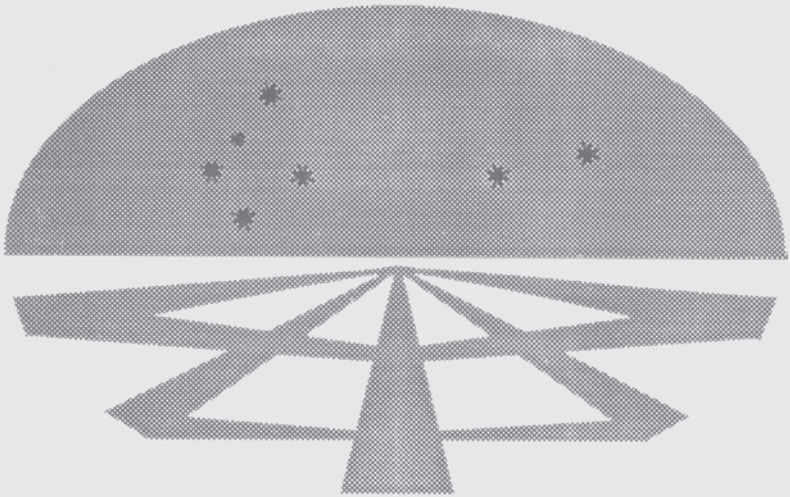
ASTRONOMY 1991



A PRACTICAL GUIDE TO
ASTRONOMICAL
EVENTS DURING 1991

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WE ARE ALL ASTRONOMERS

If you have ever gone out at night and looked up and wondered about the starry heavens, you are an amateur astronomer. You are using the same scientific instrument that was available to astronomers up to the time of Galileo, the human eye !

To all those astronomers, no matter how lowly, this book is dedicated to you. Whether you are :-

- an astronomer planning your observing session by checking when the moon will rise to destroy your "dark sky"
- or just wondering what that bright star is, low in the western evening sky, that moves slowly from night to night

This book has been designed to help you.

Mankind has always been fascinated with the night sky. In particular the "wanderers", in the early days, raised many disturbing questions. These stars continued to disturb the otherwise stable star patterns of the heavens. It was not until the discovery of the telescope that the true nature of these "wanderers", or planets, were revealed. Mathematics completed the picture by introducing us to the beautiful order that exists in the movement of the planets, our Solar System neighbours. This handbook is concerned with helping you in finding the Sun, Moon, planets and many of their satellites. It also concentrates on highlighting the best times to observe these objects. The information has been optimised for Sydney observers, but much of it is generally useful for any location within NSW.

The data is interpreted and presented in various forms, making use of finder charts, diagrams and tables. In many cases, detailed explanations and worked examples have been presented to assist in understanding. Astronomy, like any Science, may seem to be "swamped" in jargon. Where possible these words have been kept to a minimum. However, where they are necessary, astronomical terms are either explained in the text or covered in the glossary. To a beginner some of this information (especially the tables of numbers) may seem difficult to understand. It is important not to allow yourself to be overwhelmed. Comprehension will come with experience and when there is a need to know.

Star charts have been included to assist in finding some of the planets. These have been deliberately simplified and are not meant to be a substitute for a good star atlas. Any modern star atlas such as Norton's or Sky Atlas 2000.0 would make an excellent companion to this volume.

A questionnaire has been included in the back of this publication. The authors would appreciate any feedback from the users of this handbook.

Wishing you clear skies and many hours of enjoyable observing.

Glenn Dawes *Peter Northfield* *Ken Wallace*

(November 1990)

ACKNOWLEDGEMENTS

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

- Floppy Almanac for the Year 1991 -IBM version. (US Naval Observatory)
- Astronomical Almanac for the Year 1991. (US Naval Observatory/ Royal Greenwich)
- General Phenomena for the Year 1991. (US Naval Observatory/ Royal Greenwich)
- Voyager the Interactive Desktop Planetarium (Carina Software)
- Ephemerides of Minor Planets (Moscow, USSR)
- Sky Catalogue 2000.0 - Vol. 1. (Hirshfeld and Sinnott - Cambridge and Sky Publishing)
- International Lunar Occultation Centre. (Tokyo, Japan)
- Southern Astronomy Magazine (Vol. 3, No. 3)
- Comets, Vagabonds of Space. (D. Seargent)
- Sky and Telescope - Various issues (Sky Publishing)
- NAPO Meteor Observer's Guide.
- Minor Planet Circulars/ Minor Planets and Comets - Various bulletins. (SAO)

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Our thanks go to Ben Pawlutschenko for permission to use his Lunar map.

NOTES ON THE USE OF THIS YEARBOOK

LOCATION.

The information in this handbook has been calculated for Sydney, NSW.

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

Unless specifically stated in the text, the data is generally useful for most of NSW. Where it is appropriate, correction factors have been included for locations other than Sydney.

TIME.

The times used are in Eastern Australian Standard Time or EAST unless otherwise indicated. EAST is the mean solar time on the meridian of longitude of 150" E. No adjustments are made in this book for Daylight savings, also known as "Summer Time". When daylight savings is in force, the time is one hour ahead of EAST, you will need to add one hour to any EAST time for the correct local time. The 24 hr clock is used eg. 16:00 hr is equal to 4:00pm. This avoids having to distinguish between "am" and "pm". In some areas it was convenient to use decimal hours. eg. 5.3hr is the same as 5hr 18min or 5: 18hr.

UNIVERSAL TIME, or UT, is based on Greenwich Mean Sidereal Time (GMST. UT is therefore equivalent to Greenwich Mean Time (GMT. EAST is 10 hours ahead of UT. For example, midnight UT, or O hr, is equal to 10:00hr or 10:00am EAST.

ASTRONOMICAL CO-ORDINATES OR POSITIONS.

The astronomical positions are given as equatorial co-ordinates. These are right ascension (RA) and Declination (Dec) which are analogous to longitude and latitude for finding places on the Earth. RA is not measured in degrees, as is longitude, but in hours. The 360 degrees, for once around the sky, are broken up into 24 hour divisions. Each hour is further divided, like a clock, into minutes and seconds. Declination does not use north or south. Objects north of the celestial equator have positive(+) declinations, south are negative(-).

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

RISE AND SET TIMES

Where listed rise and set times for various objects are given in EAST. The times given are for when the upper limb of the object is coincident with the theoretical "true" horizon. Atmospheric refraction is taken into account

THE "POSITION" TABLES.

All RA's and Dec's have been calculated for O hr UT of date listed, Epoch 2000. All positions are "geocentric". That means they have been calculated for the position of the centre of the Earth. There is no taking into account the parallax effect of the observer being located on the surface of the Earth. With the exception of the Moon, this slight shift is certainly insignificant.

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

JULIAN DATE

JULIAN DATE at 0hrs UT		
Month		Julian Date
Jan	0	244 8256.5
Feb	0	244 8287.5
Mar	0	244 8315.5
Apr	0	244 8346.5
May	0	244 8376.5
Jun	0	244 8407.5
Jul	0	244 8437.5
Aug	0	244 8468.5
Sep	0	244 8499.5
Oct	0	244 8529.5
Nov	0	244 8560.5
Dec	0	244 8590.5

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

To calculate Julian Date (JD), 1st convert local time to UT (subtract 10 hrs from EAST) correcting the date if necessary. Next find the Julian date given in the table on the far left for the month you are interested in. Now add the day of the month. This will give you JD for 0hrs UT on the date in question. Just add the fraction of day from the second table that matches the time you are calculating for. **Example:** you wish to know the Julian date at 23:00 Sydney time on July 17th. Subtract 10 hours to get UT.

23 - 10 = 13:00 hrs

From the table the JD for July is 2448437.5 Add the day of month, 17 gives us 2448437.5

Now add the hours as a fraction of a day from the 2nd table. 13hr is 0.542. Thus JD at 23:00hr 17 Jul 1991 at Sydney is 2448455.042

SIDEREAL TIME — 1991

Greenwich mean sidereal time at 0hrs UT					
Jan	0	06.6106	Jul	0	18.5041
Feb	0	08.6476	Aug	0	20.5411
Mar	0	10.4875	Sep	0	22.5781
Apr	0	12.5245	Oct	0	00.5494
May	0	14.4958	Nov	0	02.5864
Jun	0	16.5328	Dec	0	04.5577

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

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

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

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

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

where longitude is expressed in HOURS (not degrees!)

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

Example:

Find LMST at 23:00 hours Sydney time on 17th July 1991.

23:00 local time = 13:00 UT. GMST for July 0 is 18.5041 hrs.

GMST = 18.5041 + (0.06571 × 17) + (1.00274 × 13) = 32.6568

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

LMST = 32.6568 + 10.0833 = 42.7401

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

42.7401 - 24 = 18.**740** hrs

DIARY OF EVENTS

Configurations of the Sun, Moon and Planets

For completeness, the Diary of Events lists all configurations of the Sun, Moon, planets and minor planets regardless of their suitability for observation from southern or NSW latitudes. This listing is designed so that an observer may quickly check if any interesting events are likely to occur during an observation session. For more detail on the observable events, reference should be made to the sections devoted to the Moon and Planets.

All events are given to the nearest hour (E.A.S.T.), in many instances the time and separation of conjunctions provided in the more detailed sections will vary from this listing as the objects may be below the horizon at their closest approach. Others will be ignored because of their close proximity to the Sun or general unsuitability for observation.

Visibility areas of events marked Occ* (occultations of planets and bright stars by the Moon) are provided below. Those marked Eclipse* (eclipses) follow this section.

* OCCULTATIONS of PLANETS and BRIGHT STARS by the MOON

DATE	d	h	BODY	AREAS of VISIBILITY
Jan	12	13	Antares	Middle East, Asia, India, China Philippines
Feb	08	21	Antares	SE of N America, Cuba, West Indies, W Africa
	11	14	Uranus	S Pacific, Ross Dependency Antarctica
	13	04	Saturn	Central pacific, Hawaii, Mexico, parts of America
Mar	08	05	Antares	Korea, Japan, NE U.S.S.R, N Pacific
	11	01	Uranus	S Pacific, Antarctica, S Atlantic
	12	18	Saturn	N Africa, Europe, British Isles, Turkey
	23	03	Mars	Greenland, Iceland, British Isles, N Europe, U.S.S.R.
Apr	04	13	Antares	British Isles, part of Europe, W U.S.S.R, W Turkey
	07	10	Uranus	Antarctica, Australia except NW, S New Zealand
	20	10	Mars	S Pacific, Tahiti, SW of S America
May	04	18	Uranus	S Pacific, S of S America, S Atlantic
	31	23	Uranus	Australia, New Zealand, Tahiti, S Pacific
Jun	01	06	Neptune	Ross Dependency Antarctica, S Pacific
Jun	28	03	Uranus	Australia, E New Guinea, S Indian Ocean, New Caledonia
	28	10	Neptune	Australian Antarctic Territory
Jul	25	07	Uranus	S Atlantic, S of S Africa, N Indian Ocean
Aug	11	18	Mercury	Europe, Scandinavia, U.S.S.R. India, China
	21	12	Uranus	S Pacific, S of Sth America, Atlantic
Sep	17	19	Uranus	Indian Ocean, S Australia, New Zealand Fiji
	18	03	Neptune	Ocean S of Australia, coast of Antarctica
Oct	05	01	Venus	Pacific, Hawaii, W coast of Mexico, S America
	15	04	Uranus	Central & N of S America, central Africa
	15	12	Neptune	Pacific S of New Zealand, coast of Antarctica
Nov	11	13	Uranus	New Guinea, extreme N of Australia, Hawaii
	11	21	Neptune	Australia except E, Aust Antarctic Territory
Dec	09	00	Uranus	W & N Africa, Europe, Middle East
	09	06	Neptune	S Pacific, central and S of S America

Diary of Events

JANUARY

d	h		
02	01	Venus 1°.2 S of Saturn	
02	02	Mars stationary	
03	09	Jupiter 2° N of Moon	
03	13	Earth at perihelion	
04	05	Mercury stationary	
05	13	Neptune in conjunction with Sun	
05	18	Vesta stationary	
08	05	LAST QUARTER	
12	13	Antares 0°.6 S of Moon.	Occ*
12	21	Moon at apogee	
14	06	Mercury 4° N of Moon	
14	19	Mercury greatest elongation W (24°)	
16	10	NEW MOON	Eclipse*
18	04	Venus 3° S of Moon	
18	18	Saturn in conjunction with Sun	
24	00	FIRST QUARTER	
24	03	Mercury 0°.4 N of Uranus	
24	07	Pallas stationary	
26	01	Mars 2° S of Moon	
27	00	Mercury 1°.1 S of Neptune	
28	19	Moon at perigee	
29	10	Jupiter at opposition	
30	15	Jupiter 1°.8 N of Moon	
30	16	FULL MOON	Eclipse*

FEBRUARY

d	h		
06	02	Mercury 1°.2 S of Saturn	
07	00	LAST QUARTER	
08	21	Antares 0°.7 S of Moon	Occ*
09	14	Moon at apogee	
11	14	Uranus 1°.1 N of Moon	Occ*
11	21	Neptune 1°.9N of Moon	
13	04	Saturn 0°.5 S of Moon	Occ*
15	04	NEW MOON	
17	02	Venus 6° S of Moon	
22	09	FIRST QUARTER	
22	18	Mars 8° N of Aldebaran	
22	23	Mars 1°.6 S of Moon	
25	11	Moon at perigee	
26	00	Pluto stationary	
26	19	Jupiter 1°.6 N of Moon	

MARCH

d	h		
01	04	FULL MOON	
02	13	Mercury in superior conjunction	
04	09	Ceres stationary	
06	18	Pallas at opposition	
08	05	Antares 0°.8 S of Moon	Occ*
08	21	LAST QUARTER	
09	11	Moon at apogee	
11	01	Uranus 0°.9 N of Moon	Occ*
11	07	Neptune 1°.8 N of Moon	
12	18	Saturn 0°.9 S of Moon	Occ*
16	18	NEW MOON	
18	01	Mercury 5° S of Moon	
19	10	Venus 5° S of Moon	
21	13	Equinox	
22	15	Moon at perigee	
23	03	Mars 0°.7 S of Moon	Occ*
23	16	FIRST QUARTER	
25	23	Jupiter 1°.6 N of Moon	
28	01	Mercury greatest elongation E (19°)	
28	12	Pallas 0°.9 N of Moon	Occ*
30	17	FULL MOON	
31	00	Jupiter stationary	

APRIL

d	h		
04	13	Antares 1°.1 S of Moon	Occ*
05	03	Mercury stationary	
06	07	Moon at apogee	
07	10	Uranus 0°.6 N of Moon	Occ*
07	16	Neptune 1°.5 N of Moon	
07	17	LAST QUARTER	
09	17	Saturn 1°.4 S of Moon	
10	10	Pallas stationary	
15	06	NEW MOON	
15	07	Mercury in inferior conjunction	
18	02	Ceres at opposition	
18	02	Venus 2° S of Moon	
18	03	Moon at perigee	
18	22	Uranus stationary	
19	09	Neptune stationary	
20	10	Mars 0°.6 N of Moon	Occ*
21	23	FIRST QUARTER	
22	05	Jupiter 1°.9 N of Moon	
22	04	Venus 7° N of Aldebaran	
27	06	Mercury stationary	
29	07	FULL MOON	

Diary of Events

MAY

d	h		
04	01	Moon at apogee	
04	18	Uranus 0°.3 N of Moon	Occ*
05	00	Neptune 1°.2 N of Moon	
06	17	Saturn 1°.8 S of Moon	
07	10	LAST QUARTER	
10	13	Pluto at opposition	
12	23	Mercury 9° S of Moon	
13	04	Mercury greatest elongation W (26°)	
14	15	NEW MOON	
16	03	Moon at perigee	
16	15	Mars 5° S of Pollux	
17	17	Venus 1°.6 N of Moon	
17	21	Saturn stationary	
18	20	Mars 2° N of Moon	
19	17	Jupiter 2° N of Moon	
21	06	FIRST QUARTER	
24	05	Juno stationary	
28	22	FULL MOON	
31	10	Venus 4° S of Pollux	
31	13	Moon at apogee	
31	23	Uranus 0°.2 N of Moon	

JUNE

d	h		
01	06	Neptune 1°.1 N of Moon	Occ*
03	00	Saturn 2° S of Moon	
06	01	LAST QUARTER	
10	20	Ceres stationary	
12	22	NEW MOON	
13	10	Moon at perigee	
14	08	Venus greatest elongation E (45°)	
14	15	Mars 0°.6 N of Jupiter	
16	06	Venus 4° N of Moon	
16	08	Jupiter 3° N of Moon	
16	10	Mars 4° N of Moon	
17	15	Mercury in superior conjunction	
18	09	Venus 1°.2 N of Jupiter	
19	14	FIRST QUARTER	
22	07	Solstice	
23	22	Venus 0°.3 N of Mars	
27	13	FULL MOON Penumbral Eclipse*	
27	17	Moon at apogee	
28	03	Uranus 0°3 N of Moon	Occ*
28	10	Neptune 1°.1 N of Moon	Occ*
30	04	Saturn 2° S of Moon	

JULY

d	h		
01	08	Mercury 5° S of Pollux	
04	17	Uranus at opposition	
05	13	LAST QUARTER	
07	01	Earth at aphelion	
08	10	Neptune at opposition	
10	05	Vesta in conjunction with Sun	
11	18	Venus 1° S of Regulus	
11	20	Moon at perigee	
12	05	NEW MOON	Eclipse*
14	00	Mercury 3° N of Moon	
14	03	Jupiter 3° N of Moon	
15	01	Mars 5° N of Moon	
15	02	Mars 0°.7 N of Regulus	
15	04	Venus 3° N of Moon	
15	18	Mercury 0°.08 S of Jupiter	
17	09	Juno at opposition	
17	15	Venus greatest brilliancy	
19	01	FIRST QUARTER	
22	16	Venus 4° S of Mars	
24	21	Moon at apogee	
25	07	Uranus 0°.4 N of Moon	Occ*
25	12	Mercury greatest elongation E (27°)	
25	15	Neptune 1°.2 N of Moon	
27	04	FULL MOON Penumbral Eclipse*	
27	06	Saturn l 0.9 S of Moon	
27	10	Saturn at opposition	
27	11	Mercury 2° S of Regulus	
30	14	Venus stationary	

AUGUST

d	h		
03	05	Pluto stationary	
03	21	LAST QUARTER	
07	14	Mercury stationary	
07	16	Mercury 2° N of Venus	
09	04	Moon at perigee	
10	12	NEW MOON	
11	17	Venus 3° S of Moon	
11	18	Mercury 0°.6 S of Moon	Occ*
12	18	Mars 6° N of Moon	
17	10	Venus 9° S of Regulus	
17	15	FIRST QUARTER	
18	08	Jupiter in conjunction with Sun	
20	12	Moon at apogee	
21	12	Uranus 0°.4 N of Moon	Occ*
21	20	Neptune 1°.2 N of Moon	
22	07	Mercury in inferior conjunction	
23	06	Venus in inferior conjunction	
23	09	Saturn 1°.8 S of Moon	
25	19	FULL MOON	
29	15	Mercury 6° N of Moon	
31	08	Mercury stationary	

Diary of Events

SEPTEMBER

d	h		
02	04	LAST QUARTER	
06	05	Moon at perigee	
07	03	Venus 5° S of Moon	
07	04	Juno stationary	
07	15	Mercury 3° N of Moon	
07	21	Jupiter 5° N of Moon	
08	04	Mercury greatest elongation W (18°)	
08	21	NEW MOON	
10	12	Mars 6° N of Moon	
10	18	Jupiter 0°.4 N of Regulus	
10	20	Mercury 0°.07 S of Jupiter	
10	20	Mercury 0°.3 N of Regulus	
12	12	Venus stationary	
16	08	FIRST QUARTER	
17	19	Uranus 0°.2 N of Moon	Occ*
18	01	Moon at apogee	
18	03	Neptune 1° N of Moon	Occ*
19	14	Saturn 1°.8 S of Moon	
19	19	Uranus stationary	
23	23	Equinox	
24	09	FULL MOON	
26	15	Neptune stationary	
29	09	Venus greatest brilliancy	

OCTOBER

d	h		
01	10	LAST QUARTER	
03	04	Moon at perigee	
04	03	Mercury in superior conjunction	
05	01	Venus 0°.2 N of Moon	Occ*
05	12	Saturn stationary	
05	15	Jupiter 5° N of Moon	
06	10	Mars 3° N of Spica	
08	08	NEW MOON	
08	14	Venus 3° S of Regulus	
15	04	Uranus 0°.06 S of Moon	Occ*
15	12	Neptune 0°.7 N of Moon	Occ*
15	21	Moon at apogee	
16	04	FIRST QUARTER	
16	22	Saturn 2° S of Moon	
17	13	Venus 2° S of Jupiter	
23	21	FULL MOON	
28	02	Moon at perigee	
30	17	LAST QUARTER	

NOVEMBER

d	h		
02	06	Jupiter 6° N of Moon	
02	19	Venus greatest elongation W (47°)	
03	07	Venus 6° N of Moon	
05	01	Pallas in conjunction with Sun	
06	21	NEW MOON	
08	15	Mercury 0°.7 N of Moon	Occ*
08	19	Mars in conjunction with Sun	
11	13	Uranus 0°.4 S of Moon	Occ*
11	17	Mercury 2° N of Antares	
11	21	Neptune 0°.4 N of Moon	Occ*
12	18	Moon at apogee	
13	08	Saturn 2° S of Moon	
13	14	Pluto in conjunction with Sun	
15	00	FIRST QUARTER	
19	12	Mercury greatest elongation E (22°)	
22	09	FULL MOON	
24	12	Moon at perigee	
29	01	LAST QUARTER	
29	04	Mercury stationary	
29	18	Jupiter 6° N of Moon	
29	19	Venus 4° N of Spica	

DECEMBER

d	h		
03	00	Venus 8° N of Moon	
06	14	NEW MOON	
09	00	Uranus 0°.6 S of Moon	Occ*
09	01	Mercury in inferior conjunction	
09	06	Neptune 0°.2 N of Moon	Occ*
10	12	Moon at apogee	
10	20	Saturn 3° S of Moon	
12	01	Mars 4° N of Antares	
12	05	Ceres in conjunction with Sun	
14	02	Mercury 3° N of Mars	
14	20	FIRST QUARTER	
16	08	Mercury 8° N of Antares	
18	22	Mercury stationary	
21	16	Mercury 7° N of Antares	
21	20	FULL MOON	Eclipse*
22	19	Moon at perigee	
22	19	Solstice	
27	03	Jupiter 7° N of Moon	
28	07	Mercury greatest elongation W (22°)	
28	12	LAST QUARTER	
31	22	Jupiter stationary	

ECLIPSES

During 1991 there will be six eclipses, two of the Sun and four of the Moon. The annular eclipse of the Sun on January 16th will appear partial from Sydney, it will however, be seen as annular in the southern portion of Western Australia and northern area of Tasmania, the south of the North Island and the north of the South Island of New Zealand.

Of the four lunar eclipses (none total) two are visible from Sydney. The duration of the penumbra! eclipse on July 27th is only 2 hours and 40 minutes. The experienced amateur will note a light shading as the Moon skims the Earth's penumbra! shadow, however, a casual observer would probably not notice anything unusual in the Moon's appearance.

The partial eclipse of December 21st will begin about 2 hours and 35 minutes prior to moonrise. The brief period of partiality (I hour and 6 minutes) will be visible from Sydney as the Moon grazes the Earth's umbra! shadow. At mid eclipse the Moon will be fully immersed within the penumbra.

1. ANNULAR ECLIPSE of the SUN, January 16th (see diagrams pages 13 and 14)

Visible East of Indonesia, South of New Guinea, Australia, New Zealand, part of Antarctica, Polynesia.

	Time	Longitude	Latitude
Eclipse begins	06h51.0	+129°29'.9	-24°29'.9
Central eclipse begins	07 59.9	+109 35 8	-29 51 9
Central eclipse at local apparent noon	09 43.5	-173 30 5	-37 47 7
Central eclipse ends	11 45.9	-114 17 3	+00 27 4
Eclipse ends	12 54.7	-133 36 7	+05 57 0

2 PENUMBRAL ECLIPSE of the MOON, January 30th

Beginning visible from eastern Asia, North, central and South America, Greenland, Europe, part of Africa, Palmer Peninsula of Antarctica, the Arctic, eastern Pacific and Atlantic Oceans. End visible from eastern Asia, part of New Zealand, North, central and South America, Greenland, the Arctic region, the Pacific and the northern Atlantic Oceans.

3 PENUMBRAL ECLIPSE of the MOON, June 27th

Beginning visible in eastern North, Central and South America, Antarctica, Africa, part of Europe, western Indian, Atlantic and south-eastern Pacific Oceans. End visible in North, Central and South America (except for Alaska and northwest Canada), Antarctica, western Africa, the Atlantic and south-eastern Pacific Oceans.

Eclipses

4 TOTAL ECLIPSE of the SUN, July 12th (see diagram page 15)

Visible Hawaiian Islands, South West of Canada, U.S.A. Except extreme North East, Mexico, Central and South America except extreme South.

	Time	Longitude	Latitude
Eclipse begins	02h28.7	-161°00'1	+12°32'.5
Central eclipse begins	03 23.2	-174 36 2	+12 28 7
Central eclipse at local apparent noon	05 06.1	-105 10 1	+21 59 0
Central eclipse ends	06 48.8	-046 12 2	-12 58 4
Eclipse ends	07 43.4	-059 48 5	-12 54 5

5 PENUMBRAL ECLIPSE of the MOON, July 27th (see diagram page 13)

Beginning visible in south and east Africa, most of Asia, Australia, New Zealand, most of Antarctica, the western Pacific and the Indian Oceans. End visible in most of Europe Africa and Asia, Australia, southern New Zealand, Antarctica, the eastern South Atlantic and the Indian Oceans.

	Time	Contact of penumbra with limb of Moon	Position angles from the north point
Moon enters penumbra	02h47.5	First	135°.8 to East
Middle of eclipse	04 07.8		
Moon leaves penumbra	05 28.3	Last	173°.6 to West

Penumbral magnitude of the eclipse = 0.280

6 PARTIAL ECLIPSE of the MOON, December 21st (see diagram page 13)

Beginning of the umbral phase visible in eastern Australia, New Zealand, north and east Asia, North and Central America, Greenland, the Arctic regions. End visible in north and east Asia, Australia, New Zealand, North and Central America, Greenland, the Arctic regions.

	Time	Contact of Umbra with limb of Moon	Position angles from the north point
Moon enters penumbra	18h25.4		
Moon enters umbra	20 00.0	First	167°.0 to East
Middle of eclipse	20 33.0		
Moon leaves umbra	21 06.1	Last	156°.6 to West
Moon leaves penumbra	22 40.6		

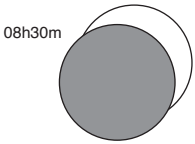
Magnitude of eclipse = 0.093

ECLIPSES

The diagrams below represent the appearance of the observable eclipses as seen from Sydney during 1991.

ANNULAR ECLIPSE OF THE SUN, JANUARY 16th

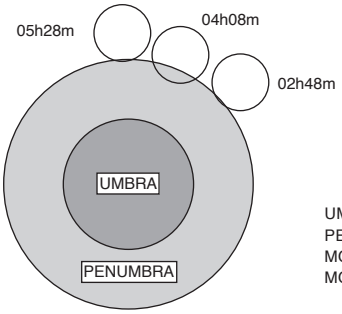
Eclipse begins with the Sun 22° above the Eastern horizon.



SUN DIAMETER - 0°32'
MOON DIAMETER = 0°30'
SUN DISTANCE - 0.9836 au
MOON DISTANCE - 404100 km

PENUMBRAL ECLIPSE OF THE MOON, July 27th

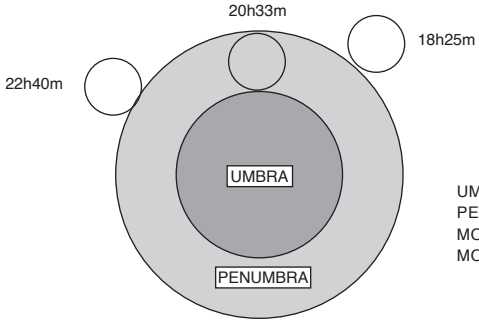
Eclipse begins as the Moon enters the penumbra when at altitude 49° and ends when the Moon leaves the penumbra 16° above the Western horizon.



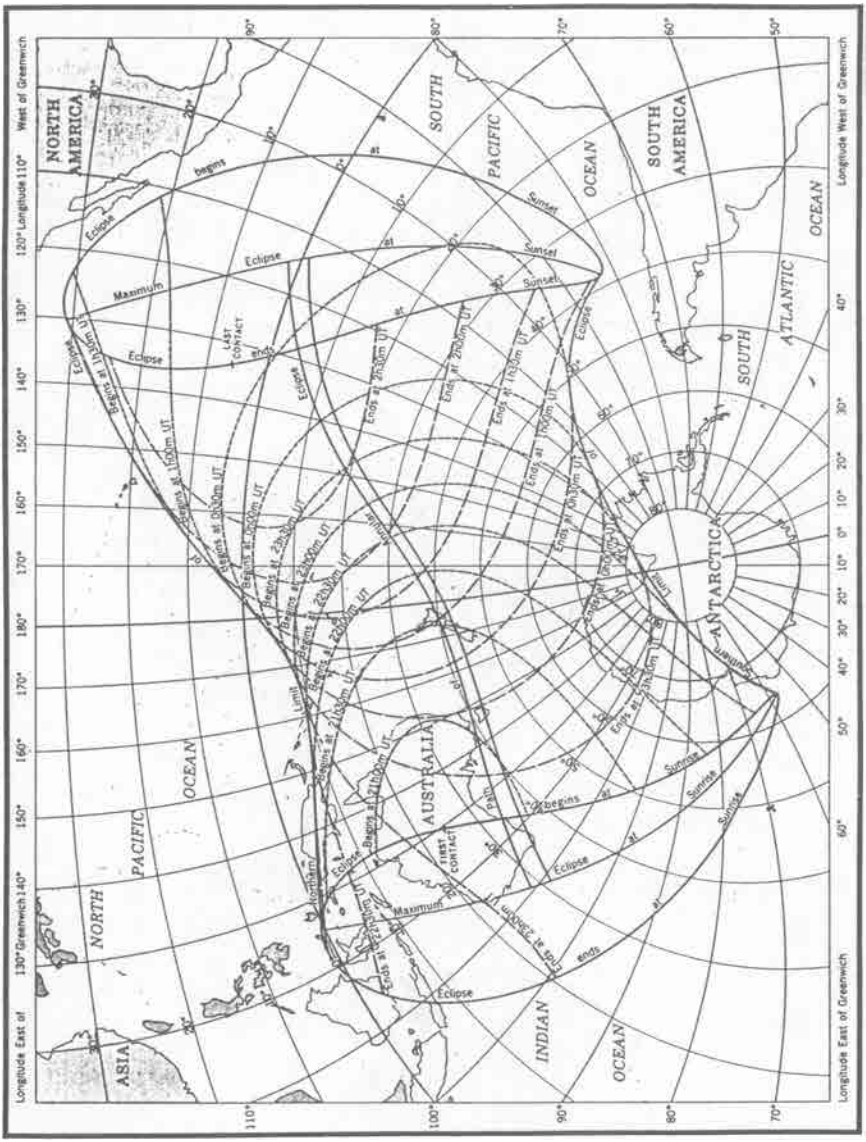
UMBRA DIAMETER = 1°17'
PENUMBRA DIAMETER = 2°21'
MOON DIAMETER = 0°30'
MOON DISTANCE = 395700 km

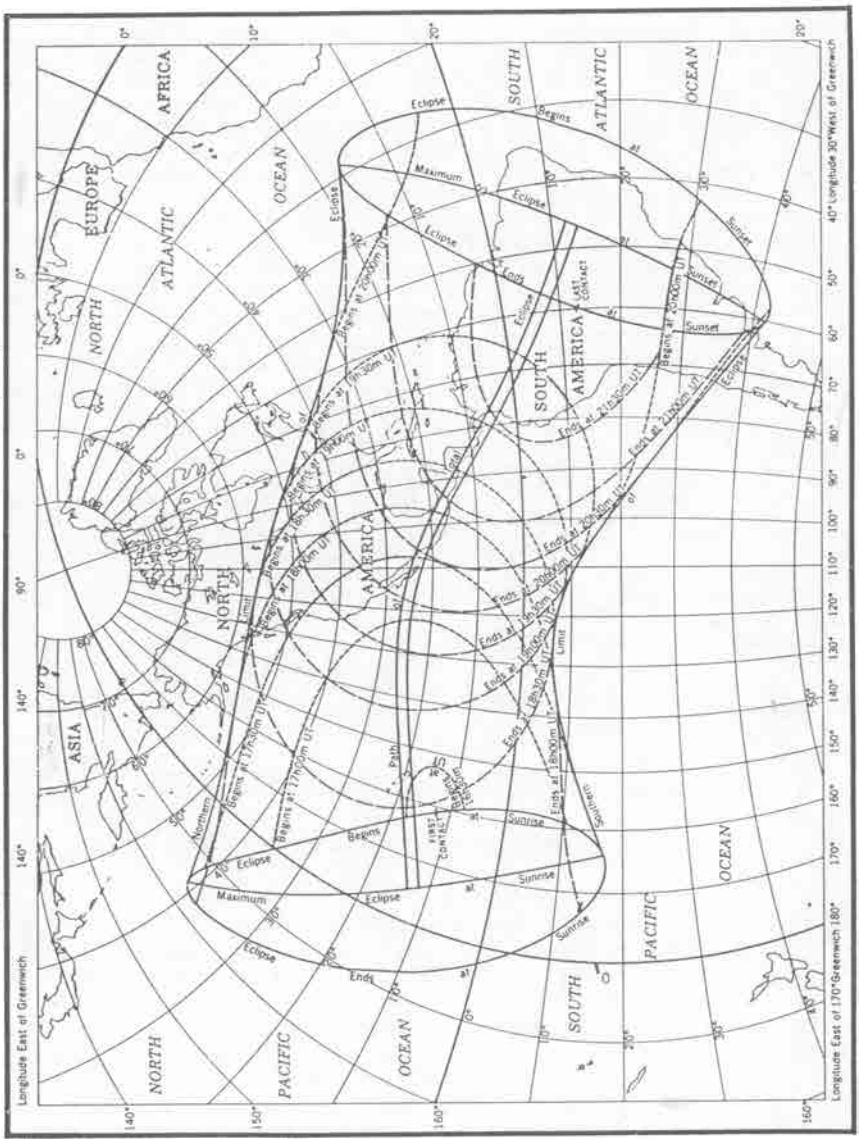
PARTIAL ECLIPSE OF THE MOON, December 21st

The initial stages of the eclipse are not visible as the Moon rises at 19h01m in the Northeast. At first contact with the umbra the Moon will be 8°45' above the horizon, and it will leave the umbra when at altitude 18° 15'.



UMBRA DIAMETER = 1°30'
PENUMBRA DIAMETER = 2°35'
MOON DIAMETER = 0°33'
MOON DISTANCE= 351700 km


ANNULAR SOLAR ECLIPSE OF 1991 JANUARY 15-16
NORTH AMERICA
PACIFIC OCEAN
ASIA
AUSTRALIA
INDIAN OCEAN
SOUTH PACIFIC OCEAN
SOUTH AMERICA
SOUTH ATLANTIC OCEAN
ANTARCTICA
Longitude East of Greenwich
Longitude West of Greenwich
Eclipse begins at 19h00m UT
Eclipse begins at 20h00m UT
Eclipse begins at 21h00m UT
Eclipse begins at 22h00m UT
Eclipse begins at 23h00m UT
Eclipse ends at 19h00m UT
Eclipse ends at 20h00m UT
Eclipse ends at 21h00m UT
Eclipse ends at 22h00m UT
Eclipse ends at 23h00m UT
Maximum Eclipse
Sunrise
Sunset
Limit of Path
Northern limit of Path
Southern limit of Path
FIRST CONTACT
LAST CONTACT


TOTAL SOLAR ECLIPSE OF 1991 JULY 11
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
NORTH AMERICA
SOUTH AMERICA
ATLANTIC OCEAN
EUROPE
AFRICA
ASIA
Path of Totality
Northern Limit
Southern Limit
Eclipse Begins at 17h30m UT
Eclipse Ends at 20h40m UT
Maximum Eclipse
Sunrise
Sunset
Longitude East of Greenwich
Longitude East of 170°Greenwich 180°
40° Longitude 30°West of Greenwich

COMETS FOR 1991

INTRODUCTION

WHAT IS A COMET ? It is a member of the Solar System which is normally in a very eccentric orbit around the Sun. The orbits of the "periodic", or regularly reappearing, comets are quite elongated or "egg shaped" compared to those of the planets. They also differ from the planets by being far less massive and mainly composed of water, in the form of ice, and dust. A common analogy is a "dirty snowball" (admittedly a number of kilometres in diameter). The time a periodic comet takes to orbit the Sun varies greatly from comet to comet. The comet with the shortest period, of just over 3 years, is "Encke". There are also a number of comets that are not expected to return for hundreds of years. Each year sees the discovery of around 10 to 20 new comets that have not been recorded before. The majority of these have either open ended orbits (ie. they are believed to be making their only visit to the Solar System and are not expected to ever return) or have extremely long orbital periods, in the thousands of years.

As the comet draws closer to the Sun, the nucleus, or snowball, heats up and the ice evaporates forming a cloud, called a "Coma", around the core. The coma can be tens of thousands of kilometres in diameter. The solar radiation, on its outward journey from the Sun, sweeps the coma cloud away forming the "tail" of the comet. The lost material from the coma will continue to be replenished from the nucleus as long as the comet stays close to the Sun. The point of closest approach a comet makes to the Sun, is referred to as it's perihelion. Comets are normally named after their discoverers.

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

This section is devoted to the periodic comets. The table below lists the comets expected to return in 1991. The tables on the following pages, give "ephemerides", a list of expected positions in the sky for different dates, for some of the brighter comets. Most of the comets expected in 1991 are extremely faint and would require professional size telescopes or long exposure astrophotographs to detect them.

NAME	PERIHELION DATE	PERIHELION DISTANCE (AU)	NAME	PERIHELION DATE	PERIHELION DISTANCE (AU)
Russell 1	Jan 04	2.174	Takamizawa (*)	Aug 18	1.59
Swift-Gehrels	Feb 22	1.355	Tsuchinshan 1	Aug 30	1.497
Wolf-Harrington	Apr 04	1.607	Skiff-Kosai	Sep 14	2.846
Haneda-Campos	Apr 09	1.224	Hartley 2 (*)	Sep 17	0.952
van Biesbroeck	Apr 24	2.4	Wirtanen	Sep 20	1.083
Hartley 1	Apr 28	1.795	Arend-Rigaux (*)	Oct 02	1.437
Arend	May 26	1.85	Faye(*)	Nov 16	1.593
Harrington-Abell	Jul 06	1.774	Shoemaker 1	Dec 18	1.985
Kowal-Mrkos	Jul 19	2.667	Kowal 2	Dec 28	1.5
Machholz (*)	Jul 22	0.125			

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

EXPLANATION OF COMET EPHEMERIDES

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

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

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

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

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

Mag — This is the expected total magnitude of the comet. The value is only an estimate (*) and is invariably based on its brightness at its previous return(s).

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

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

where H is the absolute magnitude of the comet, which is the theoretical brightness the comet would reach if it was one AU from the Sun and the Earth. The value, "n", is a constant for the comet. For most comets it's value is equal to 4.

Periodic Comets

ABEND-RIGAUX

Year	Mon	Day	R.A.		Dec		R	Δ	Elong	Mag
			h	m	°	'	AU	AU	°	
1991	JUL	13	4	23	7	56	2.22	1.69	47	15.5
1991	JUL	20	4	43	8	43	2.15	1.65	48	15.2
1991	JUL	27	5	04	9	24	2.09	1.62	49	15.0
1991	AUG	3	5	26	9	59	2.03	1.58	50	14.7
1991	AUG	10	5	48	10	27	1.97	1.55	51	14.5
1991	AUG	17	6	10	10	48	1.92	1.53	52	14.3
1991	AUG	24	6	32	11	01	1.87	1.50	53	14.1
1991	AUG	31	6	55	11	07	1.82	1.48	54	13.9
1991	SEP	7	7	18	11	06	1.78	1.47	55	13.7
1991	SEP	14	7	40	10	59	1.74	1.45	56	13.6
1991	SEP	21	8	03	10	45	1.71	1.44	58	13.5
1991	SEP	28	8	25	10	27	1.68	1.44	59	13.4
1991	OCT	5	8	47	10	04	1.64	1.44	60	13.4
1991	OCT	12	9	09	9	39	1.62	1.44	62	13.4
1991	OCT	19	9	30	9	12	1.59	1.45	63	13.4
1991	OCT	26	9	51	8	44	1.56	1.46	65	13.4
1991	NOV	2	10	11	8	18	1.54	1.48	68	13.5
1991	NOV	9	10	30	7	55	1.51	1.50	70	13.6
1991	NOV	16	10	48	7	36	1.48	1.52	73	13.7
1991	NOV	23	11	06	7	23	1.46	1.54	76	13.8
1991	NOV	30	11	22	7	16	1.43	1.57	79	13.9
1991	DEC	7	11	38	7	18	1.40	1.61	83	14.1
1991	DEC	14	11	52	7	30	1.37	1.64	86	14.2
1991	DEC	21	12	05	7	53	1.35	1.68	91	14.4
1991	DEC	28	12	17	8	28	1.32	1.71	95	14.5

FAYE

Year	Mon	Day	R.A.		Dec		R	Δ	Elong	Mag
			h	m	°	'	AU	AU	°	
1991	AUG	10	0	56	13	53	1.17	1.88	119	12.6
1991	AUG	17	1	05	14	27	1.08	1.84	123	12.3
1991	AUG	24	1	13	14	49	1.00	1.81	128	12.1
1991	AUG	31	1	21	14	57	0.93	1.78	133	11.8
1991	SEP	7	1	28	14	51	0.86	1.75	138	11.6
1991	SEP	14	1	34	14	27	0.80	1.72	144	11.4
1991	SEP	21	1	38	13	45	0.75	1.69	150	11.2
1991	SEP	28	1	42	12	44	0.71	1.67	156	11.0
1991	OCT	5	1	45	11	26	0.67	1.65	163	10.8
1991	OCT	12	1	47	9	53	0.64	1.63	170	10.7
1991	OCT	19	1	48	8	10	0.62	1.62	176	10.6
1991	OCT	26	1	49	6	25	0.62	1.61	174	10.5
1991	NOV	2	1	50	4	45	0.62	1.60	167	10.5
1991	NOV	9	1	52	3	18	0.63	1.60	160	10.5
1991	NOV	16	1	55	2	08	0.65	1.59	153	10.6
1991	NOV	23	1	59	1	20	0.68	1.59	146	10.7
1991	NOV	30	2	04	0	54	0.71	1.60	140	10.8
1991	DEC	7	2	11	0	49	0.75	1.61	135	10.9
1991	DEC	14	2	18	1	02	0.80	1.62	130	11.1
1991	DEC	21	2	27	1	32	0.85	1.63	125	11.3
1991	DEC	28	2	37	2	15	0.91	1.65	121	11.5
1992	JAN	4	2	48	3	08	0.98	1.67	117	11.7
1992	JAN	11	3	00	4	08	1.05	1.69	113	11.9
1992	JAN	18	3	12	5	12	1.12	1.72	109	12.1
1992	JAN	25	3	25	6	19	1.20	1.75	106	12.3

HARTLEY 2

Year	Mon	Day	R.A.		Dec		R	Δ	Elong	Mag
			h	m	°	'	AU	AU	°	
1991	JUN	8	22	57	5	43	1.35	1.67	89	13.5
1991	JUN	15	23	15	8	18	1.24	1.61	90	13.1
1991	JUN	22	23	35	11	07	1.13	1.54	91	12.7
1991	JUN	29	23	58	14	08	1.04	1.47	92	12.4
1991	JUL	6	0	23	17	22	0.95	1.41	91	12.0
1991	JUL	13	0	52	20	43	0.87	1.34	90	11.6
1991	JUL	20	1	25	24	05	0.80	1.28	88	11.2
1991	JUL	27	2	03	27	12	0.75	1.22	86	10.8
1991	AUG	3	2	47	29	47	0.71	1.16	82	10.5
1991	AUG	10	3	35	31	28	0.69	1.11	78	10.2
1991	AUG	17	4	25	32	00	0.68	1.06	74	10.0
1991	AUG	24	5	14	31	18	0.69	1.02	71	09.9
1991	AUG	31	6	00	29	34	0.71	0.99	67	09.8
1991	SEP	7	6	41	27	04	0.74	0.96	65	09.8
1991	SEP	14	7	18	24	08	0.78	0.95	63	09.8
1991	SEP	21	7	50	21	01	0.82	0.95	62	10.0
1991	SEP	28	8	18	17	52	0.86	0.97	62	10.1
1991	OCT	5	8	43	14	48	0.91	0.99	62	10.3
1991	OCT	12	9	05	11	51	0.95	1.02	63	10.6
1991	OCT	19	9	25	9	04	0.99	1.06	65	10.8
1991	OCT	26	9	42	6	28	1.02	1.11	67	11.1
1991	NOV	2	9	58	4	03	1.05	1.16	69	11.4
1991	NOV	9	10	11	1	50	1.08	1.22	72	11.6
1991	NOV	16	10	23	0	13	1.09	1.28	76	11.9
1991	NOV	23	10	33	-2	05	1.11	1.35	80	12.1

MACHHOLZ

Year	Mon	Day	R.A.		Dec		R	Δ	Elong	Mag
			h	m	°	'	AU	AU	°	
1991	APR	6	22	18	-39	25	2.50	2.15	59	18.3
1991	APR	13	22	35	-39	21	2.33	2.06	62	17.9
1991	APR	20	22	52	-39	18	2.17	1.97	65	17.6
1991	APR	27	23	12	-39	16	2.00	1.88	68	17.2
1991	MAY	4	23	34	-39	12	1.84	1.77	70	16.7
1991	MAY	11	23	58	-39	03	1.67	1.67	72	16.3
1991	MAY	18	0	26	-38	44	1.52	1.56	73	15.8
1991	MAY	25	0	59	-38	06	1.36	1.45	73	15.2
1991	JUN	1	1	37	-36	53	1.22	1.33	72	14.6
1991	JUN	8	2	20	-34	42	1.10	1.20	69	14.0
1991	JUN	15	3	09	-31	02	1.00	1.07	64	13.2
1991	JUN	22	4	02	-25	24	0.93	0.93	57	12.4
1991	JUN	29	4	55	-17	37	0.89	0.77	47	11.6
1991	JUL	6	5	47	-8	04	0.91	0.60	36	10.5
1991	JUL	13	6	36	2	46	0.98	0.40	23	08.9
1991	JUL	20	7	29	15	49	1.11	0.17	8	05.6
1991	JUL	27	9	04	27	58	1.06	0.23	13	06.7
1991	AUG	3	10	37	27	31	0.96	0.45	26	09.4
1991	AUG	10	11	56	22	00	0.95	0.64	38	10.9
1991	AUG	17	12	58	14	51	1.02	0.81	47	12.1
1991	AUG	24	13	45	8	11	1.14	0.96	53	13.1
1991	AUG	31	14	20	2	40	1.28	1.10	56	13.9
1991	SEP	7	14	48	-1	44	1.45	1.24	57	14.7
1991	SEP	14	15	11	-5	13	1.62	1.36	57	15.3
1991	SEP	21	15	30	-8	01	1.80	1.48	55	15.9

Periodic Comets

TAKAMIZAWA

Year	Mon	Day	R.A.		Dec		R	Δ	Elong	Mag
			h	m	°	'	AU	AU	°	
1991	MAY	18	13	54	8	24	0.94	1.84	142	09.8
1991	MAY	25	13	52	8	05	0.94	1.81	136	09.7
1991	JUN	1	13	50	7	28	0.95	1.78	130	09.7
1991	JUN	8	13	51	6	32	0.96	1.75	125	09.6
1991	JUN	15	13	53	5	20	0.98	1.72	119	09.6
1991	JUN	22	13	57	3	53	1.00	1.70	115	09.6
1991	JUN	29	14	03	2	15	1.02	1.67	110	09.6
1991	JUL	6	14	10	0	26	1.05	1.65	106	09.6
1991	JUL	13	14	20	-1	31	1.08	1.63	103	09.6
1991	JUL	20	14	30	-3	33	1.11	1.62	99	09.6
1991	JUL	27	14	42	-5	39	1.14	1.61	96	09.6
1991	AUG	3	14	56	-7	47	1.17	1.60	94	09.7
1991	AUG	10	15	11	-9	54	1.21	1.59	91	09.7
1991	AUG	17	15	27	-11	59	1.25	1.59	89	09.8
1991	AUG	24	15	44	-13	59	1.29	1.59	86	09.9
1991	AUG	31	16	01	-15	52	1.34	1.60	84	10.0
1991	SEP	7	16	20	-17	37	1.39	1.60	82	10.1
1991	SEP	14	16	40	-19	12	1.44	1.61	80	10.2
1991	SEP	21	17	00	-20	36	1.50	1.63	78	10.3
1991	SEP	28	17	21	-21	46	1.56	1.64	76	10.4
1991	OCT	5	17	41	-22	43	1.63	1.66	74	10.6
1991	OCT	12	18	03	-23	27	1.69	1.69	72	10.7
1991	OCT	19	18	24	-23	56	1.77	1.71	70	10.9
1991	OCT	26	18	45	-24	12	1.84	1.74	68	11.0
1991	NOV	2	19	06	-24	15	1.92	1.77	66	11.2

VAN BIESBROECK

Year	Mon	Day	R.A.		Dec		R	Δ	Elong	Mag
			h	m	°	'	AU	AU	°	
1991	MAR	2	19	05	-17	32	2.86	2.44	56	13.7
1991	MAR	9	19	19	-17	07	2.78	2.43	59	13.6
1991	MAR	16	19	32	-16	38	2.70	2.42	63	13.5
1991	MAR	23	19	44	-16	07	2.63	2.42	67	13.4
1991	MAR	30	19	57	-15	33	2.55	2.41	71	13.3
1991	APR	6	20	09	-14	58	2.47	2.41	75	13.3
1991	APR	13	20	20	-14	21	2.39	2.40	79	13.2
1991	APR	20	20	31	-13	44	2.31	2.40	83	13.1
1991	APR	27	20	41	-13	07	2.23	2.40	87	13.0
1991	MAY	4	20	50	-12	32	2.15	2.40	92	13.0
1991	MAY	11	20	58	-11	59	2.07	2.40	96	12.9
1991	MAY	18	21	06	-11	29	2.00	2.41	101	12.8
1991	MAY	25	21	13	-11	03	1.93	2.41	106	12.8
1991	JUN	1	21	19	-10	41	1.86	2.42	111	12.7
1991	JUN	8	21	23	-10	26	1.79	2.43	117	12.6
1991	JUN	15	21	27	-10	18	1.73	2.44	123	12.6
1991	JUN	22	21	29	-10	17	1.68	2.45	129	12.5
1991	JUN	29	21	30	-10	24	1.63	2.46	135	12.5
1991	JUL	6	21	30	-10	39	1.59	2.47	142	12.4
1991	JUL	13	21	29	-11	01	1.56	2.49	149	12.4
1991	JUL	20	21	27	-11	31	1.54	2.50	156	12.4
1991	JUL	27	21	24	-12	06	1.53	2.52	164	12.4
1991	AUG	3	21	21	-12	45	1.53	2.54	171	12.5
1991	AUG	10	21	17	-13	26	1.54	2.56	178	12.5
1991	AUG	17	21	13	-14	08	1.57	2.58	173	12.6

ORIENTATION OF THE SUN

Date	P°	B_o°	L_o°	Date	P°	B_o°	L_o°	Date	P°	B_o°	L_o°
Jan 05	+00.32	-3.44	139.79	May 11	-22.15	-3.15	278.61	Sep 07	+22.39	+7.23	144.54
Jan 12	-03.05	-4.20	47.61	May 18	-20.27	-2.36	186.04	Sep 14	+23.80	+7.21	52.11
Jan 19	-06.33	-4.90	315.44	May 25	-18.09	-1.54	93.44	Sep 21	+24.91	+7.08	319.70
Jan 26	-09.46	-5.52	223.27	Jun 0l	-15.62	-0.71	0.81	Sep 28	+25.71	+6.85	227.31
Feb 02	-12.41	-6.06	131.10	Jun 08	-12.92	+0.13	268.17	Oct 05	+26.17	+6.52	134.94
Feb 09	-15.13	-6.50	38.94	Jun 15	-10.01	+0.97	175.52	Oct 12	+26.29	+6.10	42.59
Feb 16	-17.59	-6.84	306.77	Jun 22	-06.96	+1.80	82.86	Oct 19	+26.05	+5.58	310.25
Feb 23	-19.78	-7.08	214.59	Jun 29	-03.82	+2.60	350.20	Oct 26	+25.43	+4.98	217.93
Mar 02	-21.68	-7.21	122.38	Jul 06	-00.65	+3.36	257.55	Nov 02	+24.42	+4.31	125.62
Mar 09	-23.26	-7.23	30.16	Jul 13	+02.51	+4.09	164.91	Nov 09	+23.04	+3.57	33.32
Mar 16	-24.53	-7.01	297.91	Jul 20	+05.61	+4.75	72.29	Nov 16	+21.27	+2.77	301.04
Mar 23	-25.46	-6.95	205.63	Jul 27	+08.59	+5.35	339.68	Nov 23	+19.14	+1.93	208.77
Mar 30	-26.05	-6.65	113.32	Aug 03	+11.42	+5.89	247.09	Nov 30	+16.67	+1.06	116.50
Apr 06	-26.29	-6.26	20.96	Aug 10	+14.07	+6.34	154.53	Dec 07	+13.89	+0.17	24.26
Apr 13	-26.18	-5.78	288.57	Aug 17	+16.51	+6.70	61.99	Dec 14	+10.87	-0.73	292.03
Apr 20	-25.71	-5.22	196.14	Aug 24	+17.73	+6.98	329.48	Dec 21	+07.66	-1.61	199.80
Apr 27	-28.87	-4.59	103.67	Aug 31	+20.69	+7.15	237.00	Dec 28	+04.32	-2.47	107.59
May 04	-23.68	-3.89	11.16								

VARIATION OF L_o

HOUR	VARIATION	DAY	VARIATION
1	0.55	1	13.18
2	1.10	2	26.37
3	1.65	3	39.55
4	2.20	4	52.73
5	2.75	5	65.91
6	3.30	6	79.10
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		

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

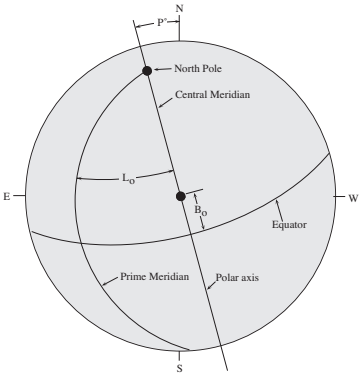
B_o — Heliocentric Latitude of centre of Sun

L_o — Heliocentric Longitude of centre of Sun

SYNODIC ROTATION NUMBERS

NUMBER	BEGINS	
1837	Dec	19.28
1838	Jan	15.62
1839	Feb	11.96
1840	Mar	11.29
1841	Apr	7.59
1842	May	4.84
1843	Jun	1.06
1844	Jun	28.26
1845	Jul	25.46
1846	Aug	21.69
1847	Sep	17.95
1848	Oct	15.23
1849	Nov	11.53
1850	Dec	8.84
1851	Jan	5.17

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



P° Position angle of Polar Axis.
+ if north pole is east of north point
- if north pole is west of north point

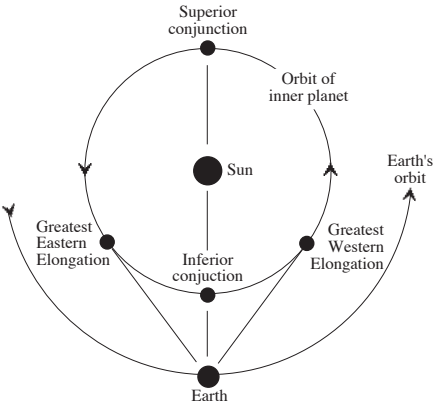
B_o Heliocentric Latitude of centre of Sun

L_o Heliocentric Longitude of centre of Sun

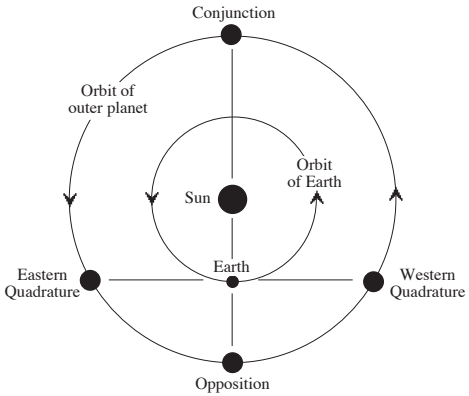
The rotation period of the Sun depends on latitude. The sidereal period of rotation at the equator is 25.38 days.

The mean synodic period is 27.28 days.

ORBITAL ASPECTS



INNER PLANETS



OUTER PLANETS

THE

This section includes all information on the planets, their satellites, and the major asteroids that will allow the observer to choose the most advantageous period for observation. Much of the data is expressed in several different forms, and it will depend on the readers requirements on how this information is extracted. For example planetary rise/set times are given to the nearest minute in tabular form, but a near approximation of rise/set times may be obtained by simply glancing at a chart.

Immediately after this introduction to the tables and diagrams, a brief section on each planet is provided. A short description of the visibility of the planet during the year, general data, geocentric and heliocentric events are included. Conjunctions are provided when the planet is at it's best placement for observation, and not necessarily when the two bodies are at their nearest separation. The appearance (size and phase) of each planet, except Pluto, is given in graphical form. They are all drawn to the same scale to enable comparisons. Details of planetary satellites conclude each section.

PLANET RISE and SET (p. 46)

This diagram is oriented with the midnight line centred. The evening sky (4pm to 12pm) is below the midnight line and the morning sky (12pm to 8am) is above. The planet rise set chart will quickly show if a planet is visible during twilight or night The two bands of light shading indicate morning and evening twilight.

MAGNITUDES of the PLANETS and MAJOR ASTEROIDS (p. 45)

This chart details the variation in magnitude of the planets and asteroids and can be used in conjunction with several other charts to determine the best observation time of each object.

MERIDIAN PASSAGE of the SUN and PLANETS (p. 54)

This diagram shows the local mean time of meridian passage of the Sun and planets throughout the year. At a glance, the observer can determine the following:

1. Whether a planet is visible in the morning or evening sky.
2. Position of the planets during twilight.
3. If a planet is too close to the Sun for observation.
4. If a planet is in close proximity to another.

The shaded band on each side of the Sun line is 45 minutes wide. Any planet within this area is generally considered too close to the Sun for observation. When the meridian passage of a planet occurs near midnight, it is close to opposition to the Sun and will be visible all night and during the morning and evening twilights.

PLANETARY ELONGATION (p. 52)

Similar presentation to the meridian passage diagram but the vertical axis is expressed in degrees in lieu of hours. A planet situated at 180° from the Sun is at opposition and visible all night and during the morning and evening twilights and is at conjunction as it crosses the 0° line.

PLANETS

DECLINATIONS of the SUN and PLANETS (p. 53)

The declination diagram is useful in establishing which planets are favoured with southern declinations during the year. A planet with northern declination(+) will appear closer to the northern horizon at meridian transit than when at a southern declination(-) and consequently a higher altitude at meridian transit.

The declination diagram should not be relied on to obtain the best observation period for each planet. Mars for example, on the declination diagram would appear best suited from August to December, but a check of the planetary angular size diagram shows that it's disk size is at it's largest during early January. Also it can be seen from the meridian passage diagram that it crosses the meridian almost 9 hours after the Sun in January, providing an 8 hour observing window.

PLANETARY ANGULAR SIZE (p. 55)

The planetary angular size diagram shows the variation in angular diameter of each planet's disk throughout the year. By using this diagram in conjunction with the meridian passage chart each planet may be observed at it's largest diameter.

PHOTOGRAPHIC EXPOSURE GUIDE for the PLANETS (p. 56)

The exposure guide will give satisfactory results provided the focal length of the system is known to a reasonable degree of accuracy. Although high speed film will produce a desirable short exposure, the image may be degraded by unacceptable grain on the enlargement. An accurate right ascension drive is essential for good planetary photography. Novices should not be deterred as trial and error will give results, once a correct exposure has been taken it can be plotted on the graph and estimations for other objects may be calculated. It is recommended that beginners try their hand at lunar photography before proceeding to planetary work.

PLANET RISE/SET TABLE through to NEPTUNE'S SATELLITES

The editors feel that these pages are self explanatory and require no introduction. Should any reader feel they need help on these pages or any other information in ASTRONOMY 1991 please write to our FREE INFORMATION SERVICE, we will be pleased to assist.

QUASAR PUBLICATIONS
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MERCURY

Mercury can only be seen low in the east before sunrise, or low in the west after sunset (about the time of civil twilight, when the Sun is 6° below the horizon). It is visible in the mornings between the following dates: January 1st to February 18th, April 23rd to June 10th, August 30th to September 23rd and December 14th to December 31st. Mercury is brighter at the end of each period, (the best conditions for southern observers occur during most of January and early February and from the end of April until the end of May).

In the evenings, Mercury is visible between the following dates: March 12th to April 6th, June 25th to August 15th and October 18th to December 3rd. Mercury is brighter at the end of each period, (the best conditions for southern observers occur from early July until just before mid-August and late October to late November).

GENERAL DATA

EQUATORIAL DIAMETER	4870 kms	MASS {Earth= 1)	0.055
SIDEREAL PERIOD	87.97 days	No. of MOONS	0
SYNODIC PERIOD	115.8 days	AXIAL ROTATION	59 days
MEAN DISTANCE FROM SUN	57856000 kms	ECCENTRICITY	0.20562
DIST. FROM SUN (Earth= 1)	0.387	INCLINATION TO ECLIPTIC	7°00'
MAGNITUDE AT ELONGATION	0.16		

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

		d h		d h		d h		d h
STATIONARY	Jan	04 05	Apr	27d16h	Aug	31 08	Dec	18 22
GREATEST ELONG. WEST	Jan	14 19 (24°)	May	13 04	Sep	08 04 (18°)	Dec	28 07
SUPERIOR CONJUNCTION	Mar	02 13	Jun	17 15	Oct	04 03		
GREATEST ELONG. EAST	Mar	28 01	Jul	25 12 (27°)	Nov	19 12 (22°)		
STATIONARY	Apr	05 03	Aug	17 14	Nov	29 04		
INFERIOR CONJUNCTION	Apr	15 07	Aug	22 07	Dec	09 01		

HELIOCENTRIC EVENTS (as measured from the centre of the Sun)

APHELION	PERIHELION	GREATEST LATITUDE NORTH	DESCENDING NODE	GREATEST LATITUDE SOUTH	ASCENDING NODE
Feb 3	Mar 19	Jan 1	Jan 24	Feb 24	Mar 15
May 2	Jun 15	Mar 30	Apr 22	May 23	Jun 11
Jul 29	Sep 11	Jun 26	Jul 19	Aug 19	Sep 7
Oct 25	Dec 8	Sep 22	Oct 15	Nov 15	Dec 4
		Dec 19			

CONJUNCTIONS of MERCURY with the MOON, PLANETS and BRIGHT STARS.

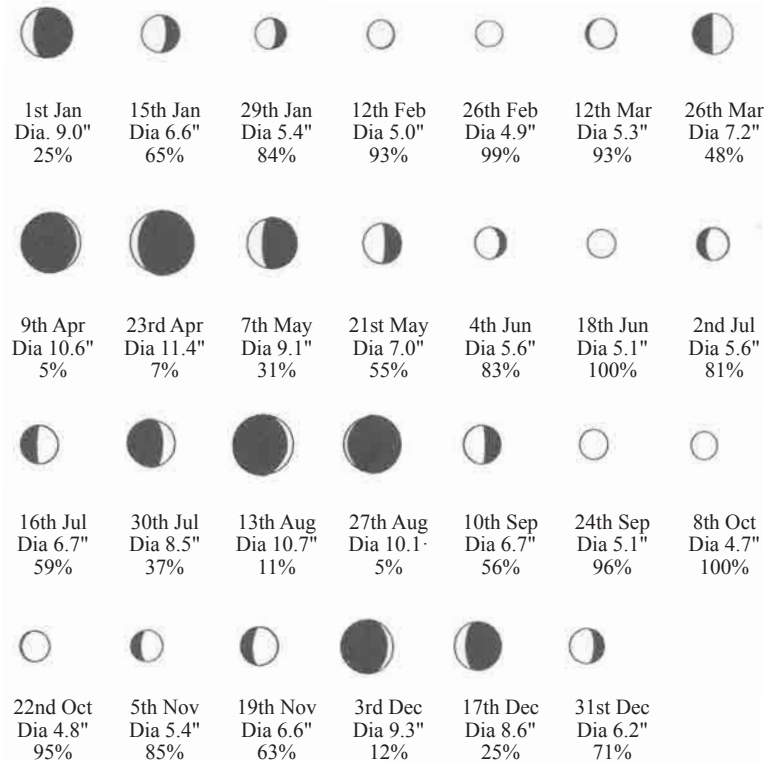
Each event is given al the time of Civil Twilight (when the Sun is 6° below the horizon), while the planet is still at a reasonable altitude for observations. (Data given for events with separation of 5° or less)

DATE	TIME	BODY	ALTITUDE of MERCURY	SEPARATION
Jan 14	04.38 am	Moon	15°	3°50'
Jan 23	04.45 am	Uranus	15°	1°15'
Jan 26	04.45 am	Uranus	14°	2°40'
Jan 26	04.45 am	Neptune*	14°	1°30'
Feb 06	05.00 am	Saturn	11°	1°15'
Jul 15	05.25 pm	Jupiter	17°	0°05'
Jul 27	05.45 pm	Regulus	19°	2°10'
Aug 08	05.40 pm	Venus	16°	2°00'
Aug 11	05.50 pm	Moon	110	1°30'
Nov 08	06.49 pm	Moon	15°	2°00'
Nov 11	07.00 pm	Antares	15°	2°00'

*Neptune situated 0° 15' from Omicron Sagittarii (Mag 3.8)

APPEARANCE of MERCURY

The diagrams below illustrate the appearance of Mercury every fortnight from 1st January. Below each image is the date, diameter in seconds of arc and the percentage of the disc illuminated.



VENUS

Venus is a brilliant object in the evening sky from the beginning of the year until mid-August when it becomes too close to the Sun for observation. Towards the end of August it reappears in the morning sky where it stays until the end of the year.

Venus will be visible in the morning twilight between August 27th and December, and in the Evening twilight between January 1st to August 18th.

GENERAL DATA

EQUATORIAL DIAMETER	12100 kms	MASS (Earth= 1)	0.816
SIDEREAL PERIOD	224.7 days	No of MOONS	0
SYNODIC PERIOD	583.9 days	AXIAL ROTATION	243 days
MEAN DISTANCE FROM SUN	108132000 kms	ECCENTRICITY	0.00681
DIST. FROM SUN (Earth =1)	0.723	INCLINATION TO ECLIPTIC	3°23'38"
MAGNITUDE AT ELONGATION	-4.07	OBLIQUITY OF EQ. TO ORBIT	92°00'

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

GREATEST ELONG. EAST	Jun	14d08h (45°)	STATIONARY	Sep	12dl2h
GREATEST BRILLIANCY	Jul	17 15	GREATEST BRILLIANCY	Sep	29 09
STATIONARY	Jul	30 14	GREATEST ELONG. WEST	Nov	02 19 (47°)
INFERIOR CONJUNCTION	Aug	23 06			

HELIOCENTRIC EVENTS (as measured from the centre of the Sun)

APHELION	PERIHELION	GREATEST LATITUDE NORTH	DESCENDING NODE	GREATEST LATITUDE SOUTH	ASCENDING NODE
	Apr 21	May 12	Jul 7	Jan 21	Mar 18
Aug 11	Dec 2	Dec 23		Sep 2	Oct 29

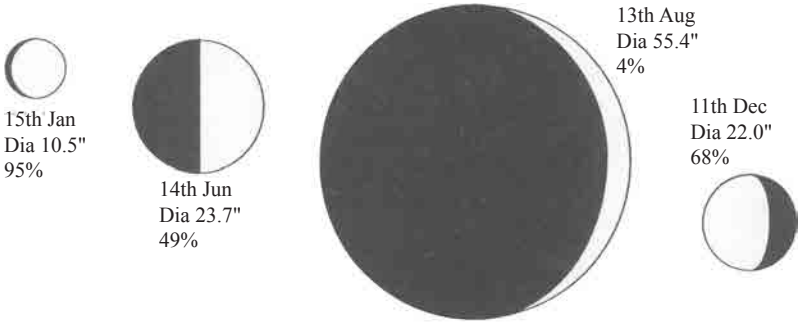
CONJUNCTIONS of VENUS with the MOON, PLANETS and BRIGHT STARS.

Each event is given al the time of Civil Twilight (when the Sun is 6° below the horizon), while the planet is still at a reasonable altitude for observations. (Data given for events with separation of 5° or less)

DATE	TIME	BODY	ALTITUDE of VENUS	SEPARATION
May 17	05.30 pm	Moon	20°	1°00'
May 31	05.30 pm	Pollux	23°	4°10'
Jun 18	05.20 pm	Jupiter	28°	1°00'
Jun 24	05.30 pm	Mars	29°	0°15'
Jul 11	05.30 pm	Regulus	31°	1°00'
Jul 11	05.30 pm	Mars	31°	3°00'
Jul 22	05.40 pm	Mars	28°	3°30'
Aug 8	05.40 pm	Mercury	17°	2°00'
Aug 11	05.50 pm	Moon	12°	3°20'
Oct 4	04.50 am	Moon	16°	2°33'
Oct 8	05.00 am	Regulus	19°	3°20'
Oct 16	04.50 am	Jupiter	19°	2°30'
Nov 3	04.25 am	Moon	18°	4°50'
Nov 29	04.10 am	Spica	20°	4°45'

APPEARANCE of VENUS

The diagrams below illustrate the appearance of Venus. Near each image is the date, diameter in seconds of arc and the percentage of the disc illuminated.



MARS

Mars can be seen in January for more than half the night in Taurus, it's eastward elongation gradually decreases until it can only be seen in the evening sky passing from Taurus through Gemini, Cancer, Leo and into Virgo where towards the end of September it becomes too close to the Sun for observation. It reappears in the morning sky in Ophiuchus in late December.

GENERAL DATA

EQUATORIAL DIAMETER	6760 kms	MASS (Earth= l)	0.107
SIDEREAL PERIOD	687.0 days	No of MOONS	2
SYNODIC PERIOD	779.8 days	AXIAL ROTATION	24.6 hrs
MEAN DISTANCE FROM SUN	227780000 kms	ECCENTRICITY	0.09333
DIST. FROM SUN (Earth =,,l)	1.524	INCLINATION TO ECLIPTIC	1°51'01"
MAGNITUDE AT Opposition	-2.01	OBLIQUITY OF EQ. TO ORBIT	25°10'

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

STATIONARY	Jul 02d 01h	CONJUNCTION	Nov 08d 19h

HELIOCENTRIC EVENTS (as measured from the centre of the Sun)

APHELION	PERIHELION	GREATEST LATITUDE NORTH	DESCENDING NODE	GREATEST LATITUDE SOUTH	ASCENDING NODE
Jun 9		May 2	Nov 16		

CONJUNCTIONS of MARS with the MOON, PLANETS and BRIGHT STARS.

(with separation of 5° or less)

DATE	EVENT	TIME	BODY	SEPARATION
Jan 25	3	11.30 pm	Moon (9 days old)	3°00'
Feb 22	3	10.15 pm	Moon (8 days old)	2°30'
Mar 22	3	09.20 pm	Moon (7 days old)	4°00'
May 18	3	08.10 pm	Moon (5 days old)	1°40'
Jun 14	1	06.20 pm	Jupiter	0°40'
Jun 24	1	06.30 pm	Venus	0°15'
Jul 11	2	05.30 pm	Venus	3°00'
Jul 14	3	07.10 pm	Moon (3 days old)	5°00'
Jul 15	0	06.30 pm	Regulus	0°40'
Jul 22	1	05.40 pm	Venus	3°30'
Jul 22	1	06.30 pm	Venus	3°40'

All events are listed either at the closest approach or at the best observable time nearest conjunction with the separation given for that time, the actual conjunction may occur during daylight hours or when the object is below the observers horizon. The Event column indicates whether conjunction is observable (0) or if the event has been chosen for a convenient time when the objects appear closest and can be seen by the observer (1,2 or3).

Event 0 = Closest approach
1 = At astronomical twilight (when the Sun is 18° below the horizon).
2 = At civil twilight (when the Sun is 6° below the horizon)
3 = The actual conjunction occurs when the moon is very close to or below the horizon. At the time chosen, the moon has an altitude of 10°, which is more reasonable for observations.

APPEARANCE of MARS

The diagrams below illustrate the appearance of Mars. Below each image is the date, diameter in seconds of arc and the percentage of the disc illuminated.

1st Jan	1st Apr	30th Jun	28th Sep	27th Dec
Dia 13.8"	Dia 6.1·	Dia 4.1"	Dia 3.9"	Dia 3.9"
95%	90%	95%	100%	99%

SATELLITES of MARS

SATELLITE	ORBITAL PERIOD (days)	SEMI MAJOR AXIS ($x10^3$ km)	ORBITAL ECCEN-TRICITY	INCL. TO PLANET EQUATOR	DIAMETER (KMS)	MAG AT OPP.
Phobos	0.319	9.378	0.015	1°0	27x21.6x18.8	11.3
Deimos	1.262	23.459	0.0005	0°9 - 2°7	15x12.2x11	12.4

MINOR PLANETS

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

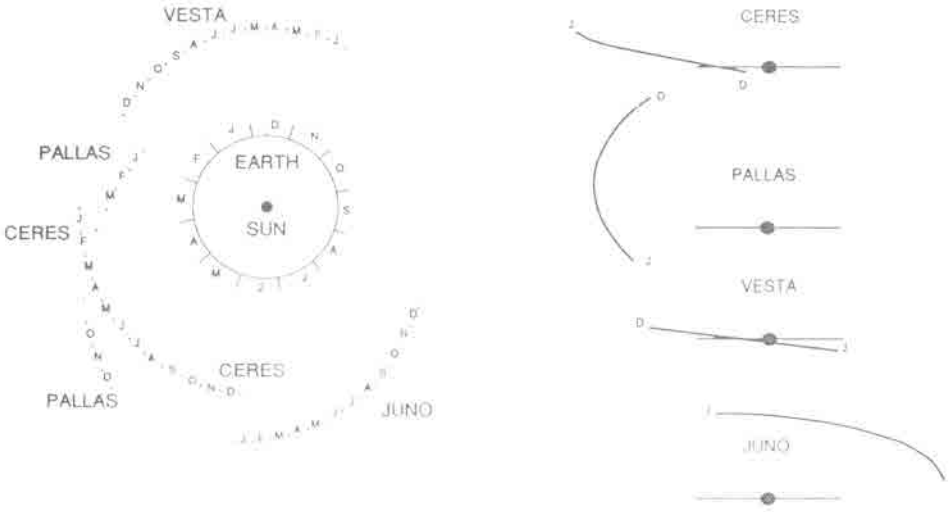
	STATIONARY	OPPOSITION	STATIONARY	CONJUNCTION
CERES	Mar 03	Apr 17	Jun 10	Dec 11
PALLAS	Jan 23	Mar 06	Apr 10	Nov 04
JUNO	May 23	Jul 16	Sep 06	-
VESTA	-	-	Jan 05	Jul 09

VISUAL MAGNITUDES

DATE	CERES	PALLAS	JUNO	VESTA
Jan 04	8.6	8.0	11.3	7.4
Feb 13	8.1	7.2	11.4	8.0
Mar 25	7.3	7.1	11.1	8.3
May 04	7.2	8.3	10.7	8.4
Jun 13	8.0	9.0	10.0	8.3
Jul 23	8.6	9.5	9.4	8.1
Sep 01	9.0	9.6	9.9	8.3
Oct 11	9.0	9.7	10.3	8.2
Nov 20	8.8	9.8	10.5	7.9
Dec 30	8.8	10.0	10.4	7.4

HELIOCENTRIC POSITIONS

The diagram on left shows the positions of the major asteroids in relation to the Earth for each month of the year as viewed from a point in space 90° above the ecliptic. The diagrams on right shows the view along the ecliptic plane, the horizontal line represents the Earth's orbit. All distances are drawn to scale.



JUPITER

Jupiter can be seen for most of the night in Cancer, it's westward elongation gradually increases until it is at opposition on January 29th when it can be seen throughout the night. It's eastward elongation then gradually decreases as it passes into Leo in mid-July where it can be seen only in the evening sky. In early August it becomes too close to the Sun for observation until the beginning of September when it reappears in the morning sky in Leo in which constellation it remains for the rest of the year (passing 0°.4 north of Regulus on September 10th). Its eastward elongation gradually increases until by mid-December it can be seen for more than half the night.

CONJUNCTIONS of JUPITER with the MOON, PLANETS.

(with separation of 5° or less)

DATE	EVENT	TIME	BODY	SEPARATION
Jan 3	1	03.10 am	Moon (17 days old)	3°40'
Jan 30	1	08.40 pm	Moon (15 days old)	4°50'
Feb 26	1	08.00 pm	Moon (12 days old)	1°40'
Mar 25	0	10.30 pm	Moon (10 days old)	1°00'
Apr 21	3	10.30 pm	Moon (7 days old)	4°30'
May 19	0	06.30 pm	Moon (6 days old)	2°10'
Jun 14	1	06.20 pm	Mars	0°40'
Jun 18	2	05.20 pm	Venus	1°00'
Jul 15	2	05.25 pm	Mercury	0°05'
Oct 16	2	04.50 am	Venus	2°30'
Nov 11	1	03.30 am	Moon (25 days old)	4°30'

All events are listed either at the closest approach or at the best observable time nearest conjunction with the separation given for that time, the actual conjunction may occur during daylight hours or when the object is below the observers horizon. The Event column indicates whether conjunction is observable (0) or if the event has been chosen for a convenient time when the objects appear closest and can be seen by the observer (1,2 or3).

Event 0 = Closest approach
1 = At astronomical twilight (when the Sun is 18° below the horizon).
2 = At civil twilight (when the Sun is 6° below the horizon)
3 = The actual conjunction occurs when the moon is very close to or below the horizon. At the time chosen, the moon has an altitude of 10°, which is more reasonable for observations.

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

STATIONARY	OPPOSITION	STATIONARY	CONJUNCTION
Dec 3ld22h	Jan 29d10h	Mar 3ld00h	Aug 18d08h

GENERAL DATA

EQUATORIAL DIAMETER..... 142800 kms
SIDEREAL PERIOD..... 11.86 years
SYNODIC PERIOD..... 398.8 days
MEAN DISTANCE FROM SUN 7777760000 kms
DIST. FROM SUN (Earth =1)..... 5.203
MAGNITUDE AT OPPOSITION ..... -2.7

MASS (Earth= 1)..... 317.9
No of MOONS..... 16
EQUATORIAL ROTATION..... 9.8 hrs
ECCENTRICITY..... 0.04837
INCLINATION TO ECLIPTIC ..... 1 °18'28"
OBLIQUITY OF EQ. TO ORBIT ..... 3°07

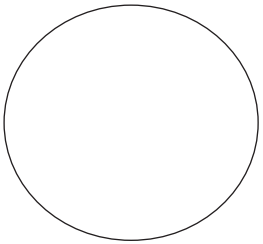
SATELLITES of JUPITER

SATELLITE	ORBITAL PERIOD (days)	SEMI MAJOR AXIS ($x10^3$ km)	ORBITAL ECCEN-TRICITY	INCL. TO PLANET EQUATOR	DIAMETER (KMS)	MAG AT OPP.
Io	1.769	422	0.004	0°.04	3630	5.02
Europa	3.551	671	0.009	0°.47	3138	5.29
Ganymede	7.155	1070	0.002	0°.21	5262	4.61
Callisto	16.689	1883	0.007	0°.51	4800	5.65
Amalthea	0.498	181	0.003	0°.40	270xl66x150	14.1
Himalia	250.566	11480	0.15798	27°.63	186	14.84
Elara	259.653	11737	0.20719	24°.77	76	16.77
Pasiphae[1]	735	23500	0.378	145°	50	17.03
Sinope[1]	758	23700	0.275	153°	36	18.3
Lysithea	259.22	11720	0.107	29°.02	36	18.4
Carme[1]	692	22600	0.20678	164°	40	18.0
Aanake[1]	631	21200	0.1687	147°	30	18.9
Leda	238.72	11094	0.14762	26°.07	16	20.2
Thebe	0.675	222	0.015	0°.08	110x90	15.6
Adratea	0.298	129	-	-	25x20x15	19.1
Metis	0.295	128	-	-	40	17.5

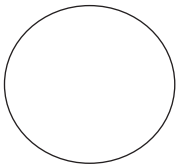
[1] = In retrograde

APPEARANCE OF JUPITER

The diagrams below illustrate the appearance of Jupiter at it's largest and smallest diameter during 199l.



31st Jan
Dia 45.7"



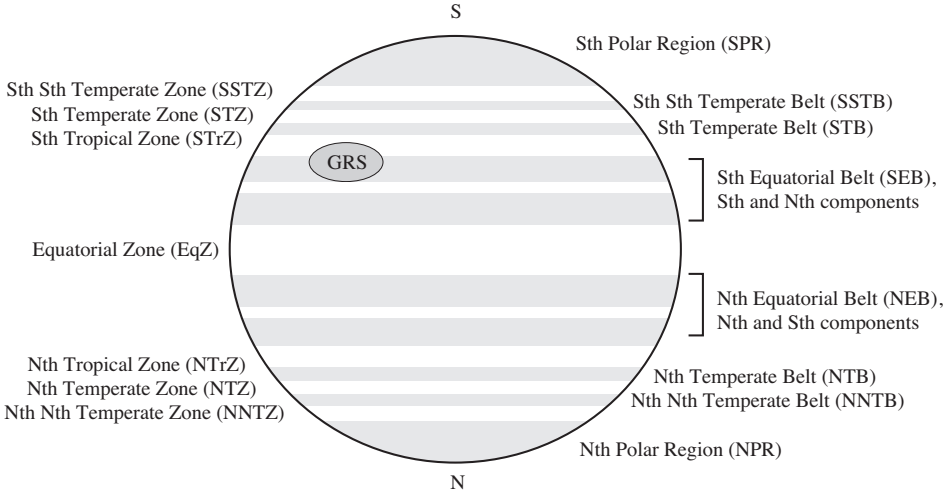
29th Aug
Dia 31.0"

OBSERVING JUPITER

The diagram below details Jupiter's belts and zones. The telescopic appearance may not always show such clear divisions due to instrument size, atmospheric turbulence and the tendency for belts and zones to merge and change in size and intensity from time to time. The most obvious features in small instruments are the North and South Equatorial Belts separated by the equatorial zone. The North and South Polar Regions appear lighter than the equatorial belts and the temperate banding is general! y less clear.

At the boundaries between the belts and zones, where there is a substantial change in wind speed, a wealth of detail awaits the patient observer. Bright ovals, and wisps may be visible within the belts, and zones may contain projections and bridges.

JUPITER'S SYSTEM OF BELTS AND ZONES.



GRS = Great Red Spot

SATURN

Saturn can be seen on January 1st in the evening sky in Sagittarius then it becomes too close to the Sun for observation. It reappears in the morning sky in early February in Capricornus in which constellation it remains for the rest of the year. Its westward elongation gradually increases until it is at opposition on July 27th when it is visible throughout the night Its eastward elongation then gradually decreases until from late October it can only be seen in the evening sky.

CONJUNCTIONS of SATURN with the MOON, PLANETS.

(with separation of 5° or less)

DATE	EVENT	TIME	BODY	SEPARATION
Feb 6	2	05.00 am	Mercury	1°15'
Apr 9	0	04.50 am	Moon (23 days old)	1°25'
Jun 6	0	09.30 pm	Moon (19 days old)	2°10'
Jun 30	0	01.10 am	Moon (17 days old)	2°10'
Jul 27	0	04.50 am	Moon (15 days old)	2°30'
Aug 23	3	03.58 am	Moon (12 days old)	3°20'
Sep 19	1	07.15 pm	Moon (10 days old)	4°10'
Oct 10	0	07.10 pm	Moon (8 days old)	2°20'
Dec 12	1	08.40 pm	Moon (4 days old)	3°25'

All events are listed either at the closest approach or at the best observable time nearest conjunction with the separation given for that time, the actual conjunction may occur during daylight hours or when the object is below the observers horizon. The Event column indicates whether conjunction is observable (0) or if the event has been chosen for a convenient time when the objects appear closest and can be seen by the observer (1,2 or3).

Event 0 = Closest approach
1 = At astronomical twilight (when the Sun is 18° below the horizon).
2 = At civil twilight (when the Sun is 6° below the horizon)
3 = The actual conjunction occurs when the moon is very close to or below the horizon. At the time chosen, the moon has an altitude of 10°, which is more reasonable for observations.

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

STATIONARY	OPPOSITION	STATIONARY	CONJUNCTION
May 17d22h	Jul 29d10h	Oct 05d 12h	Jan 18d18h

GENERAL DATA

EQUATORIAL DIAMETER..... 120000 kms	MASS (Earth = 1) 95.2
SIDEREAL PERIOD.....29.46 years	No of MOONS..... 17
SYNODIC PERIOD .....378.0 days	AXIAL ROTATION..... 10.4 hrs
MEAN DISTANCE FROM SUN 1425983000 kms	ECCENTRICITY..... 0.05582
DIST. FROM SUN (Earth = 1) 9.540	INCLINATION TO ECLIPTIC. ..... 2°29'29"
MAGNITUDE AT OPPOSITION 0.67	OBLIQUITY OF EQ. TO ORBIT .....26°45'

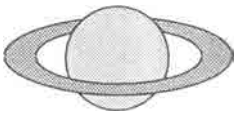
SATELLITES of SATURN

SATELLITE	ORBITAL PERIOD (days)	SEMI MAJOR AXIS ($x10^3$ km)	ORBITAL ECCEN-TRICITY	INCL. TO PLANET EQUATOR	DIAMETER (KMS)	MAG AT OPP.
Mimas	0.942	185.52	0.0202	1°.53	392	12.9
Enceladus	1.370	238.02	0.00452	0°.00	500	11.7
Tethys	1.888	294.66	0.00000	1°.86	1060	10.2
Dione	2.737	377.40	0.002230	0°.02	1120	10.4
Rhea	4.518	527.04	0.00100	0°.35	1530	9.7
Titan	15.945	1221.83	0.029191	0°.33	5150	8.28
Hyperion	21.277	1481.10	0.104	0°.43	410x260x110	14.19
Iapetus	79.330	3561.30	0.02828	14°.72	1460	11.1
Phoebe [1]	550.48	12952.00	0.16326	177° [2]	220	16.45
Janus	0.695	151.47	0.007	0°.14	220x200x160	14
Epimetheus	0.694	151.42	0.009	0°.34	140x120x100	15
Helene	2.737	377.40	0.005	0°.0	36x32x30	18
Telsto	1.888	294.66	-	-	34x28x26	18.5
Calypso	1.888	294.66	-	-	34x22x22	18.7
Atlas	0.602	137.67	0.000	0°.3	40x10	18
Prometheus	0.613	139.35	0.003	0°.0	140x100x80	16
Pandora	0.629	141.7	0.004	0°.0	110x90x70	16

[1] = In retrograde [2] = Relative to ecliptic plane

APPEARANCE OF SATURN

The diagram below illustrates Saturn as it appears when at it's largest diameter during 1991, it is at it's smallest at the beginning of the year at 15.1 arc seconds.



30th July
Dia of disc 18.5"

URANUS

Uranus is too close to the Sun for observation until towards the end of January when it appears in the morning sky in Sagittarius, in which constellation it remains throughout the year. It is at opposition on July 4th when it can be seen throughout the night, after which its eastward elongation gradually decreases. From early October it can only be seen in the evening sky until the second half of December when it again becomes too close to the Sun for observation.

CONJUNCTIONS of URANUS with the MOON, PLANETS.

(with separation of 5° or less)

DATE	EVENT	TIME	BODY	SEPARATION
Jan 15	0	02.45 am	Moon (28 days old)	0°45'
Jan 23	2	04.45 am	Mercury	1°15'
Feb 11	0	04.00 am	Moon (26 days old)	4°40'
Mar 11	3	01.45 am	Moon (24 days old)	1°20'
Apr 15	1	04.45 am	Neptune	3°10'
May 4	3	10.00 pm	Moon (20 days old)	2°55'
May 31	0	09.45 pm	Moon (17 days old)	0°05'
Jun 28	0	04.25 am	Moon (15 days old)	0°15'
Jul 25	3	04.45 am	Moon (13 days old)	2°00'
Aug 21	1	06.53 pm	Moon (11 days old)	3°40'
Sep 17	1	07.05 pm	Moon (9 days old)	0°05'
Nov 11	1	08.05 pm	Moon (5 days old)	2°50'

All events are listed either at the closest approach or at the best observable time nearest conjunction with the separation given for that time, the actual conjunction may occur during daylight hours or when the object is below the observers horizon. The Event column indicates whether conjunction is observable (0) or if the event has been chosen for a convenient time when the objects appear closest and can be seen by the observer (1,2 or3).

Event 0 = Closest approach
1 = At astronomical twilight (when the Sun is 18° below the horizon).
2 = At civil twilight (when the Sun is 6° below the horizon)
3 = The actual conjunction occurs when the moon is very close to or below the horizon. At the time chosen, the moon has an altitude of 10°, which is more reasonable for observations.

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

STATIONARY	OPPOSITION	STATIONARY	CONJUNCTION
Apr 18d 22h	Jul 04d 17h	Sep 19d 19h	

GENERAL DATA

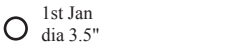
EQUATORIAL DIAMETER..... 50800 kms
SIDEREAL PERIOD.....84.1 years
SYNODIC PERIOD .....369.7 days
MEAN DISTANCE FROM SUN.. 2867760000 kms
DIST. FROM SUN (Earth= l)..... 19.18
MAGNITUDE AT OPPOSITION 5.52

MASS (Earth= 1) 14.5
No of MOONS..... 15
AXIAL ROTATION..... 10.8 hrs
ECCENTRICITY..... 0.04710
INCLINATION TO ECLIPTIC ..... 0°46'22"
OBLIQUITY OF EQ. TO ORBIT .....98°00'

SATELLITES of URANUS

SATELLITE	ORBITAL PERIOD (days)	SEMI MAJOR AXIS ($x10^3$ km)	ORBITAL ECCEN-TRICITY	INCL. TO PLANET EQUATOR	DIAMETER (KMS)	MAG AT OPP.
Ariel	2.520	191.02	0.0034	0°.3	1158	14.16
Umbriel	4.144	266.30	0.0050	0°.36	1172	14.81
Titania	8.706	435.91	0.0022	0°.14	1580	13.73
Oberon	13.463	583.52	0.0008	0°.10	1524	13.94
Miranda	1.413	129.39	0.0027	4°.2	480	16.30
Cordelia	0.335	49.77	<0.001	-	50	-
Ophelia	0.376	53.79	0.01	-	50	-
Bianca	0.434	59.17	<0.001	-	50	-
Cressida	0.464	61.78	<0.001	-	60	-
Desdemona	0.493	62.68	<0.001	-	60	-
Juliet	0.513	64.35	<0.001	-	80	-
Portia	0.558	66.09	<0.001	-	80	-
Posiland	0.623	69.94	<0.001	-	60	-
Belinda	0.625	75.26	<0.001	-	50	-
Puck	0.761	86.01	<0.001	-	170	-

APPEARANCE OF URANUS



NEPTUNE

Neptune is too close to the Sun for observation until late January when it can be seen in the morning sky shortly before sunrise in Sagittarius, in which constellation it remains throughout the year. It is at opposition on July 8th when it can be seen throughout the night. From mid-October it can only be seen in the evening sky until mid-December when it again becomes too close to the Sun for observation.

GENERAL DATA

EQUATORIAL DIAMETER	48600 kms	MASS (Earth= 1)	17.4
SIDEREAL PERIOD	164.8 years	No of MOONS	8
SYNODIC PERIOD	367.5 days	AXIAL ROTATION	15.7 hrs
MEAN DISTANCE FROM SUN	4492800000 kms	ECCENTRICITY	0.00855
DIST. FROM SUN (Earth = 1)	30.7	INCLINATION TO ECLIPTIC	1°46'38"
MAGNITUDE AT OPPOSITION	7.84	OBLIQUITY OF EQ. TO ORBIT	29°00'

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

STATIONARY	OPPOSITION	STATIONARY	CONJUNCTION
Apr 19d 09h	Jul 08d 10h	Sep 26d 15h	Jan 05d 13h

SATELLITES of NEPTUNE

SATELLITE	ORBITAL PERIOD (days)	SEMI MAJOR AXIS ($x10^3$ km)	ORBITAL ECCEN-TRICITY	INCL. TO PLANET EQUATOR	DIAMETER (KMS)	MAG AT OPP.
Naiad	0.300	48.00	(0)	(0)	1158	14.16
Thalassa	0.310	50.00	(0)	(4°.5)		
Despina	0.330	52.50	(0)	(0)		
Galatea	0.430	62.00	(0)	(0)		
Larissa	0.550	73.60	(0)	(0)		
Proteus	1.120	117.60	(0)	(0)	1172	14.81
Triton	5.880	354.80	0.00	157.00	1580	13.73
Nereid [1]	360.130	5513.40	0.75	29°.0	1524	13.94

[1] = In retrograde

APPEARANCE OF NEPTUNE

PLUTO

Pluto can be seen in the morning sky from the beginning of the year. It is at opposition on May 10th when it can be seen throughout the night. From mid-August it can only be seen in the evening sky until mid-October when it becomes too close to the Sun for observation.

GENERAL DATA

EQUATORIAL DIAMETER	3000 kms	MASS (Earth = 1)	0.003
SIDEREAL PERIOD	249.9 years	No of MOONS	1
SYNODIC PERIOD	366.7 days	AXIAL ROTATION	153.0 hrs
MEAN DISTANCE FROM SUN	5745000000 kms	ECCENTRICITY	0.2486
DIST. FROM SUN (Earth =l)	39.67	INCLINATION TO ECLIPTIC	17°09'
MAGNITUDE AT OPPOSITION	15.12	OBLIQUITY OF EQ. TO ORBIT	118°00'

GEOCENTRIC EVENTS (as measured from the centre of the Earth)

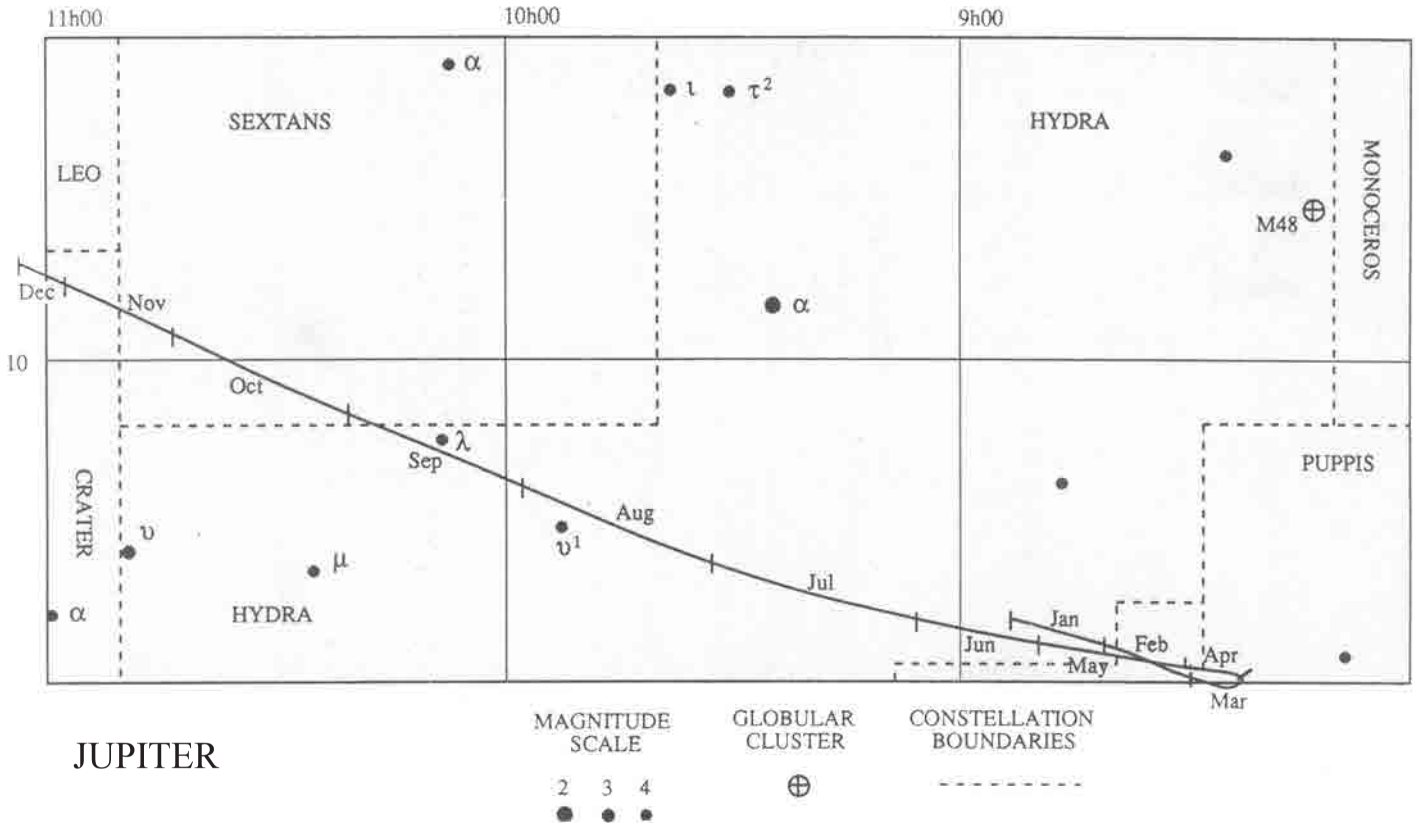
STATIONARY	OPPOSITION	STATIONARY	CONJUNCTION
Feb 26d00h	May 10d13h	Aug 03d05h	Nov 13d14h

SATELLITE of PLUTO

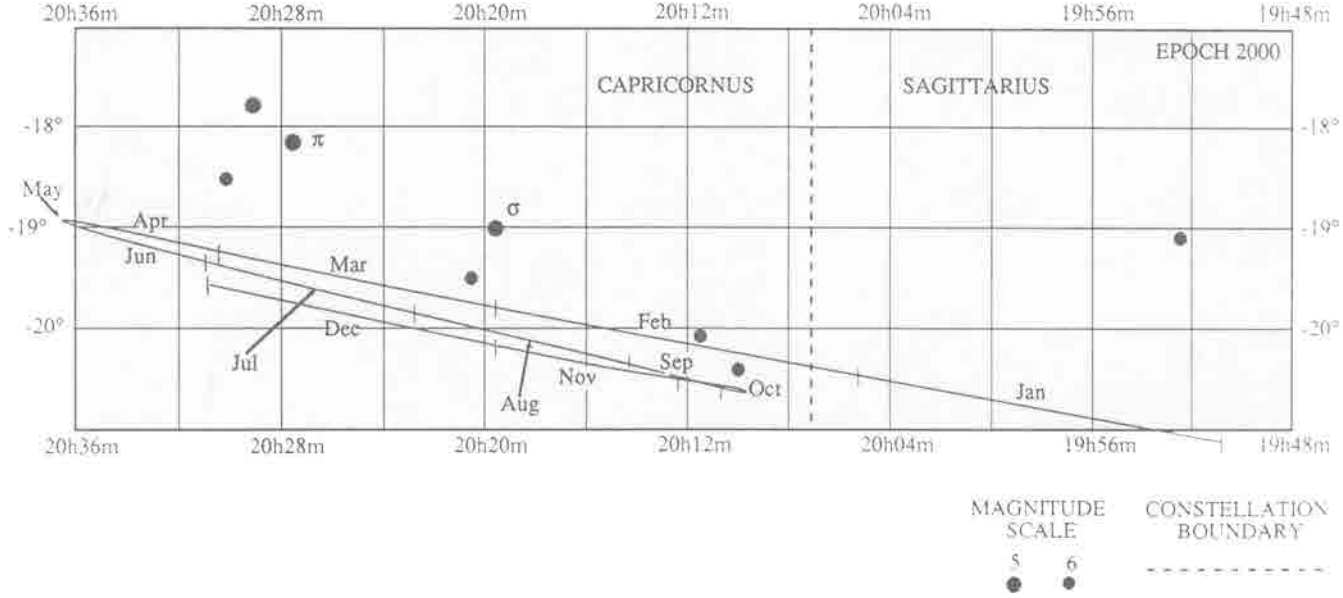
SATELLITE	ORBITAL PERIOD (days)	SEMI MAJOR AXIS ($x10^3$ km)	ORBITAL ECCEN-TRICITY	INCL. TO PLANET EQUATOR	DIAMETER (KMS)	MAG AT OPP.
Charon	6.387	19.13	-	94°.0	1500	16.8

PLANET FINDER CHARTS

The planet finder charts are provided as a reference to the planet monthly positions throughout the year. Charts for Mercury, Venus and Mars have been omitted because of the large angular movement of these planets, making finder charts of a scale that would be difficult to read in this publication. Both Mercury and Venus generally do not require finder charts; Venus because of it's brilliance and Mercury because it is visible only in twilight when few, if any stars are visible.

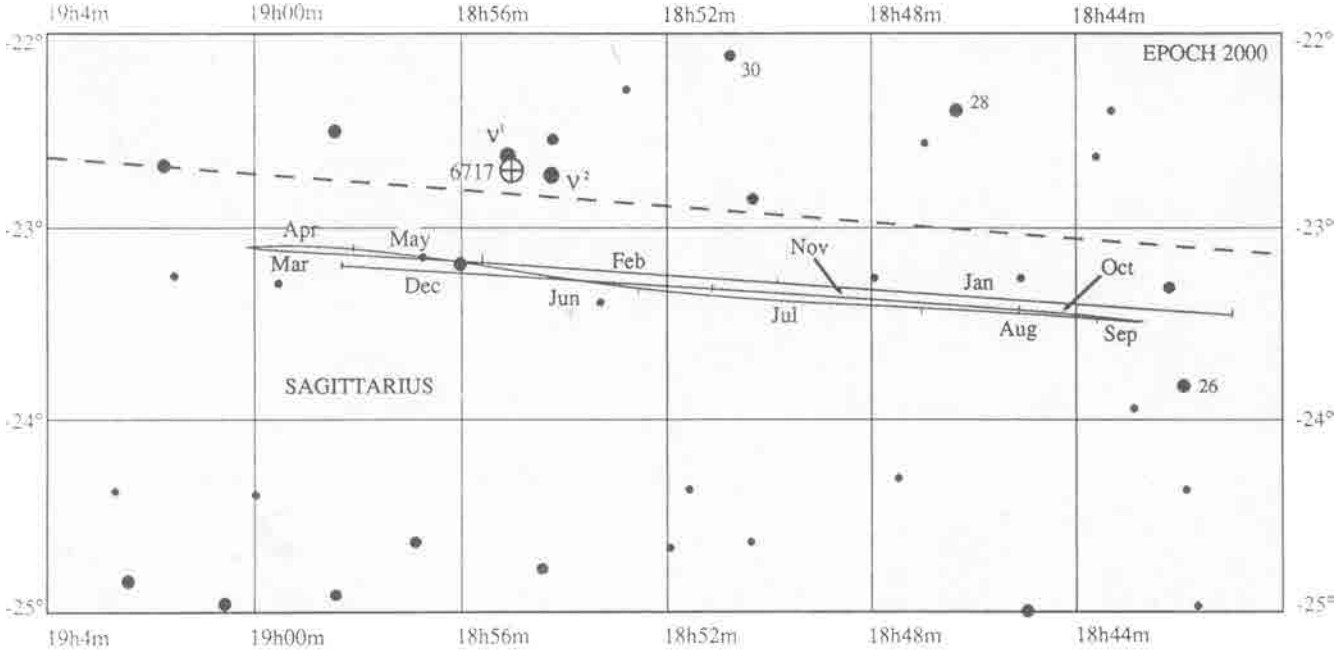


JUPITER



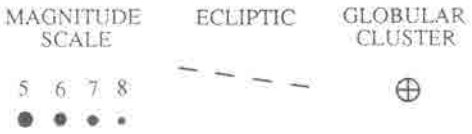
SATURN

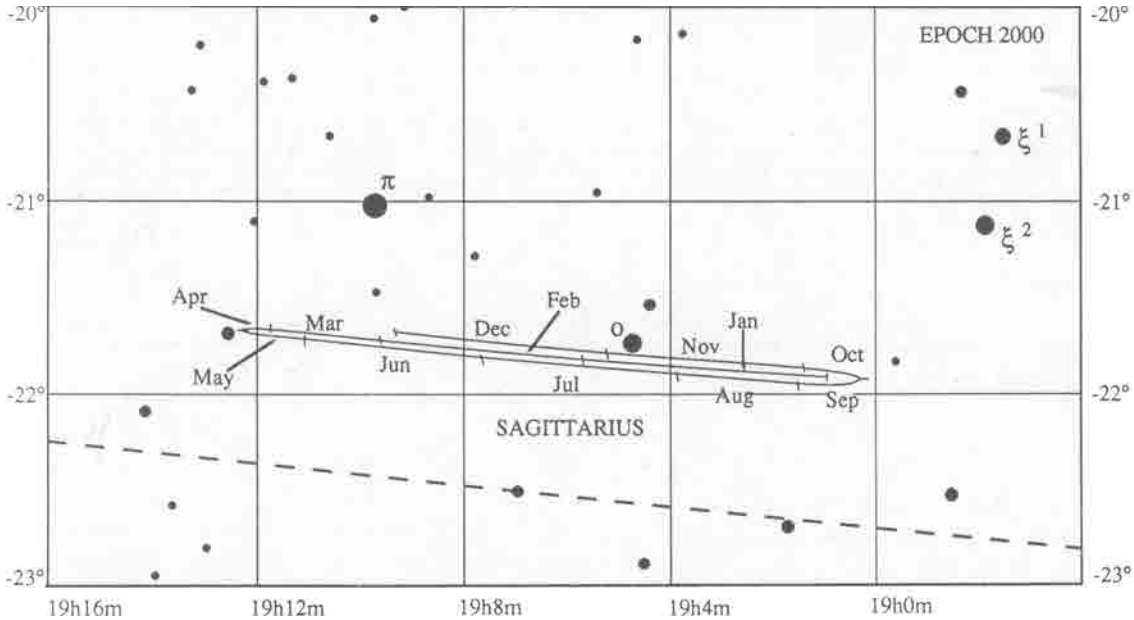
Ranging in magnitude from -1 to 1.5, Saturn is easy to locate. The ring system is visible in any small telescope using about 40 magnification.



URANUS

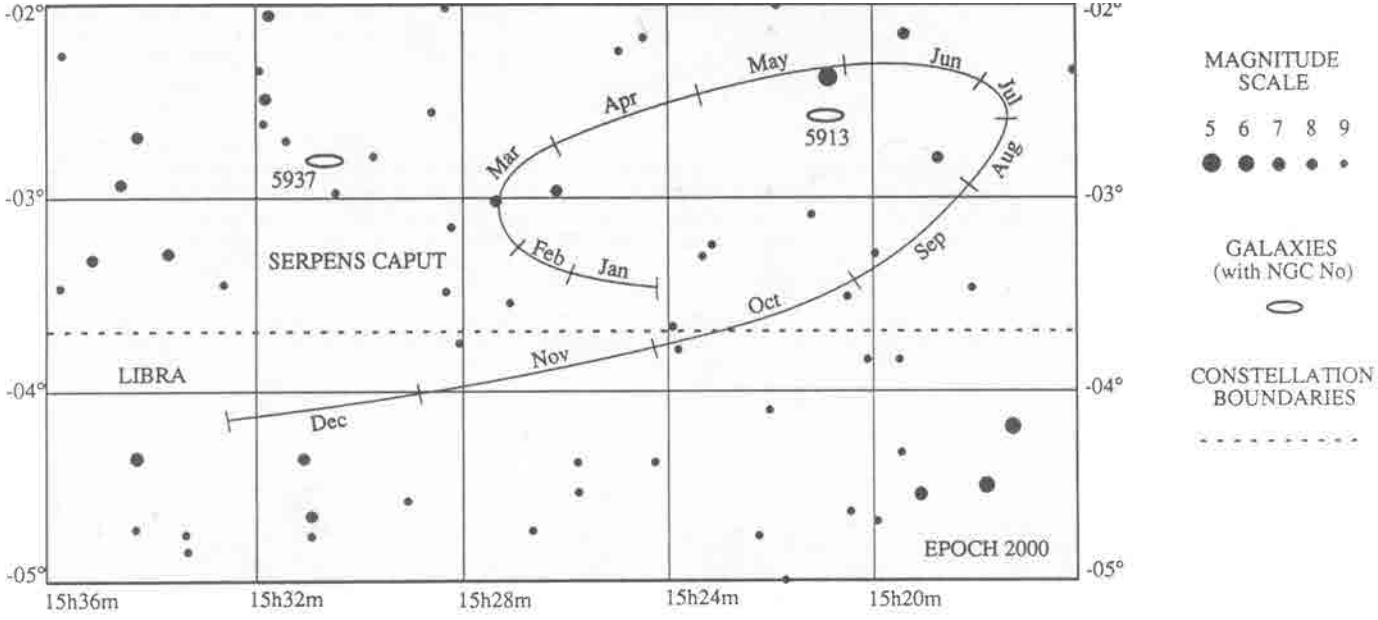
At magnitude 5.6, Uranus may be seen with the unaided eye under dark sky conditions. It can easily be seen with binoculars and it's greenish disk can be resolved in 75mm telescopes. Uranus remains within a few degrees of the globular M22 (NGC 6717) during the year, and by sweeping from the cluster the planet will easily be found.





NEPTUNE

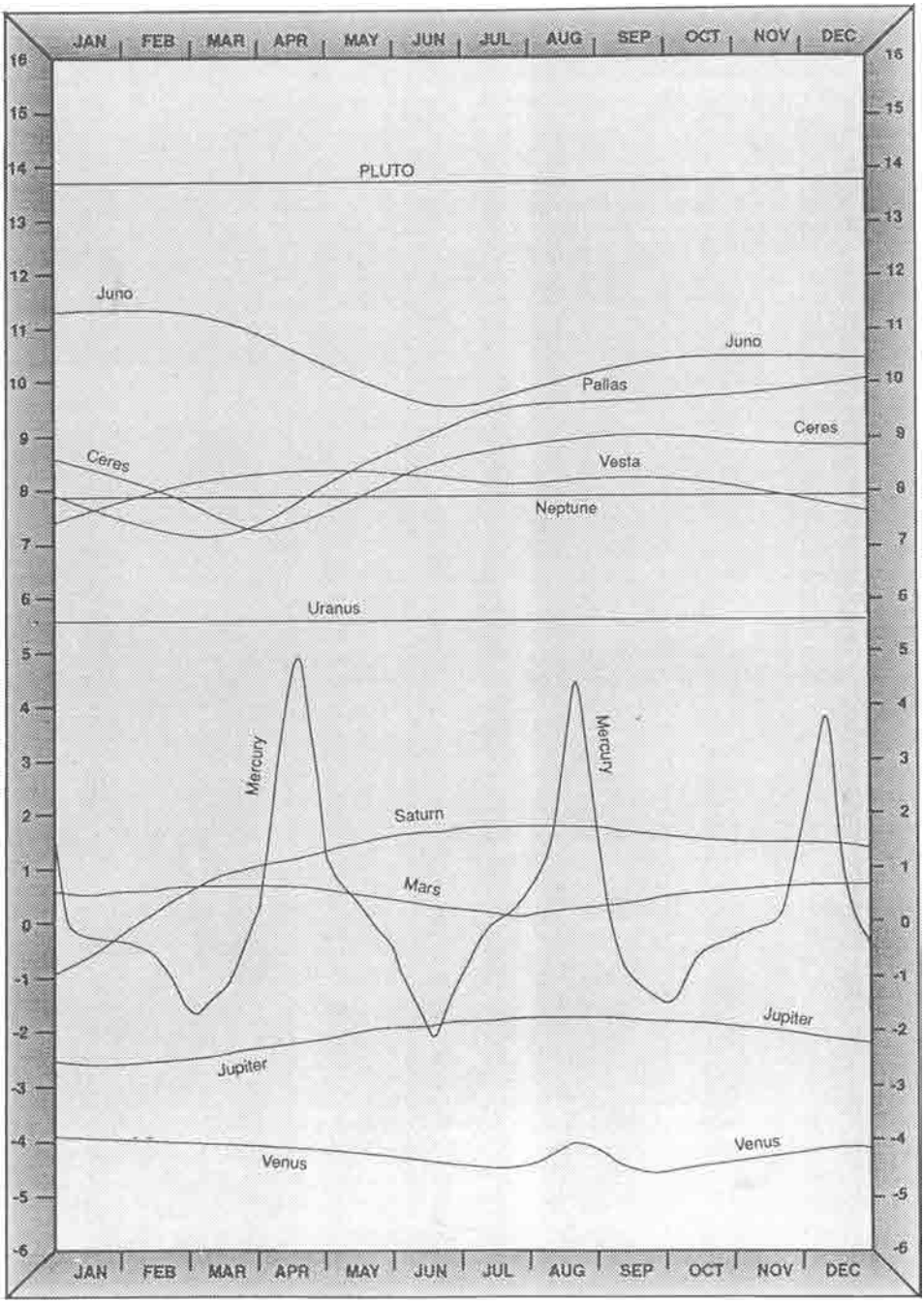
At magnitude 7.9, binoculars (7x50) will be required to locate Neptune. To resolve the planet's bluish disk it is necessary to use at least 200x. Neptune will be easy to locate when nearby 3rd magnitude Pi Sagittarii and 4th magnitude Omicron Sagittarii. By lining up the lower right hand two squares of the Neptune finder chart with the upper left hand two squares of the Uranus finder chart, it can be seen that the two planets remain within a few degrees of each other during the year.



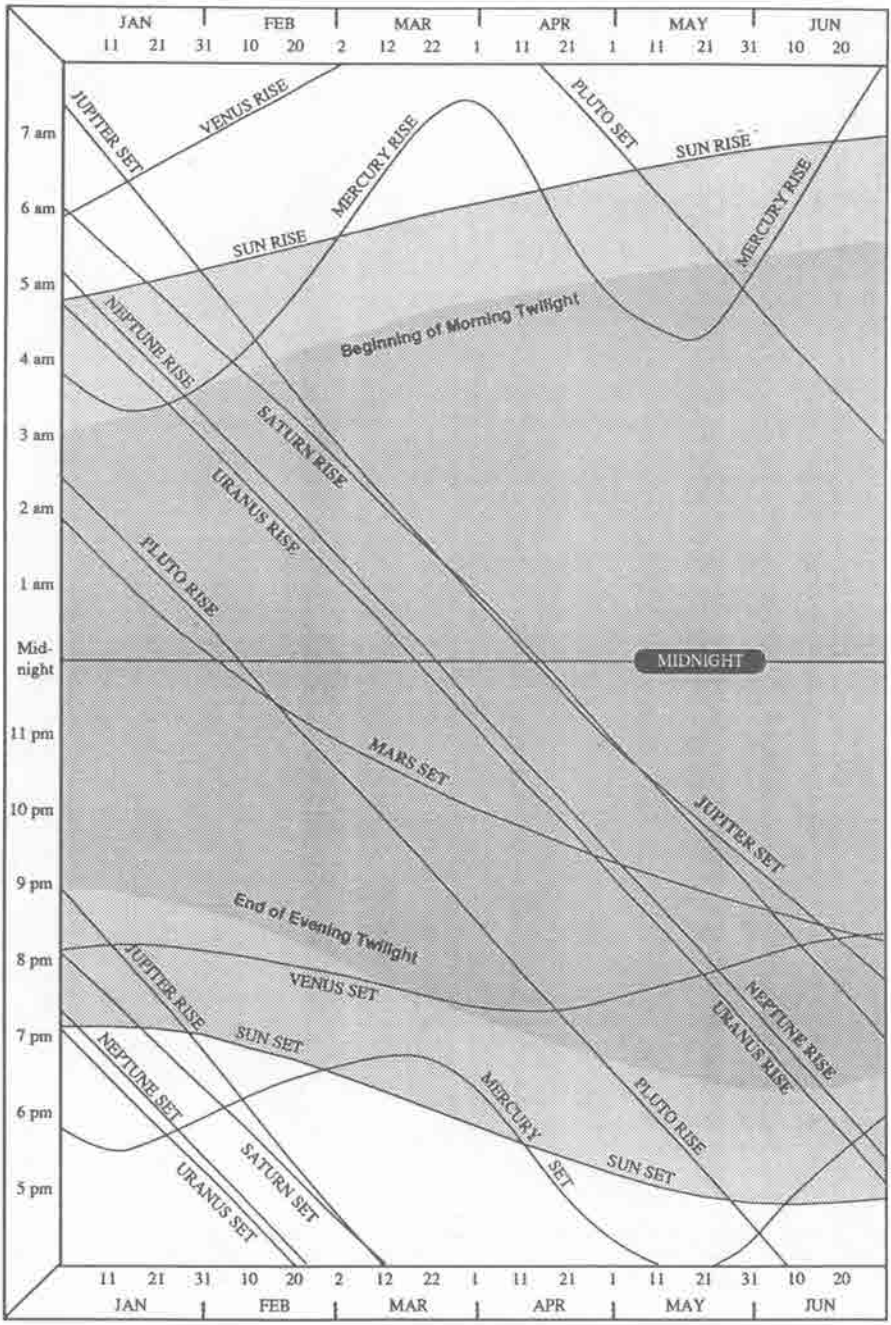
PLUTO

At magnitude 14, at least a 200mm telescope will be required to locate Pluto. Two observations, a few days apart, will be necessary to confirm a sighting. The chart has been drawn with a limiting magnitude of 9. At the scale presented, the chart would be very difficult to read with stars down to 14th magnitude shown. Perhaps the easiest method to capture Pluto is on film, with photographs taken a day or two apart.

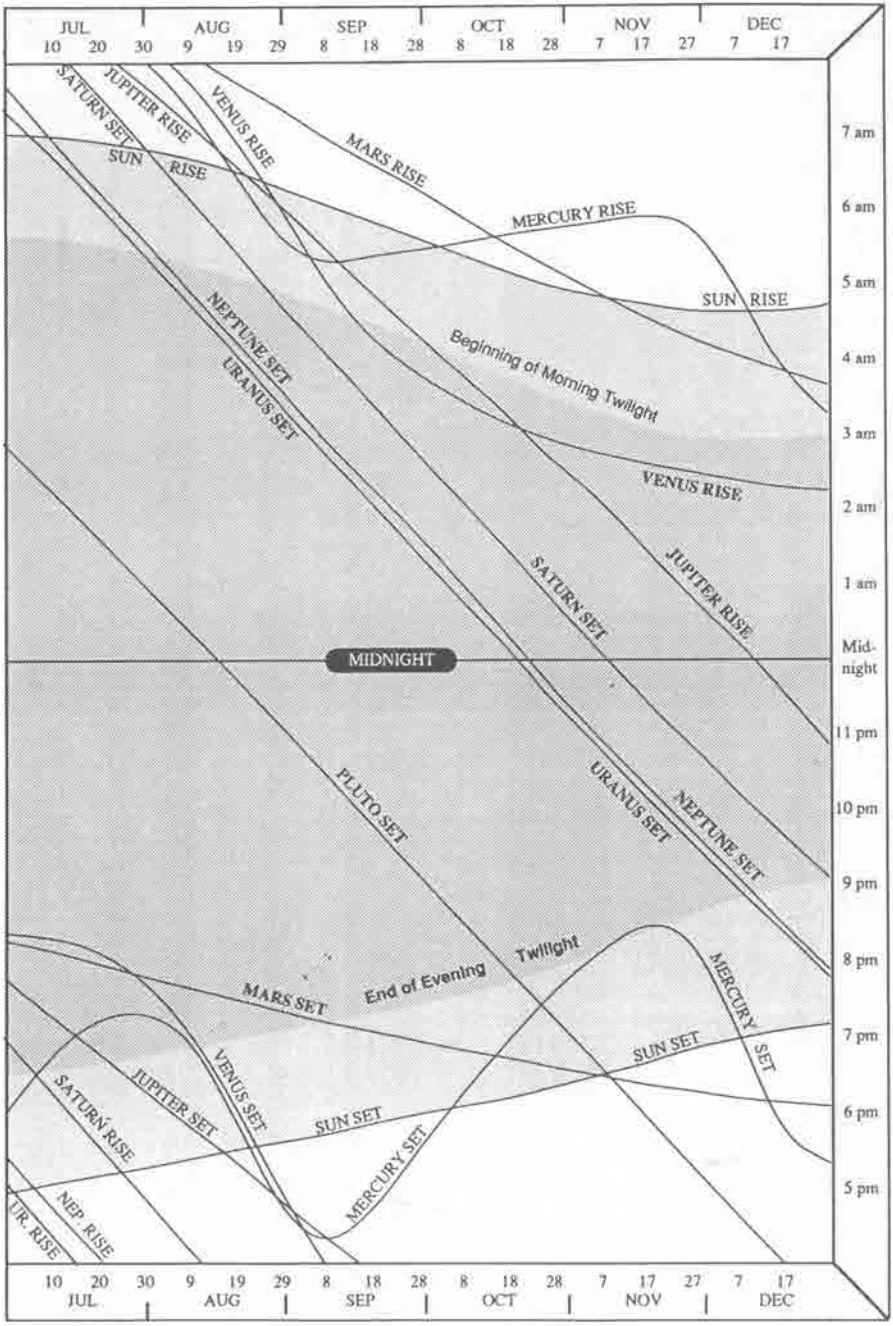
MAGNITUDES of the PLANETS and MAJOR ASTEROIDS



RISE AND SET OF THE SUN AND PLANETS (inc. twilight) - January to June)



RISE AND SET OF THE SUN AND PLANETS (inc. twilight) - July to December)



MERCURY (E.A.S.T.)

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

VENUS (E.A.S.T.)

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

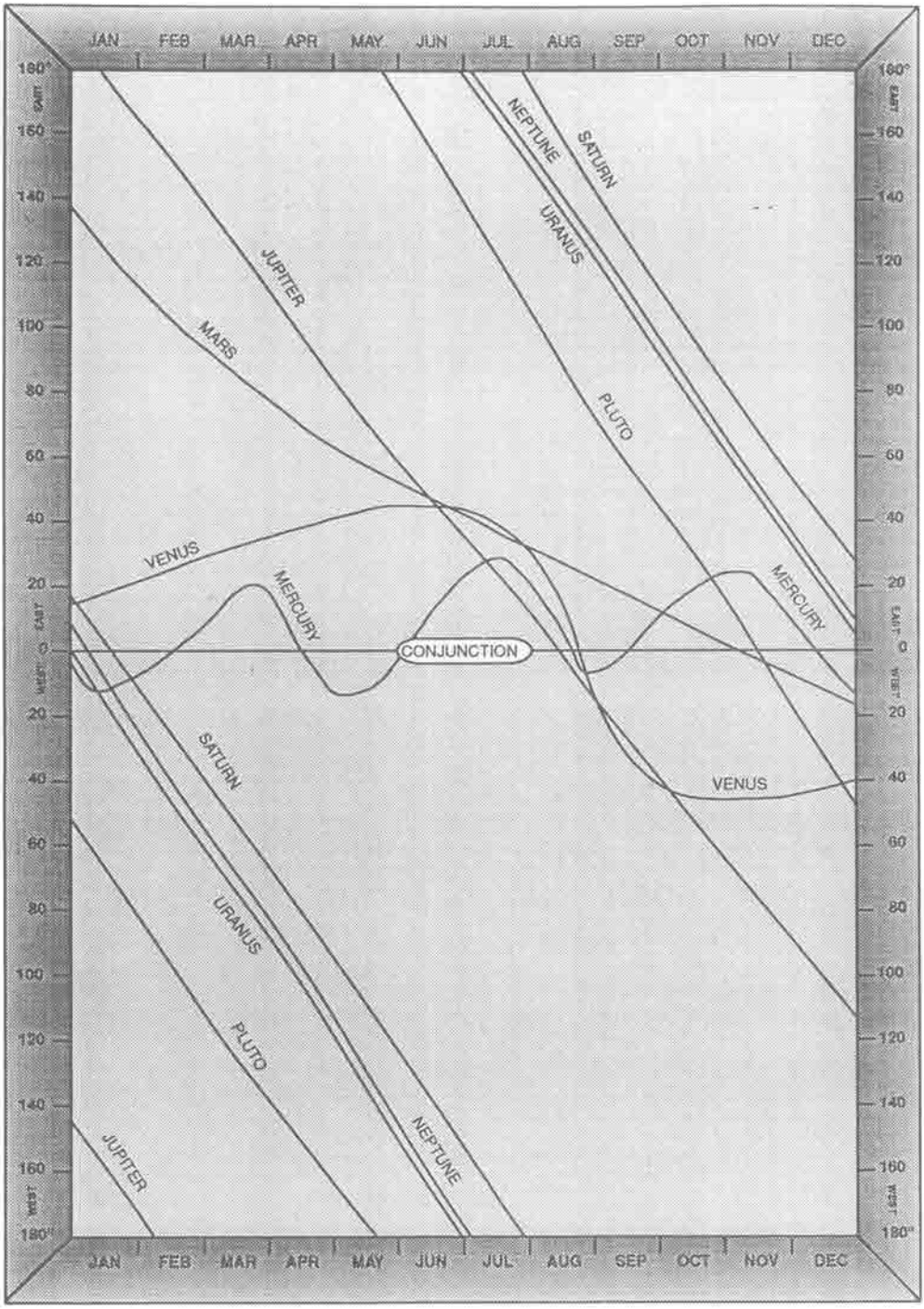
RISING AND SETTING OF THE SUN AND PLANETS E.A.S.T.

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

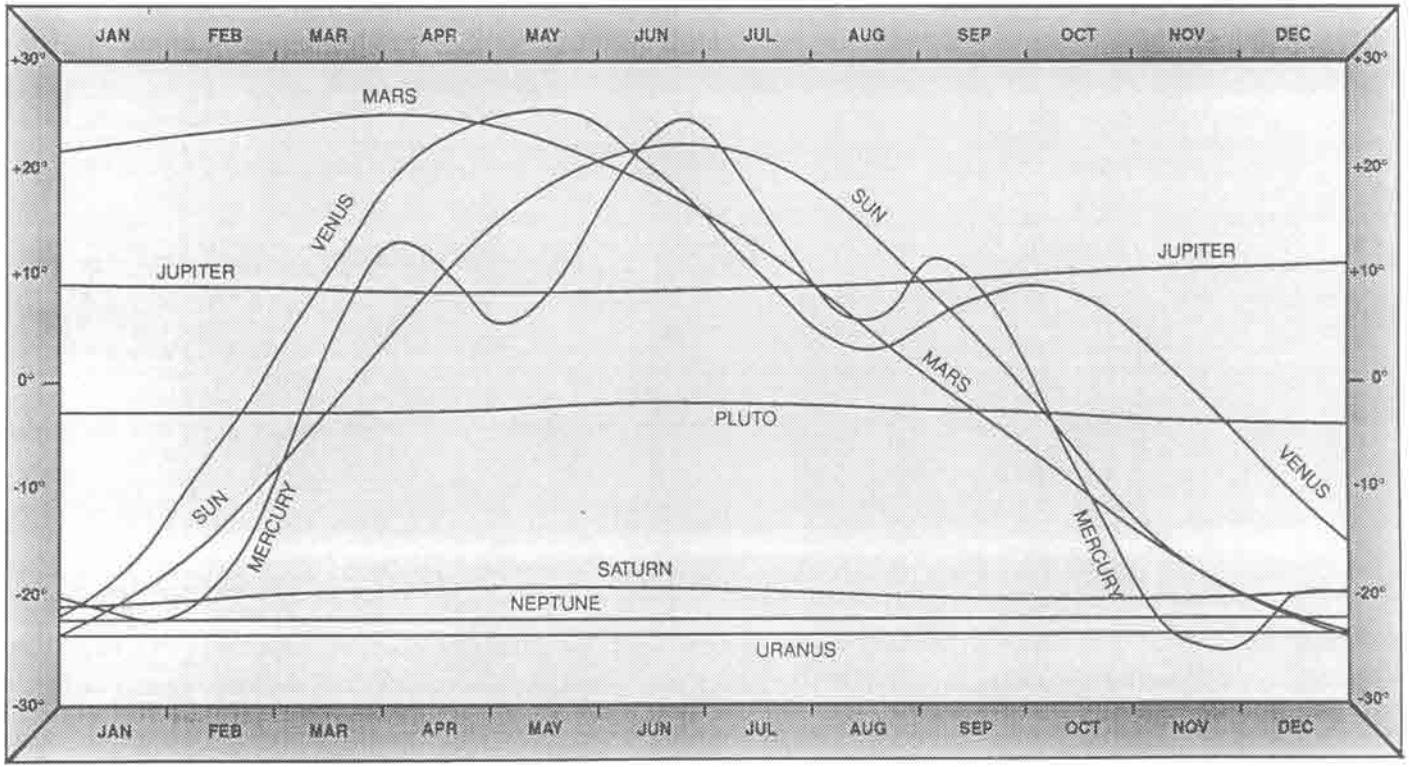
RISING AND SETTING OF THE SUN AND PLANETS E.A.S.T.

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

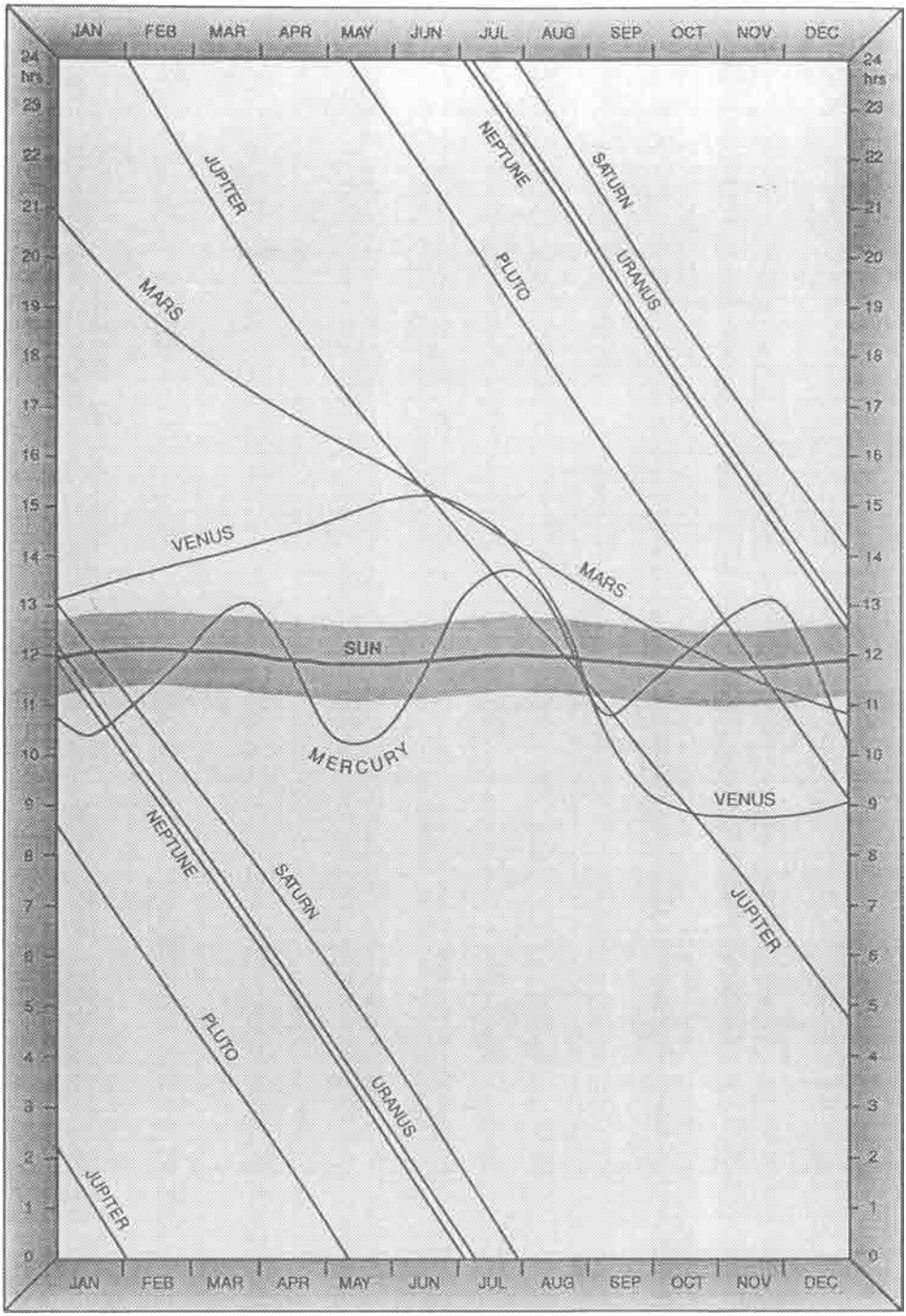
PLANETARY ELONGATION



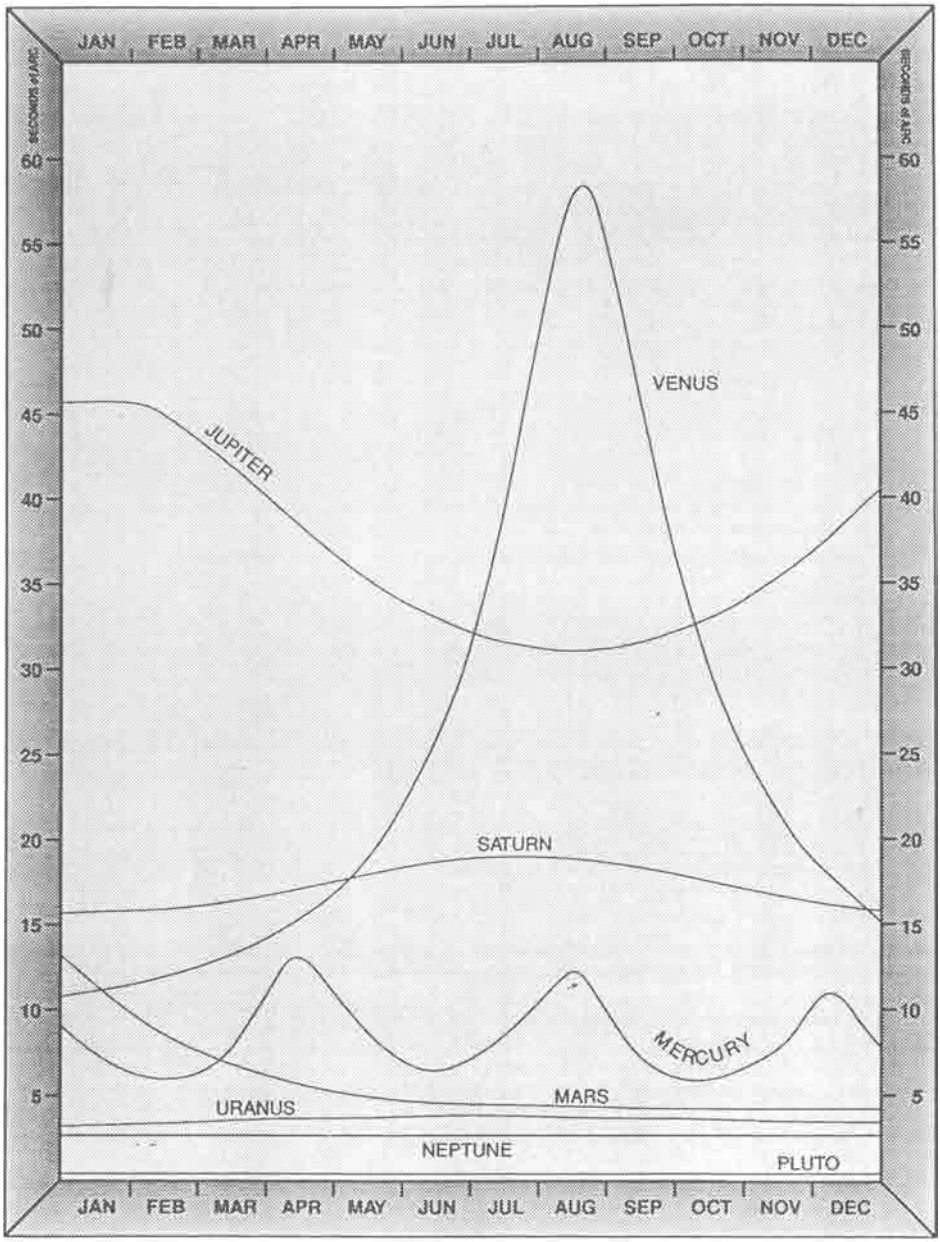
DECLINATIONS OF THE SUN AND PLANETS



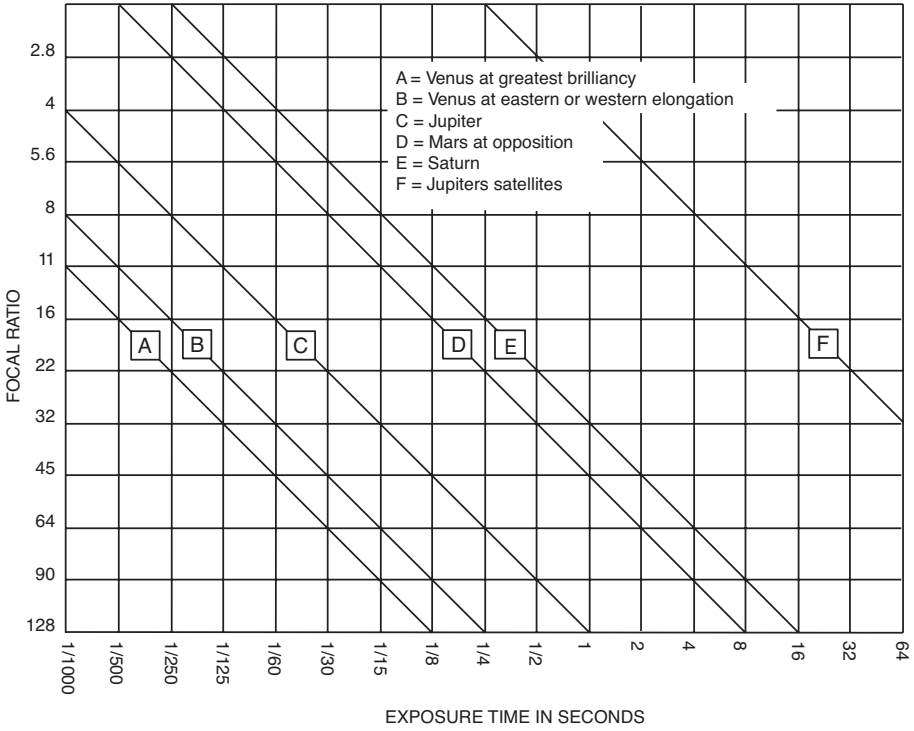
MERIDIAN PASSAGE of the SUN and PLANETS



PLANETARY ANGULAR SIZE



PHOTOGRAPHIC EXPOSURE GUIDE for the PLANETS



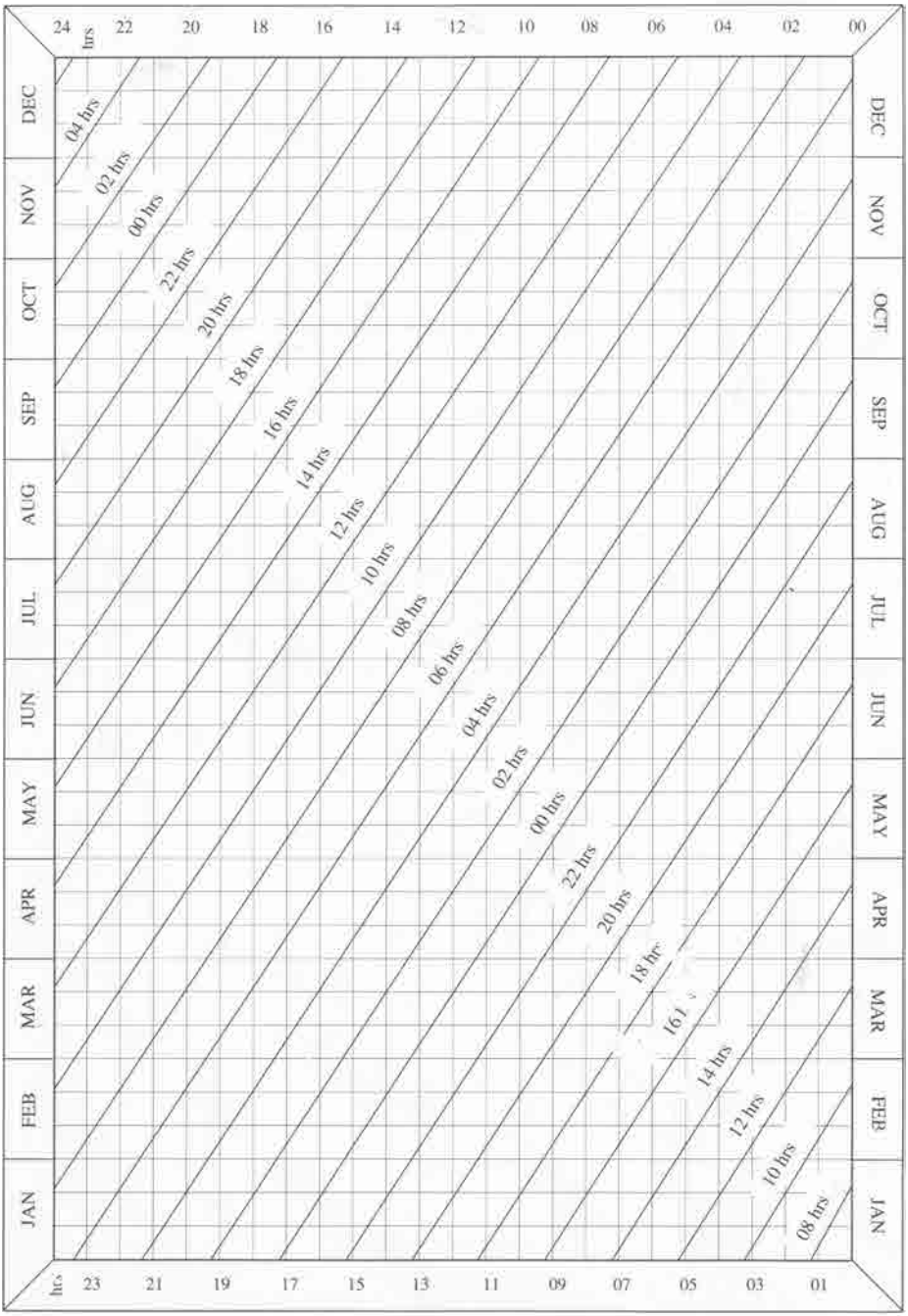
These charts provide recommended photographic exposures for selected planets (right) using 100 ISO film. The charts should only be treated as a guide as many factors will influence the exposure time.

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

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

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

HOUR of RIGHT ASCENSION on the MERIDIAN
(also equals SIDEREAL TIME)



POSITION OF THE SUN (J2000) @ 0 hrs U.T.

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

POSITION OF THE SUN (J2000) @ 0hrs U.T.

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

POSITION OF MERCURY (J2000) @ 0hrs U.T.

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

POSITION OF MERCURY (J2000) @ 0hrs U.T.

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

POSITION OF VENUS (J2000) @ 0 hrs U.T.

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

POSITION OF VENUS (J2000) @ 0 hrs U.T.

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

POSITIONS OF THE OUTER PLANETS (J2000) @ 0hrs U.T.

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

POSITIONS OF THE OUTER PLANETS (J2000) @ 0hrs U.T.

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

MINOR PLANET POSITIONS (J2000) @ 0hrs U.T.

DATE	CERES		JUNO		PALLAS		VESTA	
	RA hh mm ss	Dec. ° ' "	RA hh mm ss	Dec ° ' "	RA hh mm ss	Dec ° ' "	RA hh mm ss	Dec ° ' "
Jan 5	13 46.6	00 11	17 49.0	-13 18	11 05.1	-18 07	03 00.1	10 43
12	13 54.5	00 14	17 58.9	-13 15	11 08.1	-17 45	03 00.7	11 15
19	14 01.6	00 33	18 08.7	-13 09	11 09.8	-17 04	03 02.6	11 50
26	14 08.0	00 47	18 18.4	-12 59	11 10.1	-16 02	03 05.8	12 29
Feb 2	14 13.5	00 54	18 28.0	-12 46	11 09.0	-14 38	03 10.1	13 10
9	14 18.0	00 55	18 37.3	-12 30	11 06.6	-12 49	03 15.4	13 54
16	14 21.5	00 50	18 46.4	-12 10	11 03.1	-10 36	03 21.6	14 39
23	14 23.7	00 39	18 55.2	-11 48	10 58.7	-08 02	03 28.7	15 24
Mar 2	14 24.7	00 22	19 03.7	-11 23	10 53.9	-05 11	03 36.5	16 10
9	14 24.4	00 01	19 11.8	-10 55	10 49.1	-02 12	03 45.0	16 55
16	14 22.8	00 23	19 19.5	-10 25	10 44.7	00 49	03 54.1	17 39
23	14 19.9	00 51	19 26.8	-09 53	10 41.0	03 43	04 03.8	18 22
30	14 15.8	01 18	19 33.5	-09 20	10 38.4	06 24	04 14.0	19 03
Apr 6	14 10.7	01 45	19 39.6	-08 46	10 37.0	08 47	04 24.6	19 42
13	14 04.9	02 08	19 45.2	-08 11	10 36.9	10 49	04 35.7	20 18
20	13 58.8	02 26	19 50.0	-07 36	10 38.2	12 32	04 47.1	20 51
27	13 52.6	02 37	19 54.0	-07 01	10 40.6	13 55	04 58.9	21 21
May 4	13 46.7	02 40	19 57.3	-06 27	10 44.3	14 59	05 10.9	21 47
11	13 41.5	02 34	19 59.6	-05 55	10 49.0	15 47	05 23.3	22 10
18	13 37.1	02 19	20 00.9	-05 26	10 54.7	16 20	05 35.8	22 29
25	13 33.8	01 57	20 01.3	-04 60	11 01.2	16 40	05 48.6	22 44
Jun 1	13 31.7	01 26	20 00.6	-04 38	11 08.3	16 49	06 01.5	22 55
8	13 30.7	00 49	19 58.8	-04 21	11 16.1	16 49	06 14.5	23 01
15	13 30.9	00 05	19 55.9	-04 10	11 24.5	16 39	06 27.7	23 03
22	13 32.2	-00 43	19 52.0	-04 06	11 33.2	16 23	06 40.9	23 01
29	13 34.5	-01 36	19 47.2	-04 10	11 42.4	16 01	06 54.2	22 55
Jul 6	13 37.8	-02 32	19 41.7	-04 21	11 51.8	15 33	07 07.5	22 44
13	13 42.0	-03 31	19 35.8	-04 41	12 01.6	15 01	07 20.8	22 30
20	13 47.1	-04 32	19 29.6	-05 07	12 11.6	14 25	07 34.1	22 11
27	13 52.9	-05 34	19 23.5	-05 41	12 21.8	13 46	07 47.3	21 49
Aug 3	13 59.3	-06 38	19 17.8	-06 19	12 32.2	13 04	08 00.5	21 22
10	14 06.4	-07 43	19 12.7	-07 02	12 42.8	12 21	08 13.5	20 52
17	14 14.0	-08 48	19 08.6	-07 47	12 53.5	11 36	08 26.5	20 19
24	14 22.1	-09 52	19 05.6	-08 34	13 04.3	10 51	08 39.3	19 44
31	14 30.8	-10 57	19 03.7	-09 21	13 15.3	10 05	08 52.0	19 05,
Sep 7	14 39.8	-12 00	19 03.2	-10 06	13 26.3	09 20	09 04.5	18 24
14	14 49.3	-13 03	19 03.9	-10 49	13 37.5	08 35	09 16.8	17 41
21	14 59.1	-14 04	19 05.8	-11 30	13 48.8	07 51	09 29.0	16 56
28	15 09.3	-15 03	19 08.9	-12 06	14 00.1	07 09	09 40.9	16 10
Oct 5	15 19.8	-16 01	19 13.2	-12 39	14 11.6	06 29	09 52.7	15 24
12	15 30.6	-16 56	19 18.5	-13 08	14 23.1	05 50	10 04.1	14 37
19	15 41.7	-17 49	19 24.7	-13 32	14 34.6	05 15	10 15.3	13 50
26	15 53.1	-18 39	19 31.9	-13 51	14 46.2	04 42	10 26.2	13 03
Nov 2	16 04.7	-19 26	19 39.8	-14 05	14 57.8	04 13	10 36.8	12 19
9	16 16.4	-20 10	19 48.5	-14 14	15 09.4	03 48	10 47.1	11 35
16	16 28.4	-20 50	19 57.8	-14 18	15 21.0	03 27	10 56.9	10 55
23	16 40.6	-21 28	20 07.7	-14 16	15 32.6	03 10	11 06.3	10 17
30	16 52.8	-22 01	20 18.1	-14 09	15 44.2	02 58	11 15.2	09 44
Dec 7	17 05.2	-22 31	20 29.0	-13 57	15 55.6	02 51	11 23.5	09 15
14	17 17.6	-22 58	20 40.3	-13 40	16 07.0	02 49	11 31.2	08 52
21	17 30.1	-23 20	20 51.9	-13 17	16 18.2	02 53	11 38.2	08 35
28	17 42.6	-23 39	21 03.8	-12 50	16 29.2	03 02	11 44.3	08 25

JUPITER ECLIPSE CO-ORDINATES

MONTH	I.Ec.D	I.Ec.R	II.Ec.D	11.Ec.R	III.Ec.D	III.Ec.R	IV.Ec.D	IV.Ec.R
JAN	1.3W-0.0N	—	1.4W-0.0N	—	1.6W-0.1N	—	1.9W-0.1N	—
FEB	-	1.4E-0.0N	—	1.6E-0.0N	—	1.9E-0.1N	1.3E-0.1N	3.3E-0.1N
MAR	-	1.SE-0.0N	—	2.3E-0.0N	1.2E-0.1N	3.1E-0.1N	2.6E-0.2N	4.SE-0.2N
APR	-	2.1E-0.0N	—	2.7E-0.0N	1.8E-0.2N	3.7E-0.2N	3.9E-0.2N	S.9E-0.2N
MAY	-	2.0E-0.0N	—	2.7E-0.0N	1.7E-0.1N	3.6E-0.1N	3.8E-0.2N	5.7E-0.2N
JUN	-	1.8E-0.0N	—	2.3E-0.0N	1.1E-0.1N	3.1E-0.1N	2.SE-0.1N	4.SE-0.1N
JUL	-	1.SE-0.0N	—	1.8E-0.0N	—	2.2E-0.1N	—	2.6E-0.0N
AUG	-	1.0E-0.0N	—	1.1E-0.1S	—	1.2E-0.0N	—	1.6E-0.1S
SEP	1.4W-0.1S	—	1.6W-0.1S	—	2.1W-0.1S	—	2.SW-0.2S	—
OCT	1.7W-0.1S	—	2.2W-0.2S	—	3.0W-0.2S	1.0W-0.2S	4.4W-0.4S	2.SW-0.4S
NOV	2.0W-0.1S	—	2.6W-0.2S	—	3.6W-0.2S	1.6W-0.2S	S.6W-0.SS	3.7W-0.5S
DEC	2.0W-0.1S	—	2.7W-0.3S	—	3.7W-0.3S	1.7W-0.3S	S.6W-0.6S	3.8W-0.6S

The co-ordinates above are offsets from the centre of Jupiter. The units are "Jupiter Radii". These figures are graphically represented at the bottom of the configuration diagrams. (see pp 72-75)

The following legend applies to the above table of eclipse coordinates as well as to the Jupiter Satellite events on the following pages.

The 1st part of each heading above and "events" on following pages is the satellite:

I = Io II = Europa I = Ganymede IV = Callisto.

The second part is the event type:

Ec = Eclipse Oc = occultation Tr = satellite transit Sh = satellite shadow transit

For the final part: E is Egress, I is Ingress, D is Disappearance and R is Reappearance.

JANUARY

3	1 43.1	III.Ec.D
3	4 37.4	II.Ec.D
4	3 18.5	I.Ec.D
4	23 09.2	II.Sh.I
5	0 20.8	II.Tr.I
5	0 34.8	I.Sh.I
5	1 09.6	I.Tr.I
5	2 03.8	II.Sh.E
5	2 51.6	I.Sh.E
5	3 15.4	II.Tr.E
5	3 26.5	I.Tr.E
5	21 47.3	I.Ec.D
6	0 40.8	I.Oc.R
6	21 20.6	I.Sh.E
6	21 25.3	III.Tr.E
6	21 50.1	II.Oc.R
6	21 52.6	I.Tr.E
11	20 55.8	IV.Tr.I
11	21 38.5	IV.Sh.E
12	1 40.6	IV.Tr.E
12	1 45.9	II.Sh.I
12	2 28.8	I.Sh.I
12	2 37.9	II.Tr.I
12	2 53.2	I.Tr.I
12	4 40.5	II.Sh.E
12	4 45.8	I.Sh.E
12	23 41.9	I.Ec.D
13	2 24.8	I.Oc.R
13	20 27.6	II.Ec.D
13	20 56.3	I.Sh.I
13	21 07.5	III.Tr.I
13	21 19.9	I.Tr.I
13	23 10.7	III.Sh.E
13	23 13.9	I.Sh.E
13	23 36.2	I.Tr.E
14	0 05.9	II.Oc.R
14	0 44.3	III.Tr.E
14	20 50.9	I.Oc.R
19	4 21.7	I.Sh.I
19	4 22.2	II.Sh.I
19	4 37.9	I.Tr.I
19	4 53.7	II.Tr.I
20	0 39.6	IV.Ec.D
20	1 35.7	I.Ec.D
20	4 08.6	I.Oc.R
20	22 50.2	I.Sh.I
20	23 01.9	II.Ec.D
20	23 02.4	I.Tr.I
20	23 33.4	III.Sh.I
21	0 23.5	III.Tr.I
21	1 07.2	I.Sh.E
21	1 20.1	I.Tr.E
21	2 18.8	II.Oc.R
21	3 09.6	III.Sh.E
21	4 00.3	III.Tr.E
21	20 04.6	I.Ec.D
21	22 34.8	I.Oc.R
22	19 46.4	I.Tr.E
22	20 35.9	II.Sh.E
22	20 55.9	II.Tr.E
27	3 30.4	I.Ec.D
28	0 44.7	I.Sh.I
28	0 46.8	I.Tr.I
28	1 35.7	II.Ec.D
28	3 01.7	I.Sh.E
28	3 03.8	I.Tr.E
28	3 31.7	III.Sh.I
28	3 38.7	III.Tr.I
28	4 31.5	II.Oc.R
28	21 59.8	I.Ec.D
29	0 18.3	I.Oc.R
29	19 12.3	I.Tr.I
29	19 12.3	I.Sh.I
29	20 16.6	II.Tr.I
29	20 17.7	II.Sh.I
29	21 29.5	I.Tr.E
29	21 30.6	I.Sh.E
29	23 10.1	II.Tr.E
29	23 12.2	II.Sh.E
31	21 16.4	III.Ec.R

FEBRUARY

4	2 29.5	I.Tr.I
4	2 38.7	I.Sh.I
4	3 51.6	II.Oc.D
4	4 46.8	I.Tr.E
4	23 43.5	I.Oc.D
5	2 12.9	I.Ec.R
5	20 55.1	I.Tr.I
5	21 06.2	I.Sh.I
5	22 31.8	II.Tr.I
5	22 54.7	II.Sh.I
5	23 12.2	I.Tr.E
5	23 24.1	I.Sh.E
5	23 32.9	IV.Ec.R
6	1 26.7	II.Tr.E
6	1 49.3	II.Sh.E
6	20 41.5	I.Ec.R
7	20 18.3	II.Ec.R
7	20 40.6	III.Oc.D
8	1 16.5	III.Ec.R
11	4 13.6	I.Tr.I
12	1 28.5	I.Oc.D
12	4 07.5	I.Ec.R
12	22 39.2	I.Tr.I
12	23 00.5	I.Sh.I
13	0 47.2	II.Tr.I
13	0 56.3	I.Tr.E
13	1 18.4	I.Sh.E
13	1 31.4	II.Sh.I
13	3 42.5	II.Tr.E
13	19 54.7	I.Oc.D
13	22 35.7	I.Ec.R
14	1 18.3	IV.Tr.I
14	19 12.8	II.Oc.D
14	19 22.1	I.Tr.E
14	19 46.1	I.Sh.E
14	22 52.3	II.Ec.R
14	23 57.7	III.Oc.D
18	19 04.9	III.Sh.E
19	3 12.3	I.Oc.D
20	0 24.1	I.Tr.I
20	0 55.2	I.Sh.I
20	2 41.8	I.Tr.E
20	3 04.3	II.Tr.I
20	3 12.3	I.Sh.E
20	21 39.8	I.Oc.D
21	0 30.1	I.Ec.R
21	18 50.7	I.Tr.I
21	19 23.4	I.Sh.I
21	21 07.8	I.Tr.E
21	21 27.3	II.Oc.D
21	21 40.3	I.Sh.E
22	1 27.6	II.Ec.R
22	3 17.5	III.Oc.D
22	18 59.3	I.Ec.R
23	19 08.7	II.Tr.E
23	20 22.9	II.Sh.E
25	19 27.9	III.Sh.I
25	20 26.2	III.Tr.E
25	23 04.5	III.Sh.E
27	2 09.3	I.Tr.I
27	2 49.1	I.Sh.I
27	23 25.6	I.Oc.D
28	2 25.9	I.Ec.R
28	20 35.5	I.Tr.I
28	21 18.7	I.Sh.I
28	22 52.9	I.Tr.E
28	23 35.6	I.Sh.E
28	23 44.2	II.Oc.D

MARCH

1	20 54.8	I.Ec.R
2	20 04.5	II.Sh.I
2	20 40.2	IV.Tr.E
2	21 27.4	II.Tr.E
2	22 55.6	IV.Sh.I
2	22 59.8	II.Sh.E
4	20 15.8	III.Tr.I
4	23 26.9	III.Sh.I
4	23 51.4	III.Tr.E
7	1 12.7	I.Oc.D
7	22 22.2	I.Tr.I
7	23 12.5	I.Sh.I
8	0 39.1	I.Tr.E
8	1 29.8	I.Sh.E
8	2 02.2	II.Oc.D
8	19 38.5	I.Oc.D
8	22 49.3	I.Ec.R
9	19 06.9	I.Tr.E
9	19 58.4	I.Sh.E
9	20 54.6	II.Tr.I
9	22 41.6	II.Sh.I
9	23 48.3	II.Tr.E
10	1 36.1	II.Sh.E
10	22 11.3	IV.Oc.D
11	19 54.4	II.Ec.R
11	23 44.4	III.Tr.I
15	0 10.7	I.Tr.I
15	1 07.5	I.Sh.I
15	21 14.8	III.Ec.R
15	21 27.1	I.Oc.D
16	0 44.4	I.Ec.R
16	18 37.3	I.Tr.I
16	19 35.2	I.Sh.I
16	20 54.6	I.Tr.E
16	21 52.2	I.Sh.E
16	23 18.9	II.Tr.I
17	1 19.1	II.Sh.I
17	19 13.2	I.Ec.R
18	22 29.4	II.Ec.R
19	21 44.2	IV.Sh.E
22	20 52.5	III.Oc.R
22	21 35.2	III.Ec.D
22	23 16.3	I.Oc.D
23	1 14.1	III.Ec.R
23	20 26.2	I.Tr.I
23	21 30.1	I.Sh.I
23	22 43.6	I.Tr.E
23	23 47.3	I.Sh.E
24	21 08.1	I.Ec.R
25	18 16.8	I.Sh.E
25	19 59.9	II.Oc.D
26	1 04.5	II.Ec.R
27	18 53.1	IV.Oc.R
27	20 08.6	II.Sh.E
28	0 51.8	IV.Ec.D
29	20 55.4	III.Oc.D
30	0 32.7	III.Oc.R
30	22 17.5	I.Tr.I
30	23 25.5	I.Sh.I
31	0 33.5	I.Tr.E
31	19 34.4	I.Oc.D
31	23 04.8	I.Ec.R

APRIL

1	17 54.4	I.Sh.I
1	19 01.1	I.Tr.E
1	20 11.9	I.Sh.E
1	22 26.4	II.Oc.D
2	19 00.1	III.Sh.E
3	19 52.3	II.Sh.I
3	20 20.2	II.Tr.E
3	22 45.6	II.Sh.E
4	23 46.1	IV.Tr.I
7	0 08.2	I.Tr.I
7	21 27.4	I.Oc.D
8	18 36.2	I.Tr.I
8	19 49.1	I.Sh.I
8	20 53.8	I.Tr.E
8	22 05.3	I.Sh.E
9	18 00.8	III.Tr.E
9	19 23.5	III.Sh.I
9	19 28.3	I.Ec.R
9	23 00.8	III.Sh.E
10	19 59.8	II.Tr.I
10	22 29.3	II.Sh.I
10	22 52.3	II.Tr.E
12	19 33.4	II.Ec.R
13	18 56.2	IV.Ec.D
13	23 50.3	IV.Ec.R
14	23 20.8	I.Oc.D
15	20 29.3	I.Tr.I
15	21 44.3	I.Sh.I
15	22 46.4	I.Tr.E
16	17 48.6	I.Oc.D
16	18 18.1	III.Tr.I
16	21 23.1	I.Ec.R
16	21 53.4	III.Tr.E
16	23 23.1	III.Sh.I
17	18 29.9	I.Sh.E
17	22 32.9	II.Tr.I
19	22 09.1	II.Ec.R
21	21 49.9	IV.Tr.E
22	22 23.7	I.Tr.I
23	19 43.7	I.Oc.D
23	22 14.7	III.Tr.I
23	23 18.8	I.Ec.R
24	18 08.7	I.Sh.I
24	19 09.6	I.Tr.E
24	20 24.6	I.Sh.E
25	17 47.5	I.Ec.R
26	19 18.8	II.Oc.D
27	17 33.2	III.Ec.D
27	21 13.7	III.Ec.R
28	17 19.2	II.Tr.E
28	19 52.7	II.Sh.E
30	17 55.5	IV.Ec.R
30	21 38.3	I.Oc.D

MAY

1	18 47.1	I.Tr.I
1	20 03.9	I.Sh.I
1	21 04.5	I.Tr.E
1	22 19.6	I.Sh.E
2	19 42.8	I.Ec.R
3	21 54.5	II.Oc.D
4	20 02.6	III.Oc.R
4	21 33.9	III.Ec.D
5	19 36.3	II.Sh.I
5	19 57.9	II.Tr.E
5	22 28.7	II.Sh.E
8	20 43.7	I.Tr.I
8	21 58.9	I.Sh.I
9	18 03.3	I.Oc.D
9	21 37.7	I.Ec.R
10	17 29.7	I.Tr.E
10	18 43.8	I.Sh.E
11	20 30.2	III.Oc.D
12	19 44.9	II.Tr.I
12	22 13.8	II.Sh.I
14	19 16.5	II.Ec.R
15	18 59.2	III.Sh.E
16	19 21.6	IV.Oc.D
16	20 01.5	I.Oc.D
17	17 10.4	I.Tr.I
17	18 22.2	I.Sh.I
17	19 27.9	I.Tr.E
17	20 39.9	I.Sh.E
18	18 01.1	I.Ec.R
22	18 12.3	III.Tr.E
22	19 21.6	III.Sh.I
23	16 59.5	II.Sh.E
24	19 08.2	I.Tr.I
24	20 17.5	I.Sh.I
24	21 25.2	I.Tr.E
25	17 05.9	IV.Sh.I
25	19 56.9	I.Ec.R
26	17 03.3	I.Sh.E
28	19 17.8	II.Oc.D
29	18 49.8	III.Tr.I
30	17 22.6	II.Tr.E
30	19 35.9	II.Sh.E
31	21 06.3	I.Tr.I

JUNE

1	18 27.7	I.Oc.D
2	17 12.6	III.Ec.R
2	17 53.2	I.Tr.E
2	18 58.3	I.Sh.E
2	19 33.3	IV.Oc.R
6	17 13.3	II.Tr.I
6	19 19.9	II.Sh.I
6	20 06.4	II.Tr.E
8	20 26.2	I.Oc.D
9	17 02.4	III.Oc.R
9	17 31.5	III.Ec.D
9	17 35.9	I.Tr.I
9	18 36.9	I.Sh.I
9	19 53.3	I.Tr.E
10	18 14.1	I.Ec.R
13	19 58.2	II.Tr.I
15	19 01.7	II.Ec.R
16	17 42.8	III.Oc.D
16	19 35.2	I.Tr.I
17	16 55.1	I.Oc.D
17	20 09.9	I.Ec.R
18	17 17.3	I.Sh.E
19	19 12.6	IV.Ec.D
22	16 58.2	II.Oc.D
24	18 55.4	I.Oc.D
25	16 55.7	I.Sh.I
25	18 23.1	I.Tr.E
25	19 12.9	I.Sh.E
27	18 58.3	III.Sh.E
29	19 46.8	II.Oc.D

JULY

1	17 45.2	II.Tr.E
1	19 13.4	II.Sh.E
2	18 06.3	I.Tr.I
2	18 50.9	I.Sh.I
3	18 27.1	I.Ec.R
4	19 18.7	III.Sh.I
6	18 07.1	IV.Ec.R
8	17 40.3	II.Tr.I
8	18 56.7	II.Sh.I
10	17 26.7	I.Oc.D
11	17 31.9	I.Sh.E
14	17 56.6	IV.Tr.I
15	17 07.8	III.Ec.R
17	18 48.7	II.Ec.R
18	17 08.8	I.Sh.I
24	17 41.9	II.Oc.D

AUGUST

2	17 59.2	I.Oc.D
3	17 30.1	I.Tr.E
3	17 45.1	I.Sh.E
3	18 50.9	I.Sh.I
24	17 41.9	II.Oc.D

SEPTEMBER

2	17 59.2	I.Oc.D
3	17 30.1	I.Tr.E
3	17 45.1	I.Sh.E
14	5 37.9	I.Ec.D
15	5 38.3	I.Tr.E
16	5 58.1	II.Oc.R
22	5 21.3	I.Tr.I
23	4 50.5	I.Oc.R
25	5 12.3	III.Ec.D

OCTOBER

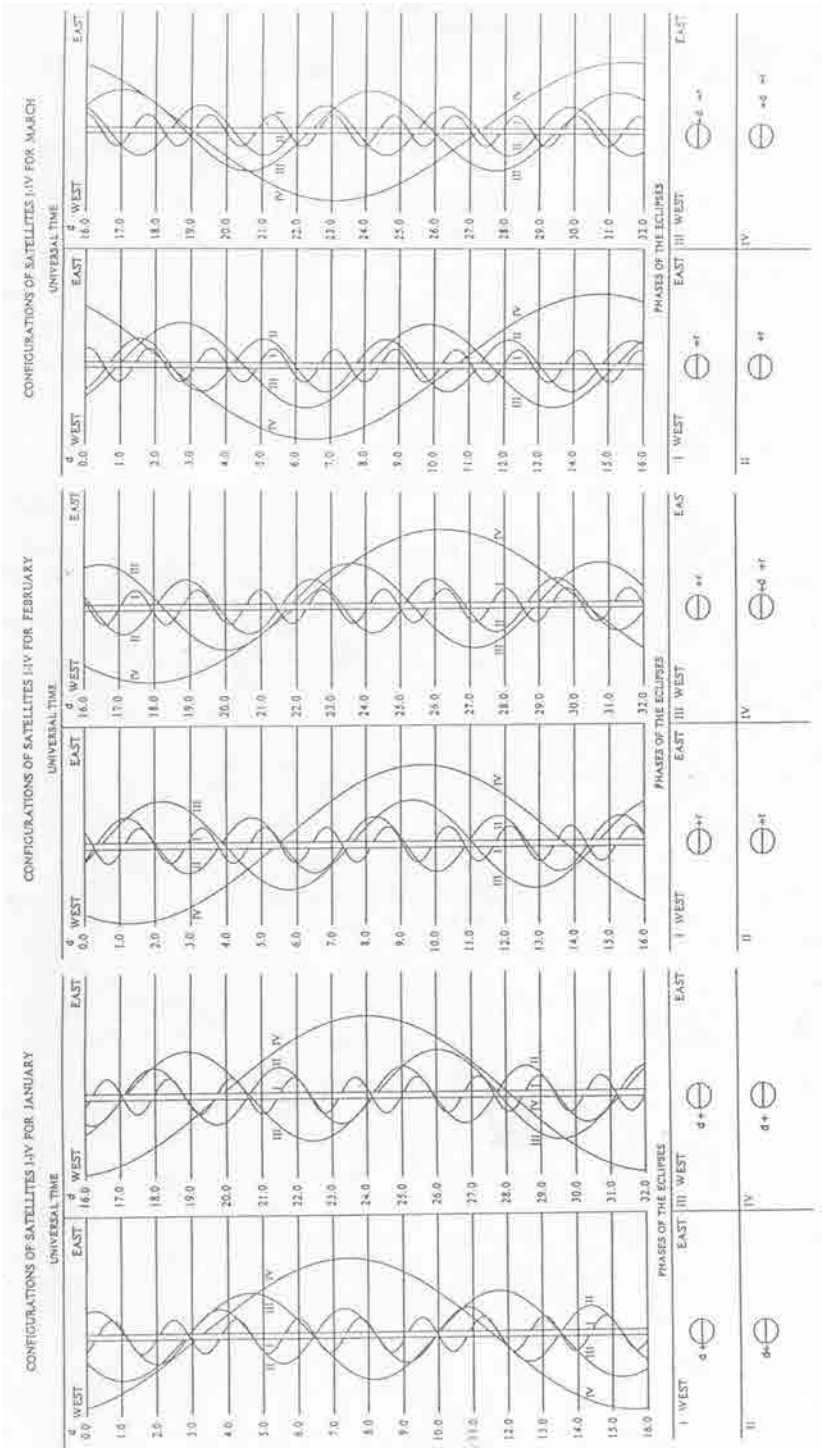
2	4 33.5	II.Sh.E
7	4 51.7	IV.Tr.E
8	5 21.4	I.Sh.E
9	4 18.6	II.Sh.I
11	3 47.6	II.Oc.R
15	4 58.5	I.Sh.I
16	5 18.8	I.Oc.R
23	4 00.5	I.Ec.D
24	3 37.7	I.Sh.E
24	4 36.3	I.Tr.E
24	4 39.1	III.Oc.R
25	4 26.4	II.Ec.D
27	3 30.5	II.Tr.E

NOVEMBER

3	3 25.3	II.Tr.I
3	4 04.6	II.Sh.E
7	4 59.3	III.Ec.D
8	2 15.9	I.Ec.D
9	3 00.1	I.Tr.E
10	3 49.9	II.Sh.I
11	3 07.3	III.Tr.E
12	4 05.3	II.Oc.R
15	4 08.5	I.Ec.D
16	2 40.1	I.Tr.I
16	3 46.7	I.Sh.E
17	2 04.8	I.Oc.R
18	2 28.4	III.Sh.E
18	3 44.8	III.Tr.I
19	1 30.6	II.Ec.D
23	3 23.4	I.Sh.I
23	4 35.8	I.Tr.I
24	4 00.4	I.Oc.R
25	1 19.1	I.Tr.E
25	2 51.6	III.Sh.I
26	3 22.9	IV.Sh.E
26	4 05.9	II.Ec.D
28	1 02.3	II.Sh.E
28	3 28.6	II.Tr.E
29	1 26.9	III.Oc.R
31	2 22.5	I.Ec.D

DECEMBER

2	0 58.2	I.Tr.I
2	2 01.9	I.Sh.E
2	3 13.5	I.Tr.E
5	0 48.5	II.Sh.I
5	3 18.6	II.Tr.I
5	3 36.3	II.Sh.E
6	1 55.1	III.Oc.D
7	1 14.7	II.Oc.R
8	4 16.7	I.Ec.D
9	1 37.8	I.Sh.I
9	2 51.2	I.Tr.I
9	3 54.1	I.Sh.E
10	2 15.3	I.Oc.R
12	3 23.2	II.Sh.I
13	0 47.5	III.Ec.D
13	4 23.6	III.Ec.R
14	3 47.8	II.Oc.R
16	3 31.7	I.Sh.I
16	4 43.5	I.Tr.I
17	0 37.5	I.Ec.D
17	4 08.2	I.Oc.R
18	0 15.1	I.Sh.E
18	1 27.6	I.Tr.E
20	4 45.3	III.Ec.D
21	1 06.6	II.Ec.D
21	1 28.6	IV.Ec.D
23	0 23.3	II.Tr.E
23	23 33.3	III.Tr.I
24	2 30.3	I.Ec.D
24	2 58.3	III.Tr.E
24	23 52.5	I.Sh.I
25	1 02.2	I.Tr.I
25	2 08.6	I.Sh.E
25	3 17.6	I.Tr.E
26	0 26.3	I.Oc.R
28	3 40.2	II.Ec.D
30	0 08.9	II.Tr.I
30	0 37.5	II.Sh.E
30	1 22.8	IV.Tr.E
30	2 52.3	II.Tr.E
31	2 12.2	III.Sh.E
31	3 17.6	III.Tr.I
31	4 24.4	I.Ec.D
31	1 45.6	I.Sh.I
32	2 52.9	I.Tr.I
32	4 01.3	I.Sh.E


CONFIGURATIONS OF SATELLITES I-IV FOR JANUARY
UNIVERSAL TIME
CONFIGURATIONS OF SATELLITES I-IV FOR FEBRUARY
UNIVERSAL TIME
CONFIGURATIONS OF SATELLITES I-IV FOR MARCH
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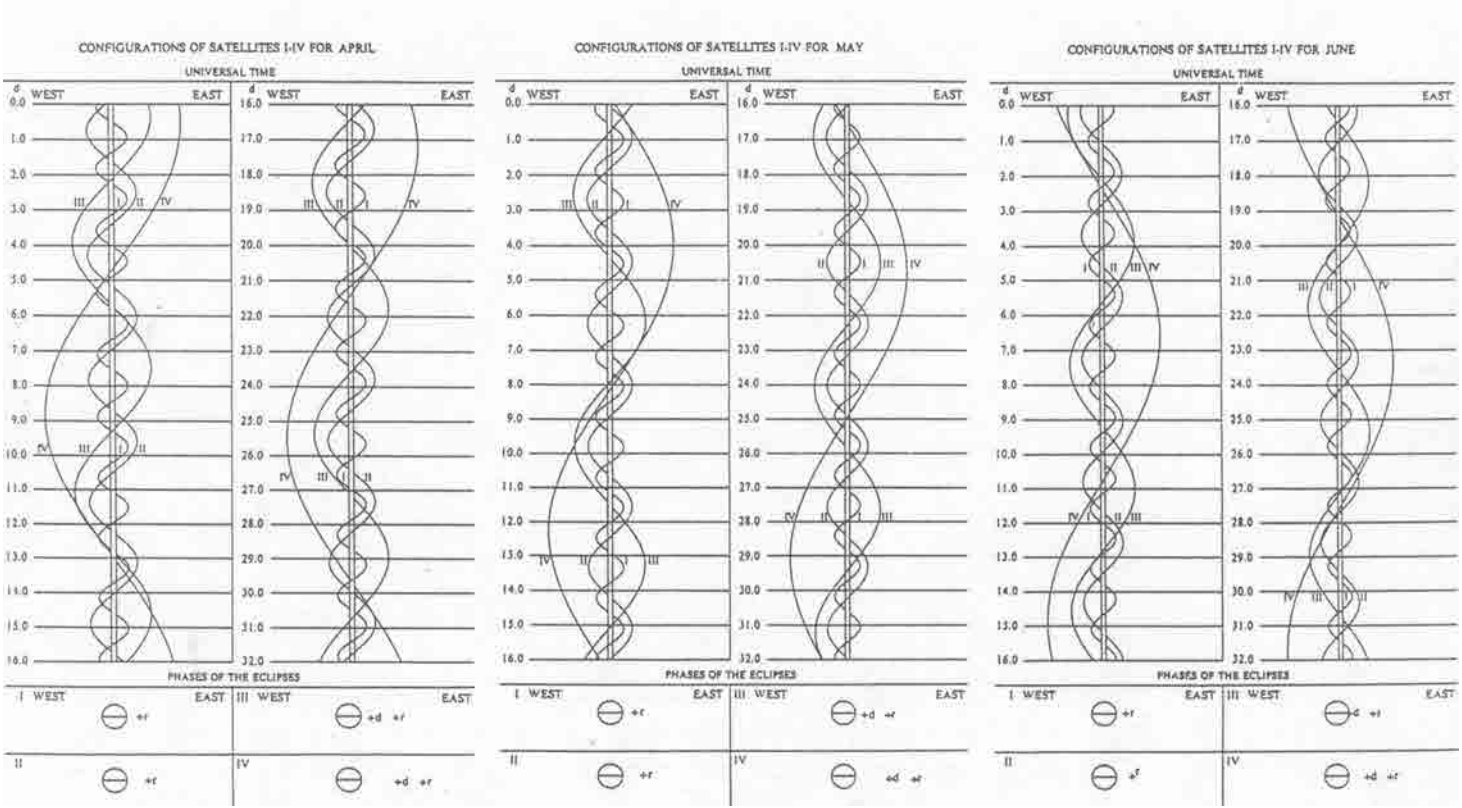
III WEST
EAST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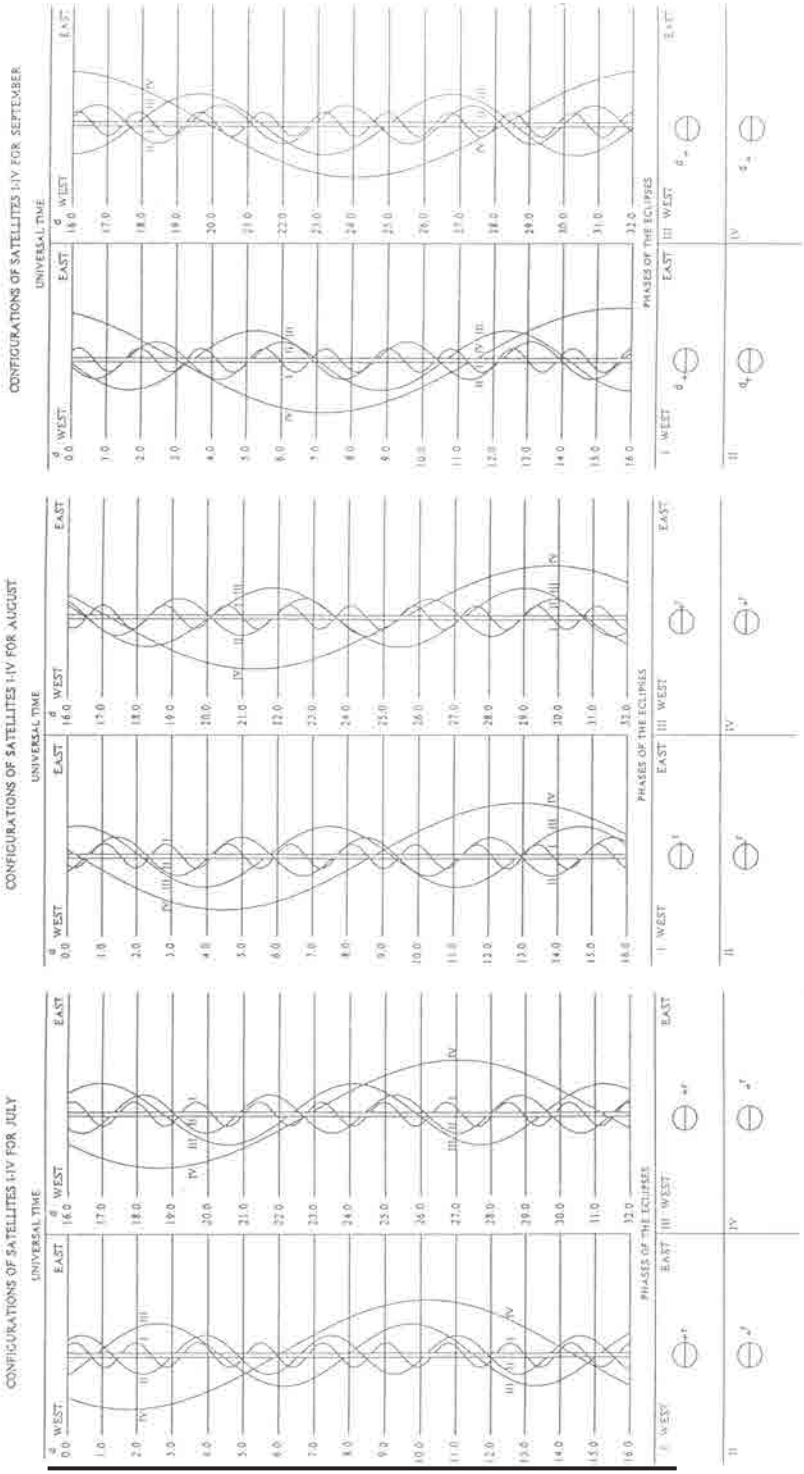
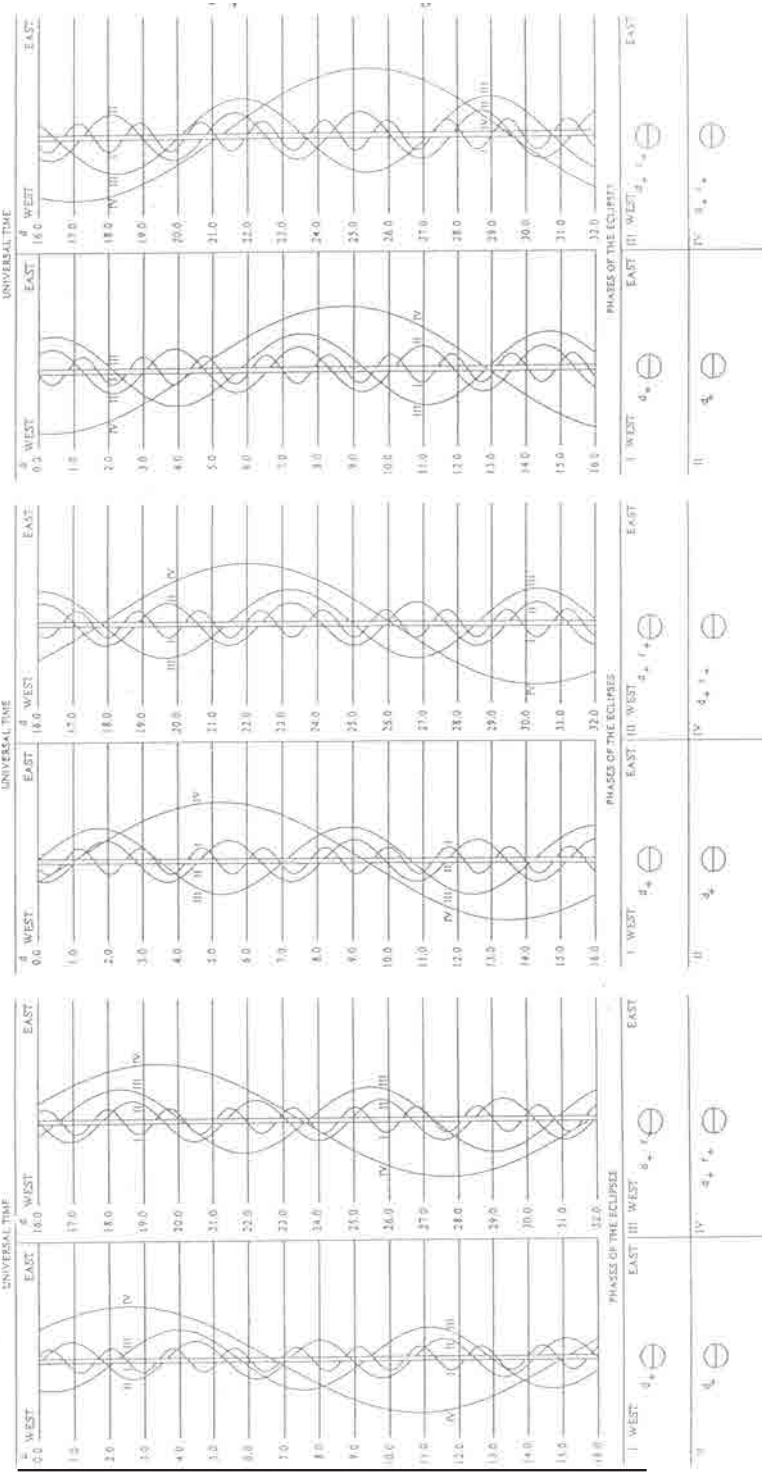
I WEST EAST
III WEST EAST
II
IV
CONFIGURATIONS OF SATELLITES I-IV FOR MAY
UNIVERSAL TIME
d WEST EAST
PHASES OF THE ECLIPSES
I WEST EAST
III WEST EAST
II
IV
CONFIGURATIONS OF SATELLITES I-IV FOR JUNE
UNIVERSAL TIME
d WEST EAST
PHASES OF THE ECLIPSES
I WEST EAST
III WEST EAST
II
IV


CONFIGURATIONS OF SATELLITES I-IV FOR JULY
CONFIGURATIONS OF SATELLITES I-IV FOR AUGUST
CONFIGURATIONS OF SATELLITES I-IV FOR SEPTEMBER
UNIVERSAL TIME
d WEST
EAST
PHASES OF THE ECLIPSES
I WEST
EAST III WEST
II
IV


CONFIGURATIONS OF SATELLITES I-IV FOR OCTOBER
CONFIGURATIONS OF SATELLITES I-IV FOR NOVEMBER
CONFIGURATIONS OF SATELLITES I-IV FOR DECEMBER
UNIVERSAL TIME
d WEST 0.0
d EAST 16.0
PHASES OF THE ECLIPSES
I WEST
EAST III WEST
EAST

JUPITER LONGITUDE OF CENTRAL MERIDIAN

SYSTEM I — 12:00 U.T. (22:00 E.A.S.T.)

Date	January	February	March	April	May	June
01	194.2	053.5	157.2	011.4	064.5	273.0
02	352.3	211.5	315.1	169.2	222.2	070.7
03	150.3	001.6	113.0	327.0	019.9	228.4
04	308.4	167.6	271.0	124.8	177.6	026.0
05	106.4	325.6	068.9	282.6	335.3	183.7
06	264.5	123.6	226.8	080.4	133.0	341.4
07	062.5	281.6	024.7	238.2	290.8	139.0
08	220.5	079.6	182.6	036.0	088.5	296.7
09	018.6	237.6	340.6	193.8	246.2	094.4
10	176.6	035.7	138.5	351.6	043.9	252.0
11	334.7	193.7	296.4	149.4	201.6	049.7
12	132.7	351.7	094.3	307.2	359.3	207.4
13	290.8	149.7	252.2	105.0	157.0	005.0
14	088.8	307.6	050.0	262.7	314.7	162.7
15	246.9	105.6	207.9	060.5	112.4	320.3
16	044.9	263.6	005.8	218.3	270.1	118.0
17	203.0	061.6	163.7	016.0	067.8	275.7
18	001.0	219.6	321.6	173.8	225.5	073.3
19	159.0	017.6	119.4	331.6	023.2	231.0
20	317.1	175.6	277.3	129.3	180.9	028.6
21	115.1	333.5	075.2	287.1	338.5	186.3
22	273.2	131.5	233.0	084.8	136.2	344.0
23	071.2	289.4	030.9	242.6	293.9	141.6
24	229.2	087.4	188.7	040.3	091.6	299.3
25	027.3	245.4	346.6	198.1	249.3	096.9
26	185.3	043.3	144.4	355.8	047.0	254.6
27	343.4	201.3	302.3	153.5	204.6	052.2
28	141.4	359.2	100.1	311.3	002.3	209.9
29	299.4		257.9	109.9	160.0	007.6
30	097.4		055.8	266.7	317.7	165.2
31	255.5		213.6		115.3	

Date	July	August	September	October	November	December
01	322.9	170.3	018.4	070.0	281.2	336.7
02	120.5	328.0	176.1	227.8	079.0	134.6
03	278.2	125.6	333.8	025.5	236.8	292.5
04	075.8	283.3	131.5	183.3	034.6	090.4
05	233.5	081.0	289.2	341.0	192.4	248.3
06	031.1	238.6	086.9	138.8	350.3	046.2
07	188.8	036.3	244.6	296.6	148.1	204.1
08	346.4	194.0	042.3	094.3	305.9	002.0
09	144.1	351.6	200.0	252.1	103.8	160.0
10	301.8	149.3	357.8	049.8	261.6	317.9
11	099.4	307.0	155.5	207.6	059.4	115.8
12	257.1	104.7	313.2	005.4	217.3	273.7
13	054.7	262.4	110.9	163.1	015.1	071.6
14	212.4	060.0	268.6	320.9	173.0	229.6
15	010.0	217.7	066.3	118.7	330.8	027.5
16	167.7	015.4	224.0	276.5	128.7	185.4
17	325.4	173.1	021.8	074.2	286.5	343.4
18	123.0	330.8	179.5	232.0	084.4	141.3
19	280.7	128.4	337.2	029.8	242.2	299.2
20	078.3	286.1	134.9	187.6	040.1	097.2
21	236.0	083.8	292.7	345.4	198.0	255.1
22	033.7	241.5	090.4	143.2	355.8	053.1
23	191.3	039.2	248.1	301.0	153.7	211.0
24	349.0	196.9	045.9	098.8	311.6	001.0
25	146.6	354.5	203.6	256.6	109.4	167.0
26	304.3	152.2	001.3	054.3	267.3	324.9
27	102.0	309.9	159.1	212.1	065.2	122.9
28	259.6	107.6	316.8	010.0	223.1	280.8
29	057.3	265.3	114.6	167.8	021.0	078.8
30	215.0	063.0	272.3	325.6	178.8	236.8
31	012.6	220.7		123.4		034.8

INCREASE OF LONGITUDE

Rotation: 9h 50m 30.003s

hr	deg°	min	deg°
00	000.0	00	00.0
01	036.6	05	03.0
02	073.2	10	06.1
03	109.7	15	09.1
04	146.3	20	12.2
05	182.9	25	15.2
06	219.5	30	18.3
07	256.1	35	21.3
08	292.6	40	24.4
09	329.2	45	27.4
10	005.8	50	30.5
11	042.4	55	33.5
12	079.0	60	36.6
13	115.5		
14	152.1		
15	188.7		
16	225.3		
17	261.8		
18	298.4		
19	335.0		
20	011.6		
21	048.2		
22	084.7		
23	121.3		
24	157.9		

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.

JUPITER LONGITUDE OF CENTRAL MERIDIAN

SYSTEM II — 12:00 U.T. (22:00 E.A.S.T.)

Date	January	February	March	April	May	June
01	050.4	033.2	283.2	260.9	085.1	057.1
02	200.9	183.6	073.5	051.1	235.2	207.2
03	351.3	334.0	223.8	201.3	025.3	357.2
04	141.7	124.4	014.1	351.5	175.4	147.3
05	292.1	274.7	164.4	141.6	325.5	297.3
06	082.5	065.1	314.7	291.8	115.6	087.3
07	232.9	215.5	105.0	082.0	265.6	237.4
08	023.3	005.9	255.3	232.2	055.7	027.4
09	173.8	156.3	045.6	022.3	205.8	177.4
10	324.2	306.6	195.8	172.5	355.9	327.5
11	114.6	097.0	346.1	322.6	145.9	117.5
12	265.0	247.4	136.4	112.8	296.0	267.6
13	055.4	037.8	286.6	262.9	086.1	057.6
14	205.8	188.1	076.9	053.1	236.2	207.6
15	356.2	338.5	227.2	203.2	026.2	357.6
16	146.6	128.8	017.4	353.4	176.3	147.7
17	297.1	279.2	167.7	143.5	326.4	297.7
18	087.5	069.6	317.9	293.6	116.4	087.7
19	237.9	219.9	108.1	083.8	266.5	237.8
20	028.3	010.2	258.4	233.9	056.5	027.8
21	178.7	160.6	048.6	024.0	206.6	177.8
22	329.1	310.9	198.8	174.1	356.6	327.9
23	119.5	101.3	349.1	324.2	146.7	117.9
24	270.0	251.6	139.3	114.4	296.8	267.9
25	060.4	041.9	289.5	264.5	086.8	057.9
26	210.8	192.2	079.7	054.6	236.9	208.0
27	001.2	342.6	229.9	204.7	026.9	358.0
28	151.6	132.9	020.1	354.8	177.0	148.0
29	302.0		170.3	144.9	327.0	298.0
30	092.4		320.5	295.0	117.0	088.1
31	242.8		110.7		267.1	
Date	July	August	September	October	November	December
01	238.1	209.0	180.6	003.3	337.9	164.6
02	028.1	359.0	330.7	153.4	128.1	314.8
03	178.2	149.1	120.7	303.6	278.3	105.1
04	328.2	299.1	270.8	093.7	068.5	255.4
05	118.2	089.2	060.9	243.8	218.7	045.6
06	268.2	239.2	211.0	033.9	008.9	195.9
07	058.3	029.2	001.0	184.1	159.1	346.2
08	208.3	179.3	151.1	334.2	309.3	136.4
09	358.3	329.3	301.2	124.3	099.5	286.7
10	148.3	119.4	091.3	274.4	249.7	077.0
11	298.4	269.4	241.4	064.6	039.9	227.3
12	088.4	059.5	031.4	214.7	190.1	017.6
13	238.4	209.5	181.5	004.9	340.3	167.9
14	028.4	359.6	331.6	155.0	130.5	318.2
15	178.5	149.6	121.7	305.2	280.7	108.5
16	328.5	299.7	271.8	095.3	070.9	258.8
17	118.5	089.7	061.9	245.4	221.2	049.1
18	268.6	239.8	212.0	035.6	011.4	199.4
19	058.6	029.8	002.1	185.7	161.6	349.7
20	208.6	179.9	152.2	335.9	311.8	140.0
21	358.6	329.9	302.3	126.0	102.1	290.4
22	148.7	120.0	092.4	276.2	252.3	080.7
23	298.7	270.0	242.5	066.4	042.6	231.0
24	088.8	060.1	032.6	216.5	192.8	021.3
25	238.8	210.2	182.7	006.7	343.0	171.6
26	028.8	000.2	332.8	156.9	133.3	322.0
27	178.8	150.3	122.9	307.0	283.5	112.3
28	328.9	300.3	273.0	097.2	073.8	262.6
29	118.9	090.4	063.1	247.4	224.0	053.0
30	269.0	240.5	213.2	037.6	014.3	203.3
31	059.0	030.5		187.7		353.7

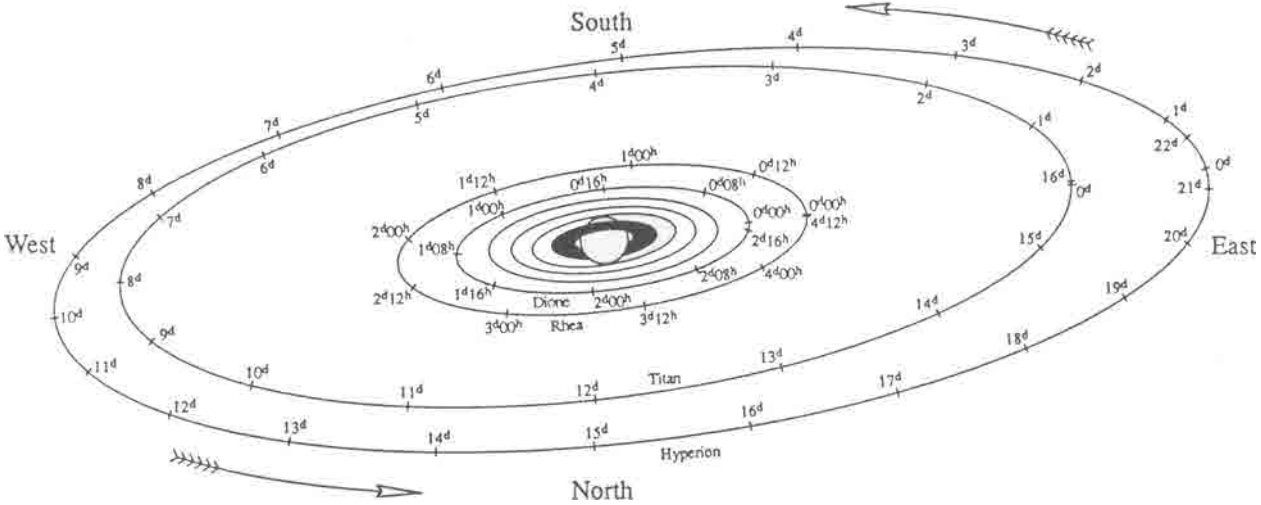
INCREASE OF LONGITUDE

Rotation: 9h 55m 40.062s

hr	deg°	min	deg°
00	000.0	00	00.0
01	036.3	05	03.0
02	072.5	10	06.0
03	108.8	15	09.1
04	145.0	20	12.1
05	181.3	25	15.1
06	217.6	30	18.1
07	253.8	35	21.2
08	290.1	40	24.2
09	326.4	45	27.2
10	002.6	50	30.2
11	038.9	55	33.2
12	075.1	60	36.3
13	111.4		
14	147.7		
15	183.9		
16	220.2		
17	256.5		
18	292.7		
19	329.0		
20	005.2		
21	041.5		
22	077.8		
23	114.0		
24	150.3		

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

SYSTEM II applies to the remainder of the surface.



NAME		MEAN SYNODIC PERIOD	
		d	h
I	Mimas	0	22.6
II	Enceladus	1	08.9
III	Tethys	I	21.3
IV	Dione	2	17.1
V	Rhea	4	12.5
VI	Titan	15	23.3
VII	Hyperion	21	07.6
VIII	lapetus	79	22.1
IX	Phoebe	523	15.6

TITAN

EASTERN ELONGATION	INFERIOR CONJUNCTION	WESTERN ELONGATION	SUPERIOR CONJUNCTION
Jan 15 08.0	Jan 3 08.7	Jan 7 13.7	Jan 11 12.5
Jan 31 08.7	Jan 19 09.6	Jan 23 14.6	Jan 27 13.1
Feb 16 09.3	Feb 4 10.4	Feb 8 15.3	Feb 12 13.7
Mar 4 09.7	Feb 20 11.1	Feb 24 16.0	Feb 28 14.2
Mar 20 09.9	Mar 8 11.7	Mar 12 16.4	Mar 16 14.4
Apr 5 09.8	Mar 24 11.9	Mar 28 16.5	Apr 1 14.3
Apr 21 09.4	Apr 9 11.8	Apr 13 16.3	Apr 17 14.0
May 7 08.6	Apr 25 11.4	Apr 29 15.6	May 3 13.2
May 23 07.3	May 11 10.4	May 15 14.6	May 19 12.0
Jun 8 05.6	May 27 09.1	May 31 13.1	Jun 4 10.4
Jun 24 03.6	Jun 12 07.2	Jun 16 11.2	Jun 20 08.5
Jul 10 01.2	Jun 28 05.0	Jul 2 09.0	Jul 6 06.2
Jul 25 22.8	Jul 14 02.6	Jul 18 06.5	Jul 22 03.8
Aug 10 20.2	Jul 30 00.0	Aug 3 03.9	Aug 7 01.3
Aug 26 17.9	Aug 14 21.4	Aug 19 01.3	Aug 22 22.9
Sep 11 15.8	Aug 30 19.0	Sep 3 23.1	Sep 7 20.8
Sep 27 14.1	Sep 15 16.9	Sep 19 21.1	Sep 23 19.0
Oct 13 12.8	Oct 1 15.3	Oct 5 19.6	Oct 9 17.6
Oct 29 11.9	Oct 17 14.1	Oct 21 18.6	Oct 25 16.7
Nov 14 11.5	Nov 2 13.5	Nov 6 18.0	Nov 10 16.2
Nov 30 11.5	Nov 18 13.2	Nov 22 17.9	Nov 26 16.0
Dec 16 11.7	Dec 4 13.4	Dec 8 18.1	Dec 12 16.2
Jan 1 12.2	Dec 20 13.8	Dec 24 18.5	Dec 28 16.5

HYPERION

EASTERN ELONGATION	INFERIOR CONJUNCTION	WESTERN ELONGATION	SUPERIOR CONJUNCTION
Jan 10 12.6	Jan 15 23.7	Jan 21 06.8	Jan 4 09.9
Jan 31 22.5	Feb 6 08.6	Feb 10 23.5	Jan 25 19.4
Feb 22 08.7	Feb 27 17.6	Mar 4 08.3	Feb 16 05.2
Mar 15 18.9	Mar 21 02.6	Mar 25 17.2	Mar 9 15.1
Apr 6 04.9	Apr 11 11.6	Apr 16 02.0	Mar 31 01.1
Apr 27 14.4	May 2 20.2	May 7 10.4	Apr 21 10.6
May 18 23.2	May 24 04.5	May 28 18.6	May 12 19.6
Jun 9 07.5	Jun 14 12.3	Jun 19 02.2	Jun 3 04.0
Jun 30 15.0	Jul 5 19.6	Jul 10 09.4	Jun 24 11.6
Jul 21 22.1	Jul 27 02.7	Jul 31 16.6	Jul 15 18.8
Aug 12 05.2	Aug 17 10.0	Aug 21 23.9	Aug 6 01.9
Sep 2 12.8	Sep 7 17.6	Sep 12 07.6	Aug 27 09.2
Sep 23 20.9	Sep 29 01.8	Oct 3 16.1	Sep 17 17.3
Oct 15 06.1	Oct 20 10.8	Oct 25 01.4	Oct 9 02.3
Nov 5 16.0	Nov 10 20.2	Nov 15 11.1	Oct 30 12.2
Nov 27 02.5	Dec 2 06.0	Dec 6 21.4	Nov 20 23.1
Dec 18 13.4	Dec 23 15.9	Dec 28 07.7	Dec 12 10.3

IAPETUS

EASTERN ELONGATION	INFERIOR CONJUNCTION	WESTERN ELONGATION	SUPERIOR CONJUNCTION
Mar 16 03.5	Jan 13 20.3	Feb 4 04.0	Feb 24 20.8
Jun 4 00.7	Apr 4 23.4	Apr 26 00.4	May 16 04.9
Aug 21 09.4	Jun 23 09.4	Jul 13 21.9	Aug 2 18.1
Nov 8 14.7	Sep 9 15.2	Sep 30 07.1	Oct 20 13.0
	Nov 28 08.5	Dec 19 14.1	Jan 9 04.7

GREATEST EASTERN ELONGATIONS — E.A.S.T.

TETHYS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
0 19.5	1 22.2	2 06.2	1 11.4	1 16.4	2 18.5	1 01.9	2 03.9	1 08.6	1 13.4	2 15.8	2 21.1
2 16.8	3 19.5	4 03.5	3 08.7	3 13.7	4 15.8	2 23.2	4 01.2	3 05.9	3 10.7	4 13.1	4 18.4
4 14.1	5 16.9	6 00.8	5 06.0	5 11.0	6 13.1	4 20.5	5 22.5	5 03.2	5 08.1	6 10.5	6 15.7
6 11.5	7 14.2	7 22.1	7 03.3	7 08.3	8 10.4	6 17.8	7 19.7	7 00.5	7 05.4	8 07.8	8 13.1
8 08.8	9 11.5	9 19.5	9 00.6	9 05.6	10 07.7	8 15.1	9 17.0	8 21.8	9 02.7	10 05.1	10 10.4
10 06.2	11 08.9	11 16.8	10 21.9	11 02.9	12 05.0	10 12.4	11 14.3	10 19.1	11 00.0	12 02.4	12 07.7
12 03.5	13 06.2	13 14.1	12 19.3	13 00.2	14 02.3	12 09.7	13 11.6	12 16.4	12 21.3	13 23.8	14 05.1
14 00.8	15 03.5	15 11.5	14 16.6	14 21.5	15 23.6	14 07.0	15 08.9	14 13.7	14 18.6	15 21.1	16 02.4
15 22.2	17 00.9	17 08.8	16 13.9	16 18.8	17 20.9	16 04.3	17 06.2	16 11.0	16 15.9	17 18.4	17 23.7
17 19.5	18 22.2	19 06.1	18 11.2	18 16.1	19 18.2	18 01.5	19 03.5	18 08.3	18 13.3	19 15.7	19 21.0
19 16.8	20 19.5	21 03.4	20 08.5	20 13.4	21 15.5	19 22.8	21 00.8	20 05.6	20 10.6	21 13.1	21 18.4
21 14.2	22 16.8	23 00.8	22 05.8	22 10.7	23 12.8	21 20.1	22 22.1	22 02.9	22 07.9	23 10.4	23 15.7
23 11.5	24 14.2	24 22.1	24 03.1	24 08.0	25 10.1	23 17.4	24 19.4	24 00.2	24 05.2	25 07.7	25 13.1
25 08.9	26 11.5	26 19.4	26 00.5	26 05.3	27 07.4	25 14.7	26 16.7	25 21.5	26 02.5	27 05.1	27 10.4
27 06.2	28 08.2	28 16.7	27 21.8	28 02.6	29 04.6	27 12.0	28 14.0	27 18.8	27 23.9	29 02.4	29 07.7
29 03.5		30 14.0	29 19.1	29 23.9		29 09.3	30 11.3	29 16.1	29 21.2	30 23.7	31 05.1
31 00.9				31 21.2		31 06.6			31 18.5		33 02.4

DIONE

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
2 13.8	1 17.0	1 02.4	2 23.1	3 01.8	2 04.3	2 06.5	1 08.7	3 04.5	3 07.0	2 09.7	2 12.7
5 07.5	4 10.7	3 20.1	5 16.8	5 19.5	4 21.9	5 00.2	4 02.3	5 22.2	6 00.7	5 03.5	5 06.5
8 01.3	7 04.5	6 13.8	8 10.5	8 13.2	7 15.6	7 17.8	6 20.0	8 15.9	8 18.4	7 21.2	8 00.2
10 19.0	9 22.2	9 07.6	11 04.2	11 06.9	10 09.3	10 11.5	9 13.6	11 09.5	11 12.1	10 14.9	10 17.9
13 12.8	12 15.9	12 01.3	13 21.9	14 00.5	13 02.9	13 05.1	12 07.3	14 03.2	14 05.8	13 08.6	13 11.7
16 06.5	15 09.7	14 19.0	16 15.6	16 18.2	15 20.6	15 22.8	15 00.9	16 20.9	16 23.5	16 02.4	16 05.4
19 00.3	18 03.4	17 12.7	19 09.3	19 11.9	18 14.2	18 16.4	17 18.6	19 14.6	19 17.2	18 20.1	18 23.2
21 18.0	20 21.2	20 06.5	22 03.0	22 05.6	21 07.9	21 10.1	20 12.2	22 08.3	22 10.9	21 13.8	21 16.9
24 11.7	23 14.9	23 00.2	24 20.7	24 23.2	24 01.5	24 03.7	23 05.9	25 01.9	25 04.6	24 07.5	24 10.6
27 05.5	26 08.6	25 17.9	27 14.4	27 16.9	26 19.2	26 21.4	25 23.5	27 19.6	27 22.3	27 01.3	27 04.4
29 23.3		28 11.6	30 08.1	30 10.6	29 12.9	29 15.0	28 17.2	30 13.3	30 16.0	29 19.0	29 22.1
		31 05.4					31 10.9				32 15.9

RHEA

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
2 20.3	3 12.4	2 15.8	3 07.4	4 22.7	1 01.2	2 15.6	3 05.9	3 20.3	5 11.0	1 13.8	3 05.5
7 08.9	8 00.9	7 04.3	7 19.9	9 11.2	5 13.5	7 04.0	7 18.2	8 08.6	9 23.5	6 02.3	7 18.0
11 21.4	12 13.5	11 16.9	12 08.4	13 23.6	10 01.9	11 16.3	12 06.5	12 21.0	14 11.9	10 14.8	12 06.6
16 10.1	17 02.1	16 05.4	16 20.9	18 12.0	14 14.3	16 04.6	16 18.9	17 09.4	19 00.4	15 03.3	16 19.2
20 22.6	21 14.7	20 17.9	21 09.4	23 00.4	19 02.6	20 16.9	21 07.2	21 21.8	23 12.9	19 15.9	21 07.7
25 11.2	26 03.2	25 06.4	25 21.8	27 12.8	23 14.9	25 05.2	25 19.5	26 10.2	28 01.3	24 04.4	25 20.3
29 23.8		29 18.9	30 10.3		28 03.3	29 17.6	30 07.9	30 22.6		28 17.0	30 08.9

DATE	Major "	Minor "	U°	B°	DATE	Major "	Minor "	U°	B°
Jan 00	34.5	13.2	169.8	22.5	Jul 11	42.0	14.2	179.2	19.8
Jan 16	34.4	12.8	171.8	21.9	Jul 27	42.2	14.6	178.0	20.2
Feb 01	34.5	12.5	173.7	21.3	Aug 12	42.0	14.8	176.9	20.6
Feb 17	34.7	12.3	175.6	20.7	Aug 28	41.5	14.9	175.8	21.0
Mar 05	35.2	12.2	177.3	20.2	Sep 13	40.7	14.7	175.1	21.2
Mar 21	35.9	12.1	178.7	19.7	Sep 29	39.8	14.5	174.7	21.4
Apr 06	36.7	12.1	179.9	19.3	Oct 15	38.7	14.1	174.8	21.4
Apr 22	37.7	12.3	180.8	19.0	Oct 31	37.7	13.6	175.3	21.2
May 08	38.7	12.5	181.2	18.9	Nov 16	36.8	13.1	176.1	20.9
May 24	39.7	12.9	181.2	18.9	Dec 02	35.9	12.6	177.4	20.5
Jun 09	40.7	13.3	180.9	19.1	Dec 18	35.3	12.1	178.9	20.0
Jun 25	41.5	13.8	180.2	19.4					

SATURNS RINGS

U Geocentric Longitude of Saturn

B Tilt of rings

P Position Angle of rings measured E of N. = 6.9° in 1991

Factors by which axes of outer rings are to be multiplied to obtain axes of:

Ring A: Inner edge of outer ring	0.8801
Ring B: Outer edge of inner ring	0.8599
Ring B: Inner edge of inner ring	0.6650
Ring C: Inner edge of dusky ring	0.5486
Saturn Equatorial	0.4440

GREATEST NORTHERN ELONGATIONS

TITANIA

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
2 21.0	6 15.8	4 18.1	8 13.5	4 16.2	8 12.3	4 15.6	8 12.1	3 15.3	8 11.1	3 13.5	8 08.5
11 13.7	15 08.7	13 11.0	17 06.4	13 09.3	17 05.4	13 08.7	17 05.2	12 08.3	17 03.9	12 06.3	17 01.3
20 06.4	24 01.4	22 03.8	25 23.3	22 02.3	25 22.5	22 01.9	25 22.2	21 01.2	25 20.7	20 23.0	25 18.0
28 23.1		30 20.6		30 19.3		30 19.0		29 18.1		29 15.8	

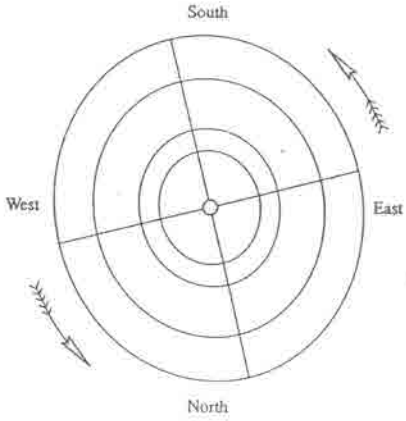
OBERON

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
8 13.0	4 10.3	3 07.7	12 16.3	9 14.8	5 13.5	2 12.3	11 22.7	7 21.2	4 19.7	14 04.2	11 01.6
21 23.5	17 20.8	16 18.4	26 03.6	23 02.2	19 00.7	15 23.7	25 09.9	21 08.5	18 06.8	27 14.9	24 12.4
		30 05.2				29 11.3			31 17.7		

UMBRIEL

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
1 02.9	3 06.1	4 06.2	2 06.2	1 06.2	3 09.9	2 10.5	4 14.6	2 15.0	1 15.1	3 18.6	2 18.8
5 06.3	7 09.6	8 09.6	6 09.6	5 09.6	7 13.3	6 13.9	8 18.1	6 18.4	5 18.5	7 22.1	6 22.3
9 09.7	11 12.8	12 12.9	10 13.2	9 13.2	11 16.8	10 17.4	12 21.6	10 21.8	9 21.9	12 01.6	11 01.7
13 13.1	15 16.3	16 16.4	14 16.6	13 16.6	15 20.3	14 21.0	17 01.1	15 01.3	14 01.4	16 05.1	15 05.1
17 16.5	19 19.8	20 19.9	18 20.0	17 20.0	19 23.9	19 00.5	21 04.5	19 04.7	18 04.9	20 08.5	19 08.4
21 19.8	23 23.2	24 23.3	22 23.4	21 23.5	24 03.4	23 04.1	25 08.0	23 08.2	22 08.4	24 12.0	23 11.8
25 23.2	28 02.7	29 02.8	27 02.8	26 02.9	28 06.9	27 07.6	29 11.4	27 11.6	26 11.8	28 15.4	27 15.4
30 02.7				30 06.4		31 11.1			30 15.2		31 18.7

APPARENT ORBITS OF SATELLITES I–IV AT DATE OF OPPOSITION, JULY 4



	Name	Sidereal Period d	h
V	Miranda	1.4	
I	Ariel	2	12.489
II	Umbriel	4	03.460
III	Titania	8	16.941
IV	Oberon	13	11.118

RINGS OF URANUS

Ring	Semimajor Axis km	Eccentricity	Azimuth of Periapse °	Precession Rate °/d
6	41870	0.0014	256	2.77
5	42270	0.0018	182	2.66
4	42600	0.0012	120	2.60
α	44750	0.0007	331	2.18
β	45700	0.0005	231	2.03
η	47210	— —	—	—
γ	47660	— —	—	—
δ	48330	0.0005	140	—
ε	51180	0.0079	216	1.36

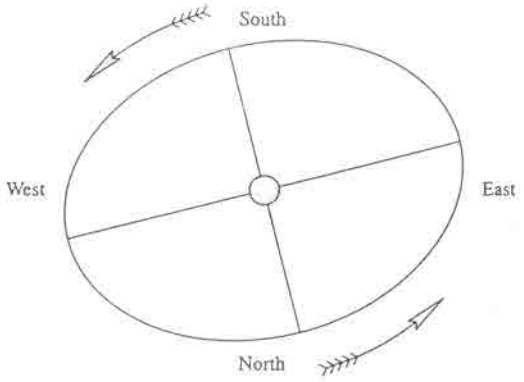
Epoch: 1977 March 10, 20^h UT (J.D. 244 3213.33)

GREATEST EASTERN ELONGATIONS — E.A.S.T.

TRITON

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h	d h
0 22.9	5 04.5	6 13.3	4 22.2	4 07.4	2 16.8	2 02.4	6 09.2	4 18.7	4 04.0	2 13.1	1 22.0
6 19.9	11 01.5	12 10.2	10 19.2	10 04.5	8 13.9	7 23.5	12 06.3	10 15.8	10 01.1	8 10.1	7 18.9
12 16.8	16 22.4	18 07.2	16 16.2	16 01.5	14 11.0	13 20.7	18 03.4	16 12.8	15 22.1	14 07.1	13 15.9
18 13.7	22 19.4	24 04.2	22 13.3	21 22.6	20 08.1	19 17.8	24 00.5	22 09.9	21 19.1	20 04.1	19 12.8
24 10.7	28 16.3	30 01.2	28 10.3	27 19.7	26 05.3	25 14.9	29 21.6	28 07.0	27 16.1	26 01.0	25 09.8
30 07.6						31 12.0					31 06.7

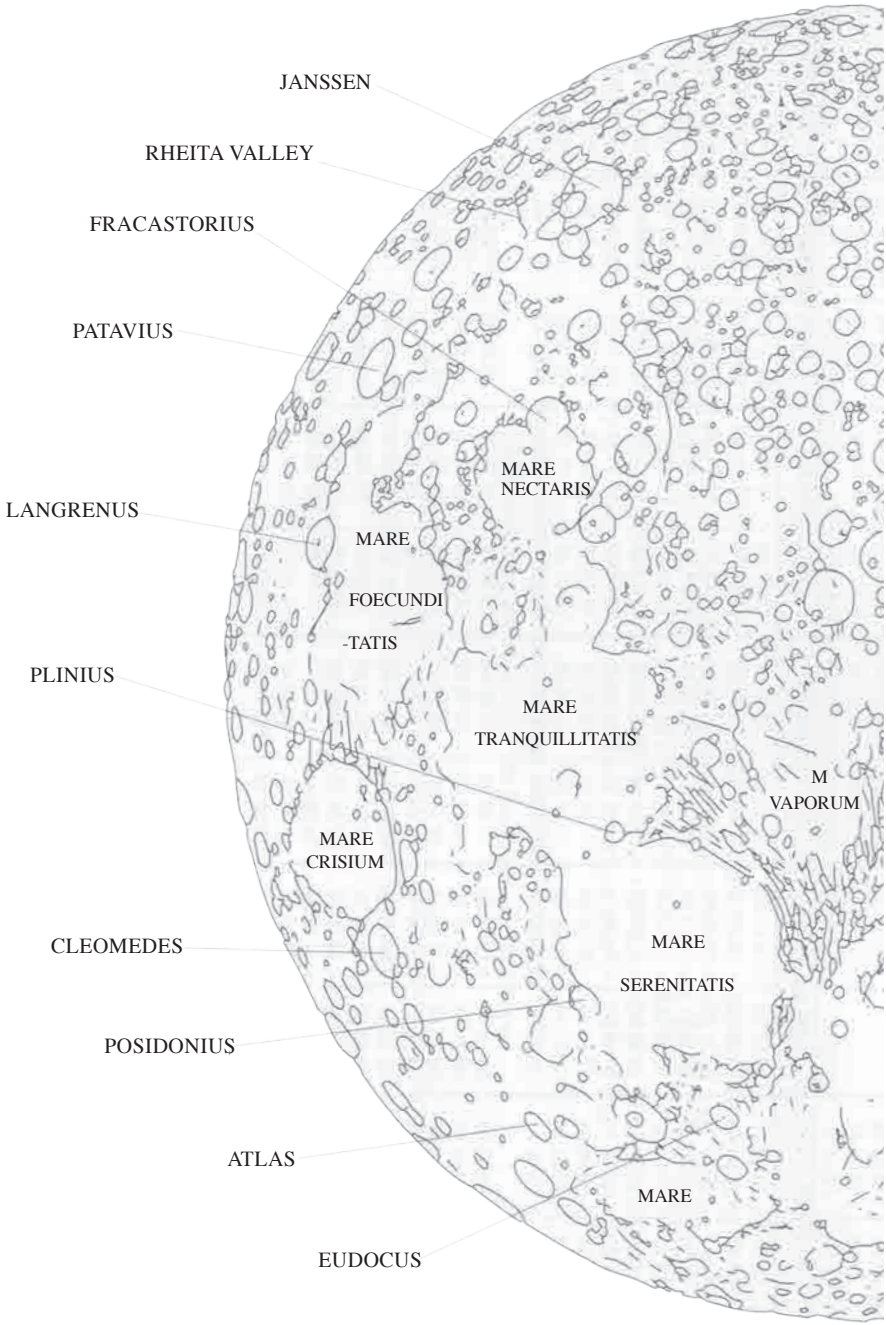
APPARENT ORBIT OF TRITON AT DATE OF OPPOSITION, JULY 8

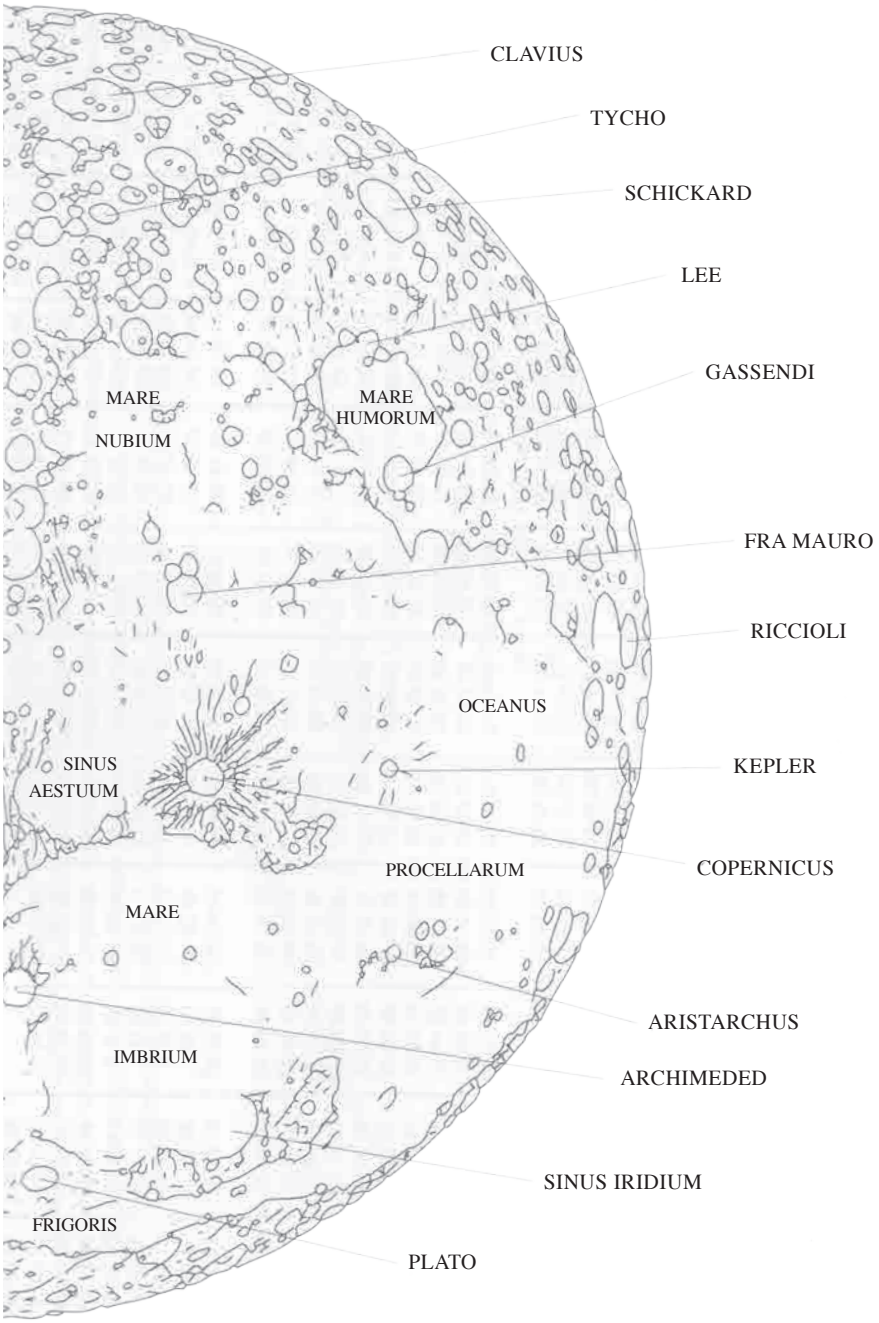


	Name	Sidereal Period
I	Triton	$5^d\ 21^h.044$
II	Nereid	$360^d.2$

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

— means moon either doesn't rise or doesn't set during that day


JANSSEN
RHEITA VALLEY
FRACASTORIUS
PATAVIUS
LANGRENUS
PLINIUS
CLEOMEDES
POSIDONIUS
ATLAS
EUDOCUS
MARE
NECTARIS
MARE
FOECUNDI
-TATIS
MARE
TRANQUILLITATIS
M
VAPORUM
MARE
CRISIUM
MARE
SERENITATIS
MARE


CLAVIUS
TYCHO
SCHICKARD
LEE
GASSENDI
MARE
NUBIUM
MARE
HUMORUM
FRA MAURO
RICCIOLI
OCEANUS
SINUS
AESTUUM
KEPLER
COPERNICUS
PROCELLARUM
MARE
ARISTARCHUS
IMBRIUM
ARCHIMEDED
SINUS IRIDIUM
FRIGORIS
PLATO

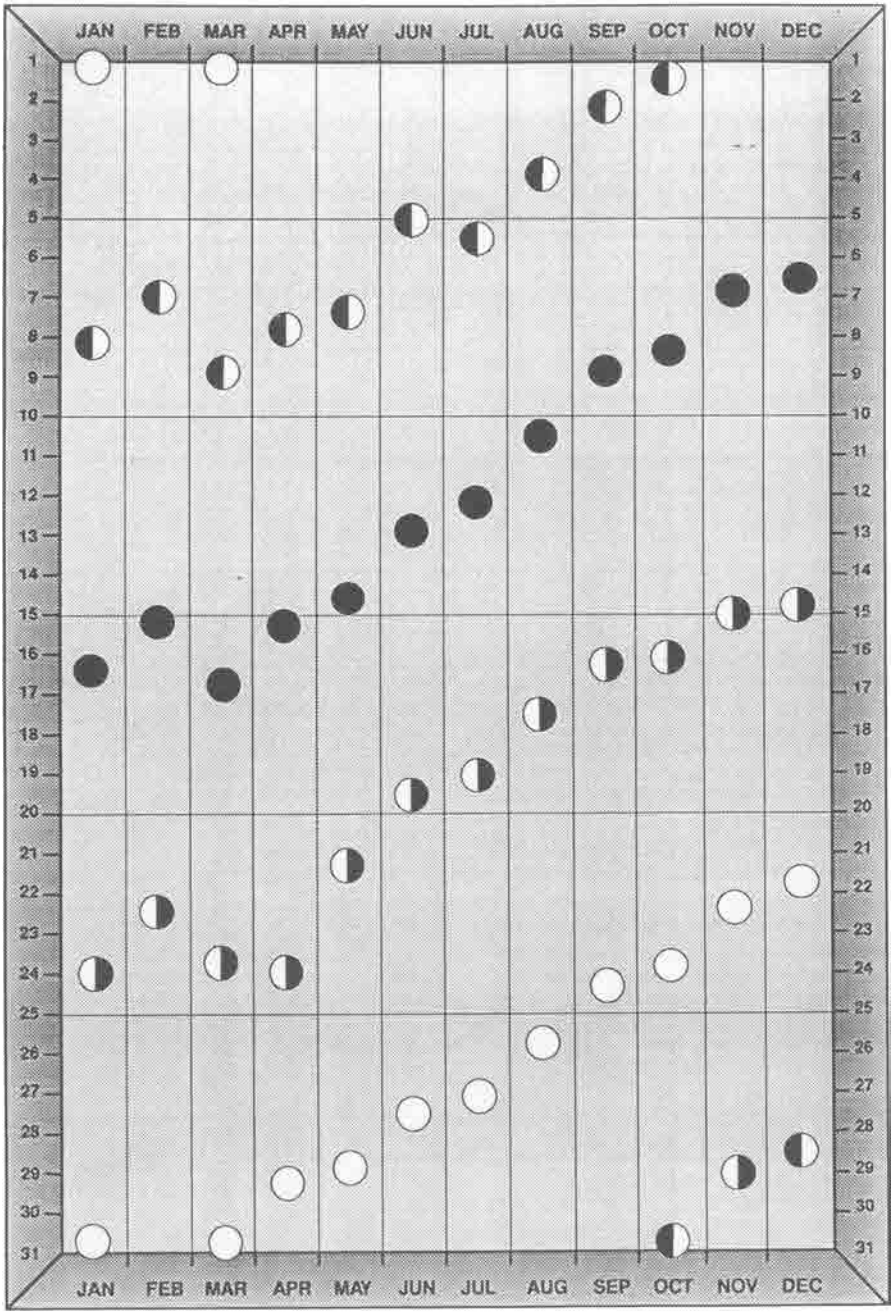
POSITION OF THE MOON (J2000) @ 0 hrs U.T.

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

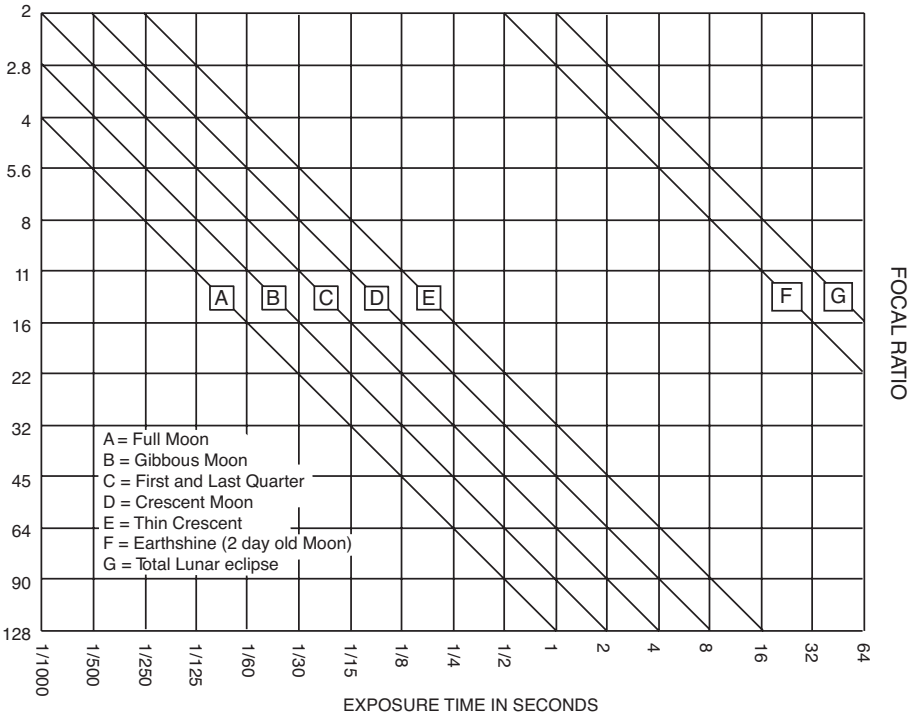
POSITION OF THE MOON (J2000) @ 0hrs U.T.

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

MOON PHASE CALENDAR



PHOTOGRAPHIC EXPOSURE GUIDE for the MOON



The above chart provides recommended photographic exposures for the moon using 100 ISO film. The chart should only be treated as a guide as many factors will influence the exposure time.

Follow a horizontal line nearest to your system's focal ratio to the oblique line that represents the Moon aspect required, then follow the intersecting vertical line to the bottom of the graph to find the correct exposure. For the best result always take one photo at the recommended speed and follow up with one at half and one at twice the exposure. Bracketing exposures will help smooth out variables and should provide at least one image at the required density.

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

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

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 is large, half a degree wide, because of its proximity to us. The Moon travels along a half degree wide path across the sky, as the Sun does.
2) The rapid motion of the Moon across the sky. It completes one revolution approximately every 28 days.
3) With it moving approximately in the plane of the ecliptic, as do all Solar System bodies, the Moon frequently (monthly) moves across the heavily star populated Milky Way. It also occasionally occults the Sun and the planets. An eclipse of the Sun is indeed the most spectacular lunar occultation!

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

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

Without a doubt “dark” limb events, in particular disappearances, are the easiest to observe. Following a star until it “winks out” is much easier than scanning the lunar limb waiting for it to suddenly reappear. The brighter the star the more spectacular the event. The following tables present the easier to observe occultations for 1992. For any particular star, both events (ie. the disappearance and reappearance) are not necessarily included. An event may not be present because:-

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

GRAZING OCCULTATIONS

Occasionally a star will come very close to not being occulted by the Moon. In fact the situation can arise where an observer will see a star disappear behind the lunar limb, but a companion less than a kilometre away will see no occultation. A grazing occultation, like the name implies, is when a star grazes or skims along the lunar limb. Because of the moons East-West motion a graze only occurs along the North or Southern "Polar" limb regions of the Moon. In regards to observing a "graze" the potential is there for multiple events ie. more than one disappearance or reappearance. The star can disappear behind mountains and reappear (briefly) in valleys and troughs a number of times before eventually clearing the lunar limb. To the enthusiast, the few minutes a graze takes to occur is an exciting time.

To observe a "graze" your location on Earth is critical. A graze path is a narrow East-West band which is only a kilometre or so wide. It can be thought of as a projection of the profile of the lunar limb moving along the Earth's surface.

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 stopwatch and the telephone time signal, as a reference, is all that is required. For multiple events, such as grazes, amateurs often use a tape recorder at the telescope. The recorder is used to simultaneously record the observer's voice (as he/she calls out the events) and the time "pips" from a shortwave radio which is tuned to a suitable time service. The tape is later played back and the data reduced (times determined). To be useful, timings need to be accurate to the nearest 0.1-0.2 sec. With practice these simple techniques can reach such precision.

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

If you require further information on timing methods for occultations or grazes it would be worthwhile contacting your local astronomical society (see list elsewhere in this book). Although maps are presented which show the "graze paths" in NSW for 1991, it is best to make contact with the amateur astronomical community before attempting such observations. The maps are only intended as a guide to the general area for the event. The exact path needs to be professionally calculated a few days before the "big day" and the greatest contribution you can make (and your best chance of being in the right place) is by participating in an organised "graze" party.

LUNAR OCCULTATION TABLES

* DATE,hr,min	are in E.A.S.T.
* STAR NAME	is indicated by Flamsteed Numbers and Bayer letters. Sometimes the number of the star in the catalogues of Bode, Gould or Hevelius is used and they are noted by the letters B,G or H respectively. The star's constellation uses the standard 3 letter abbreviation (see also the "Observing the Constellations" table). If the constellation name is in (brackets), precession has moved the star out of the constellation since the star was named.
* ZC NUM	Number of the star in the Zodiacal Catalogue.
* Mag	Magnitude of the star.
* PH	Phenomena - first letter D : Disappearance R : Reappearance - second letter D : Dark Limb B : Bright Limb
* ELONG	The elongation of the Moon from the Sun or how far the Moon is east of the Sun measured in degrees.
* A	Coefficient of Longitude (see next page)
* B	Coefficient of Latitude (see next page) **** NB. For some stars the values for A and B were not available.
* P	The position angle on the lunar limb of the event. This is traditionally expressed as degrees east of North.

CALCULATING EVENT TIME FOR OTHER LOCATIONS

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

The formula is:

Predicted Time at your location

= Time from Table + (A × n) + (B × p)

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

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

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

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

WORKED EXAMPLE

An observer wishes to calculate a more accurate time for the disappearance of 10 (pi) Cap on Apr 9 for their location in Canberra (149° 06' E, -35° 12' S).

-The change in longitude from Sydney = 150°.25-149°.1 = 1°.15 = "n"

-The change in latitude from Sydney = 33°.9- (-35°.2) = -1°.3

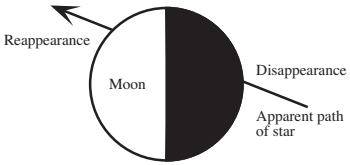
The sign needs to be changed because it is a southern change in latitude. Therefore p= -1.3

From the table, the values of A and B are -1.2 and 1.4 respectively. Therefore the equation becomes:-

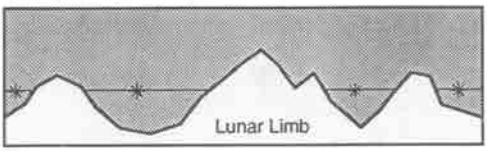
59.3 + (-1.2 * 1.15) + (1.4 * -1.3) = 56.1 mins.

The event will be visible from Canberra approx. 3 mins earlier than Sydney, i.e., at 2:56 AM on April 9th.

LUNAR OCCULTATION



GRAZING LUNAR OCCULTATION



Lunar Occultation Table

DATE	hr	min.	Star Name	ZC Num.	MAG.	PH.	ELONG.	A	B	P
Jan 11	02	09.9	64 G Lib	2183	5.7	R.D.	302	0.3	-1.8	309
Jan 23	20	36.3	3 (Ari)	263	6.5	D.D.	88	-1.6	0.8	101
Jan 26	23	19.5	-	732	7.8	D.D.	129	-0.7	-0.6	140
Feb 07	00	39.1	43 B Lib	2134	6.1	R.D.	270	-0.2	-1.5	286
Feb 08	03	43.9	31 B Sco	2269	5.4	R.D.	283	-1.8	-0.8	262
Feb 19	19	30.9	-	223	8.1	D.D.	57	-1.0	1.4	79
Feb 21	21	09.3	-	499	8.1	D.D.	84	-0.3	-0.6	138
Feb 23	20	14.6	-	833	7.1	D.D.	109	-2.1	0.0	103
Feb 23	22	44.2	112 B Aur	844	5.7	D.D.	111	-1.4	1.3	78
Feb 25	00	15.5	27 ε Gem	1030	3.2	D.D.	125	-0.6	0.3	116
Feb 25	22	54.8	192 B Gem	1167	6.3	D.D.	137	-1.9	0.3	99
Mar 04	22	43.8	85 Vir	1970	6.2	R.D.	227	-0.7	-1.5	285
Mar 25	20	23.6	-	1249	9.0	D.D.	118	-1.0	-1.9	158
Mar 26	19	46.5	82 π Cnc	1375	5.6	D.D.	131	-2.4	-0.6	91
Apr 01	21	59.0	43 H Vir	2039	5.6	R.D.	207	-0.9	-1.6	290
Apr 01	23	06.0	231 G Vir	2045	6.4	R.D.	207	-2.4	-0.3	256
Apr 02	00	16.2	236 G Vir	2051	5.7	R.D.	208	-2.2	-1.0	278
Apr 03	04	21.2	64 G Lib	2183	5.7	R.D.	221	-2.1	-3.9	338
Apr 04	03	00.6	24 G Sco	2311	6.2	R.D.	231	*	*	354
Apr 07	00	05.5	26 Sgr	2714	6.1	R.D.	262	*	*	339
Apr 09	02	59.0	10 π Cap	2981	5.2	R.D.	286	-1.2	1.4	213
Apr 09	04	18.0	11 ρ Cap	2987	5.0	R.D.	286	-1.7	-1.6	279
Apr 19	17	57.7	139 Tau	900	4.9	D.D.	61	*	*	178
Apr 20	17	56.3	42 ω Gem	1070	5.2	D.D.	74	-2.1	0.0	102
Apr 21	21	39.2	-	1223	7.8	D.D.	89	0.5	-2.0	170
Apr 24	19	42.6	35 Sex	1565	6.3	D.D.	126	-2.1	-1.1	113
Apr 25	01	24.2	227 B (Leo)	1577	7.1	D.D.	129	0.0	0.0	52
Apr 26	01	07.1	431 B (Leo)	1688	6.3	D.D.	141	-0.9	-0.4	128
May 05	03	22.2	222 B Sgr	2822	5.6	R.D.	245	-2.2	2.2	222
May 18	19	20.2	-	1174	7.5	D.D.	58	0.0	-1.2	156
May 21	21	06.8	-	1541	8.0	D.D.	98	*	*	193
May 22	20	18.5	-	1640	8.5	D.D.	110	-1.5	-1.4	137
May 25	01	35.2	-	1872	7.3	D.D.	136	-0.7	-0.2	126
May 25	21	32.3	83 Vir	1967	5.7	D.D.	146	-0.6	-4.1	171
May 31	21	35.5	154 B Sgr	2754	5.9	R.D.	213	-0.7	-1.0	264
May 31	22	27.6	-	Uranus	5.6	R.D.	213	-1.1	-0.9	264
Jun 09	04	28.1	99 η Psc	221	3.7	R.D.	308	-0.3	0.6	218
Jun 15	19	07.8	20 d Cnc	1259	5.9	D.D.	41	-0.4	0.2	118
Jun 16	19	35.3	-	1386	6.6	D.D	54	-0.8	0.5	108
Jun 17	17	43.4	-	1492	8.5	D.D.	67	-0.4	-2.3	169
Jun 17	20	43.7	-	1502	8.9	D.D.	68	-0.2	-1.2	154
Jun 19	22	11.8	24 B Vir	1726	6.9	D.D.	94	-1.1	2.1	74
Jun 20	19	26.8	-	1819	8.7	D.D.	105	-2.0	-1.0	119
Jun 21	22	29.7	75 Vir	1944	5.7	D.D.	118	-1.3	-2.9	161
Jun 22	17	51.9	231 G Vir	2045	6.4	D.D.	127	-1.4	-1.7	114
Jun 22	18	59.2	236 G Vir	2051	5.7	D.D.	127	-2.4	-0.8	95
Jun 24	00	08.9	64 G Lib	2183	5.7	D.D.	141	-1.4	2.2	67
Jun 24	23	32.5	24 G Sco	2311	6.2	D.D.	152	-2.2	1.7	72
Jun 25	03	07.4	41 G Sco	2328	6.4	D.D.	154	0.0	1.9	63
Jul 05	03	26.4	41 d Psc	42	5.6	R.D.	265	-1.1	1.1	219
Jul 07	03	25.9	35 B Ari	302	6.4	R.D.	290	-0.3	0.7	216
Jul 17	21	08.4	163 B Vir	1788	6.7	D.D.	76	-0.7	-0.7	138
Jul 20	20	56.0	43 B Lib	2134	6.1	D.D.	111	-2.3	2.1	70
Jul 21	20	05.3	23 B Sco	2257	6.7	D.D.	122	-2.9	1.2	72
Jul 21	23	49.0	32 B Sco	2270	5.4	D.D.	123	-0.9	1.8	73
Aug 05	05	50.2	18 Tau	538	5.6	R.D.	287	-2.6	-0.9	286
Aug 05	05	26.3	19 q Tau	539	4.4	R.D.	287	-0.8	1.6	203
Aug 05	05	58.3	21 Tau	542	5.9	R.D.	287	-1.3	1.3	213
Aug 05	05	56.3	22 Tau	543	6.5	R.D.	287	-1.0	1.8	203
Aug 12	18	59.0	69 ρ Leo	1623	5.4	D.D.	31	-0.1	-2.7	175

Lunar Occultation Table

DATE	hr	min.	Star Name	ZC Num.	MAG.	PH.	ELONG.	A	B	P
Aug 13	19	00.6	44 B Vir	1743	6.8	D.D.	44	-0.8	0.9	96
Aug 15	17	45.0	83 Vir	1967	5.7	D.D.	68	-1.9	-1.1	128
Aug 17	21	34.7	-	2221	8.1	D.D.	93	*	*	173
Aug 17	23	30.4	169 B Lib	2227	5.8	D.D.	94	0.2	1.9	64
Aug 19	18	41.2	-	2483	7.1	D.D.	114	-2.8	1.3	63
Aug 20	18	47.0	-	2624	8.7	D.D.	125	-2.5	0.3	73
Aug 21	20	45.6	176 B Sgr	2777	7.0	D.D.	136	-2.8	-0.6	97
Aug 21	22	57.0	-	2785	6.8	D.D.	137	-1.7	1.9	63
Aug 22	00	36.9	-	2795	8.8	D.D.	138	-1.4	1.0	94
Aug 22	03	17.5	-	2806	6.9	D.D.	139	*	*	133
Aug 30	01	15.7	99 η Psc	221	3.7	R.D.	231	-0.2	2.1	192
Sep 02	01	57.4	59 χ Tau	647	5.5	R.D.	269	-1.5	-1.8	291
Sep 12	18	23.9	231 G Vir	2045	6.4	D.D.	50	-1.3	0.4	107
Sep 12	19	19.8	236 G Vir	2051	5.7	D.D.	50	-0.9	0.2	115
Sep 15	19	58.9	88 B Oph	2442	5.9	D.D.	84	-1.7	1.1	86
Sep 15	20	10.4	26 Oph	2443	5.8	D.D.	85	-1.3	2.1	63
Sep 16	21	09.3	63 (Oph)	2577	6.1	D.D.	96	-2.5	-0.7	123
Sep 17	00	01.7	5 Sgr	2593	6.7	D.D.	97	0.3	1.8	56
Sep 17	18	20.3	-	Uranus	5.7	D.D.	106	-2.5	1.3	61
Sep 17	21	37.3	-	2728	8.5	D.D.	107	-2.0	0.7	96
Sep 18	01	09.2	32 v1 Sgr	2747	5.0	D.D.	109	-0.2	0.8	105
Sep 18	01	35.5	35 v2 Sgr	2749	5.0	D.D.	109	0.0	0.7	104
Sep 18	19	35.1	203 G Sgr	2859	6.7	D.D.	117	-1.8	2.7	37
Sep 19	02	17.5	56 f Sgr	2886	5.1	D.D.	120	0.3	1.3	74
Sep 19	20	44.7	-	2979	7.1	D.D.	128	-2.8	0.2	88
Sep 20	01	12.3	41 B Cap	2997	7.1	D.D.	130	-1.2	0.5	112
Oct 12	20	35.1	126 B (Sco)	2398	6.1	D.D.	54	-0.2	1.4	80
Oct 13	20	44.5	- -	2530	7.9	D.D.	65	-0.6	1.2	89
Oct 14	22	06.4	-	2682	7.0	D.D.	77	0.1	1.9	56
Oct 18	00	20.9	9 Aqu	3072	6.6	D.D.	110	-0.1	1.9	51
Oct 18	23	18.5	46 c1 Cap	3185	5.3	D.D.	121	0.2	3.5	4
Oct 18	23	33.5	47 c2 Cap	3187	6.2	D.D.	121	-1.3	1.3	89
Oct 25	23	11.7	16 Tau	536	5.4	R.D.	207	*	*	316
Oct 25	23	27.3	17 Tau	537	3.8	R.D.	208	-1.8	-0.6	267
Oct 25	23	47.2	20 Tau	541	4.0	R.D.	208	*	*	315
Oct 25	23	53.7	23 Tau	545	4.3	R.D.	208	-0.8	1.4	207
Oct 25	23	36.1	25 η Tau	552	3.0	D.B.	208	-2.1	-1.0	99
Oct 26	00	46.8	25 η Tau	552	3.0	R.D.	208	-1.6	0.9	225
Oct 26	01	37.1	28 Tau	561	5.2	R.D.	209	-1.6	2.0	207
Oct 30	02	59.0	217 B (Gem)	1205	6.3	R.D.	262	-1.8	-0.3	249
Oct 31	02	58.6	62 o Cnc	1336	5.2	R.D.	275	-1.3	-0.8	261
Oct 31	02	56.7	63 o Cnc	1337	5.6	R.D.	275	-1.2	-2.2	321
Nov 01	04	03.5	-	1451	8.9	D.D.	289	*	*	202
Nov 10	21	27.0	1 Sgr	2630	5.1	D.D.	46	0.0	0.5	111
Nov 11	21	43.5	-	Neptune	8.0	D.D.	56	-0.5	0.1	124
Nov 12	21	21.9	57 Sgr	2902	6.0	D.D.	67	-0.6	1.1	94
Nov 14	21	52.4	-	3138	8.2	D.D.	89	-0.6	1.9	60
Nov 18	23	49.7	91 G Psc	70	6.8	D.D.	136	-1.1	2.3	35
Dec 10	20	07.9	-	2971	8.4	D.D.	46	-0.2	1.7	64
Dec 15	21	59.1	-	21	7.9	D.D.	103	-1.0	2.4	35
Dec 16	19	52.7	-	123	9.1	D.D.	114	*	*	355
Dec 16	19	39.9	-	127	8.3	D.D.	113	-2.6	0.4	85
Dec 16	23	42.9	-	147	8.1	D.D.	115	-0.8	0.6	111
Dec 18	00	43.2	8 ι Ari	288	5.2	D.D.	128	-0.5	0.4	117
Dec 18	20	29.9	-	410	8.3	D.D.	139	-2.4	-0.2	89
Dec 19	19	30.1	20 Tau	541	4.0	D.D.	152	*	*	358
Dec 19	19	45.0	25 η Tau	552	3.0	D.D.	152	-1.9	-0.9	95
Dec 19	20	56.6	25 η Tau	552	3.0	R.B.	153	-1.6	0.7	230
Dec 19	20	47.3	28 Tau	561	5.2	D.D.	152	-2.7	-1.4	117
Dec 19	21	01.0	27 Tau	560	3.8	D.D.	153	*	*	149

LUNAR "GRAZE" PREDICTIONS FOR 1991 - LOCATION: NSW

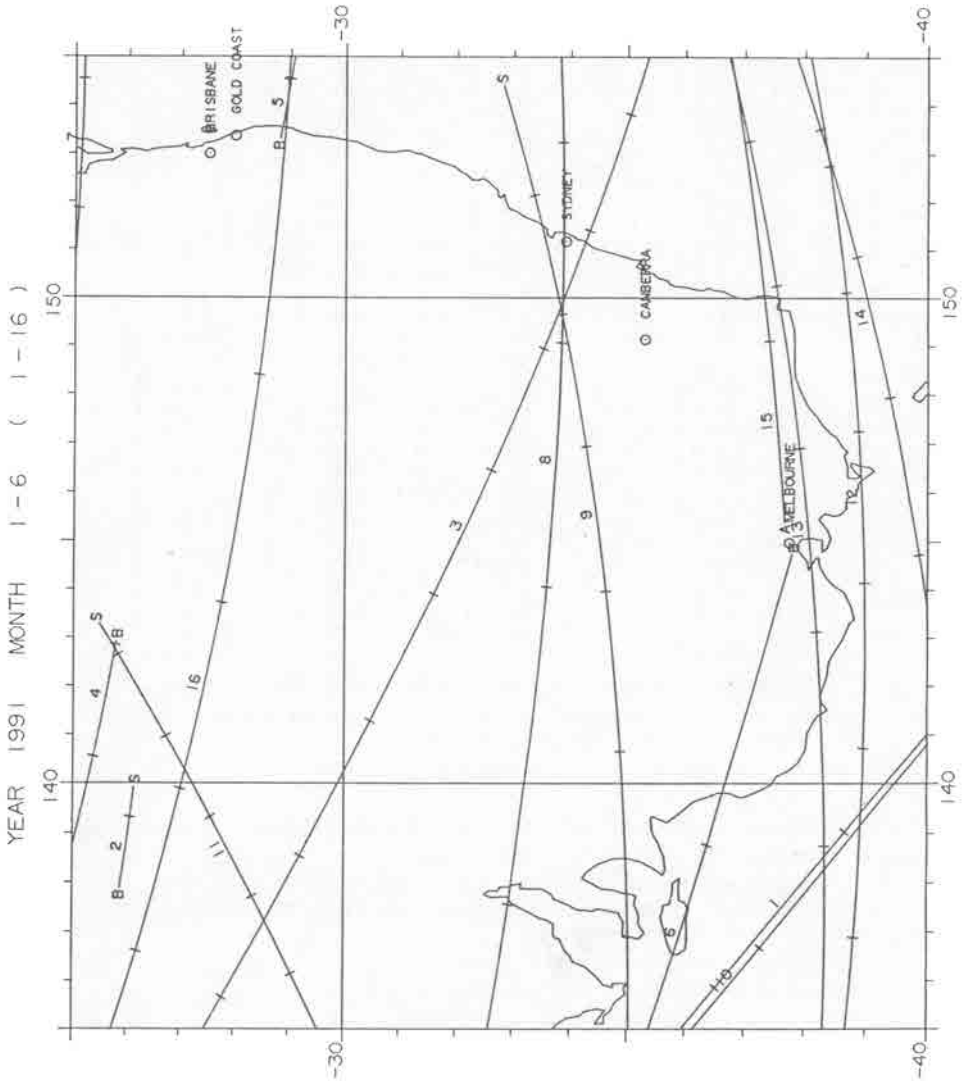
SEQ	DATE	hr	min	sec	Star Name	ZC Num	MAG	% SUNLIT	LIMIT	NOTES
1	Feb. 8	3	03	42.75	31 B Sco	2269	5.44	-38.71	S	
2	Mar. 7	6	20	02.69	42 Lib	2237	5.06	-65.06	N	B, S
3	Mar. 9	3	33	53.05	-	2501	7.50	-46.60	S	
4	Mar. 10	5	36	17.25	67 B Sgr	2652	6.43	-36.70	S	B
5	Mar. 11	4	42	16.39	191 B Sgr	2793	6.54	-28.07	N	B
6	Apr. 9	2	28	37.22	10 π Cap	2981	5.24	-35.93	S	B
7	Apr. 9	3	38	17.89	11 ρ Cap	2987	4.96	-35.59	N	
8	Apr. 10	3	43	27.09	-	3112	6.18	-26.39	N	
9	Apr. 10	5	02	42.07	-	3119	6.72	-25.99	N	S
10	Apr. 20	20	38	13.60	-	1080	6.90	37.27	N	
11	May 4	6	01	18.30	24 Sgr	2692	5.71	-78.84	N	S
12	Jun. 3	0	47	44.22	61 B Cap	3019	5.91	-77.44	N	
13	Jun. 4	1	11	19.09	96 G Cap	3145	6.83	-68.73	N	
14	Jun. 4	1	48	19.75	72 B (Aqu)	3146	6.50	-68.61	N	
15	Jun. 6	1	08	21.51	-	3371	6.40	-49.32	N	A
16	Jun. 19	22	17	14.33	24 B Vir	1726	6.87	52.85	N	
17	Jul. 7	7	13	07.52	15 Ari	320	5.92	-30.79	N	S
18	Jul. 16	20	40	40.83	431 B (Leo)	1688	6.27	26.92	N	
19	Jul. 19	18	10	56.82	-	2011	6.53	57.20	N	S
20	Jul. 20	20	47	45.44	43 B Lib	2134	6.12	67.65	N	B
21	Aug. 3	2	58	38.84	3 (Ari)	263	6.46	-57.76	N	
22	Aug. 5	4	54	46.55	18 Tau	538	5.63	-34.86	N	
23	Aug. 8	6	34	10.00	42 ω Gem	1070	5.21	-07.04	N	A, S
24	Aug. 12	19	08	22.08	69 p5 Leo	1623	5.40	06.87	S	A
25	Aug. 14	18	57	10.02	370 B Vir	1852	5.96	21.99	S	B
26	Aug. 18	23	33	56.39	22 Sco	2371	4.87	62.40	S	
27	Sep. 4	5	38	16.39	52 B Gem	1015	6.44	-26.84	S	B, S
28	Sep. 4	5	54	55.51	-	1019	6.70	-26.69	S	B
29	Sep. 13	22	19	29.66	64 G Lib	2183	5.71	26.71	S	A
30	Sep. 14	21	16	18.61	24 G Sco	2311	6.22	35.60	S	
31	Sep. 16	21	22	15.12	63 (Oph)	2577	6.13	54.79	S	
32	Nov. 8	19	54	31.60	19 Sco	2347	4.76	03.58	S	S, A
33	Nov. 11	19	14	29.79	-	2762	6.04	21.13	S	S
34	Dec. 14	22	47	11.24	-	3452	6.82	50.99	S	A

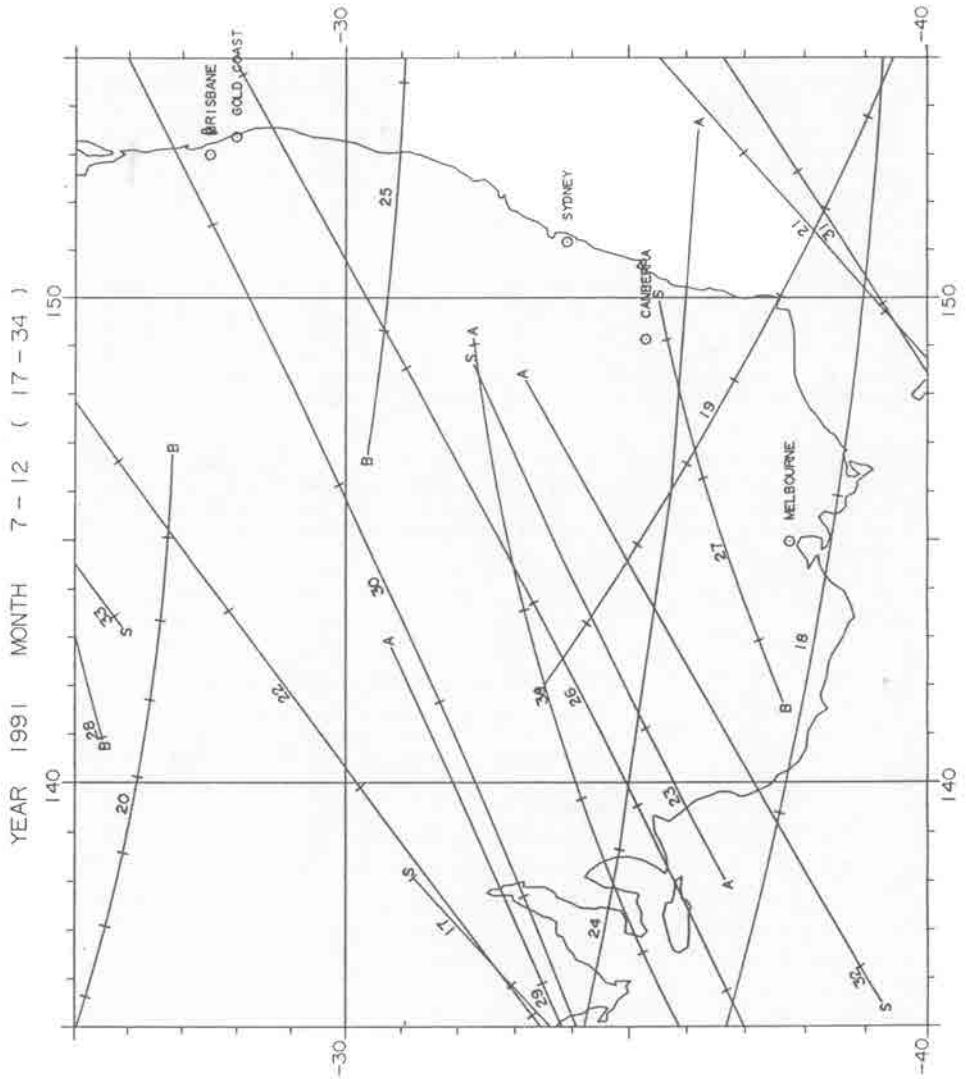
EXPLANATION FOR TABLE OF GRAZE PREDICTIONS.

* SEQ. Sequential number for the graze. This same number is used as a reference to the corresponding track on the following maps of NSW.
* DATE, hr, min, sec The time is in EAST and is for the western end of the track.
* NAME The star naming is the same as that described in the explanation to the occultation table.
* ZC Num The number of the star in the Zodiacal Catalogue.
* MAG. The magnitude of the star.
* SUNLIT The percentage of the Moon in Sunlight (as seen from Earth). A minus sign indicates the Moon is waning (or after Full Moon).
* LIMIT "N" indicates a North limb graze. "S" is South.
* NOTES "A" indicates the Moon is at a low altitude.
"B" indicates the star is occulted on the bright limb.
"g" indicates the event occurs in daylight or twilight.

EXPLANATION FOR GRAZE MAPS

The times, as recorded on the graze table, are for the western edge of the graze track. The "tick" marks then indicate 5 minute intervals. For example, graze No. 8 (ZC=3112),on Apr. 10, passes onto the map at 3hr 43min 27.09s. The "tick" marks then correspond to 3:45, 3:50, 3:55 and 4:00am respectively (from west to east).


YEAR 1991 MONTH 1-6 (1-16)
BRISBANE
GOLD COAST
SYDNEY
CANBERRA
MELBOURNE
150
140
-30
-40


YEAR 1991 MONTH 7 - 12 (17 - 34)
BRISBANE
GOLD COAST
SYDNEY
CANBERRA
MELBOURNE
150
140
-30
-40

METEOR SHOWERS

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

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

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

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

NOTES:

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

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

Meteor Showers

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

OBSERVING GUIDE TO THE CONSTELLATIONS

INTRODUCTION

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

EXPLANATION OF THE TABLE

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

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

NOTES COLUMN

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

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

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

WORKED EXAMPLE

An observer wishes to look at Virgo this evening, it is July 8. From the table it can be seen that Virgo reaches its highest in the sky at around 17:48 (5:48pm) and sets 6.5 hours later (around midnight). A correction of 28 minutes should be made ie. 7 days earlier than July 15 (or 7 x 4 mins). The corrected time is 5:20pm. From the "Sun Rise/ Set" table, astronomical twilight ends at 18:28 (6:28pm) which is after Virgo reaches culmination. Therefore, for best observing atmospheric conditions ie a minimum thickness of atmosphere to look through, it would be wise to get onto Virgo fairly early in the evening (after twilight ends). In this case, Moonlight does not interfere.

CONST.	ABR.	Notes	R/S +/- hr	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JLY.	AUG.	SEP.	OCT.	NOV.	DEC.
Andromeda	And		4.5	16:24	14:24	12:30	10:30	8:30	6:30	4:30	2:24	0:24	22:24	20:24	18:24
Antila	Ant		7.7	2:48	0:48	22:54	20:54	18:54	16:54	14:54	12:48	10:48	8:48	6:48	4:48
Apus	Aps	c	-	7:06	5:06	3:12	1:12	23:12	21:12	19:12	17:06	15:06	13:06	11:06	9:06
Aquarius	Aqr		6.1	14:24	12:24	10:30	8:30	6:30	4:30	2:30	0:24	22:24	20:24	18:24	16:24
Aquila	Aql		5.6	12:12	10:12	8:18	6:18	4:18	2:18	0:18	22:12	20:12	18:12	16:12	14:12
Ara	Ara	P/C	9.6	9:48	7:48	5:54	3:54	1:54	23:54	21:54	19:48	17:48	15:48	13:48	11:48
Aries	Ari		4.9	18:24	16:24	14:30	12:30	10:30	8:30	6:30	4:24	2:24	0:24	22:24	20:24
Auriga	Aur		3.2	21:36	19:36	17:42	15:42	13:42	11:42	9:42	7:36	5:36	3:36	1:36	23:36
Bootes	Boo		5.1	6:36	4:36	2:42	0:42	22:42	20:42	18:42	16:36	14:36	12:36	10:36	8:36
Caelum	Cae		8.5	21:00	19:00	17:06	15:06	13:06	11:06	9:06	7:00	5:00	3:00	1:00	23:00
Camelopardus	Cam	P/R (i)	1.8	21:12	19:12	17:18	15:18	13:18	11:18	9:18	7:12	5:12	3:12	1:12	23:12
Cancer	Cnc		5.5	1:18	23:18	21:24	19:24	17:24	15:24	13:24	11:18	9:18	7:18	5:18	3:18
Canes Venatici	CVn		3.9	5:18	3:18	1:24	23:24	21:24	19:24	17:24	15:18	13:18	11:18	9:18	7:18
Canis Major	CMa		6.8	23:00	21:00	19:06	17:06	15:06	13:06	11:06	9:00	7:00	5:00	3:00	1:00
Canis Minor	CMi		5.8	23:54	21:54	20:00	18:00	16:00	14:00	12:00	9:54	7:54	5:54	3:54	1:54
Capricornus	Cap		6.6	12:36	10:36	8:42	6:42	4:42	2:42	0:42	22:36	20:36	18:36	16:36	14:36
Carina	Car	P/C	10.3	22:42	20:42	18:48	16:48	14:48	12:48	10:48	8:42	6:42	4:42	2:42	0:42
Cassiopeia	Cas	P/R	0.6	17:00	15:00	13:06	11:06	9:06	7:06	5:06	3:00	1:00	23:00	21:00	19:00
Centaurus	Cen	P/C (ii)	10.5	6:00	4:00	2:06	0:06	22:06	20:06	18:06	16:00	14:00	12:00	10:00	8:00
Cepheus	Cep	N/R	-	-	-	-	-	-	-	-	-	-	-	-	-
Cetus	Cet		5.9	19:18	17:18	15:24	13:24	11:24	9:24	7:24	5:18	3:18	1:18	23:18	21:18
Chamaeleon	Cha	c	-	0:42	22:42	20:48	18:48	16:48	14:48	12:48	10:42	8:42	6:42	4:42	2:42
Circinus	Cir	c	-	7:00	5:00	3:06	1:06	23:06	21:06	19:06	17:00	15:00	13:00	11:00	9:00
Columba	Col		8.0	21:54	19:54	18:00	16:00	14:00	12:00	10:00	7:54	5:54	3:54	1:54	23:54
Coma Berenices	Com		5.2	5:18	3:18	1:24	23:24	21:24	19:24	17:24	15:18	13:18	11:18	9:18	7:18
Corona Australis	CrA		8.2	11:30	9:30	7:36	5:36	3:36	1:36	23:36	21:30	19:30	17:30	15:30	13:30
Corona Borealis	CrB		4.8	7:54	5:54	4:00	2:00	0:00	22:00	20:00	17:54	15:54	13:54	11:54	9:54
Corvus	Crv		7.2	4:30	2:30	0:36	22:36	20:36	18:36	16:36	14:30	12:30	10:30	8:30	6:30
Crater	Crt		6.9	3:18	1:18	23:24	21:24	19:24	17:24	15:24	13:18	11:18	9:18	7:18	5:18
Crux	Cru	c	-	4:48	2:48	0:54	22:54	20:54	18:54	16:54	14:48	12:48	10:48	8:48	6:48
Cygnus	Cyg	P/R	3.2	13:00	11:00	9:06	7:06	5:06	3:06	1:06	23:00	21:00	19:00	17:00	15:00
Delphinus	Del		5.3	13:00	11:00	9:06	7:06	5:06	3:06	1:06	23:00	21:00	19:00	17:00	15:00
Dorado	Dor	P/C	11.2	20:54	18:54	17:00	15:00	13:00	11:00	9:00	6:54	4:54	2:54	0:54	22:54
Draco	Dra	P/R (iii)	2.3	10:18	8:18	6:24	4:24	2:24	0:24	22:24	20:18	18:18	16:18	14:18	12:18
Equuleus	Equ		5.8	13:36	11:36	9:42	7:42	5:42	3:42	1:42	23:36	21:36	19:36	17:36	15:36
Eridanus	Eri	P/C (iv)	6.3	21:24	19:24	17:30	15:30	13:30	11:30	9:30	7:24	5:24	3:24	1:24	23:24
Fornax	For		7.5	19:30	17:30	15:36	13:36	11:36	9:36	7:36	5:30	3:30	1:30	23:30	21:30
Gemini	Gem		4.4	23:54	21:54	20:00	18:00	16:00	14:00	12:00	9:54	7:54	5:54	3:54	1:54
Grus	Gru		9.2	14:30	12:30	10:36	8:36	6:36	4:36	2:36	0:30	22:30	20:30	18:30	16:30
Hercules	Her		5.4	9:36	7:36	5:42	3:42	1:42	23:42	21:42	19:36	17:36	15:36	13:36	11:36
Horologium	Hor	P/C	8.6	20:30	18:30	16:36	14:36	12:36	10:36	8:36	6:30	4:30	2:30	0:30	22:30
Hydra	Hya		6.5	1:48	23:48	21:54	19:54	17:54	15:54	13:54	11:48	9:48	7:48	5:48	3:48
Hydrus	Hyi	c	-	18:18	16:18	14:24	12:24	10:24	8:24	6:24	4:18	2:18	0:18	22:18	20:18
Indus	Ind	P/C	9.2	12:54	10:54	9:00	7:00	5:00	3:00	1:00	22:54	20:54	18:54	16:54	14:54

CONST.	ABR.	Notes	R/S +/- hr	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JLY	AUG.	SEP.	OCT.	NOV.	DEC.
Lacerta	Lac	P/R	2.5	14:48	12:48	10:54	8:54	6:54	4:54	2:54	0:48	22:48	20:48	18:48	16:48
Leo	Leo		5.5	2:30	0:30	22:36	20:36	18:36	16:36	14:36	12:30	10:30	8:30	6:30	4:30
Leo Minor	LMi	(+)	4.0	2:48	0:48	22:54	20:54	18:54	16:54	14:54	12:48	10:48	8:48	6:48	4:48
Lepus	Lep		6.9	21:48	19:48	17:54	15:54	13:54	11:54	9:54	7:48	5:48	3:48	1:48	23:48
Libra	Lib		6.8	7:12	5:12	3:18	1:18	23:18	21:18	19:18	17:12	15:12	13:12	11:12	9:12
Lupus	Lup		9.2	7:00	5:00	3:06	1:06	23:06	21:06	19:06	17:00	15:00	13:00	11:00	9:00
Lynx	Lyn	P/R	4.2	1:42	23:42	21:48	19:48	17:48	15:48	13:48	11:42	9:42	7:42	5:42	3:42
Lyra	Lyr		3.9	10:54	8:54	7:00	5:00	3:00	1:00	23:00	20:54	18:54	16:54	14:54	12:54
Mensa	Men	c	-	22:30	20:30	18:36	16:36	14:36	12:36	10:36	8:30	6:30	4:30	2:30	0:30
Microscopium	Mic		7.8	13:06	11:06	9:12	7:12	5:12	3:12	1:12	23:06	21:06	19:06	17:06	15:06
Monoceros	Mon		6.4	0:00	22:00	20:06	18:06	16:06	14:06	12:06	10:00	8:00	6:00	4:00	2:00
Musca	Mus	c	-	5:00	3:00	1:06	23:06	21:06	19:06	17:06	15:00	13:00	11:00	9:00	7:00
Norma	Nor	P/C (vs)	9.6	8:42	6:42	4:48	2:48	0:48	22:48	20:48	18:42	16:42	14:42	12:42	10:42
Octans	Oct	C (vs)	-	15:06	13:06	11:12	9:12	7:12	5:12	3:12	1:06	23:06	21:06	19:06	17:06
Ophiuchus	Oph		5.5	9:54	7:54	6:00	4:00	2:00	0:00	22:00	19:54	17:54	15:54	13:54	11:54
Orion	Ori		5.7	22:12	20:12	18:18	16:18	14:18	12:18	10:18	8:12	6:12	4:12	2:12	0:12
Pavo	Pav	c	-	12:42	10:42	8:48	6:48	4:48	2:48	0:48	22:42	20:42	18:42	16:42	14:42
Pegasus	Peg		5.3	15:24	13:24	11:30	9:30	7:30	5:30	3:30	1:24	23:24	21:24	19:24	17:24
Perseus	Per	P/R	2.6	19:42	17:42	15:48	13:48	11:48	9:48	7:48	5:42	3:42	1:42	23:42	21:42
Phoenix	Phe	P/C	8.6	16:48	14:48	12:54	10:54	8:54	6:54	4:54	2:48	0:48	22:48	20:48	18:48
Pictor	Pic	P/C (vs)	9.9	22:06	20:06	18:12	16:12	14:12	12:12	10:12	8:06	6:06	4:06	2:06	0:06
Pisces	Psc		5.9	18:18	16:18	14:24	12:24	10:24	8:24	6:24	4:18	2:18	0:18	22:18	20:18
Piscis Austrinus	PsA		7.6	15:18	13:18	11:24	9:24	7:24	5:24	3:24	1:18	23:18	21:18	19:18	17:18
Puppis	Pup		8.4	0:12	22:12	20:18	18:18	16:18	14:18	12:18	10:12	8:12	6:12	4:12	2:12
Pyxis	Pyx		7.7	1:06	23:06	21:12	19:12	17:12	15:12	13:12	11:06	9:06	7:06	5:06	3:06
Reticulum	Ret	c	-	20:30	18:30	16:36	14:36	12:36	10:36	8:36	6:30	4:30	2:30	0:30	22:30
Sagitta	Sge		5.2	12:00	10:00	8:06	6:06	4:06	2:06	0:06	22:00	20:00	18:00	16:00	14:00
Sagittarius	Sgr		8.4	11:42	9:42	7:48	5:48	3:48	1:48	23:48	21:42	19:42	17:42	15:42	13:42
Scorpius	Sco		7.4	8:48	6:48	4:54	2:54	0:54	22:54	20:54	18:48	16:48	14:48	12:48	10:48
Sculptor	Scl		7.5	17:18	15:18	13:24	11:24	9:24	7:24	5:24	3:18	1:18	23:18	21:18	19:18
Scutum	Sct		6.4	10:54	8:54	7:00	5:00	3:00	1:00	23:00	20:54	18:54	16:54	14:54	12:54
Serpens	Ser		5.8	8:06	6:06	4:12	2:12	0:12	22:12	20:12	18:06	16:06	14:06	12:06	10:06
Sextans	Sex		6.0	2:30	0:30	22:36	20:36	18:36	16:36	14:36	12:30	10:30	8:30	6:30	4:30
Taurus	Tau		5.3	20:54	18:54	17:00	15:00	13:00	11:00	9:00	6:54	4:54	2:54	0:54	22:54
Telescopium	Tel	P/C	9.0	10:48	8:48	6:54	4:54	2:54	0:54	22:54	20:48	18:48	16:48	14:48	12:48
Triangulum	Tri		4.6	18:12	16:12	14:18	12:18	10:18	8:18	6:18	4:12	2:12	0:12	22:12	20:12
Triangulum-Austrinus	TrA	c	-	9:06	7:06	5:12	3:12	1:12	23:12	21:12	19:06	17:06	15:06	13:06	11:06
Tucana	Tuc	c	-	14:36	12:36	10:42	8:42	6:42	4:42	2:42	0:36	22:36	20:36	18:36	16:36
Ursa Major	UMa	P/R (ci)	1.8	4:18	2:18	0:24	22:24	20:24	18:24	16:24	14:18	12:18	10:18	8:18	6:18
Ursa Minor	UMi	N/R	-	-	-	-	-	-	-	-	-	-	-	-	-
Vela	Vel	P/C (c)	11.2	1:42	23:42	21:48	19:48	17:48	15:48	13:48	11:42	9:42	7:42	5:42	3:42
Virgo	Vir		6.5	5:42	3:42	1:48	23:48	21:48	19:48	17:48	15:42	13:42	11:42	9:42	7:42
Volans	Vol	c	-	1:24	23:24	21:30	19:30	17:30	15:30	13:30	11:24	9:24	7:24	5:24	3:24
Vulpecula	Vul		4.9	11:48	9:48	7:54	5:54	3:54	1:54	23:54	21:48	19:48	17:48	15:48	13:48

THE NEAREST STARS (Within 15 light years)

The table of nearest stars lists the known stars to a distance of fifteen light years. Of the thirty five stars listed (including the Sun) eighteen belong to double star systems and three to the triple system Alpha Centauri (Proxima has been listed separately to highlight its unique position). There is evidence of low mass unseen companions to four of the stars (Barnard's, Lalande 21185, 61 Cygni B, and Luyten). Most of the stars within the solar neighbourhood are much fainter and cooler than the Sun, only three are more massive and brighter (Alpha Centauri, Sirius and Procyon).

NOTES:

Mag = apparent visual magnitude. Mass = mass (if known) compared with the Sun.
P.M. = proper motion per year. Spect = spectral type.

For double stars, magnitudes are given for the A & B component and not the total integrated magnitude of each system (with the exception of L789-6 which has been resolved into two components by infrared speckle interferometry).

	NAME		epoch 2000 R.A. hh mm	DEC. ° '	MAG	Distance l.y.	parsecs	MASS	P.M.	SPECT
1	Sun				-26.72			1.00		G2
2	Proxima Centauri		14 30	-62 41	11.05	4.2	1.37	0.10	3"85	M5
3	Alpha Centauri	A	14 40	-60 50	0.00	4.3	1.40	1.09	3"68	G2
		B			1.39			0.88		K1
4	Barnard's Star		17 58	+04 34	9.54	6.0	1.96		10"31	M4
5	Wolf 359		10 56	+07 01	13.53	7.7	2.51		4"70	M6
6	Lalande 21185		11 03	+35 58	7.50	8.2	2.67	0.35	4"78	M2
7	UV Ceti		01 39	-17 57	12.52	8.4	2.74	0.04	3"36	M6
					13.02			0.04		M6
8	Sirius	A	06 45	-16 43	-1.46	8.6	2.80	2.31	1"21	A1
		B			8.30			0.98		DA
9	Ross 154		18 50	-23 50	10.45	9.4	3.06		0"72	M4
10	Ross 248		23 42	+44 10	12.29	10.4	3.39		1"60	M5
11	Epsilon Eridani		03 33	-09 28	3.73	10.8	3.52		0"98	K2
12	Ross 128		11 48	+00 48	11.13	10.9	3.55		1"38	M4
13	61 Cygni	A	21 07	+38 45	5.22	11.1	3.62	0.59	5"22	K4
		B			6.03			0.50		K5
14	Epsilon Indi		22 03	-56 47	4.68	11.2	3.65		4"70	K3
15	Groombridge 34	A	00 18	+44 01	8.08	11.2	3.65		2"90	M1
		B			11.06					M4
16	L 789-6	A	22 39	-15 19	12.18	11.2	3.65		3"26	M5
		B								M5
17	Procyon	A	07 39	+05 13	0.37	11.4	3.72	1.75	1"25	F5
		B			10.70			0.64		DF
18	BD+59°1915	A	18 43	+59 38	8.90	11.6	3.78		2"27	M3
		B			9.69					M4
19	Lacaille 9352		23 06	-35 52	7.35	11.7	3.81		6"90	M1
20	G51-15		08 30	+26 47	14.81	11.7	3.81		1"27	M7
21	Tau Ceti		01 44	-15 56	3.50	11.8	3.85		1"92	G8
22	Luyten (+5°1668)		07 26	+05 14	9.82	12.3	4.01		3"77	M4
23	L725-32		01 12	-17 00	12.04	12.5	4.08		1"32	M5
24	CD-39°14192		21 17	-38 52	6.66	12.5	4.08		3"46	K6
25	Kapteyn's Star		05 12	-45 01	8.84	12.7	4.14		8"84	M0
26	Krueger 60	A	22 28	+57 42	9.85	12.9	4.21	0.27	0"86	M3
		B			11.30			0.16		M3
27	Wolf 1061		16 30	-12 39	10.11	13.2	4.30		1"18	M4
28	Ross 614	A	06 29	-02 49	11.10	13.3	4.34		1"00	M5
		B			14.00					M5
29	Wolf 28 (van Maanens)		00 49	+05 23	12.37	14.1	4.60		2"99	DG
30	Wolf 424	A	12 33	+09 01	13.16	14.2	4.63		1"76	M5
		B			13.40					M5
31	CD-37°15492		00 06	-37 21	8.56	14.5	4.73		6"11	M2
32	L1159-16		02 00	+13 03	12.26	14.6	4.76		2"09	M5
33	BD+50°1725		10 11	+49 27	6.59	14.7	4.79		1"45	K5
34	L143-23		10 44	-62 13	13.92	14.8	4.82		1"65	
35	LP731-58		10 48	-11 20	15.60	14.9	4.86		1"64	

THE BRIGHTEST STARS (Mean positions 1991.5)

The table of brightest stars lists fifty stars of magnitude 2 and brighter, from the Sun to Mira. Variable stars (eg: Mira mag 2 to 10) have been listed at their brightest and magnitudes for double stars are given as the combined magnitudes of both components (eg: a Centauri A, magnitude 0.00 and a Centauri B, magnitude 1.39 are shown as magnitude -0.27).

NOTES: DESIGNATION = the star's Bayer letter and constellation abbreviation. NAME = the star's common name (usually of Greek or Arabic origin). MAG v = apparent visual magnitude. MAG abs = the absolute magnitude or the star's brightness if it were located at a distance of 10 parsecs (32.6 light years) from the Sun. DIST pc = distance from Sun in parsecs. DIST ly = distance from Sun in light years. SPECT = the MK system of spectral classification, which indicates the star's spectral type, luminosity class and peculiarity code. R.A. & DEC = the star's right ascension and declination for epoch 1991.5

	DESIG-NATION	NAME	Magnitude		Distance		Spectral	R.A.	DEC
			v	abs	pc	ly	Type	hh mm	° ′
1		Sun	-26.73	4.7		8 (lm)	G2 V		
2	α CMa	Sirius	-1.46	1.4	2.7	9	AI V	06 44.8	-16 43
3	α Car	Canopus	-0.72	-8.5	360.0	1174	F0 Ia	06 23.7	-52 41
4	α Cen	Rigil Kentaurus	-0.27	4.4	1.3	4	G2 V	14 38.9	-60 48
5	α Boo	Arcturus	-0.04	-0.2	11.0	36	K2 IIIp	14 15.3	+19 13
6	α Lyr	Vega	0.03	0.5	8.1	26	A0 V	18 36.6	+38 47
7	α Aur	Capella	0.08	0.3	13.0	42	G8 III	05 16.1	+46 00
8	β Ori	Rigel	0.12	-7.1	280.0	913	B8 Ia	05 14.1	-08 12
9	α CMi	Procyon	0.38	2.6	3.5	11	F5 IV	07 38.8	+05 15
10	α Eri	Achernar	0.46	-1.6	26.0	85	B5 IV	01 37.4	-57 18
11	α Ori	Betelgeuse	0.50	-5.6	95.0	310	M2 Iab	05 54.7	+07 24
12	β Cen	Hadar	0.61	-5.1	140.0	456	B1 II	14 03.2	-60 20
13	α Aql	Altair	0.77	2.2	5.1	17	A7 IV-V	19 50.4	+08 51
14	α Tau	Aldebaran	0.85	-0.3	21.0	68	K5 III	04 35.4	+16 29
15	α Cru	Acrux	0.87	-3.9	110.0	359	B1 IV	12 26.1	-63 03
16	α Sco	Antares	0.96	-4.7	100.0	326	M1 Ib	16 28.9	-26 25
17	α Vir	Spica	0.98	-3.5	79.0	258	B1 V	13 24.7	-11 06
18	β Gem	Pollux	1.14	0.2	11.0	36	KO III	07 44.8	+28 02
19	α PsA	Fomalhaut	1.16	2.0	6.7	22	A3 V	22 57.2	-29 40
20	α Cyg	Deneb	1.25	-7.5	560.0	1826	A2 Ia	20 41.1	+45 14
21	β Cru	Mimosa	1.25	-5.0	130.0	424	B0 III	12 47.2	-59 40
22	α Leo	Regulus	1.35	-0.6	26.0	85	B7 V	10 07.9	+12 00
23	ε CMa	Adara	1.50	-4.4	150.0	489	B2 II	06 58.3	-28 57
24	α Gem	Castor	1.58	1.2	14.0	46	AI V	07 34.1	+31 34
25	λ Sco	Shaula	1.63	-3.0	84.0	274	B2 IV	17 33.0	-37 06
26	γ Cru		1.63	-0.5	27.0	88	M3 III	12 30.7	-57 04
27	γ Ori	Bellatrix	1.64	-3.6	110.0	359	B2 III	05 24.7	+06 20
28	β Tau	Elnath	1.65	-1.6	40.0	130	B7 III	05 25.8	+28 35
29	β Car	Miaplacidus	1.68	-0.6	26.0	85	A0 III	09 13.1	-69 41
30	ε Ori	Alnilam	1.70	-6.2	370.0	1206	BO Ia	05 35.8	-01 12
31	α Gru	Al Na'ir	1.74	-1.1	21.0	68	B5 V	22 07.7	-47 00
32	α Per	Mirfak	1.79	-4.6	190.0	619	F5 Ib	03 23.7	+49 49
33	α UMa	Dubhe	1.79	0.2	23.0	75	K0 III	11 03.2	+61 48
34	γ Vel	Suhail al Muhlif	1.80	-6.7	460.0	1500	WC7	08 09.3	-47 19
35	ε UMa	Alioth	1.80	0.3	19.0	62	A0 p	12 53.7	+56 00
36	δ CMa	Wezen	1.84	-8.0	940.0	3064	F8 Ia	07 08.0	-26 23
37	ε Sgr	Kaus Australis	1.85	-0.3	26.0	85	B9 IV	18 23.6	-34 23
38	ε Car	Avior	1.86	-2.1	62.0	202	K0 II	08 22.3	-59 29
39	η UMa	Alkaid	1.86	-1.7	33.0	108	B3 V	13 47.2	+49 22
40	φ Sco	Sargas	1.87	-5.6	280.0	913	F0 I-II	17 36.7	-43 00
41	β Aur	Menkalinan	1.90	0.6	22.0	72	A2 IV	05 58.9	+44 57
42	α TrA	Atria	1.92	-0.1	17.0	55	K2 III	16 47.8	-69 01
43	γ Gem	Alhena	1.93	0.0	26.0	85	A0 IV	06 37.2	+16 24
44	α Pav	Peacock	1.94	-2.3	71.0	231	B3 IV	20 24.9	-56 46
45	δ Vel		1.96	0.6	21.0	68	A0 V	08 44.5	-54 41
46	α Hya	Alphard	1.98	-0.2	26.0	85	K3 III	09 27.2	-08 38
47	α Ari	Hamal	2.00	-0.1	26.0	85	K2 III	02 06.7	+23 25
48	β CMa	Murzim	2.00	-4.8	220.0	717	B1 II-III	06 22.3	-17 57
49	α UMi	Polaris	2.00	-4.6	253.0	825	F8 Ib	02 22.9	+89 13
50	o Cet	Mira	2.00	-0.5	29.0	95	Md	01 09.2	+35 34

ASTRONOMY COURSES AVAILABLE IN 1991.

The following lists astronomy programmes, known to the authors, for the Sydney region. They are evening courses and are held at various Universities and Colleges. These programmes have been specifically designed for the lay person and are not tertiary programmes. Enquiries from the general public are most welcome. It will be necessary to make contact through the relevant phone number to ascertain course details or timetable information.

* **ASTRONOMICAL ASPECTS - Conducted by Geoff McNamara. (ph 533-3473).**

Astronomy 1: Astronomy for Beginners	Cost: $45, Venue: Kogarah High.
Astronomy 2: Astronomy- The Science	Cost: $60, Venue: Riverwood
Astronomy 3: The Solar System	Cost: $60, Venue: Riverwood
Astronomy 4: Stellar Playgrounds	Cost: $60, Venue: Riverwood
Astronomy 5 : Universal Concepts	Cost: $60, Venue: Riverwood
Astronomy 6: Amateur Astronomy	Cost: $60, Venue: Riverwood

Astronomy 1 is an 8 week course run 4 times per year.
Astronomy 2 to 5 make up a 1 year (36 week) course.
Astronomy 6 is an 8 week course which is run on demand.

* **INTRODUCTORY ASTRONOMY: THE SOLAR SYSTEM**
- Conducted by Nick Lomb.

This is a WEA course in conjunction with the Powerhouse Museum
Cost: $62, a 9 week course. Venue: Sydney Observatory (ph 241-2478).

* **200 YEARS OF ASTRONOMY IN AUSTRALIA**
- Conducted by R. Bathal.

Cost: $62, a 9 week course. Venue: WEA Centre.
Address of WEA Centre is 72 Bathurst St., Sydney. (ph 264-2781)

* **EINSTEIN'S UNIVERSE**
- Conducted by Fred Sticher

Cost: $62, a 9 week course. Venue: WEA Centre.

* **INTRODUCTION TO ASTRONOMY**
- Conducted by Theo Brummelaar

Cost: $107, a 12 week course. Venue: University of Sydney.

* **ASTRONOMY FOR BEGINNERS**
- Conducted by Don Miles.

Cost: $47, an 8 week course. Venue: Mosman Evening College.

* **PRACTICAL ASTRONOMY**
- Conducted by Sutherland Astronomical Society.

Cost: $S5, an 8 week WEA course. Venue: Green Point
Observatory (Sutherland). Contact: Jon Little, ph 542-1148.

* **VARIOUS ASTRONOMY COURSES**
- Conducted by A. James

(ph 817-4650) Strathfield Area.

PLACES OF ASTRONOMICAL INTEREST

If you live in NSW and would like to visit some astronomical observatories then you are indeed fortunate. The majority of the large observatories in Australia are located in your home state on the tablelands and western slopes and plains of NSW.

SYDNEY OBSERVATORY

The observatory is located in a park which is just a short walk from the historic "Rocks" district of Sydney. It is very close to the southern end of the Harbour Bridge. Since the Powerhouse Museum took over the running of the observatory, it has had a renewed interest in public education. The centre is setup for a more "hands-on" approach for visitors, with a number of displays and films on Astronomy. On weekends, visitors are invited to observe the Sun - the safe way (weather permitting). Night time tours include observations of the Moon and Planets through the observatory's historic telescopes.

Hours: 2 to 5pm - Monday to Friday 10am to 5pm - Saturday and Sunday 8:30pm to 10:30pm - every night except Wednesdays. Bookings are required for these evening tours.

Cost: There is a small charge for evening sessions - $2:50 Adults, $1:50 Students and $6:00 for Families.

Contact: (02) 241-2478.

PARKES RADIO TELESCOPE

The observatory is located on the western plains of NSW, a few kilometres north of Parkes (just off the Newell Highway). The Parkes Telescope was indeed a pioneer in Radio Astronomy. It is still a "work horse" and will soon be able to be switched in as part of the Australia Telescope. At the observatory, public education has a high priority, hence their impressive visitors complex. As well as having a great view of the telescope, the centre offers a superbly-crafted audio/ visual presentation on Astronomy and the Universe. The displays are interactive and well supported by the very knowledgeable staff. Next year also marks the 30th anniversary of the opening of the observatory (31st Oct). Although no details on the celebrations were available at the time of printing of this publication, the Parkes staff are promising something special!

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

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

Contact: Richard Twardy - (068) 62-3677

SIDING SPRING OBSERVATORY

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

Hours: 9:00am to 12:30pm, 1:00pm to 4:00pm. 7 days a week.

Cost: $3:50 Adults, $2:50 Children/Pensioners and $9:00 Family.

Contact - phone (068) 42-6211.

MT. STROMLO OBSERVATORY

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

Mt. Stromlo is home to a multitude of telescopes. When first visiting the observatory, the number of domes, of all sizes, can be quite fascinating. None of the domes are open to the public for inspection. However, the visitors gallery, which is built onto the side of the 1.9m telescope building, gives a view of this instrument through a window. The 1.9m was the largest (most light gathering power) optical telescope before the AAT and the ATT. The visitors centre is a static display of posters and photographs which illustrates the history and work at the observatory.

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

Cost: There is no charge.

Contact: (062) 88-1111

THE AUSTRALIA TELESCOPE - NARRABRI ARRAY

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

The visitors centre, at Narrabri, is well located. Being adjacent to the array's track, excellent views of the dishes are available. The centre is still being developed but there is already an excellent display and video tape presentation which explains the concepts behind the telescope and Radio Astronomy in general.

Hours: -The Visitors Centre is never closed. It is normally "manned" from 9:30am to 11:30am on week days. During school holidays these hours are often extended and more activities are conducted.

Cost: -There is no charge to visit the centre.

Contact -phone (067) 95-9205.

TIDBINBILLA TRACKING STATION

The station is located 40km southwest of Canberra, further along the same road you would take to visit Mt. Stromlo. In fact, Stromlo and Tidbinbilla would make a fascinating day trip if you were visiting or living in the ACT.

The Tidbinbilla complex is a major link in NASA's deep space tracking network. It has played a large role in nearly all of NASA's lunar and planetary probes. The Tracking Station, in the past, has also teamed up with the Parkes Radio Telescope to jointly monitor the faint signals from the distant Voyager spacecraft as they made their historic flybys of the outer planets.

As one would expect, the visitors centre concentrates on both NASA's manned and unmanned probes. The story of the Voyager spacecraft, which has rewritten our knowledge of the Solar System, is well represented. The centre incorporates audio and visual displays as well as a multi-slide production. Late December 1990, will see the opening of their additional visitors building which has more spectacular displays and a new theatre.

The visitors area offers an excellent view of the main antenna (dish). There is also a well equipped souvenir and sandwich/ hot food shop.

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

Contact: (062) 49-0811

JOHN TEBBUTT OBSERVATORIES

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

In recent years the observatory has been expertly restored and has had reinstalled (and overhauled) Tebbutt's original 9 inch refractor. The observatory has on display some excellent and rare memorabilia on Tebbutt's life and his work. As well as the refractor, the observatory has obtained a computerized 25cm telescope for public observing nights. The Tebbutt complex also has an excellent restaurant for those who would like to make a night of their visit. A new addition to the observatory will be a planetarium which will seat 30 people. This is due to arrive in December 1990.

Hours: 12:00pm to 4:30pm - 7 days per week. The daytime tours concentrate on the history of Tebbutt and his observatory. Night observing sessions, with the telescopes, are Saturdays ONLY (weather permitting). Other nights can be organised, for parties of at least 15, by special arrangement.

Cost: $10:00 Adults, $7:00 Children (prices are subject to change).

Contact: Steven Williams - ph. (045) 77-2485

THE SIR THOMAS BRISBANE PLANETARIUM

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

Theatre Times:

General: 3:30pm and 7:30pm - Wednesday to Friday. 1:30pm, 3:30pm and 7:30pm on Saturday.
1:30pm and 3:30pm on Sunday.
* There are also additional sessions during school holidays as well as school programmes (Pre-bookings only).

Cost: Prices are subject to yearly reviews. Contact the Planetarium for details.

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

GILGANDRA OBSERVATORY

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

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

NEW SOUTH WALES ASTRONOMICAL SOCIETIES

The following lists the amateur societies in NSW. A common philosophy within all these organizations is the emphasis they place on public education. Enquiries from anyone, with an interest in astronomy, are most welcome. Where given, fees are correct as at the time of printing (November 1990).

ASTRONOMICAL SOCIETY OF NSW, Inc.

The society holds meetings twice per month at the "Catholic College of Education", 179 Albert St. Strathfield. At ordinary meetings, professional astronomers are invited to talk on various astronomical topics. The Technical meetings are less formal, where members of the Society often present discussions on their amateur projects. Guests are most welcome. The Society also runs two observing sites. One at Bowen Mountain, near Richmond (west of Sydney) and the other is the property "Wiruna" near Ilford. A monthly magazine "Universe" is published for members. The Society also runs an information service called "Astrocards". This service alerts subscribers quickly to any new discoveries such as Novae and Comets.

Membership Fees $34:00 Full, $31:00 Associate, $28:00 Student.
There is no joining fee.
Address: PO Box 1004, Campbelltown NSW 2560.
Contact: Tony Buckley (President) ph (02) 874-2070.

SUTHERLAND ASTRONOMICAL SOCIETY, Inc.

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

Membership Fees: $20:00 Full, $10:00 Junior/ Pensioners and $30:00 for families.
There is also a joining fee.
Address: PO Box 31, Sutherland NSW 2232.
Contact: Jon Little (02) 542-1148

BRITISH ASTRONOMICAL ASSOCIATION - NSW BRANCH

The BAA meets at Sydney Observatory. The Association meets on the third Wednesday of each month (except for January), commencing at 7:45pm. At these meetings, professional astronomers are often invited as guest speakers. Regular practical workshops are also held on weekends. The BAA also publish a regular newsletter called "The Bulletin".

Membership Fees: $25:00 Full, $12:00 Junior and there are family concessions available.
There is a $12:50 Joining Fee.
Address: c/o 35 Nowland St., Seven Hills NSW 2147
Contact: George Smith. ph (02) 624-1426

ILLAWARA ASTRONOMICAL SOCIETY

Address: PO Box 1814, Wollongong NSW 2500
Contact: ph (042) 29-6696

HAWKESBURY ASTRONOMICAL ASSOCIATION

Address: c/o John Tebbutt Observatories, Palmer St., Windsor NSW 2756
Contact: ph (045) 77-2485

TAREE ASTRONOMICAL SOCIETY

Address: PO Box 111, Taree NSW 2430
Contact: Mr. Jim Ross- ph (065) 50-2213

THE ASTRONOMICAL SOCIETY OF THE HUNTER

Address: c/o Newcastle Technical College, Tighes Hill NSW 2297
Contact: Mr. C. Mudge - ph (049) 58-1723

NORTHERN DISTRICTS SOCIETY OF AMATEUR ASTRONOMERS

Address: 29 Robert St., Telopea NSW 2117
Contact: Gordon Stott - ph (02) 871-7838

PORT MACQUARIE ASTRONOMICAL ASSOCIATION

Address: 5/66 Clarence St., Port Macquarie NSW 2444
Contact: I. Benson - ph (065) 82-2100

GLOSSARY

ALTITUDE	The angular elevation of an object above the horizon.
APHELION	The point in an orbit of a comet, planet or minor planet most distant from the Sun. It is the opposite to perihelion.
ASTRONOMICAL UNIT	The average distance from Earth to the Sun, approximately 149.6 million km, which equals one (1) AU.
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.
DECLINATION (Dec)	One part of the equatorial co-ordinate system used to specify the location of an object in the sky. It is the angular distance of a body north (+) or south (-) of the celestial equator and is similar to lines of latitude on the Earth
E.A.S.T.	Eastern Australian Standard Time.
ECCENTRICITY	A measure of how 'long or thin' an ellipse is. If the eccentricity equals zero, you have a circle.
ECLIPSE 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	hen 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.
ELONGATION	The angular separation of two bodies. The greatest elongation of Mercury and Venus occur when the planets are at their most angular distance from the Sun, as viewed from the Earth.
EPOCH	A date chosen as a reference point for observations. ASTRONOMY 1991 uses Epoch 2000.0 for all co-ordinate data and is compatible with modern star atlases.
GEOCENTRIC	As viewed or measured from the centre of the Earth.
HELIOCENTRIC	As viewed or measured from the centre of the Sun.
INCLINATION	The angle that the plane of the orbit of one astronomical body makes with the plane of the orbit of another. Usually the reference is the *ecliptic*.
JULIAN DATE	The number of days since noon on 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.
LIGHT YEAR	The distance that light traverses in a vacuum during one year (approximately 9,460,529,700,000 km).
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.
MERIDIAN	The local meridian is an imaginary line running directly overhead from north to south.

OCCULTATION	Passage of Moon or planet in front of a star, or of a planet in front of a satellite.
OPPOSITION	When a superior planet is in line with the Earth and Sun.
ORBIT	The path followed by one body as it moves around another.
PARALLAX	
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.
RIGHT ASCENSION (R. A.)	Part of the equatorial co-ordinate system used to specify the location of an object in the sky. It is the angular distance of an object from an imaginary line in the sky. It is similar to lines of longitude on the Earth but is measured in hours (24hrs = 360°).
SIDEREAL TIME	A method of keeping time which uses the motion of the stars rather than the Sun. One sidereal day is equal to 23hrs56m4s of normal solar time.
SYNODIC PERIOD	The period of a planet's orbit with respect to the Earth.
TRANSIT	The passage of one astronomical object across another or through some point in space.
TRANSIT	The passage of Mercury or Venus in front of the Sun's disc. Also the passage of a satellite in front of its planet.
TWILIGHT	he short period of time before sunrise and after sunset during which there is not complete darkness.
TWILIGHT - Astronomical	Astronomical twilight ends (in the evening sky) or begins (in the morning sky) when the Sun is 18° below the horizon.
TWILIGHT - Civil	Civil twilight ends or begins when the Sun is 6° below the horizon.
TWILIGHT - Nautical	Nautical twilight ends or begins when the Sun is 12° below the horizon.
UMBRA	Zone of maximum darkness in the shadow of a planet. Also the darkest part of a sunspot.
UNIVERSAL TIME	A time system measured on the Meridian of Greenwich, it is 10 hours less than Eastern Australian Standard Time.

THE GREEK ALPHABET

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

QUESTIONNAIRE.

The authors are already considering the production of "Astronomy 1992". We would appreciate some feedback from you. The questions below were designed to help our future publications reflect more closely the needs of those who count! You, our readers.
If you supply your name and address, you will be forwarded, at no cost, the corrections to any errors that may have slipped through the final proof reading. All the information received will be kept in strict confidence. Please use page numbers when applicable.

QUESTIONS ON THE BOOK

1) What information do you consider most valuable? _____

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2) Are there any sections you believe could have been presented differently, further improved or explained better?

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3) What else would you recommend for inclusion in future editions of this publication ?

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Questionnaire.

GENERAL COMMENTS

QUESTIONS ABOUT YOU.

To help us understand your feedback, we would like to know a little about you. (These questions are optional)

1) How would you describe your level of knowledge in astronomy?

Beginner ☐ Semi-experienced ☐ Experienced ☐ Other ☐ _____

2) What are your specialty interests in astronomy? _____

_____

3) Do you belong to an Astronomical Society? No ☐ Yes ☐ Which One? _____

Please print the name and address we can send information to. (Note this will NOT be divulged to anyone else.)

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Please return this page to:

"Astronomy 1991"
c/o Quasar Publications
P.O. Box 234
STRATHFIELD NSW 2135.

ASTRONOMY 1991

This book is a guide to the night sky for 1991. For anyone wishing to find or observe the Planets or Moon, it is an invaluable asset. The publication has been specifically designed to be used for locations within NSW (in particular the Sydney region). Included are :

- Best times to observe the planets. Taking into account -
  - rise/set times;
  - brightness and size; and
  - position in the sky including proximity to the Sun.
- Guide to the phases of the Moon.
- Rise and Set times for the Moon.
- Lunar and Solar Eclipses for the year.
- Best times to observe the Constellations.
- Jupiter Satellite Events.
- Periodic Comets.
- Meteor ("Shooting Stars"). Showers.
- Also more specialised data for the advanced amateur.

The authors have had many years of experience in observational astronomy, production of astronomical publications and computer programming. They have also had involvement in public education in astronomy and the amateur astronomical community.

QUASAR PUBLISHING