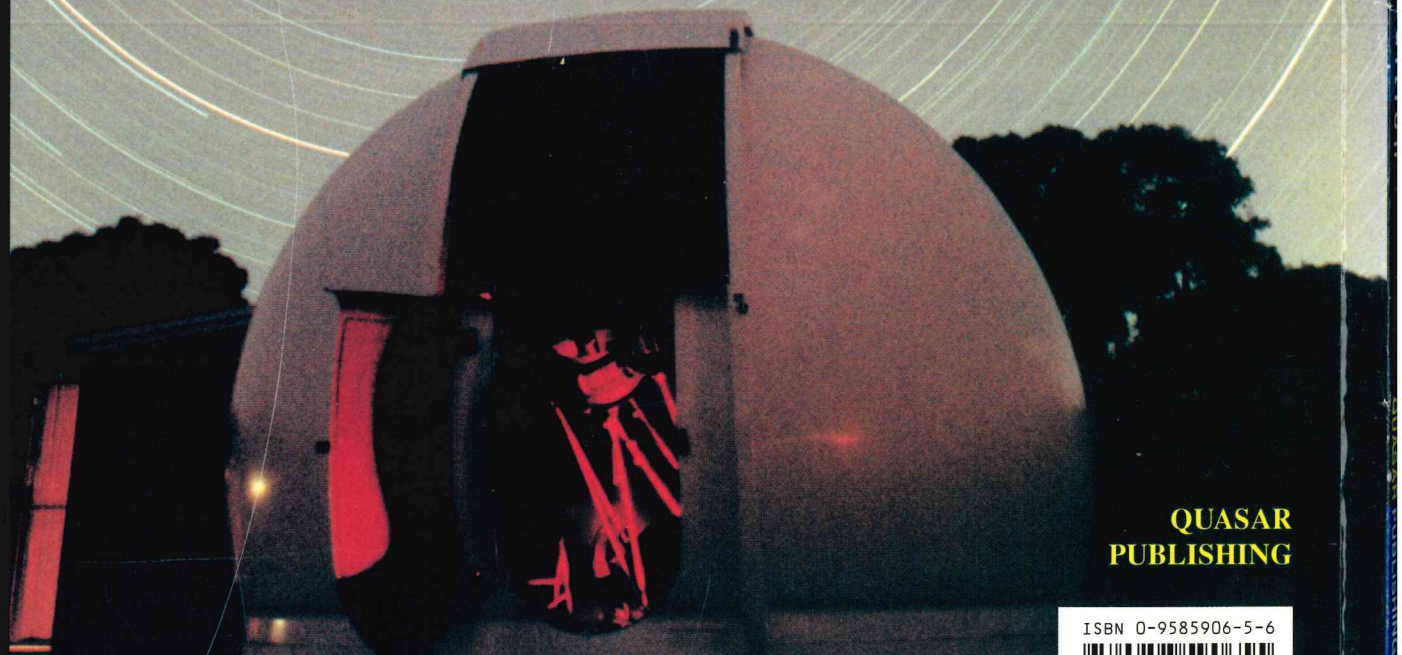
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