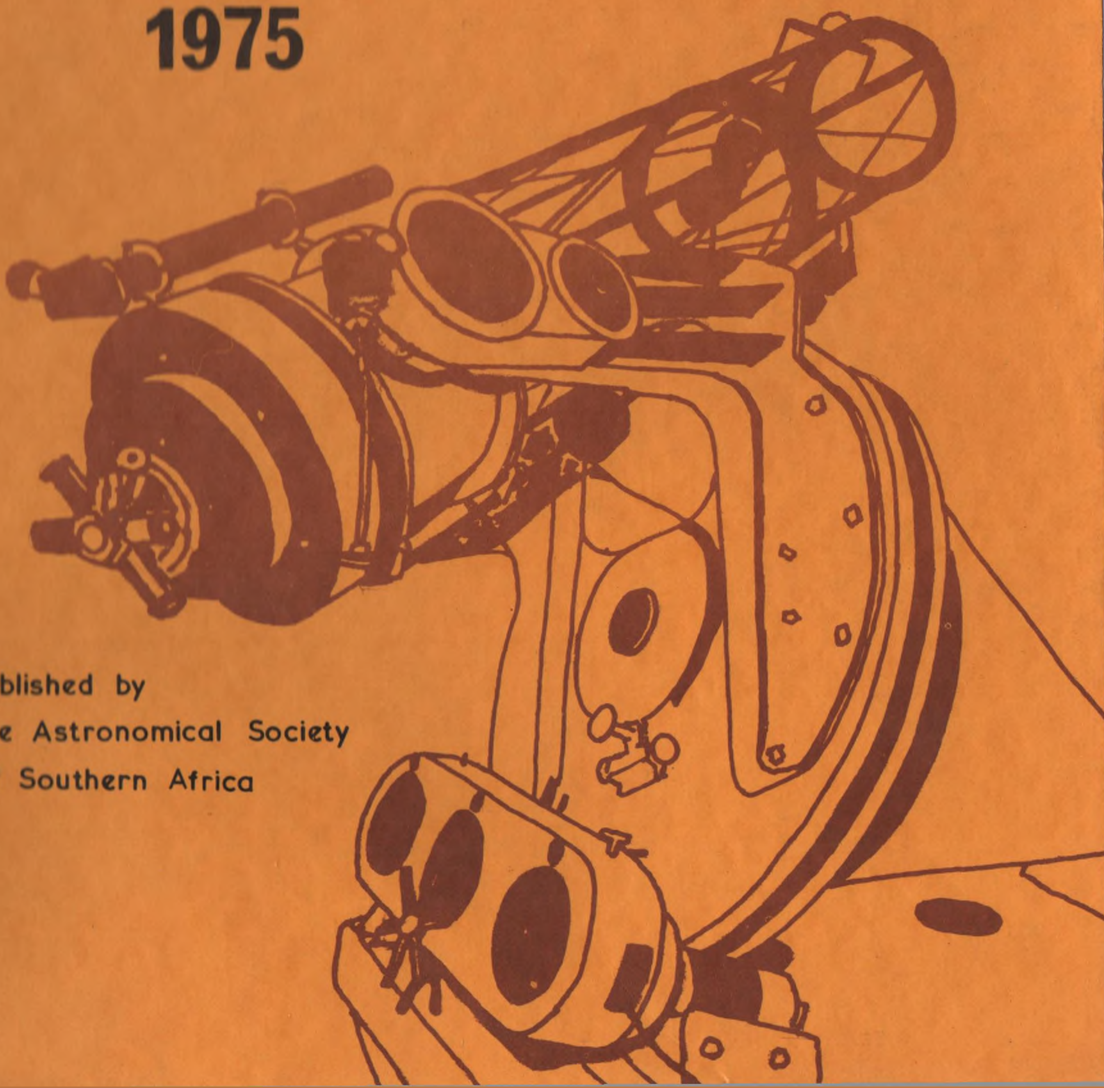
ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1975



published by
the Astronomical Society
of Southern Africa

1975 CALENDAR

JANUARY

S		5	12●	19	26
M		6	13	20◑	27O
T		7	14	21	28
W	1	8	15	22	29
T	2	9	16	23	30
F	3	10	17	24	31
S	4◐	11	18	25	

FEBRUARY

	2	9	16	23
	3◐	10	17	24
	4	11●	18	25
	5	12	19◑	26O
	6	13	20	27
	7	14	21	28
1	8	15	22	

MARCH

	2	9	16	23	30
	3	10	17	24	31
	4◐	11	18	25	
	5	12	19	26	
	6	13●	20◑	27O	
	7	14	21	28	
1	8	15	22	29	

APRIL

S					
M					
T	1	8	15	22	29
W	2	9	16	23	30
T	3◐	10	17	24	
F	4	11●	18	25O	
S	5	12	19◑	26	

MAY

	4	11●	18◑	25O
	5	12	19	26
	6	13	20	27
	7	14	21	28
1	8	15	22	29
2	9	16	23	30
3◐	10	17	24	31

JUNE

1	8	15	22	29
2◐	9●	16◑	23O	30
3	10	17	24	
4	11	18	25	
5	12	19	26	
6	13	20	27	
7	14	21	28	

JULY

S		6	13	20	27
M		7	14	21	28
T	1◐	8	15◑	22	29
W	2	9●	16	23O	30
T	3	10	17	24	31◐
F	4	11	18	25	
S	5	12	19	26	

AUGUST

	3	10	17	24	31
	4	11	18	25	
	5	12	19	26	
	6	13	20	27	
	7●	14◑	21O	28	
1	8	15	22	29	
2	9	16	23	30◐	

SEPTEMBER

	7	14	21	28◐
1	8	15	22	29
2	9	16	23	30
3	10	17	24	
4	11	18	25	
5●	12◑	19	26	
6	13	20O	27	

OCTOBER

S		5●	12◑	19	26
M		6	13	20O	27
T		7	14	21	28◐
W	1	8	15	22	29
T	2	9	16	23	30
F	3	10	17	24	31
S	4	11	18	25	

NOVEMBER

	2	9	16	23	30
	3●	10◑	17	24	
	4	11	18	25	
	5	12	19O	26◐	
	6	13	20	27	
	7	14	21	28	
1	8	15	22	29	

DECEMBER

	7	14	21	28
1	8	15	22	29
2	9	16	23	30
3●	10◑	17	24	31
4	11	18O	25◐	
5	12	19	26	
6	13	20	27	

● New Moon
◑ First Quarter
O Full Moon
◐ Last Quarter

JULIAN DATE - See Inside Back Cover

Front Cover - Telescope built by Mr. Arnold Mills, Hillside, Bulawayo

ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1975

This booklet is intended both as an introduction to observational astronomy for the interested layman - even if his interest is only a passing one - and as a handbook for the established amateur or professional astronomer.

CONTENTS

NOTE

Unless stated otherwise, all times are SOUTH AFRICAN STANDARD TIME. In order to avoid confusion between a.m. and p.m., the 24-hour clock is used (e.g. 1800 hrs. is 6 p.m. and 2100 hrs. is 9 p.m.). Emphasis is given to phenomena visible in the evening sky - between sunset and midnight.

This Handbook is produced in the Department of Astronomy, University of Cape Town, for the Astronomical Society of Southern Africa. Most of the data it contains have been adapted for Southern Africa from the "Astronomical Ephemeris for 1974" issued jointly by the Nautical Almanac Offices of the Royal Greenwich Observatory, Herstmonceux and the U.S. Naval Observatory, Washington D.C. Additional information has also been supplied direct from the Herstmonceux Office.

Thanks are due to all who have contributed to this handbook, especially: The staff of HMNAO, Herstmonceux; Messrs. G. and C. Larmuth (planet rising and setting calculations and diagram, phenomena of Jupiter's satellites and time of Sun's transit) Mr. J.C. Bennet (director of Comet and Meteor Section); Mr. M.D. Overbeek (director of Variable Star Section); Mr. A.G.F. Morrisby (director of Occultation Section); Mr. J. Hers (co-ordinator for Grazing Occultations); and Mrs. P. Dobbie who typed the script.

All correspondence concerning this booklet should be addressed to the Handbook Editor, Astronomical Society of Southern Africa, Department of Astronomy, University of Cape Town, Rondebosch 7700, Cape. Further copies can also be obtained from the same address. Enclose a postal order or cheque (in favour of the Astronomical Society of Southern Africa) for 50 cents per copy.

Although every care has been taken in the compilation of the Handbook, it is distributed and sold on the explicit condition that neither the Astronomical Society of Southern Africa nor any of its members accepts any responsibility for errors.

Dit is met spyt dat ons u meedeel dat as gevolg van beperkte fondse en produksiefasiliteite dit nie moontlik was om hierdie handboek in Afrikaans te laat druk nie.

A. P. FAIRALL
EDITOR

P & PD UCT

ASTRONOMY IN SOUTHERN AFRICA

As one of the few parts of the Earth having both access to the rich southern skies and a suitable climate, Southern Africa holds a favoured position in astronomy. Consequently it has seen the establishment of a number of professional observatories engaged in research while many individuals have become enthusiastic amateur astronomers. Planetaria and visiting nights at observatories convey to the general public much of what goes on in this field.

OBSERVATORIES

Boyden Observatory, situated at Mazelspoort, just outside Bloemfontein, is operated by an international consortium representing American, Belgium, Irish and South African interests. Thus many astronomers come from overseas to make use of its observing facilities which include the 1,5 m Rockefeller Reflector and the 0,9 m ADH Baker Schmidt. Its site offers good observing conditions, without being remote from a large centre.

On the other hand, the observatory sites in the hearts of Cape Town and Johannesburg have become unsuitable with the rapid expansion of those cities. The South African Astronomical Observatory - a joint venture between the South African Council for Scientific and Industrial Research and the British Science Council-has merged their facilities and moved the larger instruments to a new site near Sutherland in the Karroo.

During 1974 the SAAO acquired the 1.9 m Radcliffe reflector located on the outskirts of Pretoria and the largest telescope in Southern Africa. As in Cape Town and Johannesburg observing conditon in Pretoria have deteriorated seriously in recent years and therefore, in order to reap the full benefits of the large telescope, plans are in hand to move the instrument and its turret to the Sutherland site. Dismantling of the equipment in Pretoria started in mid-October and the base of the new building should be ready to receive the telescope in February 1975. Re-erection and optical testing will then take at least another six months.

The SAAO in Johannesburg also has a small outstation near Hartebeespoort, sharing the site with the Leiden Observatory Southern Station which has a 0,9 m "light collector" reflector.

In the field of radio astronomy, the 25 m dish of the Deep Space Tracking Station near Krugersdorp is used for research work when not required for tracking spacecraft, while the Rhodes University Radio Observatory just outside Grahamstown, has a number of arrays for receiving radio emission from the planet Jupiter.

In addition to the professional observatories listed above, South Africa and Rhodesia have numerous private observatories, built and operated by amateur astronomers.

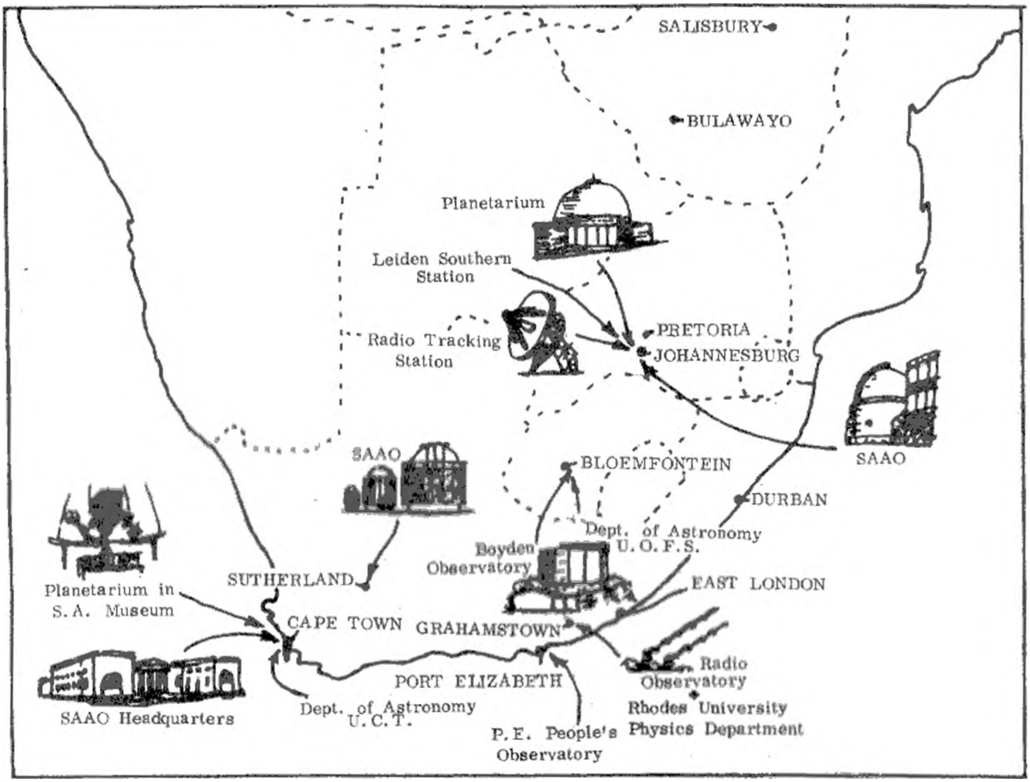
OBSERVATORIES OPEN TO THE PUBLIC

Visiting nights at Boyden Observatory are held twice per month usually around the time of first quarter. Intending visitors should contact the Information Office in Hoffman Square, Bloemfontein for tickets (gratis). Numbers are restricted to twenty persons on each visiting night.

SAAO Headquarters, Observatory, Cape are open to visitors on the second Saturday each month at 8.00 p.m. No tickets are necessary but parties of more than ten persons should contact the observatory in advance.

PLANETARIA

The major planetarium in South Africa is that situated on the grounds of the University of the Witwatersrand (entrance in Yale Road - alongside M1). It is equipped with a highly complex Zeiss



projector and seats over 400 persons.

A smaller planetarium, with a Spitz projector and seating approximately 70, is located within the South African Museum, Cape Town. Shows are given each Saturday at 3.00 p.m., each Sunday at 3.30 p.m., and at 11.00 a.m. and 3.00 p.m. on public and school holidays. Further information can be obtained by phoning the museum at 41-2668.

TEACHING DEPARTMENTS

Both the University of the Orange Free State and the University of Cape Town have departments of astronomy - concerned with optical astronomy - while the Physics department of Rhodes University specialises in radio astronomy. The UOFS department is incorporated into Boyden Observatory and is headed by the director, Prof. A.H. Jarrett. Prof. Brian Warner occupies the chair of Astronomy at UCT, his department makes use of the SAAO observing facilities at Sutherland. The Physics Department at Rhodes has its own radio observatory outside Grahamstown.

THE ASTRONOMICAL SOCIETY OF SOUTHERN AFRICA

The Astronomical Society of Southern Africa is a body consisting of both amateur and professional astronomers. Membership is open to all interested persons, regardless of knowledge or experience. In addition to this handbook, the Society issues twelve numbers of "The Monthly Notes of the Astronomical Society of Southern Africa" (MNASSA) each year. Members also receive copies of "Sky and Telescope", an excellent and very popular monthly magazine published in the United States. It provides up to date information on both professional and amateur activities, together with news of space research and other related subjects. The society's annual subscription is R8.00 and there is an entrance fee of R2.50. Information can be obtained from the Honorary Secretary, Astronomical Society of Southern Africa, c/o The South African Astronomical Observatory, P.O. Box 9, Observatory 7935, Cape.

LOCAL CENTRES OF THE SOCIETY

Autonomous local Centres of the Society hold regular meetings in Cape Town, Bloemfontein, Durban, Johannesburg, Pietermaritzburg and Pretoria. Visitors are very welcome at meetings and may, if they wish, join a centre, without becoming a full member (i.e. receiving publications for R8 subscription) of the society.

CAPE CENTRE (Cape Town) - Meetings on 2nd Wednesday of the month (except Jan. and Dec.) at the South African Astronomical Observatory at 8.00 p.m. The Centre possesses a small observatory housing the twelve inch Ron Atkins Telescope. There is also an active occultation section. Secretarial address: 4 Chalfont Road, Newlands 7700. Information on meetings also available from Department of Astronomy, U.C.T. Telephone (day time) 698531 ext. 256.

NATAL CENTRE (Durban) - Monthly meetings are held at the Teacher's Centre. Occultation and telescope making sessions. The Centre has a portable twelve inch reflecting telescope. Secretarial address: 3 Bruce Crescent, Westville 3630. Telephone (evenings) 858053.

NATAL MIDLAND CENTRE (Pietermaritzburg) - Meetings usually on the first Thursday of the month either in a private home or at the Royal Hotel in Burger St. Secretarial address: 17 Yalta Rd., Pietermaritzburg 3201.

FREE STATE CENTRE (Bloemfontein) - The Centre has its own observatory at Brandkop. Meetings on 2nd Thursday of the month at the homes of members. For further information, contact Mr. G.J. Muller, 35 Wilcocks Road, Bloemfontein 9301. Telephone (evenings) 7-3442 or Mr. J. Rhodes, Telephone 7-1981 (day time). Associate members should endeavour to have communications in the hands of the secretary a week before the monthly meetings.

PRETORIA CENTRE - The Centre has its own observatory containing a twelve inch reflecting telescope. For information contact Mr. K.J. Sterling, 5 Hekla Road, Valhalla 0137 - Phone 713272. The Centre has a small Observatory housing a 30 cm f9 telescope.

OBSERVING SECTIONS OF THE SOCIETY

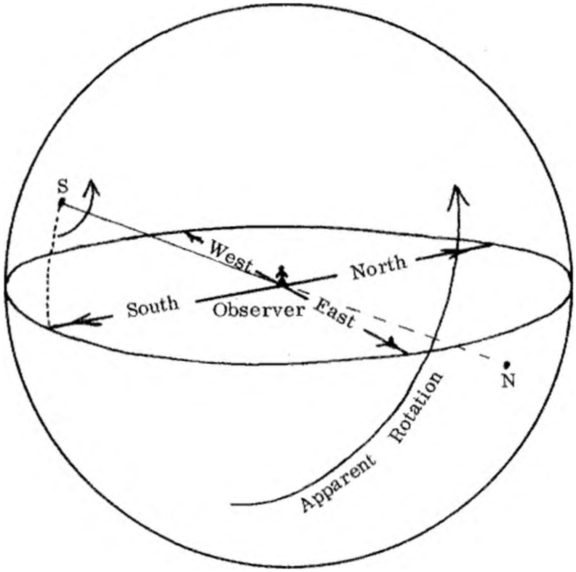
These sections exist to coordinate and encourage constructive observing programmes. Mention of the type of observations and equipment involved are made in the appropriate parts of this handbook together with the names and addresses of the directors.

THE CHANGING NIGHT SKY 1975

The annual cycle of the starry skies visible in the evening forms the backdrop to the continually changing configurations of the Moon and planets. The maps in this section are highly simplified - they show only the visible planets and the most easily identified constellations - and are intended as an identification aid for the reader. The edge of each circular map approximately represents the horizon, the centre the point overhead. The maps are best used by holding the booklet up, rather than laying it flat, and rotating it to match the direction the reader is looking. If in doubt of direction - the best place to start is where the Sun went down - which obviously must be somewhere on the western horizon.

EXPLANATION OF THE APPARENT MOVEMENT OF THE SKY

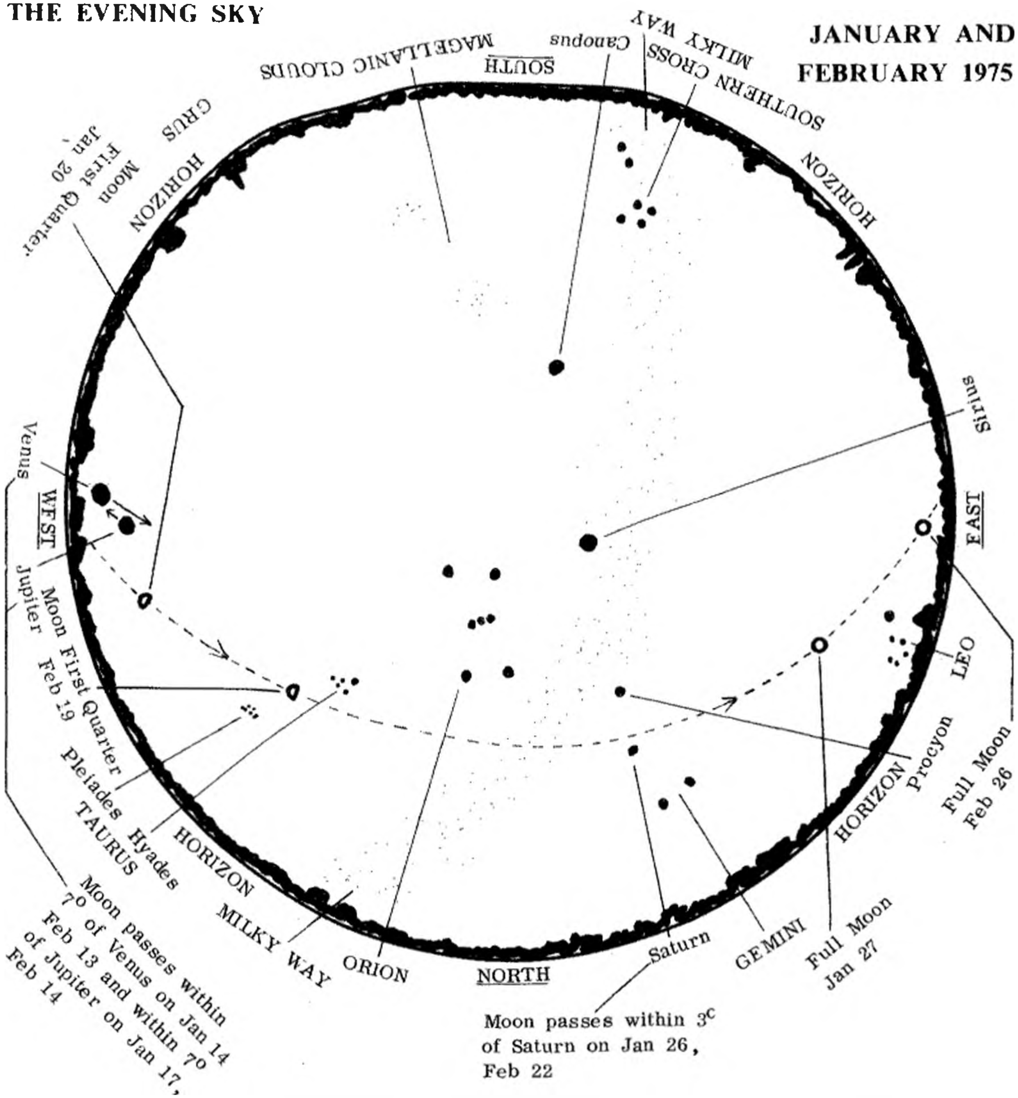
The most convenient representation of the sky is that of a sphere viewed from the inside by an observer at its centre. This is illustrated in the diagram below. If, as is usual, the observer stands on a flat surface (a local portion of the Earth's surface can be considered flat) - then his horizon divides the sphere into two halves - one which he can see, the other obscured by the ground beneath his feet.



The Earth, of course, rotates - but the observer is not aware of his rotation - and rather thinks that the whole sky is rotating instead! The sky therefore appears to rotate about the axis marked SN in the diagram - an axis parallel to the Earth's axis of rotation. Most of the sky seen from Southern Africa rises above the eastern horizon and sets below the western horizon, but a portion above the southern horizon never sets and a portion below the northern horizon never rises.

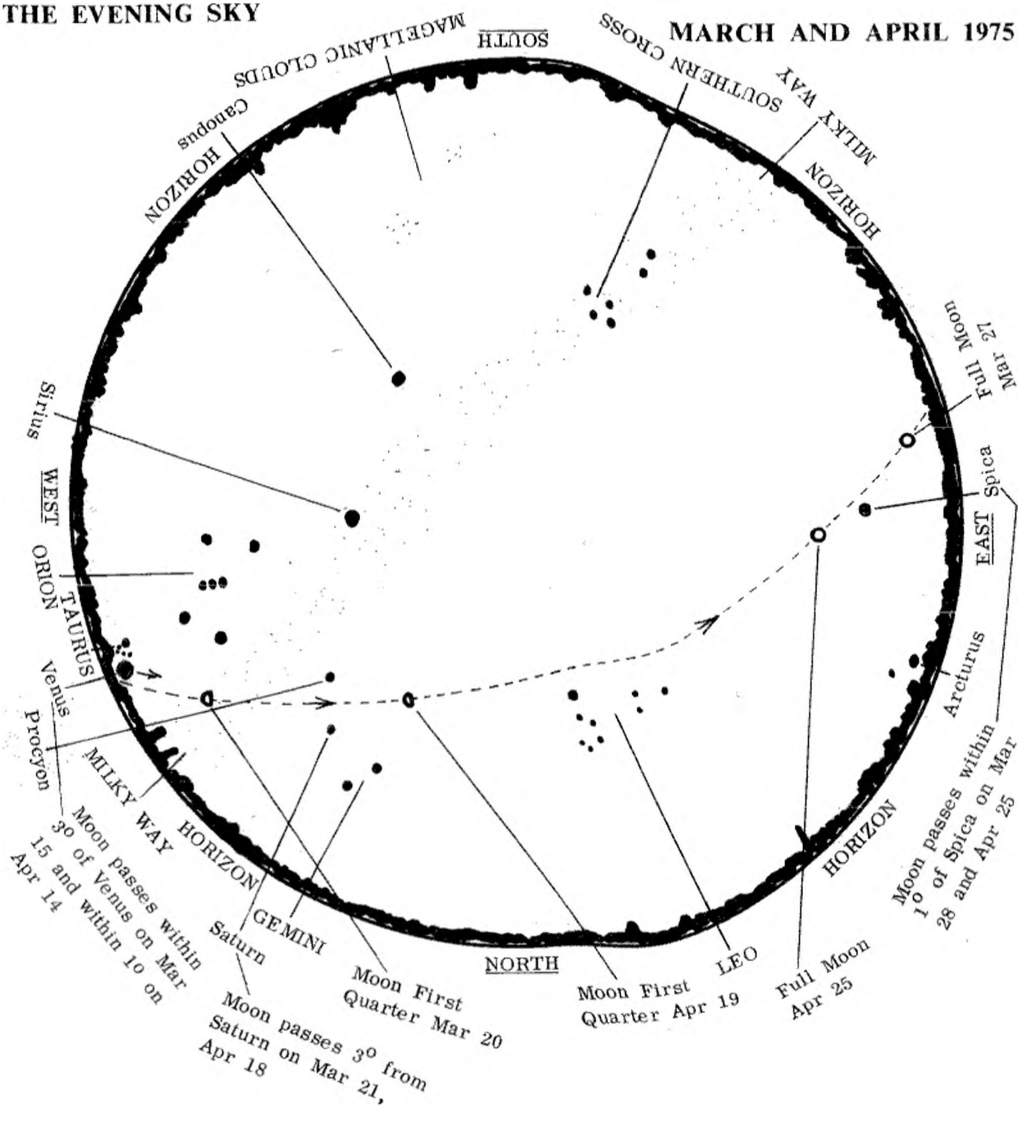
THE EVENING SKY

JANUARY AND FEBRUARY 1975



The two planets Venus and Jupiter make a spectacular pair above the western horizon in the early evening - they pass within 0°.2 of each other on February 17. The most prominent constellation is Orion - easily identified by the three bright stars in a straight line which make Orion's belt. The nearby constellation of Taurus contains the best known star clusters, the Pleiades and the Hyades. In the south the kite shaped Southern Cross is easily recognised. More detailed maps of both the Orion and Southern Cross regions, together with lists of objects for observation by naked eye, binoculars and small telescope, are given on pages 38 and 39. This is the best time for observing Saturn which is at opposition on January 6 - detailed information on the planets is given on page 22.

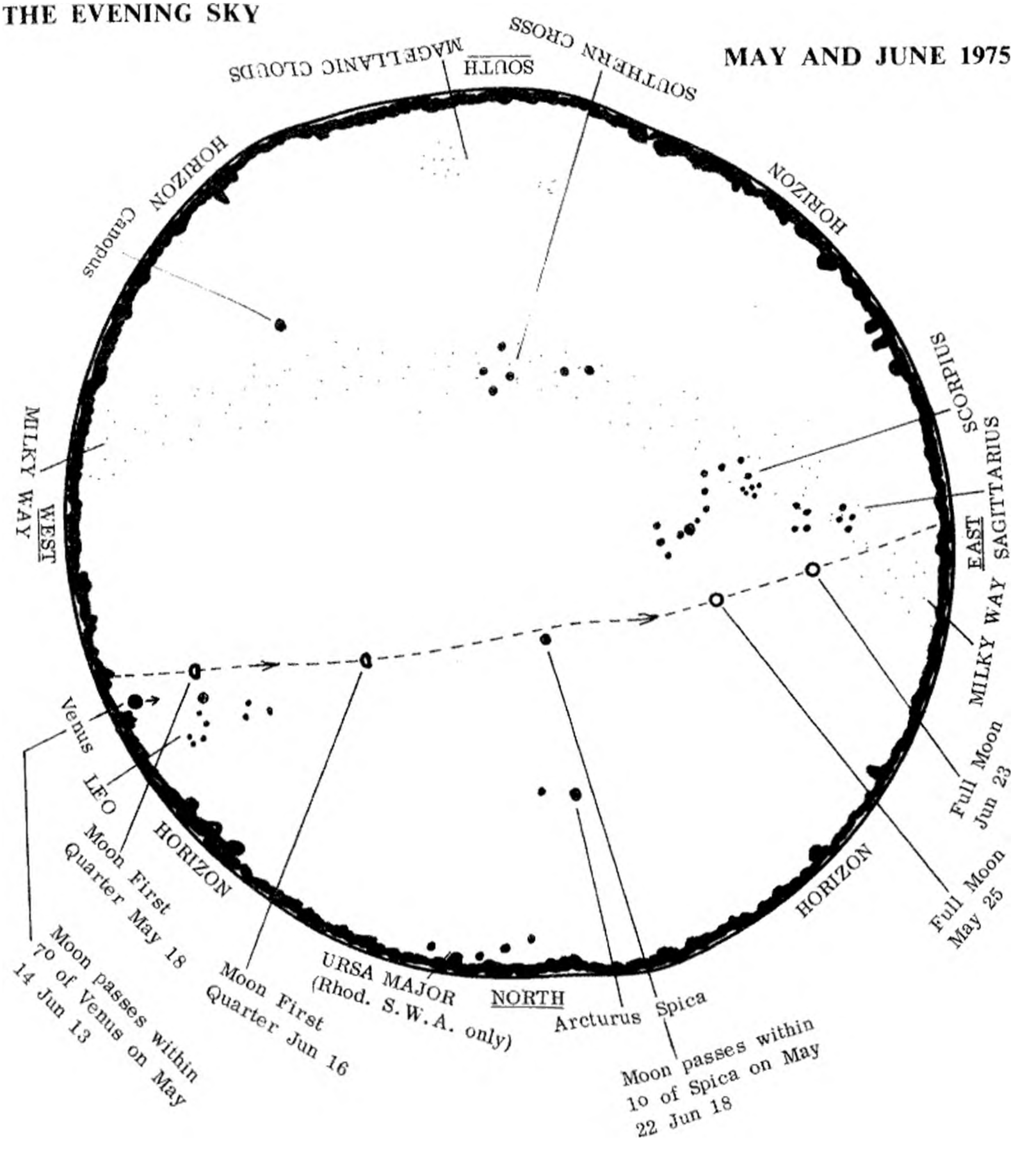
THE EVENING SKY **MARCH AND APRIL 1975**



Venus is prominent above the western horizon in the early evening and moves eastward amongst the stars of Taurus. Above Taurus, Orion is conspicuous (Map on page 38), although he will soon draw closer to the horizon and disappear from the evening sky. Saturn, which appears to move considerably slower than Venus, remains in Gemini. Leo is now high in the sky and Spica, the brightest star in Virgo is above the eastern horizon. Close to Spica is the planet Uranus (at opposition on Apr 21) which can be found with the aid of a small telescope and the map on page 29. The Southern Cross (map on page 39) is now climbing up towards its highest point.

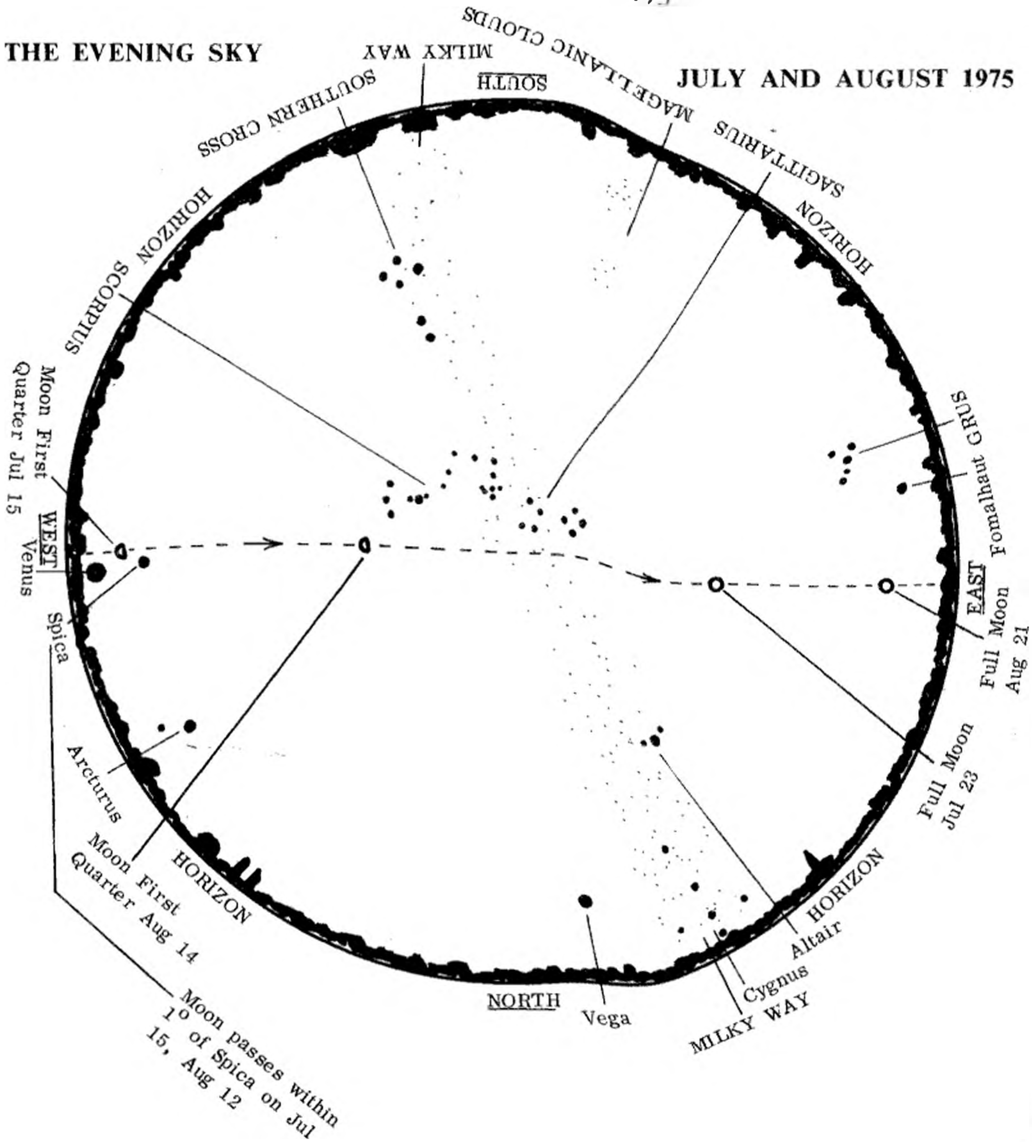
THE EVENING SKY

MAY AND JUNE 1975



Venus continues to grow brighter in its now familiar position above the western horizon. As it moves eastward against the starry background it passes 3° north of Saturn on May 24 and 4° south of Pollux on May 31. The angle between Venus and the Sun reaches maximum on Jun 18 and thereafter decreases. In the south the Southern Cross (map on page 39) reaches its highest point. Although Orion and neighbouring regions have now disappeared, the dominant winter constellation, Scorpius, has risen in the east. A more detailed map of the Scorpius region is given on page 40. The planet Neptune (at opposition on June 1) lies in the Scorpius region but is too faint to be seen with the naked eye. It can however be found with a small telescope and the map on page 29.

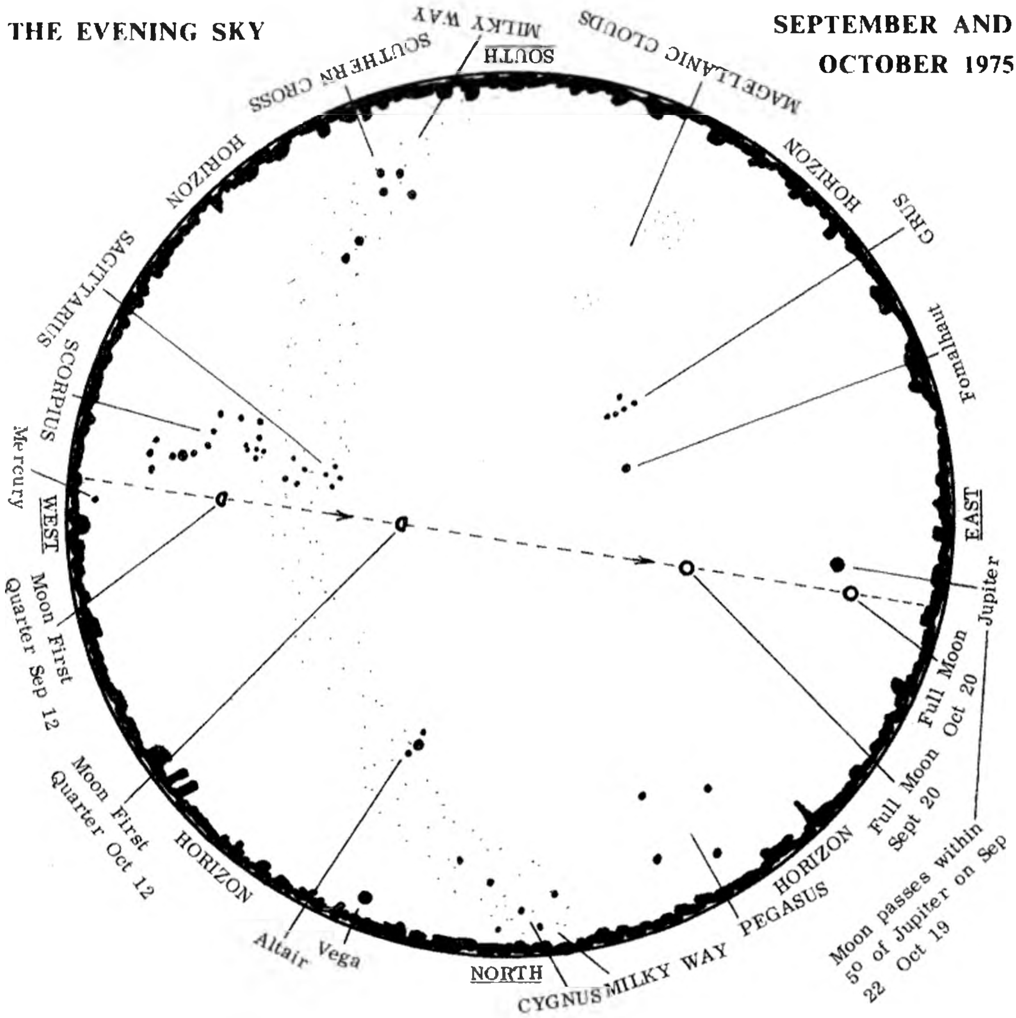
THE EVENING SKY **JULY AND AUGUST 1975**



Although attaining greatest brilliancy on Jul 22, Venus now appears to slide back towards the setting Sun. It passes 0°.4 south of Regulus on Jul 9 and disappears from the evening sky in late August. The Scorpius Region (map on page 40) is high overhead. In the south the Southern Cross (map on page 39) is somewhat passed its highest point.

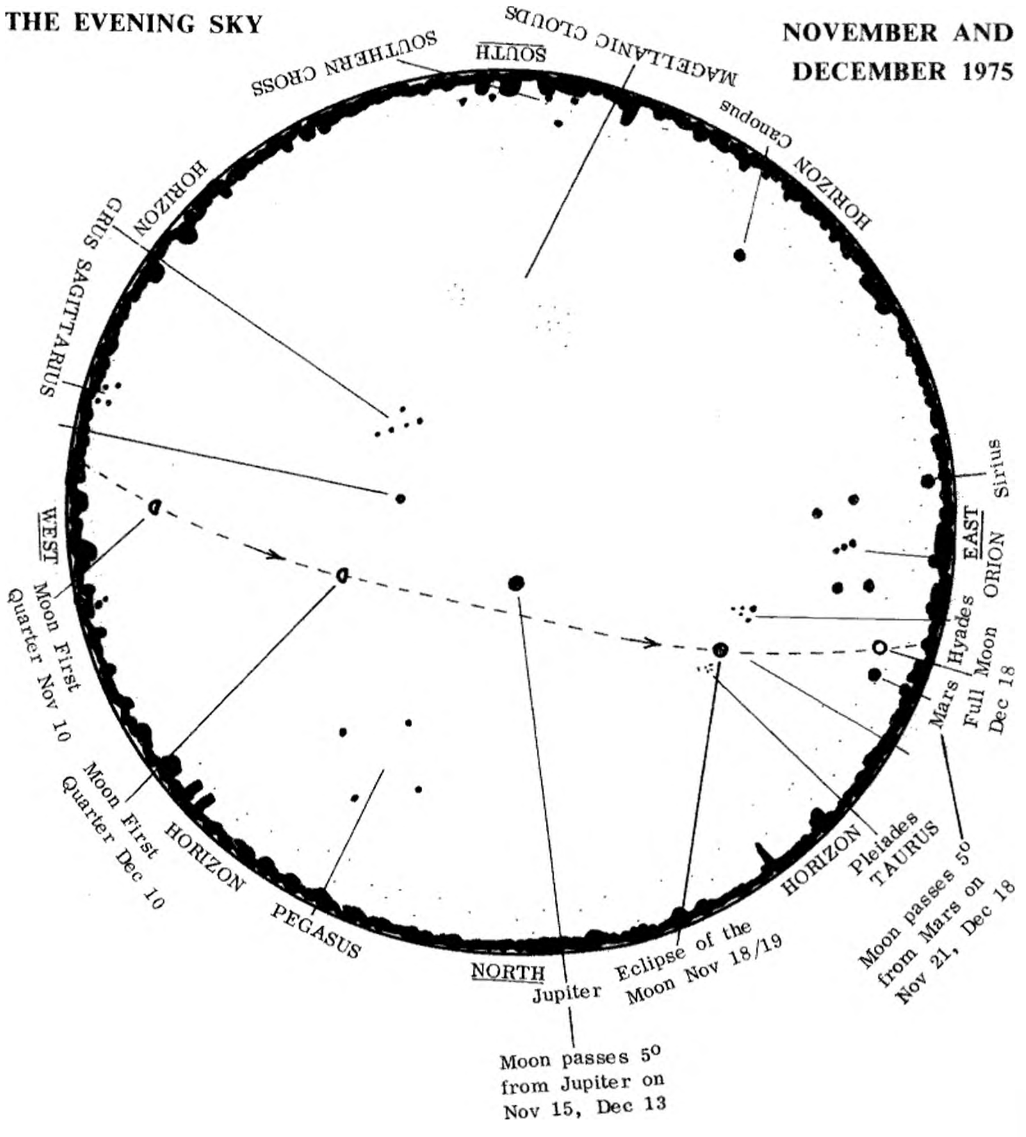
THE EVENING SKY

SEPTEMBER AND OCTOBER 1975



During September, Mercury can be seen low over the western horizon - see map on page 23. Scorpius (map on page 40) is now progressing towards the western horizon, while Jupiter makes an appearance above the eastern horizon. This planet makes a fine object for a small telescope (see page 27) - four of its moons are easily visible and their configurations change from night to night (see page 32). Jupiter is at opposition on Oct 13. Neptune in the Scorpius region is occulted by the Moon on Sept 11 - see page 29.

THE EVENING SKY **NOVEMBER AND DECEMBER 1975**



After a six month absence Orion (map on page 38) makes a reappearance in the evening sky. He is seen low above the eastern horizon, with the star clusters of neighbouring Taurus somewhat higher. Jupiter (see pages 27 and 32) is overhead but its brightness is nearly matched by Mars - also above the eastern horizon - which is at opposition on December 15. An eclipse of the Moon takes place late in the evening of November 18 and finishes in the early hours of the morning.

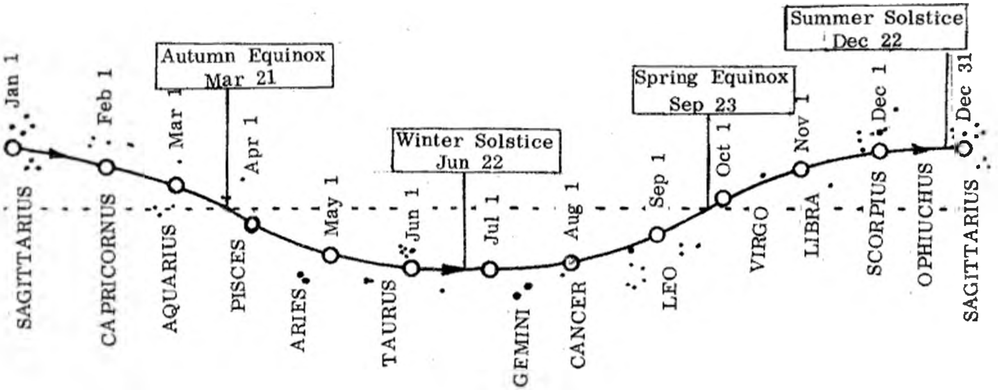
THE SUN 1975

BASIC DATA

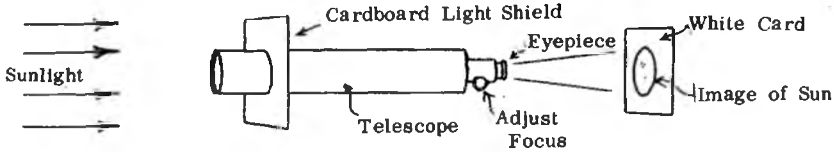
Diameter: 1 392 000 km (109 times Earth diameter)
Mass: $1,99 \times 10^{30}$ kg (330 000 times Earth Mass)
Surface Temperature: Approx. $6000^{o}C$
Temperature at centre: Approx. 10 million^{o}C

The Sun is our nearest star. It is composed chiefly of hydrogen and is in a gaseous state throughout. So hot and dense is its interior that nuclear reactions occur there - thus producing the energy that is eventually radiated from its surface. At times its surface is disturbed by sunspots (which may persist for some weeks) and flares (short lived).

The Earth's orbit around the Sun is not quite circular. In 1975 we will be closest to the Sun on January 3 (perihelion - approx. distance 147 million km.) and furthest from the Sun on July 6 (aphelion - approx. 152 million km.) During the year, the Sun appears to us to make a complete circuit of the sky (i.e. relative to the starry background) as indicated in the diagram.



Permanent damage to the eye can be caused by looking directly at the Sun. The diagram below shows how a small telescope (or half a binocular) may be used to project an image of the solar disk onto a piece of white card. It may also be advisable to stop down the telescope aperture so that the eyepiece is not damaged by the intense light passing through it. Tiny black sunspots are generally visible on the otherwise white solar disk - if monitored over a period of a week or so, the rotation of the Sun should be apparent.



TIMES OF SUNRISE AND SUNSET

	CAPE TOWN		DURBAN		BLOEMFONTEIN		JOHANNESBURG		SALISBURY	
	SUNRISE	SUNSET	SUNRISE	SUNSET	SUNRISE	SUNSET	SUNRISE	SUNSET	SUNRISE	SUNSET
Jan 1	$05^h\ 38^m$	$20^h\ 01^m$	$04^h\ 58^m$	$19^h\ 01^m$	$05^h\ 21^m$	$19^h\ 18^m$	$05^h\ 18^m$	$19^h\ 04^m$	$05^h\ 24^m$	$18^h\ 35^m$
11	05 46	20 02	05 06	19 02	05 29	19 18	05 25	19 05	05 29	18 37
21	05 55	19 59	05 14	19 00	05 37	19 17	05 33	19 04	05 37	18 38
Feb 1	06 07	19 52	05 24	18 55	05 46	19 13	05 42	19 00	05 42	18 36
11	06 17	19 44	05 32	18 48	05 54	19 06	05 49	18 55	05 47	18 32
21	06 26	19 33	05 41	18 39	06 02	18 57	05 56	18 47	.05 52	18 27
Mar 1	06 33	19 23	05 46	18 30	06 08	18 48	06 00	18 39	05 55	18 21
11	06 41	19 11	05 53	18 19	06 13	18 38	06 06	18 29	05 57	18 15
21	06 49	18 58	05 59	18 08	06 18	18 27	06 11	18 19	06 00	18 06
Apr 1	06 58	18 41	06 06	17 53	06 25	18 13	06 17	18 06	06 02	17 57
11	07 04	18 30	06 11	17 43	06 30	18 03	06 21	17 56	06 04	17 50
21	07 13	18 17	06 17	17 31	06 35	17 52	06 25	17 47	06 07	17 43
May 1	07 20	18 05	06 24	17 22	06 42	17 44	06 31	17 38	06 10	17 37
11	07 28	17 57	06 31	17 14	06 49	17 36	06 37	17 31	06 13	17 32
21	07 34	17 50	06 36	17 08	06 54	17 30	06 41	17 26	06 16	17 29
Jun 1	07 43	17 45	06 43	17 04	07 01	17 27	06 47	17 23	06 20	17 28
11	07 48	17 44	06 48	17 03	07 05	17 26	06 52	17 22	06 23	17 27
21	07 51	17 44	06 51	17 04	07 08	17 27	06 55	17 24	06 26	17 29
Jul 1	07 53	17 48	06 53	17 07	07 10	17 30	06 57	17 27	06 27	17 32
11	07 51	17 52	06 51	17 11	07 08	17 34	06 55	17 30	06 27	17 35
21	07 47	17 58	06 48	17 16	07 05	17 39	06 53	17 35	06 26	17 40
Aug 1	07 39	18 06	06 42	17 22	07 00	17 45	06 48	17 41	06 23	17 42
11	07 30	18 13	06 34	17 29	06 53	17 51	06 41	17 46	06 18	17 46
21	07 19	18 20	06 24	17 35	06 42	17 55	06 32	17 50	06 11	17 48
Sep 1	07 06	18 27	06 12	17 40	06 31	18 01	06 21	17 54	06 04	17 49
11	06 52	18 34	06 00	17 46	06 19	18 06	06 11	17 59	05 55	17 51
21	06 38	18 41	05 48	17 51	06 07	18 10	05 59	18 03	05 46	17 52
Oct 1	06 25	18 48	05 37	17 57	05 57	18 16	05 50	18 08	05 39	17 54
11	06 12	18 55	05 25	18 03	05 45	18 22	05 39	18 12	05 30	17 57
21	05 58	19 04	05 12	18 09	05 33	18 27	05 27	18 17	05 23	17 59
Nov 1	05 46	19 13	05 02	18 17	05 24	18 35	05 19	18 24	05 16	18 03
11	05 38	19 23	04 55	18 26	05 17	18 44	05 13	18 32	05 14	18 08
21	05 31	19 33	04 49	18 34	05 12	18 52	05 08	18 39	05 11	18 13
Dec 1	05 29	19 43	04 48	18 42	05 11	19 00	05 07	18 46	05 12	18 19
11	05 28	19 50	04 48	18 50	05 11	19 07	05 08	18 53	05 14	18 25
21	05 32	19 57	04 52	18 57	05 15	19 14	05 12	19 00	05 18	18 31

SOLAR ECLIPSES

During 1975 there are two partial solar eclipses but neither is visible from Southern Africa. The first, on May 11, is visible in the artic and Europe; the second, on November 3, is visible in the antarctic and southern South America.

THE MOON 1975

BASIC DATA

Diameter: 3 480 km (0,27 of Earth)
Mass: 7,35 x 10^{22} kg (1/81 of Earth)
Surface Gravity: 0,16 of Earth
Average distance from Earth: 384 000 km

PHASES AND VISIBILITY

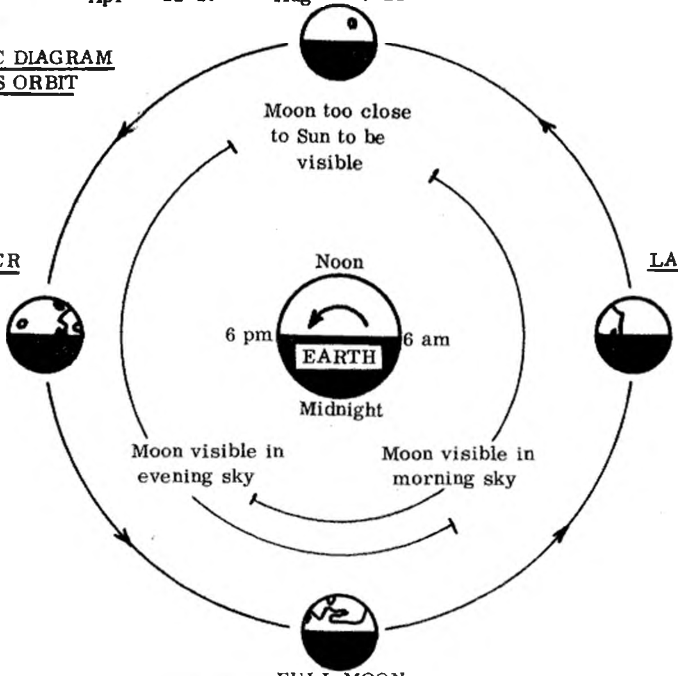
SUNLIGHT

NEW MOON

	d	h		d	h		d	h
Jan	12	12	May	11	09	Sep	5	21
Feb	11	07	Jun	9	21	Oct	5	06
Mar	13	02	Jul	9	06	Nov	3	15
Apr	11	19	Aug	7	14	Dec	3	03

SUNLIGHT

SCHEMATIC DIAGRAM OF MOON'S ORBIT



FIRST QUARTER

	d	h
Jan	20	17
Feb	19	10
Mar	20	22
Apr	19	07
May	18	12
Jun	16	17
Jul	15	22
Aug	14	04
Sep	12	14
Oct	12	03
Nov	10	20
Dec	10	17

LAST QUARTER

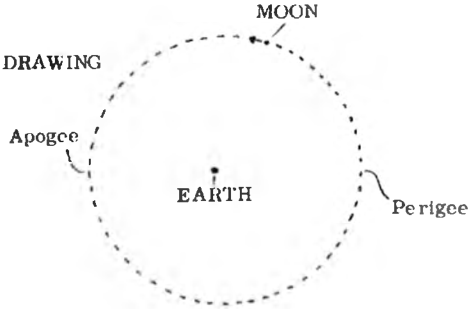
	d	h
Jan	4	21
Feb	3	08
Mar	4	22
Apr	3	14
May	3	08
Jun	2	01
Jul	1	19
Jul	31	11
Aug	30	01
Sep	28	14
Oct	28	00
Nov	26	09
Dec	25	17

FULL MOON

	d	h		d	h		d	h
Jan	27	17	May	25	08	Sep	20	14
Feb	26	03	Jun	23	19	Oct	20	07
Mar	27	13	Jul	23	07	Nov	19	00
Apr	25	22	Aug	21	22	Dec	18	17

THE MOON'S ORBIT

SCALE DRAWING



The Moon's orbit around the Earth is slightly elliptical; the Earth is situated at one of the foci of the ellipse. Thus the Earth-Moon distance varies slightly during the course of a revolution.

Dates of Apogee, when the Moon is furthest from the Earth (approx. 407 000 km) and of Perigee, when the Moon is closest to the Earth (approx. 357 000 km) are given below.

APOGEE						PERIGEE					
Jan	15	May	5	Sep	20	Jan	28	May	20	Oct	4
Feb	12	Jun	2	Oct	17	Feb	26	Jun	15	Nov	2
Mar	11	Jun	30	Nov	14	Mar	26	Jul	11	Nov	30
Apr	7	Jul	27	Dec	11	Apr	23	Aug	8	Dec	26
		Aug	24					Sep	6		

As a result of its motion around the Earth, the Moon appears to make a complete circuit of the heavens in just under a month. It occasionally passes in front of bright stars (details given in Occultation section - page 43) and close to visible planets (details given in Changing Night Sky section - page 4)

TIMES OF MOONRISE AND MOONSET

Times for Cape Town, Johannesburg and Durban are given on pages 16 to 21. Times for other places in Southern Africa can be roughly estimated from the predictions for these three stations.

LUNAR ECLIPSES

During 1975 there will be two total lunar eclipses but the first, on May 25, will not be visible from Southern Africa. The second, on November 18/19, will be visible and details are as follows:

Moon enters umbra	Nov $18^{d}22^{h}38^{m},6$	(at 58^{o} East of North point)
Total eclipse begins	19 00 02,6	
Middle of eclipse	19 00 23,4	
Total eclipse ends	19 00 44,1	
Moon leaves umbra	19 02 08,2	(at 73^{o} West of North point)

THE SURFACE OF THE MOON

In common with the inner planets of our solar system, the Moon's surface suffered bombardment by numerous minor bodies during the period 4,5 to 3,0 billion years ago. This has produced the heavily cratered topography now visible. Some particularly large impact caused large circular depressions, which were flooded by molten lava from the Moon's interior. These are the maria basins which appear smoother and darker then the rest of the surface (the latin words mare and maria come from older times when they were mistaken for seas). The maria surfaces, being younger have fewer large craters, but the entire surface is peppered with tiny craters produced by tiny bodies which have also served to plough up the ground thus forming the regolith - a layer of loose material a metre or so deep.

MAP OF THE MOON'S NEAR SIDE

LIBRATIONS

Jan 16 Feb 12 Mar 12
Apr 8 May 5 Jun 1/28
Jul 26 Aug 22 Sep 18
Oct 15 Nov 11 Dec 8

Jan 23 Feb 20 Mar 20
Apr 17 May 13 Jun 9
Jul 6 Aug 3/31 Sep 28
Oct 26 Nov 22 Dec 19

Dates of Maximum Exposure of Indicated Limbs

Jan 2/30 Feb 26 Mar 25
Apr 22 May 19 Jun 15
Jul 12 Aug 8 Sep 5
Oct 2/29 Nov 25 Dec 23

Jan 7 Feb 4 Mar 4
Apr 1/29 May 27 Jun 23
Jul 19 Aug 15 Sep 12
Oct 11 Nov 8 Dec 6

CAPE TOWN — TIMES OF MOONRISE AND MOONSET

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

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

Predictions supplied by H. M. Nautical Almanac Office (British Science Research Council)

DURBAN — TIMES OF MOONRISE AND MOONSET

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

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

Predictions supplied by H. M. Nautical Almanac Office (British Science Research Council)

JOHANNESBURG — TIMES OF

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

MOONRISE AND MOONSET

APRIL		MAY		JUNE	
RISE	SET	RISE	SET	RISE	SET
H M	H M	H M	H M	H M	H M
22 11	11 16	22 44	11 32	.. ..	11 57
23 06	12 08	23 37	12 13	00 02	12 20
.. ..	12 55	.. ..	12 50	00 53	13 02
00 00	13 38	00 29	13 25	01 43	13 36
00 53	14 16	01 20	13 58	02 35	14 11
01 45	14 52	02 10	14 30	03 29	14 50
02 36	15 26	03 01	15 03	04 25	15 33
03 27	15 58	03 52	15 38	05 22	16 21
04 17	16 31	04 45	16 15	06 19	17 14
05 08	17 04	05 40	16 55	07 16	18 12
06 00	17 39	06 36	17 40	08 10	19 14
06 53	18 17	07 33	18 30	09 01	20 17
07 48	18 58	08 30	19 24	09 47	21 20
08 44	19 44	09 24	20 22	10 31	22 23
09 40	20 35	10 16	21 23	11 12	23 25
10 35	21 29	11 04	22 25	11 52	.. ..
11 28	22 28	11 49	23 27	12 32	00 26
12 18	23 29	12 31	.. ..	13 14	01 28
13 05	.. ..	13 11	00 29	13 57	02 30
13 50	00 31	13 51	01 31	14 44	03 32
14 32	01 34	14 32	02 33	15 35	04 32
15 13	02 37	15 16	03 36	16 28	05 31
15 55	03 41	16 02	04 39	17 24	06 26
16 38	04 46	16 51	05 42	18 20	07 17
17 24	05 51	17 44	06 44	19 16	08 02
18 12	06 56	18 39	07 42	20 10	08 43
19 04	08 00	19 36	08 36	21 03	09 21
19 58	09 00	20 32	09 24	21 54	09 56
20 54	09 56	21 27	10 08	22 44	10 29
21 49	10 47	22 20	10 47	23 35	11 01
		23 12	11 23		

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

Predictions supplied by H. M. Nautical Almanac Office (British Science Research Council)

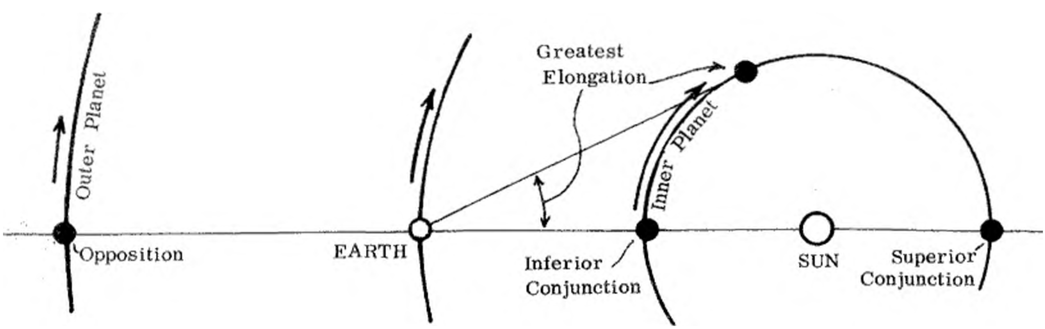
THE PLANETS 1975

BASIC DATA

	Dist from Sun 10^6 km	Period of Revolution years	Mass (Earth = 1)	Diameter 10^3 km	Rotation Period	Inclination of Equator to Orbit
Mercury	58	0,24	0,056	4,98	59d	?
Venus	108	0,62	0,817	12,4	244	?
Earth	150	1,00	1,000	12,8	$23^h 56^m$	$23^o 27'$
Mars	228	1.88	0,108	6,76	24 37	23 59
Jupiter	778	11,9	318,0	142,7	09 51	03 04
Saturn	1426	29,5	95,2	120,8	10 14	26 44
Uranus	2868	84,0	14,6	47,1	10 49	97 53
Neptune	4494	164,8	17,3	44,6	14 ?	28 48
Pluto	5896	247,6	0,9?	?	6d?	?

GENERAL

Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Unlike the distant stars, their relative positions do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the starry background are complicated as they result from a combination of their own motion and the Earth's motion. Their brightnesses also vary considerably, as both their distances from the Earth and the visible portions of their sunlit hemispheres change. Since the period of a planet increases with increasing distance from the Sun, so we find that the inner planets - Mercury and Venus - appear to "overtake" the Earth in their orbits, while the Earth in turn "overtakes" the outer planets - Mars, Jupiter and Saturn. The terms given in astronomy to the various Sun-Earth-Planet configurations are illustrated in the accompanying diagram. Dates of such configurations occurring in 1974 are listed chronologically in the Changing Night Sky Section (page 4) and are also mentioned in the text below.



VISIBILITY AND IDENTIFICATION

To determine whether a particular planet is visible, the diagram for times of rising and setting (pages 24 and 25) should be consulted. Quite often the time of rising or setting is sufficient to identify a planet, but the sky maps (pages 5 to 10) can also be used. Where the information given in those maps is still considered insufficient, further finding aids are provided in the information for individual planets below. Planets can often be distinguished from stars as, due to their greater angular diameters, they do not twinkle.

OBSERVING THE PLANETS

To the naked eye, planets appear as virtually pinpoint sources of light. However, their disks can be readily resolved with the aid of a small telescope. Even so, their angular diameters are of the order of 10 seconds of arc - roughly 1/200 of the Moon's angular diameter - so it is not always possible to distinguish details on their disks. The disks of Mercury and Venus are only seen fully illuminated when they are furthest from us - as they draw closer, their disks grow larger but the phase changes to a crescent as we see more of their dark hemispheres. In contrast, the disks of the outer planets are always seen fully or near fully illuminated.

MERCURY

The innermost planet, Mercury, revolves around the Sun faster than any other planets. To the Earth it appears to make slightly more than three complete circuits in 1975:

Greatest Eastern Elongation	Jan 23 (19°)	May 17 (22°)	Sept 14 (27°)
Inferior Conjunction	Feb 8	Jun 10	Oct 9
Greatest Western Elongation	Mar 6 (27°)	Jul 4 (22°)	Oct 25 (18°)
Superior Conjunction	Apr 18	Aug 1	Nov [illegible]

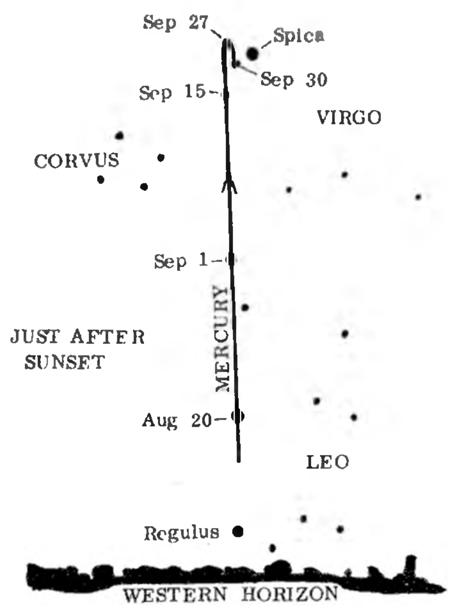
As the diagram for rising and setting times (pages 24 and 25) shows, Mercury is difficult to observe - due to its close proximity to the Sun. The best early evening period is near the September Eastern Elongation and a finding diagram is provided here.

Mercury appears to pass close to other planets and bright stars as follows:

Near Jupiter:	Apr 6	($1^{\circ}.0$S)*
Near Aldebaran:	May 11	(8°N)
Near Regulus:	Aug 11	($1^{\circ}.2$N)
Near Venus:	Aug 16	(9°N)
Near Spica:	Sep 24	($1^{\circ}.8$S)
	Sep 29	($1^{\circ}.8$S)

(* indicates visible only in morning sky)

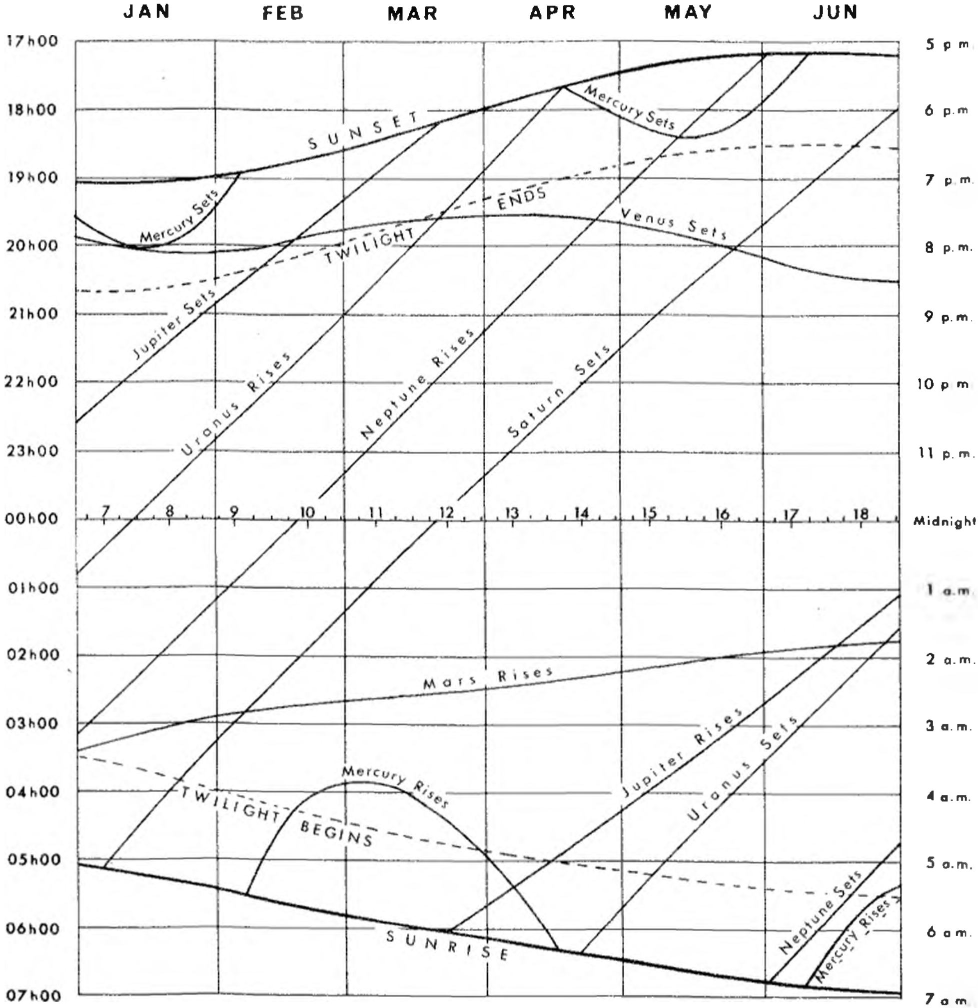
The angular diameter of Mercury's disk rarely exceeds 10 seconds of arc so it is difficult to make out any features on the disk. Close up photography by the Mariner 10 spacecraft has shown that the planets surface is incredibly similar to that of the Moon.



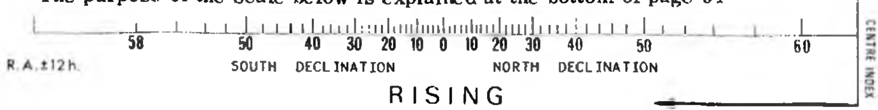
(will be higher than shown here as both time of evening and date progress)

TIMES OF RISING AND SETTING

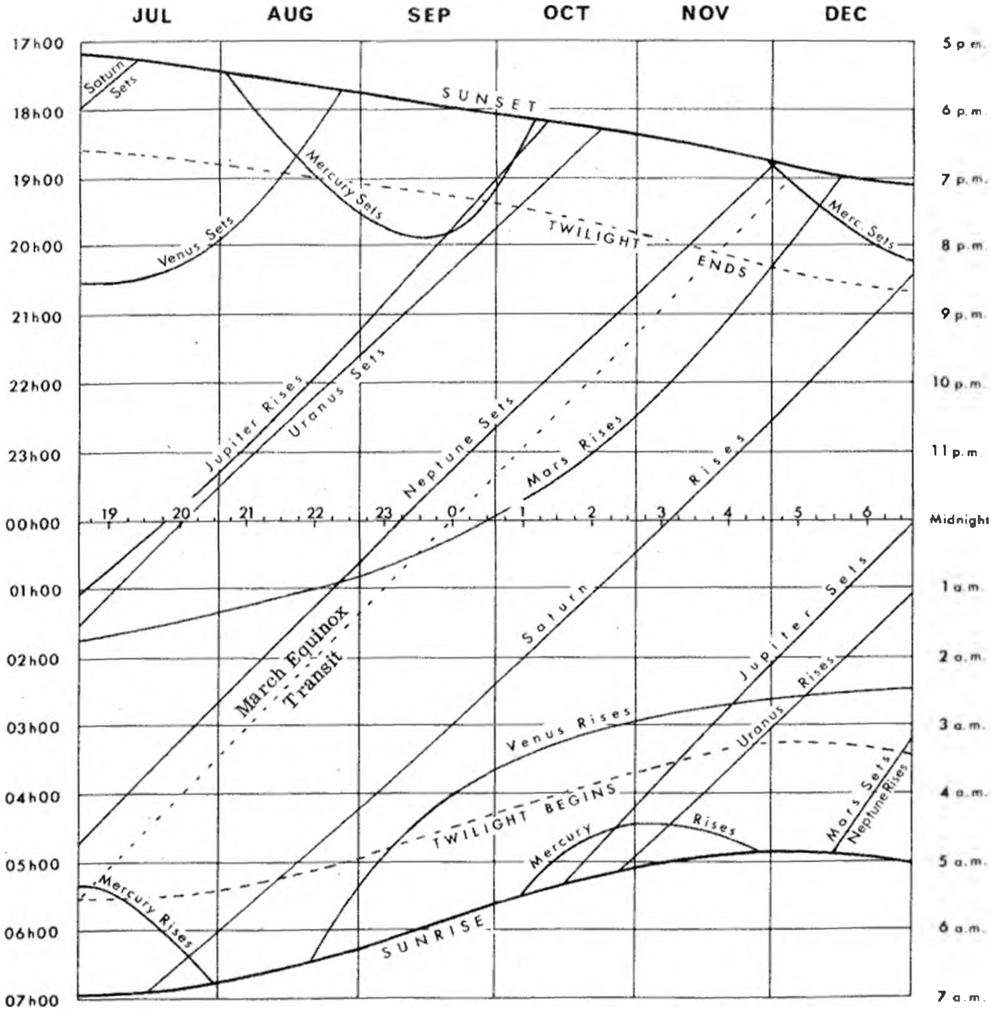
To find the times of rising and setting of the planets for any particular night of the year, place a ruler (or suitable edge) vertically on the diagram according to the date given by the horizontal scale. The intersection of the ruler with the lines of rising and setting then give the appropriate times which can be read off against the vertical scale (24 hour clock on the left hand side, or conventional 12 hour clock on the right hand side).



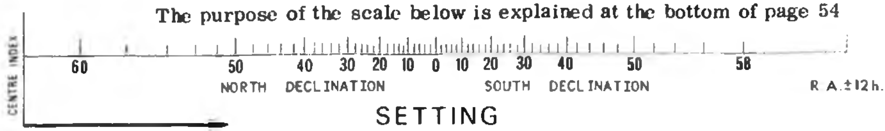
The purpose of the scale below is explained at the bottom of page 54



The times of rising and setting given by this diagram are accurate for position 30° East, 30° South, and approximately correct for other places in Southern Africa. Strictly speaking, corrections for latitude and longitude should be applied, but the latitude correction is, in general, sufficiently small to be ignored and in no case will exceed 15 minutes. Longitude corrections are given on page 55.

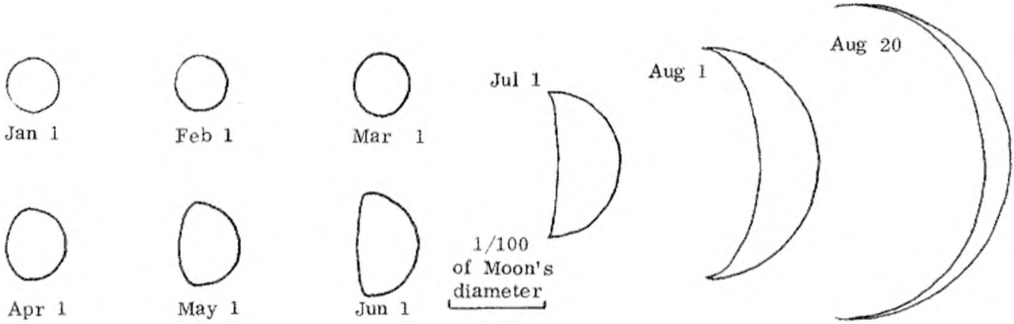


The purpose of the scale below is explained at the bottom of page 54



VENUS

Over the period January to August, Venus is the most prominent object (aside from the Moon) in the early evening sky. During January to mid March, it is accompanied by Jupiter and the two make a spectacular pair as they pass within $0^{\circ}{,}2$ on the evening of February 17. Venus reaches greatest elongation on June 18 and greatest brilliancy (magnitude -4, 2) on July 22. With the aid of a small telescope, its apparent diameter is seen to grow and its phase to change as its distance to the Earth diminishes - see diagram below. The opaque clouds of Venus' atmosphere cause the sunlit portion of the disk to appear brilliant white. Ultra violet photography, particularly that from the Mariner 10 spacecraft, have revealed cloud structure, but the actual surface is still to be seen.



On August 27, Venus passes between the Earth and the Sun (Inferior Conjunction) and thereafter appears in morning sky (Greatest brilliancy on Oct 3, greatest elongation on Nov 7).

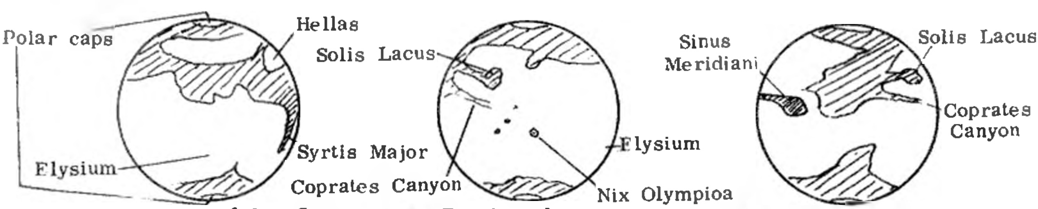
Venus appears to pass close to other planets and bright stars as follows:

Near Jupiter:	Feb 17 ($0^{\circ}.2$S)		
Near Aldebaran:	Apr 22 (7°N)		
Near Saturn:	May 24 (3°N)		
Near Pollux:	May 31 (4°S)		
Near Regulus:	Jul 9 ($0^{\circ}.4$S)	Oct	6 (4°S)
Near Mercury:	Aug 15 (9°S)		
Near Spica:	Nov 29 (5°N)*		

(* indicates visible only in the morning sky)

MARS

Mars is "hidden" away in the morning sky for most of the year. Only in December does it rise early enough to be seen in the evening sky. It becomes a very conspicuous object in the night sky as the Earth draws past it. The two planets are closest on December 9 and opposition is on December 15. Its brightness (magnitude -1, 5) and its characteristic reddish colour should make identification easy.



Evening of Dec 5 ——→ Evening of Dec 15 ——→ Evening of Dec 25

(Mar's period of rotation is only slightly greater than the Earths - the hemisphere visible each evening changes slowly as indicated)

It is worthwhile waiting to near opposition before attempting telescope observations. Even then, the angular diameter is only of the order of 15 seconds of arc (as Mars is a small planet and this opposition is not favourable). With a good instrument and good seeing conditions it may be possible to glimpse the features indicated in the diagram. Spacecraft observations reveal that much of Mars is heavily cratered - like the Moon and Mercury - while lava from conical volcanos has also covered a portion of the surface. Much loose sand is blown by the thin but ferocious Martian winds. In common with the Earth's desert scenery, it has sand dunes and dry river beds. A canyon on Mars completely dwarfs Earth's Grand Canyon. No water is visible at present and may lie under the surface - the polar caps are believed to be thin layers of solid carbon dioxide.

Mars appears to pass close to other planets and bright stars as follows:

Near Jupiter:	Jun 16 ($0^\circ.5$S)	both only visible in morning sky
Near Aldebaran:	Sep 1 (4°N)	

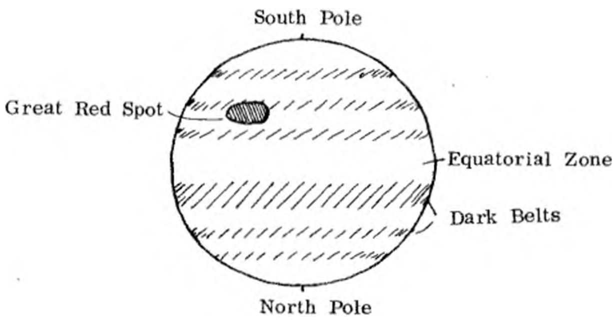
JUPITER

In January and February Jupiter will accompany Venus in the early evening sky. The two planets will make a spectacular pair as they pass closest to one another on the evening of Feb. 17. Thereafter Jupiter will draw too near to the Sun for observation. After it passes round the far side of the Sun (relative to the Earth) on Mar. 22 it reappears in the morning sky. As the year progresses, it rises earlier and earlier to become a conspicuous evening object in the latter part of the year. It is at its brightest (magnitude -2, 5) at opposition on October 13.

Other planets pass close to Jupiter as follows:

Venus:	Feb 17 ($0^\circ.2$S)
Mercury:	Apr 6 ($1^\circ.0$S)*
Mars:	Jun 16 ($0^\circ.5$S)*

(* indicates visible only in morning sky)



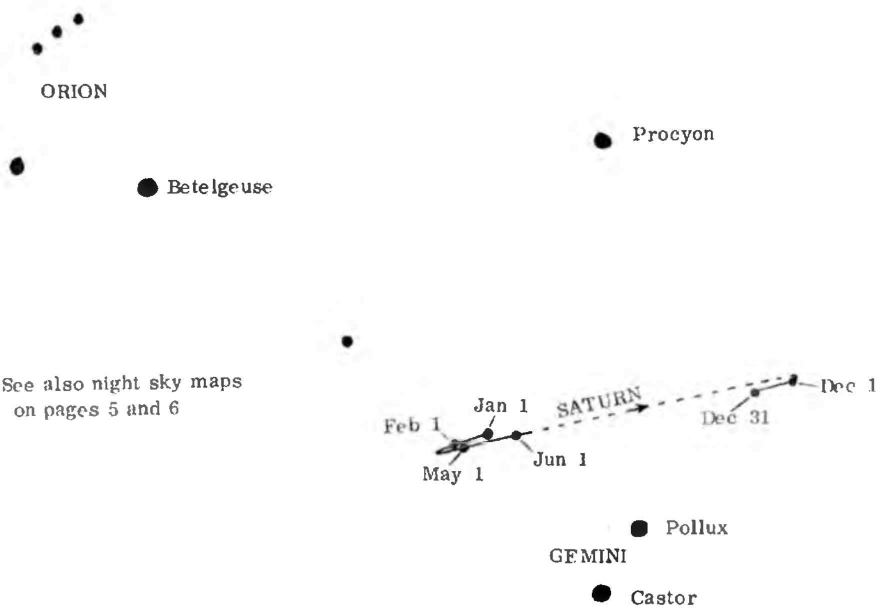
Jupiter makes an excellent object for a small telescope. It is often possible to see features on the disk: dark and light cloud bands, running parallel to the equator, and spots, in particular the famous Great Red Spot. These are indicated in the diagram above. The Great Red Spot is not always visible because of the rotation of the planet.

Jupiter is composed chiefly of hydrogen and helium and it doubtful that the planet possesses any solid surface. Had it had more mass, nuclear energy generation would have started in the core and it would have become a small star - as it is, it is found to radiate more energy than it receives from the Sun so the interior is probably hot and slow convective motions in the outer liquid or near liquid layers probably account for the observed changes seen on the disk.

Jupiter possesses thirteen moons (the thirteenth was discovered in 1974), four of which are large and are clearly seen accompanying the planet. A section dealing with their observation is given on page 32.

SATURN

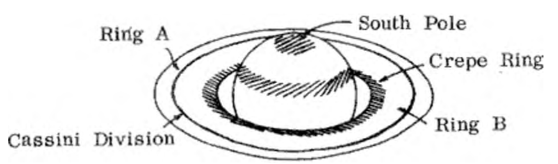
For the first half of the year, Saturn is visible in the evening sky (opposition on January 6); for the second half it is visible in the morning sky. As the map shows, it is to be found in the sky in the neighbourhood of Castor and Pollux, the twins of Gemini.



See also night sky maps on pages 5 and 6

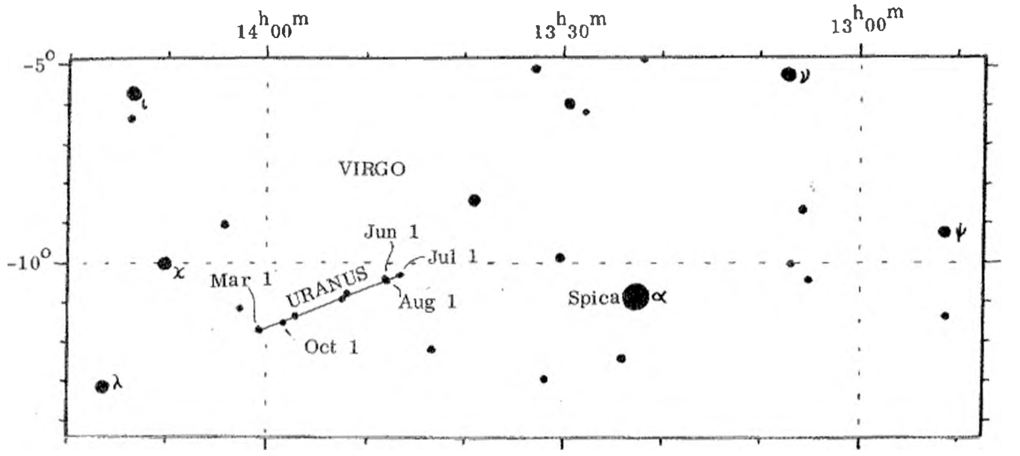
Venus passes 3° north of Saturn on May 24.

The famous rings of Saturn can be distinguished with the aid of a small telescope - their angular diameter is about 45 seconds of arc. As the diagram shows, they are presently tilted so that the north pole of Saturn is just hidden. Saturn possesses ten moons; details for observing some of them are given on page 36.



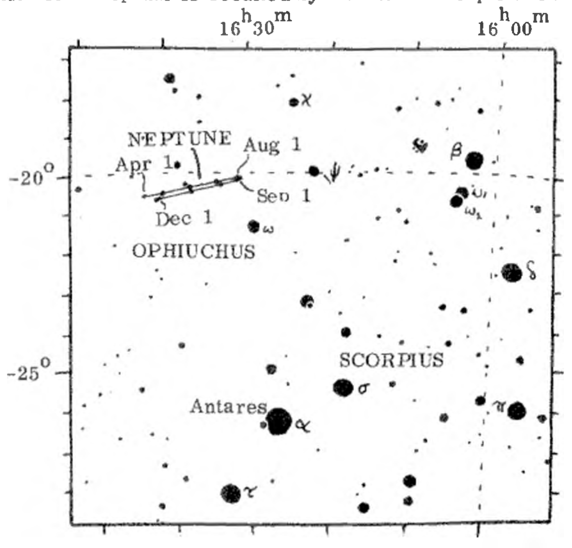
URANUS

Uranus, at opposition on April 21, lies in the constellation of Virgo, near the bright star Spica (shown on the night sky maps, pages 6 to 8). It is on the borderline of naked eye visibility (magnitude 5,7) and may be found with the aid of binoculars and reference to the accompanying finding chart, which shows all stars in the region down to the same faintness. With a small telescope, its disk (angular diameter 4 seconds of arc) may just be distinguished.



NEPTUNE

Neptune lies in the constellation of Ophiuchus very close to the conspicuous constellation of Scorpius. It is far too faint to be seen with the naked eye - magnitude 7,7 at opposition on June 1 - but may be located using the finding chart below (which shows all stars down to magnitude 7,7) and a small telescope. Its angular diameter is only 2,5 seconds of arc, but its non-stellar appearance should aid in identification. Neptune is occulted by the Moon on September 11 (see page 47).



PLUTO

Pluto lies in the Virgo/Coma region (at approximately R.A. = 12^h55^m, Decl. = $+13^o$). Since it is very faint (14th magnitude), it can only be found using a large telescope and specially prepared finding charts.

COMETS AND METEORS

COMETS

Comets are celestial bodies moving around the sun, mostly in very elongated orbits. The typical comet consists of a nucleus surrounded by a hazy aura of gas and dust called the coma, and in many cases there is a tail stretching away from the sun. Faint comets, several of which are discovered each year, usually appear only as fuzzy patches without nucleus or tail.

Comets are the most mysterious and capricious of solar system objects and the nature of the physical changes which they exhibit is still not fully understood.

Observers with quite modest equipment (say a refracting telescope of not less than 7.5 cm) can do useful work by following known comets and reporting on their appearance. The ability to make accurate brightness estimates is especially useful and well worth cultivating.

Sweeping the sky for new comets, though requiring considerable patience and tenacity, is also well within the scope of the equipment mentioned.

Interested persons should contact the Director of the Comet and Meteor Section at 90 Malan Street, Riviera, Pretoria 0002.

METEORS

Meteors, or shooting stars, (resulting from small bodies entering the Earth's upper atmosphere) are generally seen in greater abundance after midnight (due to the direction of the Earth's motion) than in the early evening. There are two categories of meteors - the sporadic ones, and the showers. A meteor shower comes from a certain direction in space (the Radiant) and is thought to be associated with the remains of a comet. When the Earth passes close to the comet's original orbit, a shower can be expected. A list of these predicted showers is given in the table opposite.

Editor's note: Mr. J.C. Bennett, the Director of the Comet and Meteor Section, who contributed this section, is to be congratulated on discovering his second comet just as this handbook goes to press!

PREDICTED METEOR SHOWERS

Date	Shower	Radiant R.A.	Radiant Dec.	Maximum Date	Hourly Rate	Transit Radiant (approx)	Recommended Time of Watch	Conditions at Maximum
		h m	°			h m		
Mar 14 - Mar 18	Corona Australids	16 20	-48	Mar 16	5	04 45	02h30m - dawn	Favourable
Mar 12 - Apr 25	Hydraids	12 16	-27	Mar 25	?	00 10	22h - 02h	Unfavourable
Apr 19 - Apr 24	April Lyrids	18 08	+32	Apr 22	15	04 15	03h - dawn	Favourable
May 1 - May 8	Eta Aquarids	22 24	00	May 5	18	07 30	03h - dawn	Unfavourable
Apr 20 - July 30	Sco-Sgr System	18 00	-30	Jun 14	?	00 30	23h - 02h	Favourable
Jun 10 - Jun 21	June Lyrids	18 32	+35	Jun 16	8	01 00	00h - 03h	Favourable
Jun 17 - Jun 26	Ophiuchids	17 20	-20	Jun 20	8	23 30	21h -02h	Unfavourable
Jul 10 - Aug 5	Capricornids	21 00	-15	Jul 25	8	00 50	23h -02h	Unfavourable
Jul 15 - Aug 15	Delta Aquarids	22 36	-17 00	Jul 27	35	02 10	00h -04h	Unfavourable
Jul 15 - Aug 20	Pisces Australids	22 40	-30	Jul 30	11	02 10	00h -04h	Unfavourable
Jul 15 - Aug 25	Alpha Capricornids	20 36	-10	Aug 2	10	00 00	20h -24h	Favourable
Jul 15 - Aug 24	Iota Aquarids	22 04 22 32	- 6 -15	Aug 6	12	01 20 01 30	00h -03h	Favourable
Oct 16 - Oct 27	Orionids	06 24	+15	Oct 21	35	04 30	02h -dawn	Unfavourable
Oct 10 - Dec 5	Taurids	03 44 03 44	+14 +21	Nov 8	16	00 50 00 50	00h -03h	Favourable
Nov 14 - Nov 20	Leonids	10 08	+22	Nov 17	10	06 30	02h -dawn	Unfavourable
Dec 5	Phoenicids	01 00	-55	Dec 5	?	20 10	21h -23h	Favourable
Dec 7 - Dec 15	Geminids	07 28	+32	Dec 14	55	02 00	02h -dawn	Favourable
Dec 5 - Jan 7	Velaids	09 56	-51	Dec 29	?	03 30	23h -02h	Favourable

THE MOONS OF JUPITER AND SATURN 1975

JUPITER'S MOONS

One of the most popular sights for an observer with a small telescope is Jupiter and its moons. Four of Jupiter's thirteen moons are large enough to be seen very easily - they would even be visible to the naked eye were it not for the glare of the mother planet. In order of increasing distance from Jupiter, the four moons are Io, which orbits once around Jupiter in less than 2 days; Europa, $3\frac{1}{2}$ days; Ganymede, 7 days; and Callisto which takes 17 days for a full circuit. All the orbits lie in Jupiter's equatorial plane and the system is seen almost edge on. As the moons circle Jupiter, they appear to oscillate from side to side alternatively passing in front of and behind the planet. Their configurations change from night to night and are shown in the diagrams on pages 34 and 35.

EVENTS RELATED TO THE MOONS PASSING IN FRONT OF AND BEHIND JUPITER

The table below lists all events occurring between the end of twilight and just after midnight when the planet is above the horizon in Southern Africa.

Explanation of table:

Date and predicted times are given - these are for mid-phenomena and are not instantaneous.

The moons concerned are I - Io, II - Europa, III - Ganymede, IV - Callisto

Phenomena - the abbreviations used are:

Ec.	-	Eclipse: the satellite passes through the shadow of Jupiter	D -	Disappearance
Oc.	-	Occultation: the satellite is obscured by the disk of Jupiter	R -	Reappearance
Tr.	-	Transit: the satellite crosses the disk of Jupiter	I -	Ingress
Sh.	-	Shadow transit: the shadow of the satellite transits the disk	E -	Egress

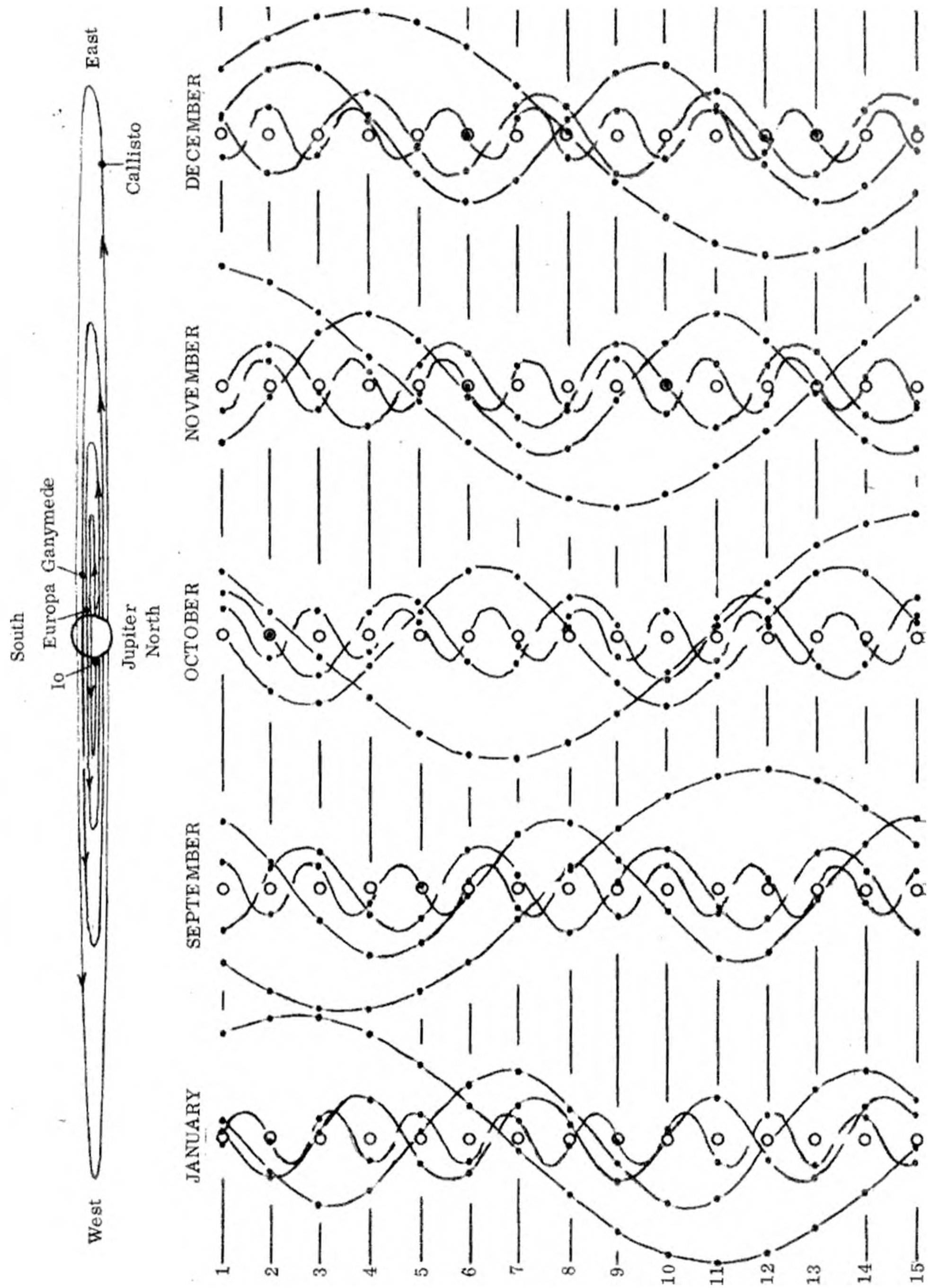
		h	m		
Jan	1	21	04	I	Oc D
	2	20	38	I	Tr E
		21	48	I	Sh E
	9	21	29	I	Sh I
	10	21	14	II	Oc D
	12	20	36	II	Sh E
	16	21	22	III	Sh E
	19	20	28	II	Sh I
		21	16	II	Tr E
	24	20	58	IV	Sh I
	25	21	10	I	Tr E
	26	21	16	II	Tr I
	28	20	56	II	Ec R
Feb	1	20	56	I	Tr I
	9	20	07	I	Oc D

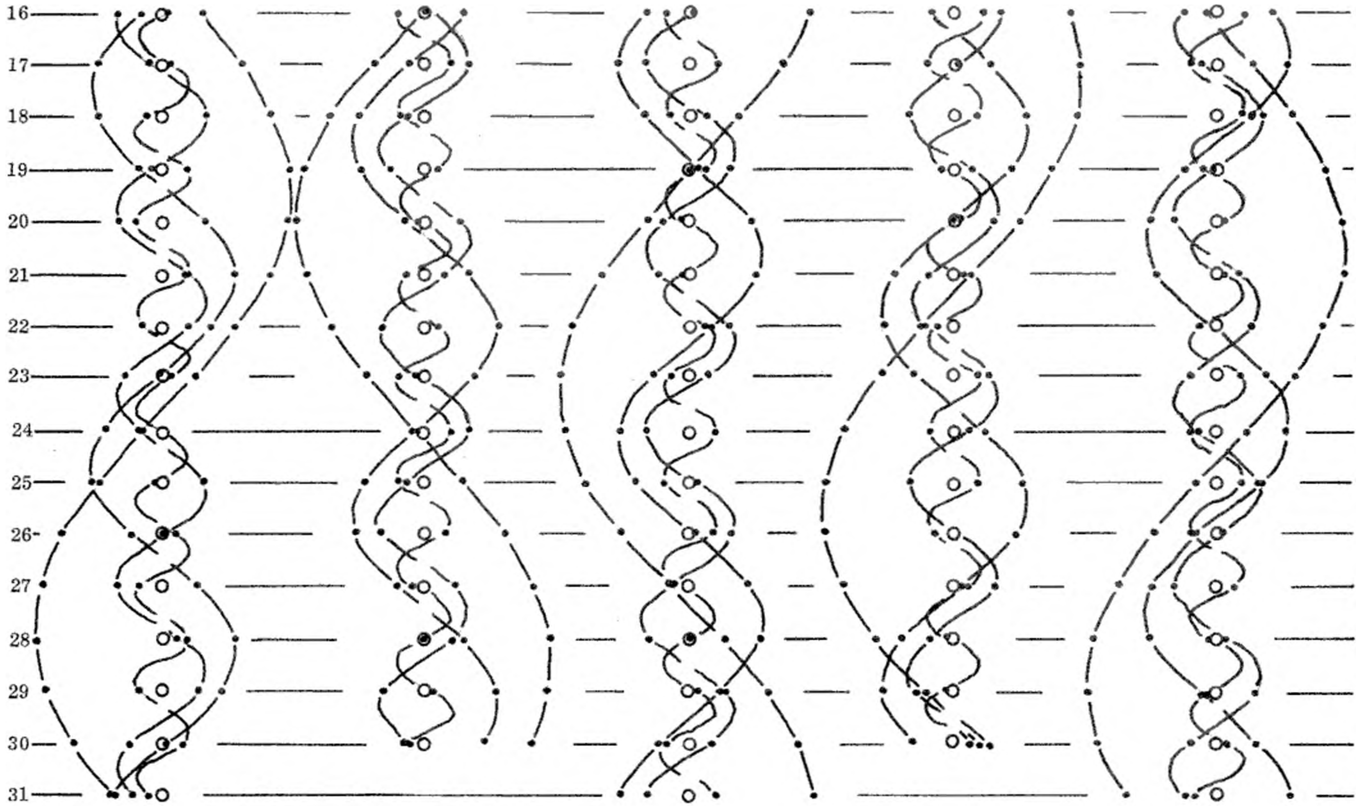
		h	m		
July	21	24	23	II	Ec R
		24	30	II	Oc D
	27	24	12	I	Ec D
	28	23	36	I	Sh E
		24	17	II	Ec D
		24	55	I	Tr E
	30	24	34	II	Tr E
Aug	1	23	38	III	Ec R
	4	23	19	I	Sh I
		24	38	I	Tr I
	5	24	07	I	Oc R
	6	24	29	II	Tr I
		24	29	II	Sh E
	8	24	56	III	Ec D
	13	23	04	I	Tr E
		24	23	II	Sh I

		h	m		
Aug	15	23	47	II	Oc R
	19	23	55	III	Tr I
		24	23	I	Ec D
	20	22	45	I	Tr I
		23	45	I	Sh E
		24	53	I	Tr E
	21	22	14	I	Oc R
	26	22	55	III	Sh I
	27	23	28	I	Sh I
		24	32	I	Tr I
	28	24	01	I	Oc R
	29	23	53	II	Ec D
	31	21	38	II	Sh E
		23	35	II	Tr E
Sept	4	22	41	I	Ec D

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

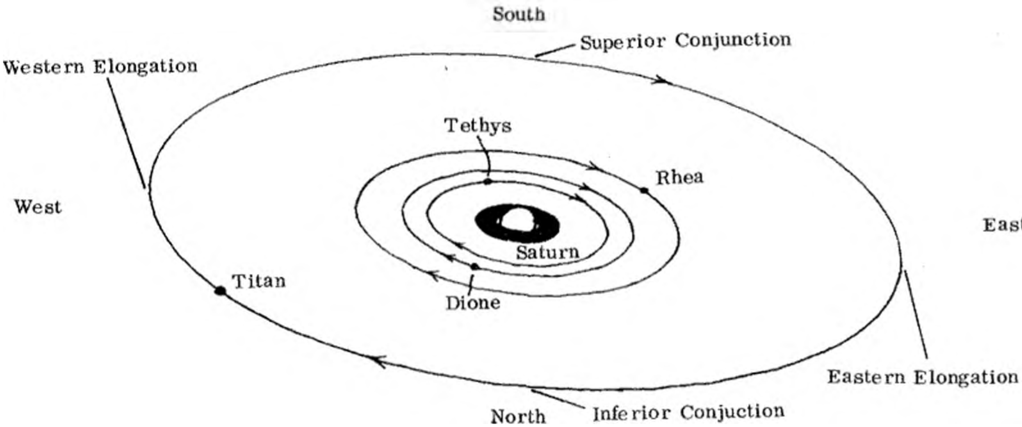
CHANGING CONFIGURATIONS OF JUPITER'S MOONS





The diagram at the top shows the orbits of the four bright moons of Jupiter (as seen from the Earth) and their positions at 9 p.m. on the evening of January 1, 1975. Io is about to pass behind the planet, Europa in front. Ganymede is seen slightly to the east (but will also pass in front several hours later). Callisto is well to the east nearing its greatest apparent separation from the planet. The 150 or so small diagrams are miniature versions of the main diagram. They show the configurations at 9 p.m. on all evenings when Jupiter is clearly visible. The columns cover the months given, the horizon lines give the day of the month. The wavy lines interpolate the apparent movement of the moons between successive diagrams.

SATURN'S MOONS



Saturn's moons are considerably fainter than the four Galilean moons of Jupiter. The diagram shows the orbits of four of Saturn's ten moons. The easiest to find is Titan (magnitude 8,5), according to the diagram and the information in the table below (which covers the period when Saturn is clearly visible in the evening sky).

TITAN

Eastern Elongation	Inferior Conjunction	Western Elongation	Superior Conjunction
		Jan 4	Jan 7
Jan 12	Jan 16	Jan 19	Jan 23
Jan 28	Feb 1	Feb 4	Feb 8
Feb 12	Feb 16	Feb 20	Feb 24
Feb 28	Mar 4	Mar 8	Mar 12
Mar 16	Mar 20	Mar 24	Mar 28
Apr 1	Apr 5	Apr 9	Apr 13
Apr 17	Apr 21	Apr 25	Apr 29
Nov 27	Dec 1	Dec 5	Dec 9
Dec 13	Dec 17	Dec 21	Dec 25
Dec 29			

THE STARS

CONSTELLATIONS

Apart from our Sun all the stars that we see are so incredibly distant that, despite their high speed velocities, their apparent positions change by only minute amounts each year. Consequently the patterns that they form appear unchanged. The Greeks and other ancient civilisations identified these patterns, or constellations, with various mythological characters and creatures, and most of the names they gave are still used today.

In all there are 88 constellations, roughly one half of which would be above the horizon at any one time. Some contain distinctive patterns of bright stars and are relatively easy to find; others are difficult to locate, even with suitable maps. The Changing Night Sky Section (page 4) gives information for finding some of the best known constellations - those easy to identify. Of those, the Southern Cross and Centaurus, Orion and Taurus, Scorpius and Sagittarius, are featured later in this section. Detailed information on other constellations is beyond the scope of this handbook and interested observers are advised to obtain a suitable star atlas.

STAR NAMES

Within each constellation, the brightest star is generally labelled α (Alpha), the next β (Beta) and so on through the Greek alphabet. Most of the brightest stars also have their own names - usually of arabic origin. For example α Canis Majoris, otherwise known as Sirius, is the brightest star in the constellation Canis Major.

STELLAR MAGNITUDES

The apparent brightness of a star - which depends both on its true luminosity and its distance - is indicated by its magnitude. Equal intervals of magnitude represent equal ratios in light intensity. A star of magnitude 1,0 (typical of the brightest stars in the night sky) would be exactly one hundred times more luminous than a star of magnitude 6,0 (about the limit of visibility to the naked eye). The maps in this section show stars down to magnitude 4,5.

STELLAR DISTANCES

Distances are often expressed in units of light years - the distance light would travel in a year (equal to $9{,}5 \times 10^{12}$ km).

DOUBLE STARS

It now appears that single stars such as our Sun are the exception, the majority of stars being double or multiple - two or more suns in orbit around one another.

STAR CLUSTERS

These are of two completely different sorts. Galactic clusters, having of the order of 100 stars, are found close to the plane of the Milky Way. The ones we can see are relatively nearby. Globular clusters are much larger and far more distant. They contain of the order of 100 000 stars each and are seen above and below the Milky Way on that side of the sky towards the centre of our galaxy. So great is their distance that small telescopes fail to resolve individual stars - instead they appear as fuzzy balls.

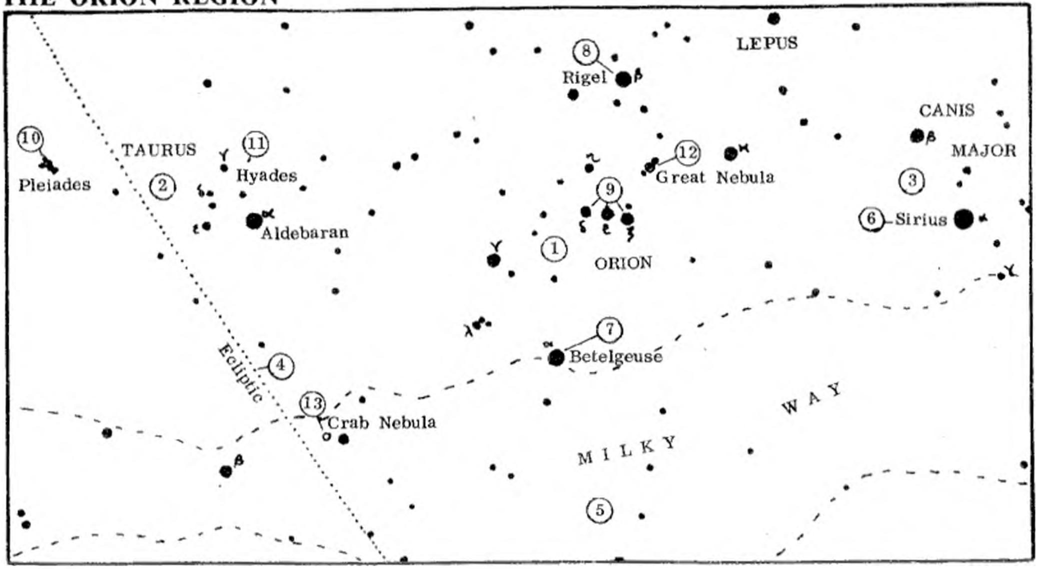
NEBULAE

Possibly one third of the matter in our region of the Galaxy is in the form of gas and dust (the remainder being contained in stars, plus a tiny amount in planets). Condensations of this material are called nebulae, some of which are illuminated by nearby stars while others are dark. They are usually referred to by their numbers in Messier's catalogue (M) or the New General Catalogue (NGC).

THREE POPULAR REGIONS

The dominating constellation of the summer skies is Orion, that of the winter skies is Scorpius, while the Southern Cross is conspicuous for most of the year. They can be found with the aid of the maps in the Changing Night Sky section (pages 4 to 8). The regions around these constellations are also rich in interesting objects - visible either to the naked eye, or with the aid of binoculars or a small telescope - and are featured in the maps and text below. It may be necessary to rotate the maps to match the orientation of the constellations in the sky.

THE ORION REGION



(1) The constellation of Orion. The figure of the legendary hunter of Greek mythology is unfortunately upside down when seen from Southern Africa. The faint stars by λ represent the head, α and γ the shoulders, δ - ε - η the belt, and β and κ the legs. Orion forms part of the "great hunting scene" in which he faces the onslaught of (2) Taurus, the bull. Only the forepart of the bull is depicted and, like Orion, it is upside down. α and ε are the eyes, γ the nose. Orion is accompanied by (3) Canis major, the large dog, and the small dog (off map) while Lepus, the hare, crouches at his feet.

(4) A section of the Ecliptic - a line encircling the entire sky and representing the plane of the Earth's orbit. As the Earth revolves around the Sun, the Sun appears to move along the ecliptic through the constellations of the Zodiac, of which Taurus is one.

(5) A portion of the Milky Way (looking out towards the edge of our Galaxy).

(6) Sirius - the brightest star in the night sky. It is somewhat brighter than our Sun and relatively close by - at a distance of 9 light years. It is a double star but the companion is a white dwarf (only slightly larger than the Earth, and with a mass comparable to our Sun) and is only visible through a large telescope.

(7) Betelgeuse - most famous of the red giant stars. Its diameter is of the order of the size of the Earth's orbit and its luminosity is nearly 10 000 times that of our Sun. Its red colour should be obvious to the eye. It is 520 light years distant.

(8) Rigel, despite being physically smaller than Betelgeuse, is more luminous (higher surface temperature - bluish colour) and more distant.

(9) The stars in Orion's belt are distant hot blue stars.

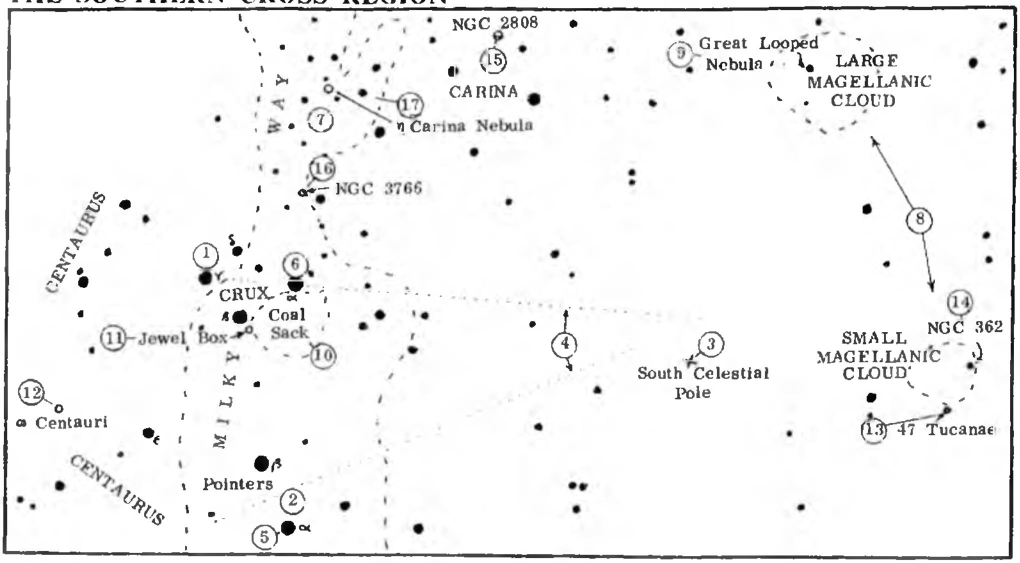
(10) The Pleiades or Seven Sisters form the best known nearby star cluster. Six or seven stars are visible to the naked eye, binoculars or a small telescope show more.

(11) The Hyades is another nearby galactic cluster, but Aldebaran is not a member (it lies closer to us).

(12) The Great Nebula in Orion, just visible to the naked eye, shows up as a fan shaped mass of luminous gas through binoculars or a telescope. A telescope will also show a tiny "Trapezium" of four stars in the centre.

(13) The Crab Nebula, the remnant of a supernova recorded by the Chinese in 1054, requires a moderate sized telescope for observation. In its heart is located the extraodinary pulsar which emits a double flash of light 30 times every second. The current belief is that it is a rapidly rotating neutron star - a star with the mass of our sun but with a diameter of only 10 km.

THE SOUTHERN CROSS REGION



(1) Crux, the Southern Cross, is one of the most compact patterns of bright stars to be found in the sky. It lies on the border of that region of the sky which never sets as seen from Southern Africa.

(2) The two "Pointer" stars lie close to the Cross. (A similar pattern to the Southern Cross - called the False Cross - lies just outside and above the map, but has no accompanying pointer stars).

(3) The South Celestial Pole: This is one of two opposite points in space towards which the Earth's axis of rotation is directed. As the Earth rotates so the sky appears to pivot about this point. It always lies above the south point on the horizon, elevated by an angle equal to the observer's southern latitude. (The north celestial pole lies below the northern horizon and can never be seen from the Earth's southern hemisphere)

(4) The intersection of a line extended through the major axis of the Cross and the perpendicular bisector to the Pointers indicates the approximate position of the South Celestial Pole.

(5) α Centauri has the distinction of being the closest star to our solar system - at a distance of approximately 40 million million km or 4,3 light years. A small telescope readily shows that it is a double star - the two components take 80 years to revolve about one another. A much fainter third star also belongs to the system.

(6) α Crucis can also be resolved as a double star by a small telescope (separation 5 sec of arc).

(7) The region indicated is one of the brightest sections of the entire Milky Way.

(8) The Large and Small Magellanic Clouds are the nearest of the external galaxies (see also next section). They can be seen with the naked eye provided the sky is reasonably dark.

(9) The Great Looped Nebula - possibly the remnant of a supernova explosion - in the Large Magellanic Cloud. (Naked eye or binoculars).

(10) The "Coal Sack" - a dark mass of gas and dust obscuring a part of the Milky Way. (Naked eye or binoculars).

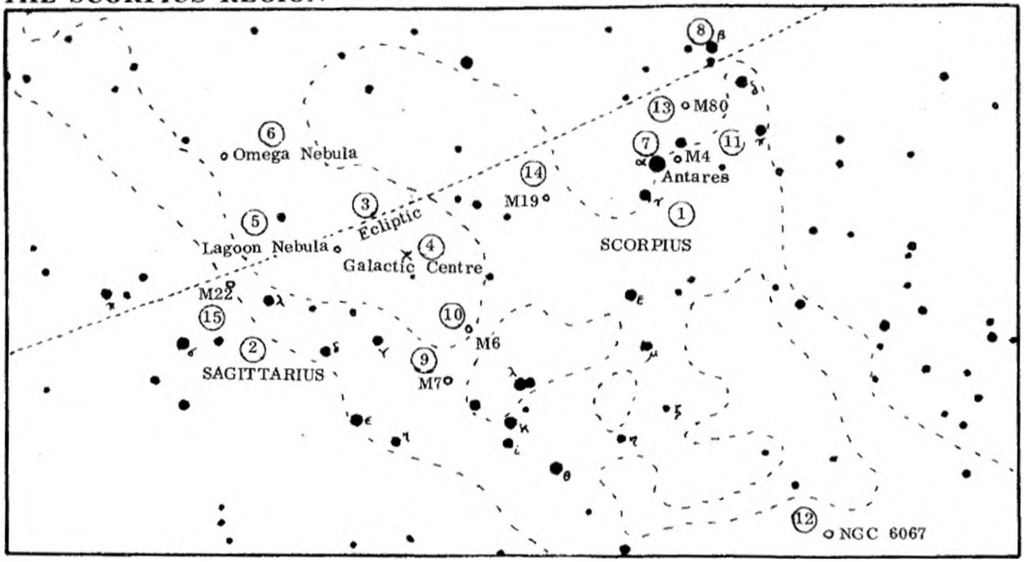
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).

(12) ω Centauri and (13) 47 Tucanae are perhaps the best known globular clusters. Binoculars will show their fuzzy appearance. (14) NGC 362 and (15) NGC 2808 are fainter globular clusters.

(16) NGC 3760 - a fine galactic cluster. (Binoculars or small telescope).

(17) The η Carinae nebula - site of a slow supernova that brightened to magnitude −0,8 in 1843 and is now of magnitude 6,4.

THE SCORPIUS REGION



(1) The constellation of Scorpius. The creature is depicted with α in the centre of the body and β and π the claws. The distinctive tail ε — ζ — θ curls round to the sting λ.

(2) Sagittarius - the figure of the centaur archer is very difficult to make out.

(3) A section of the Ecliptic. Like Taurus, Scorpius and Sagittarius are constellations of the Zodiac.

(4) The direction of the centre of our Galaxy - the Milky Way is that part of our Galaxy visible to us. Unfortunately the central nucleus is obscured by foreground gaseous and dusty matter - both dark and luminous - hence the irregular shape of the Milky Way in this region. Luminous nebulae include (5) the Lagoon nebula and (6) the Omega nebula. These are best seen with the aid of binoculars.

(7) Antares - a distant red giant, several hundred times the diameter of our Sun - is so named because its red colour rivals that of the planet Mars.

(8) β Scorpii can be resolved as a double star (separation 16 sec of arc) with a small telescope. In fact the brighter component is in itself a triple star, and the fainter component a double star.

This region includes a number of galactic clusters including (9) M7, (10) M8, (11) M4 and (12) NGC 6067. (Use binoculars or a small telescope).

Further from the plane of the Milky Way are some globular clusters: (13) M80 (14) M19 and (15) M22.

NOVA SEARCHING

On rare occasions a star may undergo a nova outburst - its brightness increasing tremendously. Even observers having no equipment can perform a useful task in keeping a watch for such novae - in an allocated area of the sky. Interested persons should contact the director of the recently revived Nova Search Section, Mr. J.C. Bennett, 90 Malan Street, Riviera, Pretoria 0002.

VARIABLE STAR OBSERVING

The General Catalogue of Variable Stars lists some 20 000 stars. Professional observatories cannot possibly monitor all of these and the observation of variable stars is a field therefore in which amateurs can make real contributions to astronomical knowledge.

Of the 20 000 stars, at least 2 000 are suitable for monitoring by Southern Hemisphere observers but less than 200 are in fact observed from South Africa and a still smaller number receive adequate attention.

The Variable Star Section of the ASSA exists for the purpose of encouraging observers and of acting as a medium of communication. The Section disseminates incoming information amongst observers and will forward (on request) the observations of individuals to various variable star bodies. These include the American Association of Variable Star Observers and the Variable Star Sections of the British Astronomical Association and Royal Astronomical Society of New Zealand. These bodies combine the South African observers' light estimates with those from other parts of the world. The resulting light curves and tables are sent to a large number of professional observatories where astronomers are interested in investigating certain of the stars more fully.

In addition to the international work, the VSS of the ASSA supplies information direct to certain South African astronomers. It is in a position to warn observatories of sudden changes in certain "VIP" stars before the overseas bodies can do so.

These are variable stars to suit all levels of skill, types of equipment and tastes:

A few stars can be followed throughout their variation by the naked eye but the majority necessitate optical aid.

Some stars vary through a light range of more than 1000 to 1 (8 magnitudes) but others change less than a magnitude.

Flare stars should be observed several times a minute, certain other stars several times a night, some nightly and long period variables only need attention a few times a month.

Variable stars near the pole can be observed during convenient evening hours all the year round but those near the Ecliptic have to be observed at times near the horizon just after sunset or just before sunrise to give maximum coverage

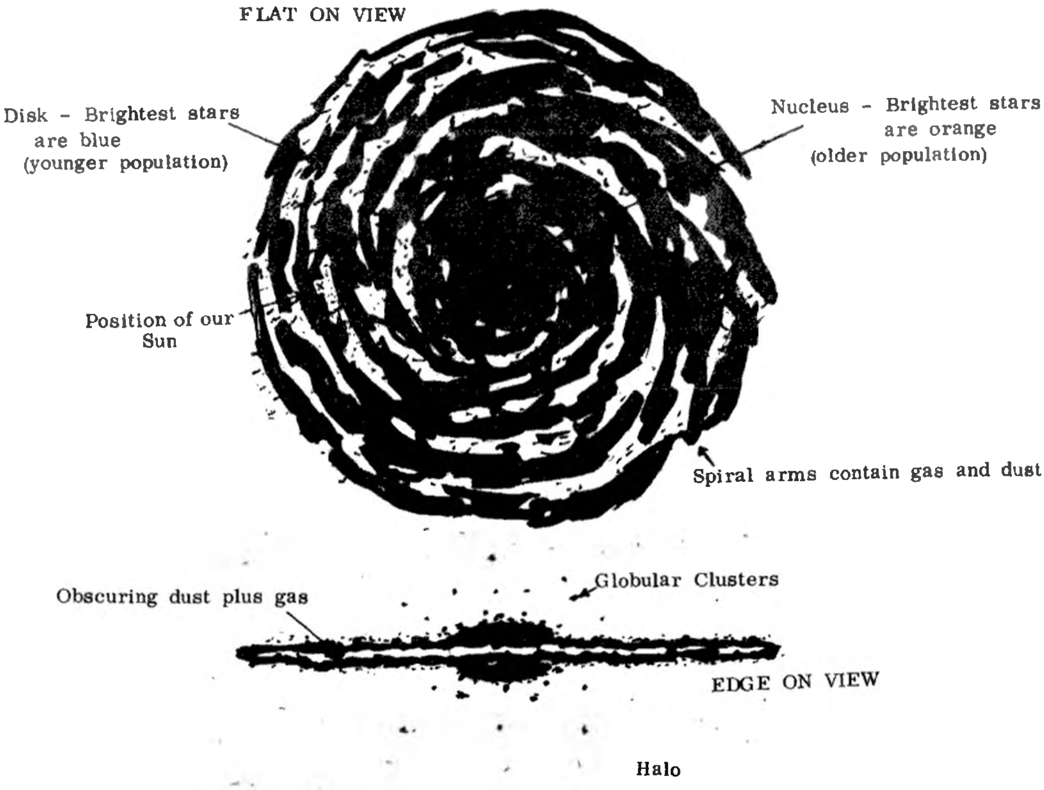
Some stars can be located with great ease but others need a certain amount of skill to identify.

Certain stars are almost completely regular in their variations but others are quite unpredictable.

Amateurs who want to start observing stars in any of the above categories should contact the Director, Mr. M.D. Overbeek, 60 Edward Drive, Glendower, Edenvale, 1610. New observers will be given charts of a few easy objects and (if possible) a certain amount of instruction at the eyepiece. When writing, prospective observers should give brief details of their equipment.

OUR GALAXY AND OTHERS

Our Sun is one amongst some 100 000 million other stars in our disk-shaped galaxy. As the diagram below shows, the Sun is situated towards the edge of the system and apparently orbits around the centre once in about 200 million years. We see the galaxy stretching round us as the Milky Way, but even with optical telescopes we can only see that portion closest to us as the remainder is obscured by dust and gas. However when we look above or below the plane of the Milky Way, we can see an indefinite distance into extragalactic space. Thus we have found the



universe to be populated by millions of other galaxies akin to ours. Our galaxy is a member of a rather poor cluster of galaxies which includes the Magellanic Clouds (our nearest neighbours) and the Great Galaxy in Andromeda (a large spiral that is very similar to our own galaxy). Spectral features in the light of distant galaxies are redshifted. This is usually interpreted as an overall expansion of the universe - the further one looks the faster the galaxies are receding.

ORDINARY OCCULTATIONS

An occultation occurs when the moon passes in front of a star. The disappearance or reappearance of the star is an instantaneous event, or almost so, and is therefore easily timed. Time signals are broadcast continuously through the 24 hours from station ZUO (see page 54) and, radio propagation permitting, occultation timings can be made, either by eye and ear or by stop watch.

The essential record of a occultation observation consists of

- (i) Date and observed time of the event (to a tenth of a second if possible). Universal Time is preferable.
- (ii) The Z.C. number of the star.
- (iii) Whether disappearance or reappearance.
- (iv) The observer's estimate of the accuracy of the observation.
- (v) Whether the time given in (i) has been corrected for personal error, and if so by how much.

Also required are the size and type of telescope used, the method of timing used, and the position of the telescope.

The telescope position must be to an accuracy of 1" or better in latitude and longitude and 30 metres or better in altitude. An observer can usually read his position off a 1/50 000 map published by the Director General of Trig. Survey, Mowbray, or his equivalent in other countries. Positions determined astronomically are NOT acceptable, not matter how carefully determined.

Timings of occultations are very valuable in determining the moon's shape and motion and consitute a field in which the amateur astronomer, often with only a small, unsophisticated telescope, can make an extremely useful contribution. Interested persons are urged to contact the Director of the Society's Occultation Section, Mr. A.G.F. Morrisby (c/o Dept. of Surveyor General, P. O. Box 8099, Causeway, Salisbury, Rhodesia).

Predictions of occultations of stars brighter than magnitude 7,5, supplied by H.M. Nautical Almanac Office, are reproduced on the next two pages.

Explanation of Table:

Z.C.	-	the number of the star in the "Catalogue of 3539 Zodiacal Stars for the Equinox 1950.0" by James Robertson (U.S. Naval Observatory, 1939). A short index of the brighter stars is given on page 47.
Mag.	-	the visual magnitude of the star
P	-	Phase. 1 = Disappearance 2 = Reappearance
El. of Moon	-	the elongation of the Moon. 0^{o} = New Moon, 90^{o} = First Quarter, 180^{o} = Full Moon, 270^{o} = Last Quarter.
U.T.	-	The predicted time in Universal Time which is exactly two hours behind South African Standard Time. For example $0^{h}55^{m}_{,}9$ UT is $2^{h}55^{m}_{,}9$ a.m. SAST.
a, b	-	the approximate time of an occultation at a place $\Delta\lambda$ degrees west and $\Delta\phi$ degrees north of the city concerned is Predicted time + $a.\Delta\lambda$ + $b.\Delta\phi$ where a and b are in minutes of time.
P	-	the position angle on the Moon's limb, measured eastward from the north point.
N	-	no occultation
S	-	sunlight interferes
A	-	Moon at very low altitude
G	-	grazing occultation

OCCULTATION PREDICTIONS

Date		Z.C. No.	Mag.	P.	El. of Moon	CAPE TOWN E. 18°.500, S. 33°.900 U.T.	a	b	P	JOHANNESBURG E. 28°.000, S. 26°.200 U.T.	a	b	P	SALISBURY E. 31°.100, S. 17°.700 U.T.	a	b	P
					o	h m	m	m	o	h m	m	m	o	h m	m	m	o
Jan.	3	1623	5.4	2	247	0 55.9	-2.5	-0.1	251	1 12.5	-2.1	-1.2	289	1 05.1	-1.7	-2.1	316
	15	3235	7.5	1	36	18 36.6	0.0	+2.3	37		A				N		
	18	42	5.6	1	70	19 59.8	.	.	7		N				N		
	21	411	7.3	1	104	19 53.3	.	.	20		N				N		
	21	421	6.6	1	105	21 27.4	-0.9	+0.7	107		A				A		
	23	709	4.3	1	129	19 59.2	-2.4	+1.5	51		N				N		
	24	861	6.5	1	142	18 52.7	-2.2	-1.0	108	19 10.4	-2.6	-0.2	92	19 21.3	-3.0	+0.9	69
	31	1815	4.8	2	241	22 24.3	-0.6	-1.6	295	22 15.1	-0.5	-2.2	323	21 52.2	+0.3	-3.8	356
Feb.	1	1949	5.8	2	254		N				N			22 50.4	-1.6	+0.1	254
	4	2217	5.5	2	281	2 52.4	-0.1	-4.4	345		N				N		
	7	2633	4.0	2	316	2 08.5	-0.8	+0.8	221	2 14.3	-0.6	-0.6	261	2 07.2	-0.3	-1.4	293
	7	2638	5.4	2	316	2 55.9	0.0	-2.4	308		N				N		
	16	244	6.9	1	61	18 16.7	-1.2	+0.2	118	18 30.7	-0.8	+0.8	94	18 42.4	-0.8	+1.4	68
	17	371	6.4	1	73	19 36.7	-0.5	-0.4	132		A				A		
	18	485	6.9	1	84		S			18 28.3	-2.2	+2.7	41		N		
	19	634	5.3	1	97		N			20 31.4	+0.3	-2.3	153	20 24.4	-0.7	-0.3	115
	20	784	6.2	1	109		N				N			19 07.0	-1.7	-1.4	131
	20	792	5.1	1	110		N				N			21 22.2	-0.1	-1.3	140
	21	969	7.1	1	123		N			22 34.0	.	.	179	22 17.8	-0.3	-0.8	131
	22	1109	7.3	1	136	20 20.9	-2.2	-0.1	100	20 49.5	-3.1	+1.8	64		N		
	27	1759	6.5	2	208	21 47.7	-1.9	-0.5	257	21 57.9	-1.7	-1.4	293	21 48.0	-1.3	-2.2	320
	28	1884	5.3	2	221		N				N			20 04.7	-1.2	+0.2	250
	28	1888	6.2	2	221	20 54.2	-0.2	-2.2	323	20 32.1	.	.	2		N		
Mar.	1	2017	6.4	2	234		N			20 02.3	-0.8	+0.8	231	20 03.8	-0.4	-0.5	266
	3	2307	4.1	1	262	23 32.3	-0.2	-1.9	122	23 27.2	-1.0	-0.8	88	23 33.0	-2.5	+1.8	50
	4	2307	4.1	2	262	0 37.4	-1.2	-1.0	268	0 37.4	-1.1	-2.1	304	0 14.3	+0.2	-4.6	344
	4	2310	4.6	2	262	0 45.4	.	.	223	1 06.9	-2.0	-0.7	270	1 01.6	-1.6	-1.9	303
	5	2457	6.3	2	274	2 39.2	-1.9	-0.5	261	2 49.8	-2.2	-1.9	297	2 26.1	.	.	342
	19	739	7.4	1	78	17 51.1	.	.	25		N				N		
	22	1198	6.2	1	118		N			22 26.3	+0.1	-1.3	151	22 21.0	-0.4	-0.3	116
	30	2233	5.5	2	228	21 31.8	-0.1	-2.4	321		N				N		
	30	2241	5.0	2	229	23 20.3	-1.4	-1.5	287	23 16.0	-1.0	-3.1	326		N		
Apr.	5	2969	3.2	1	290	3 38.1	-1.9	-1.8	104	3 52.7	-2.6	0.0	79		S		
	16	843	7.2	1	60		S			16 15.4	-2.2	+1.0	82	16 38.7	.	.	45
	16	851	6.3	1	60	17 52.7	-0.7	-0.5	136	18 01.2	-0.9	+0.5	100	18 12.9	-1.4	+1.6	67
	18	1158	5.2	1	87	20 42.3	-0.4	0.0	126		A				A		
	20	1410	5.3	1	113	20 48.5	-1.5	+0.3	105	21 16.6	.	.	54		N		
	23	1662	6.3	1	142	0 20.6	-0.6	-0.9	144	0 23.5	-0.5	+0.1	111	0 30.1	-0.5	+1.2	77
	23	1759	6.5	1	153	18 17.7	-0.8	-2.3	145	18 15.3	-1.7	-1.4	112	18 15.3	-2.8	0.0	82
	27	2330	6.3	2	209		N				N			23 25.9	.	.	222
	29	2498	4.5	1	224	2 49.3	-2.2	+0.9	81	3 19.0	-1.6	+1.9	62	3 45.1	-0.6	+3.6	32
	29	2498	4.5	2	224	4 13.2	-1.6	+1.1	266		S				S		

	30	2638	5.4	2	235		N			2 32.3	.	.	194	3 09.7	-2.0	+2.4	230
	30	2639	6.0	2	235	2 41.9	-2.4	+0.6	260	3 08.6	-2.7	-0.1	279	3 08.3	.	.	313
	30	2773	6.1	2	246		N				N			22 12.8	.	.	195
	30	2774	6.3	2	246		N			22 17.1	.	.	193	22 38.9	-1.6	+0.6	243
May	1	2787	6.4	2	247	1 03.9	-2.0	+0.9	235	1 29.2	-2.7	0.0	262	1 31.5	-3.4	-2.0	294
	3	3045	6.0	2	270	3 17.1	.	.	183		S				S		
	14	969	7.1	1	42	17 00.3	-1.5	+1.6	73		N				N		
	17	1364	6.5	1	81		S			16 09.1	-2.4	-0.5	107	16 20.0	-3.6	+1.4	73
	18	1489	6.8	1	95	19 17.3	-1.5	-0.3	118	19 37.6	-2.0	+1.7	75		N		
	20	1717	7.3	1	121	16 59.4	-1.5	-1.6	121	17 11.7	-2.9	-0.1	84		N		
	20	1726	6.9	1	123		N				S			20 04.6	-1.4	-2.0	144
	20	1727	7.1	1	123	19 56.2	-2.0	-0.4	110	20 24.4	-2.9	+2.7	64		N		
	21	1853	4.9	1	136	20 48.6	-2.0	-0.4	110	21 15.4	-2.6	+2.2	60		N		
	28	2733	6.4	2	216	4 04.1	-1.4	+1.4	258		S				S		
	30	3104	6.5	2	249	23 05.7	-0.9	+1.7	208	23 24.1	-1.5	+0.5	239	23 29.1	-1.9	-0.6	269
June	1	3229	5.6	2	261		N				N			1 12.9	-0.9	+4.4	189
	7	415	6.0	2	329	4 36.7	-1.0	-1.1	268		S				S		
	12	1198	6.2	1	37	16 15.7	-0.5	-0.9	146	16 20.8	-1.0	+0.2	107	16 31.0	-1.5	+1.5	71
	12	1210	5.9	1	38	17 35.9	-0.8	+0.9	96		A				A		
	13	1341	4.3	1	51		N				A			18 24.1	-0.1	-1.0	138
	15	1566	6.6	1	78		N			16 56.3	-1.0	-2.2	155	16 47.7	-1.9	-1.0	122
	16	1688	6.3	1	91		S			16 11.6	-2.3	-0.9	110	16 20.0	-4.1	+1.4	73
	17	1809	6.9	1	106	19 58.7	-0.9	-3.0	165	19 58.4	-1.4	-0.7	125	20 02.4	-1.7	+0.5	92
	17	1815	4.8	1	106	20 53.7	.	.	40		N				N		
	18	1949	5.8	1	119		N			21 58.5	-1.3	-3.0	167	21 46.8	-1.2	-0.9	146
	19	2063	6.7	1	131	16 58.4	-0.8	-2.6	149	16 56.2	-1.9	-1.3	107	17 00.0	-3.[illegible]	+0.7	73
	21	2217	5.5	1	146		N			0 21.7	-1.4	-1.6	143	0 19.0	-0.9	-0.2	112
June	25	2826	4.0	1	196	1 52.7	-1.9	+1.1	33	2 18.3	-1.4	+1.4	75	2 35.3	-0.9	+1.6	56
	25	2826	4.0	2	196	3 09.0	-0.8	+2.1	234	3 30.3	-0.5	+1.7	240	3 43.5	-0.6	+1.0	259
	26	3045	6.0	2	316		A			19 12.7	-0.4	+0.2	239	19 11.7	-0.4	-0.7	272
July	13	1662	6.3	1	61		N			18 48.9	-0.5	-1.0	142	18 46.1	-0.6	-0.1	109
	15	1901	6.9	1	88		N			17 42.2	-1.7	-1.7	138	17 40.3	-2.3	-0.3	105
	15	1907	6.7	1	88	18 57.9	-1.4	-1.7	146	19 05.6	-1.5	-0.1	112	19 14.3	-1.4	+1.[illegible]	79
	15	1913	7.1	1	89	20 19.2	-1.0	-1.0	141	20 25.2	-0.6	+0.1	112	20 31.7	-0.6	+1.0	81
	15	1914	6.8	1	89	20 38.9	.	.	40		N				N		
	17	2181	7.1	1	115	21 58.6	-0.9	+2.1	66	22 23.6	0.0	+3.3	41		N		
	18	2307	4.1	1	127		N			19 45.1	-2.6	-3.1	143	19 40.0	-2.6	-0.6	107
	19	2338	6.6	1	129	1 10.1	.	.	17		N				N		
	19	2445	7.4	1	138		N				N			17 15.0	-1.9	-2.3	126
	26	3371	6.4	2	220		N			21 46.8	.	.	180	22 15.4	-1.4	+2.2	214
	28	3501	5.3	2	232	0 22.8	.	.	179	0 54.9	-0.5	+3.3	188	1 26.2	-1.6	+2.9	209
Aug.	1	432	5.9	2	277	1 18.3	-1.0	-0.8	260	1 24.6	-1.7	-0.3	269	1 19.9	-2.9	-2.2	295
	1	433	5.6	2	277		N			1 03.3	.	.	175	1 28.3	-0.6	+2.0	211
	12	2002	6.8	1	71	19 02.0	-1.1	+0.5	104	19 17.8	-0.6	+1.3	79	19 37.6	+0.2	+4.0	38
	13	2119	6.7	1	83		N				N			17 40.8	-2.2	-3.3	152
	13	2136	6.8	1	85	20 40.4	-0.4	+2.9	50		N				N		
	14	2267	5.1	1	97		N				N			20 22.3	-2.1	-2.9	148
	16	2556	7.1	1	122	20 31.6	-2.8	-1.9	130	20 49.1	-2.3	-0.3	111	20 58.1	-1.8	+0.8	85
	17	2715	6.5	1	134	21 06.6	-1.9	+1.7	64	21 37.7	-1.3	+2.3	52	22 03.8	-0.3	+3.4	27

OCCULTATION PREDICTIONS

Date	Z.C. No.	Mag.	P.	El. of Moon	CAPE TOWN E. 18.500°, S. 33.900° U.T.	a	b	P	JOHANNESBURG E. 28.000°, S. 26.200° U.T.	a	b	P	SALISBURY E. 31.100°, S. 17.700° U.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
17	2718	6.7	1	134	21 52.9	-2.0	+0.8	90	22 17.4	-1.4	+1.2	80	22 33.3	-0.9	+1.7	60
19	2969	3.2	1	156	17 52.8	.	.	135	17 48.4	-1.9	-1.3	97	17 52.3	-2.2	+0.7	66
19	2969	3.2	2	156	18 33.2	.	.	194	19 10.7	-2.2	+1.9	225	19 29.7	-3.0	+0.7	253
23	3453	4.9	2	201		N			19 48.0	-0.6	+2.1	204	20 03.7	-1.3	+1.1	232
30	646	6.1	2	269		A			0 00.0	-0.3	+0.8	224	0 06.0	-1.0	+0.2	247
30	651	5.9	2	269	0 41.2	-0.5	0.0	235	0 48.8	-1.1	+0.1	245	0 52.0	-1.8	-0.4	266
Sept. 8	1925	1.2	1	36	11 27.0	-1.9	-0.9	97		N				N		
8	1925	1.2	2	36	12 39.6	-1.5	-2.0	318		N				N		
11	4008	7.7	1	79	18 21.2	-1.8	+0.5	99	18 42.9	-1.3	+1.2	81	18 59.2	-0.7	+2.1	54
13	2687	6.5	1	104	22 46.9	0.0	+2.0	53	23 00.5	+0.4	+2.0	43		A		
14	2826	4.0	1	115		N				N			21 47.0	.	.	135
14	2830	6.9	1	116	22 32.5	-0.5	+2.2	51	22 51.3	0.0	+2.2	43	23 11.5	+0.7	+3.1	18
15	2936	6.8	1	126	18 18.3	-2.0	+1.7	47	18 56.2	-1.7	+3.3	31	19 39.0	.	.	357
16	3065	7.5	1	138		G			19 23.1	.	.	115	19 28.7	-3.5	+0.3	87
27	752	4.7	2	251	1 17.3	-2.4	-2.1	303	1 25.6	.	.	319		N		
27	755	6.3	2	251	1 58.4	-1.6	+1.3	219	2 28.9	-2.7	+1.3	235	2 46.0	-3.2	+0.5	259
Oct. 8	2302	2.9	1	46		S				S			16 15.4	-1.4	+0.8	85
8	2302	2.9	2	46		S			17 14.2	-0.7	+1.7	247	17 25.4	-0.8	+0.5	273
8	2303	5.1	1	46		S				S			16 15.7	-1.4	+0.8	84
8	2322	4.3	1	47	19 06.6	0.0	+2.0	57		A				N		
9	2465	7.4	1	60	19 17.9	-1.1	-0.1	122	19 26.7	-0.5	+0.3	109	19 31.8	-0.1	+0.7	86
10	2611	6.8	1	72	17 35.3	-1.5	+2.2	55	18 05.3	-0.7	+2.8	41	18 38.1	.	.	4
11	2764	6.3	1	84		S			17 07.9	-3.0	-0.4	105	17 18.9	-2.5	+0.9	80
12	2913	5.0	1	97	21 15.6	-2.0	-0.6	126	21 28.0	-1.1	0.0	115	21 33.3	-0.5	+0.6	92
14	3166	4.8	1	120	23 47.5	-0.2	+2.0	53		A				A		
17	3501	5.3	1	152	18 25.0	-1.8	-0.3	75	18 45.7	-2.3	+0.6	66	19 03.2	-2.1	+1.9	46
24	847	3.0	1	231		A				A			20 45.3	+0.5	+2.5	26
24	847	3.0	2	231		A			21 37.9	-1.4	-1.6	289	21 24.6	-2.3	-3.4	319
28	1271	5.9	2	269		N				N			0 14.8	.	.	214
30	1519	6.5	2	297	2 50.7	.	.	359		N				N		
Nov. 2	1925	1.2	1	342	9 31.9	-2.4	+0.1	89		N				N		
2	1925	1.2	2	342	10 43.3	-1.5	-1.7	321		N				N		
5	2394	6.5	1	26		N				N			17 07.1	-0.9	-1.3	135
5	2401	5.6	1	27		S			17 31.1	+0.3	+1.8	53		A		
8	2856	6.6	1	65	18 04.4	-0.6	+2.9	34	18 30.1	0.0	+3.1	25		N		
11	3235	7.5	1	100	21 43.8	-0.7	+1.9	62	22 02.4	-0.2	+1.9	52		A		
13	3464	7.1	1	121	17 52.1	-1.6	+1.7	40	18 23.8	-1.7	+2.4	36	18 54.0	-1.1	+3.7	17
22	995	4.1	1	216	2 36.1	-1.9	0.0	108		S				N		
25	1364	6.5	2	252	0 50.0	-1.6	-0.9	266	0 59.4	-2.0	-1.3	289	0 51.6	-2.0	-2.1	314
Dec. 7	3054	6.4	1	56		S				S			16 56.8	-0.2	+3.5	17
14	363	7.3	1	136	22 54.0	-1.6	+2.2	50	23 32.1	.	.	15		N		
20	1198	6.2	2	209	23 52.0	-2.3	-0.4	270	24 09.7	-2.3	-1.0	297	24 02.8	-1.9	-2.4	326

21	1210	5.9	2	209	1 41.6	-1.6	-1.0	313	1 34.3	.	.	0	N			
22	1341	4.3	1	223	N				E				2 49.7	.	.	190
26	1925	1.2	1	288	N				N				23 44.9	+0.1	-2.2	150
27	1925	1.2	2	288	N				N				0 33.7	-1.0	-0.2	255
29	2192	6.2	2	315	N				E				1 09.9	.	.	209

INDEX TO OCCULTED STARS BRIGHTER THAN FIFTH MAGNITUDE

Z.C.	Name	Mag.	Sp	Z.C.	Name	Mag.	Sp
709	τ Taur	4,3	B5	2302*	β Scor	2,9	B1
752	ι Taur	4,7	A5	2307	ω^1 Scor	4,1	B2
847	ζ Taur	3,0	B3p	2310	ω^2 Scor	4,6	G0
995*	υ Gemi	4,1	B5	2498	ξ Ophi	4,5	F5
1341*	α Canc	4,3	A3	2633	μ Sgtr	4,0	B8p
1815	χ Virg	4,8	K0	2826	ρ Sgtr	4,0	A5
1853	ψ Virg	4,9	M3	2969*	β Capr	3,3	G0, A0
1925	Spica	1,2	B2	3453	κ Pisc	4,9	A2p

NOTES

It is interesting to note that Spica is included in the list of occulted stars. Unfortunately, of the three occultations of this star that occur in 1975, two are seen only from Cape Town in the daytime, the other only from Salisbury in the early hours of December 27.

"Z.C. 4008" is the planet Neptune which is occulted during the evening of September 11. It should be interesting to observe as, unlike a star, its disappearance does not seem instantaneous.

GRAZING OCCULTATIONS

When a star moves tangentially to the limb of the Moon, and is occulted for a very short period only - a few minutes, or even seconds - a grazing occultation is said to occur. Because the limb, as seen from the Earth, is in fact the outline of numerous mountains and valleys, there may be several disappearances and reappearances, which are not only fascinating to observe, but which may be accurately timed to yield valuable data on the relative positions of star and Moon, in both right ascension and declination, as well as on the shape of the Moon. Some of these data cannot readily be obtained in any other way.

The maps on the following pages have been prepared by H.M. Nautical Almanac Office to show the tracks of stars brighter than 7.5 magnitude which will graze the limb of the Moon when it is at a favourable elongation from the Sun and at least 10° above the observer's horizon (2° in the case of bright stars). Each track starts in the West at some arbitrary time given in the key and ends beyong the area of interest, except where the letters "A", "B", or "S" are given. "A" denotes that the Moon is at a low altitude, "B" that the bright limb interferes, and "S" that sunlight interferes. The tick marks along the tracks denote 5 minute intervals of time which, when added to the time at the beginning of the track, give the approximate time of the graze at places along the tracks.

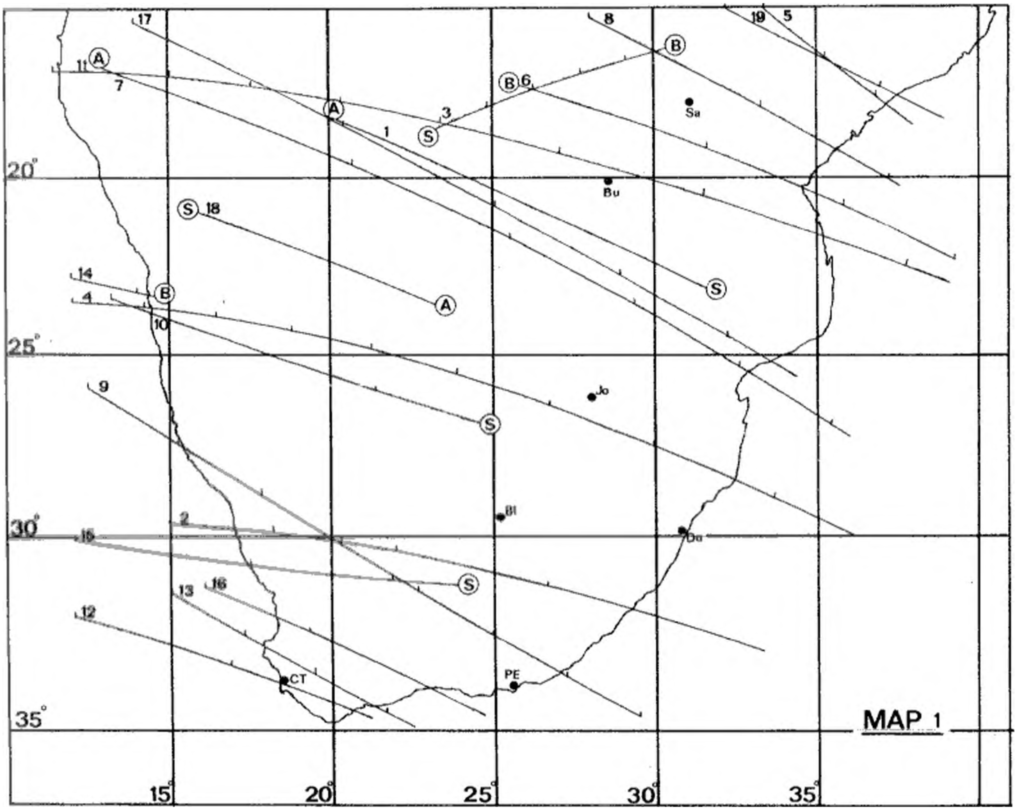
The tracks as shown on the maps are approximate only. Since the observer's location is very critical, successful observations call for very accurate predictions. With the aid of the IBM computer of the CSIR at Pretoria such predictions are at present prepared at 6-monthly intervals for a number of centres in South Africa, Rhodesia and Malawi. By plotting the predicted graze track on a reliable survey map (e.g. the South African 1:50 000 series) it is usually possible to select a convenient site from where the graze may be observed. Ideally a team of observers would be stationed at intervals along a line running at right angles to the graze track - say, along a main road - each with his own telescope and timing equipment. Each observer will see a different sequence of events, the combined results forming an accurate picture of the limb of the Moon.

The equipment needed is similar to that used for ordinary (or 'total') occultations, but must, of course, be portable. A 75 mm refractor is ideal for average events, but better instruments with a larger aperture have often shown their superiority under difficult conditions. Timing is best carried out with a portable tape recorder and radio receiver tuned to ZUO or other time signal station.

It will be seen from the maps that many grazing occultations occur in regions which are rather far removed from the main cities, and which cannot easily be reached by teams of observers from one of the ASSA centres. It is worth remembering, however, that a team of many observers, while ideal, is by no means essential; that a single good observer is worth more than many unsuccessful ones, and that one good observation is worth infinitely more than no observations at all.

Observers in other parts of southern Africa - especially the more distant regions - who may be interested, are therefore invited to contact the coordinator for grazing occultations: Mr. J. Hers, 48, Central Road, Linden Extension, Randburg 2001, so that they may be informed of all favourable grazes occurring within their neighbourhood.

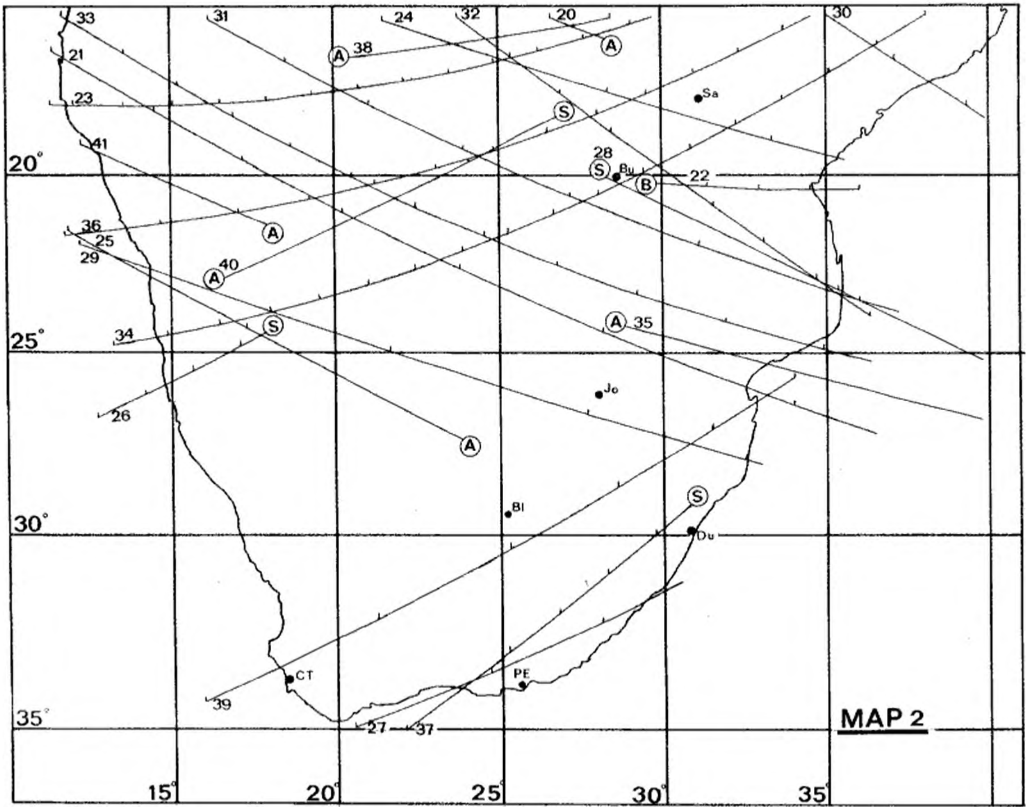
JANUARY 10 TO APRIL 16



No.	Z. C.	Mag.	Date		Beginning h m	Sunlit %	Limit
1	2529	6.6	Jan	10	4 35	5	S
2*	411	7.3	Jan	21	22 14	62	N
3	525	6.4	Jan	22	19 33	72	S
4*	709	4.3	Jan	23	22 22	82	N
5	1705	7.5	Jan	31	2 1	83	S
6	1809	6.9	Jan	31	23 1	74	S
7*	1949	5.8	Feb	2	0 19	63	S
8	2207	7.0	Feb	4	1 37	41	S
9*	2214	6.2	Feb	4	4 7	40	S
10	2794	6.7	Feb	8	5 22	7	N
11	485	6.9	Feb	18	20 35	45	N
12	487	5.2	Feb	18	21 39	46	N
13	2171	6.8	Mar	3	3 23	67	S
14	2327	6.7	Mar	4	6 6	55	S
15	3002	6.2	Mar	9	5 43	11	N
16	739	7.4	Mar	19	20 3	40	N
17	2230	6.8	Mar	30	22 50	83	S
18	534	6.0	Apr	14	19 2	10	N
19*	843	7.2	Apr	16	19 2	25	N

Explanation of map – see text on page 48
Explanation of column headings of table – see page 53
An asterisk denotes the star is double – see page 53

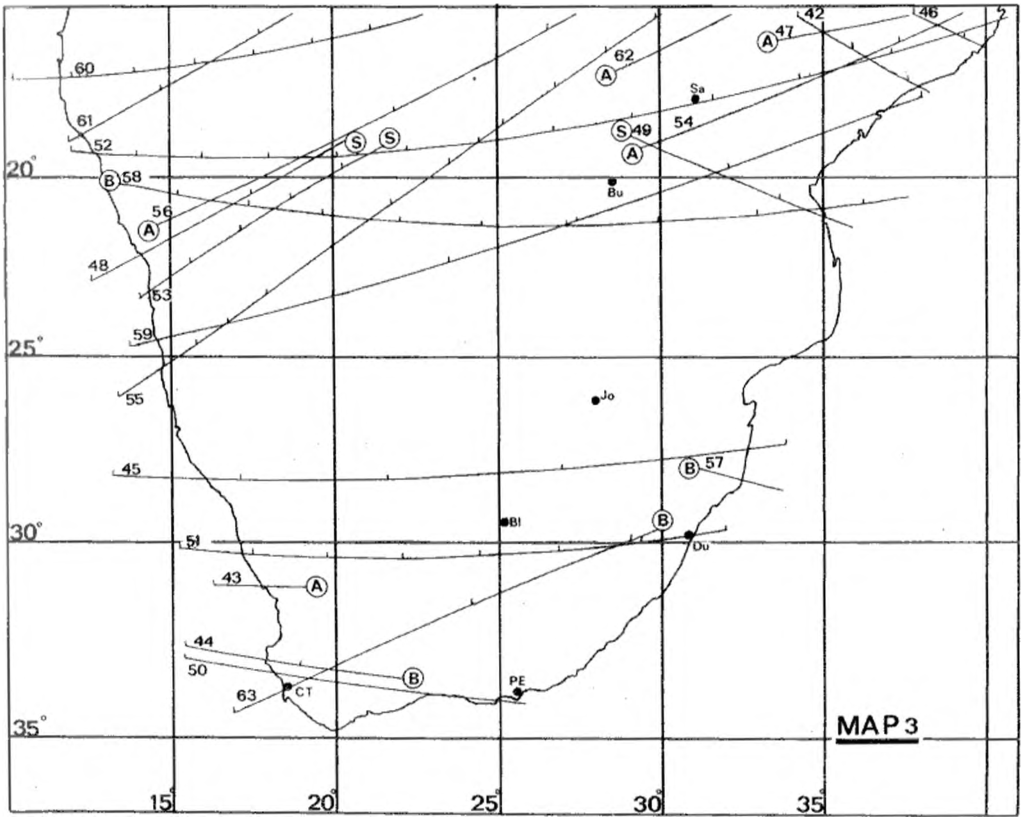
APRIL 18 TO JUNE 12



No.	Z.C.	Mag.	Date	Beginning h m	Sunlit %	Limit	No.	Z.C.	Mag.	Date	Beginning h m	Sunlit %	Limit
20	1158	5.2	Apr 18	23 17	47	N	31	1489	6.8	May 18	21 39	55	N
21*	1410	5.3	Apr 20	23 3	70	N	32	1717	7.3	May 20	19 17	76	N
22	2632	7.2	Apr 30	2 3	79	N	33	1727	7.1	May 20	22 2	77	N
23	2639	6.0	Apr 30	3 37	78	N	34*	2871	7.1	May 29	2 50	84	N
24*	2773	6.1	Apr 30	23 54	70	S	35*	2969	3.2	May 29	21 39	77	S
25	2774	6.3	Apr 30	23 57	70	S	36	3111	6.8	May 31	2 28	67	N
26	2927	7.2	May 2	6 28	59	N	37	3235	7.5	Jun 1	5 51	57	N
27	3511	6.7	May 7	5 55	14	N	38	3464	7.1	Jun 3	2 5	39	N
28	792	5.1	May 13	17 48	6	N	39	163	7.2	Jun 5	5 18	20	N
29*	969	7.1	May 14	19 26	13	N	40	415	6.0	Jun 7	6 2	7	N
30	1364	6.5	May 17	18 53	42	N	41	1210	5.9	Jun 12	20 3	11	N

Explanation of map - see text on page 48
Explanation of column headings of table - see page 53
An asterisk denotes the star is double - see page 53

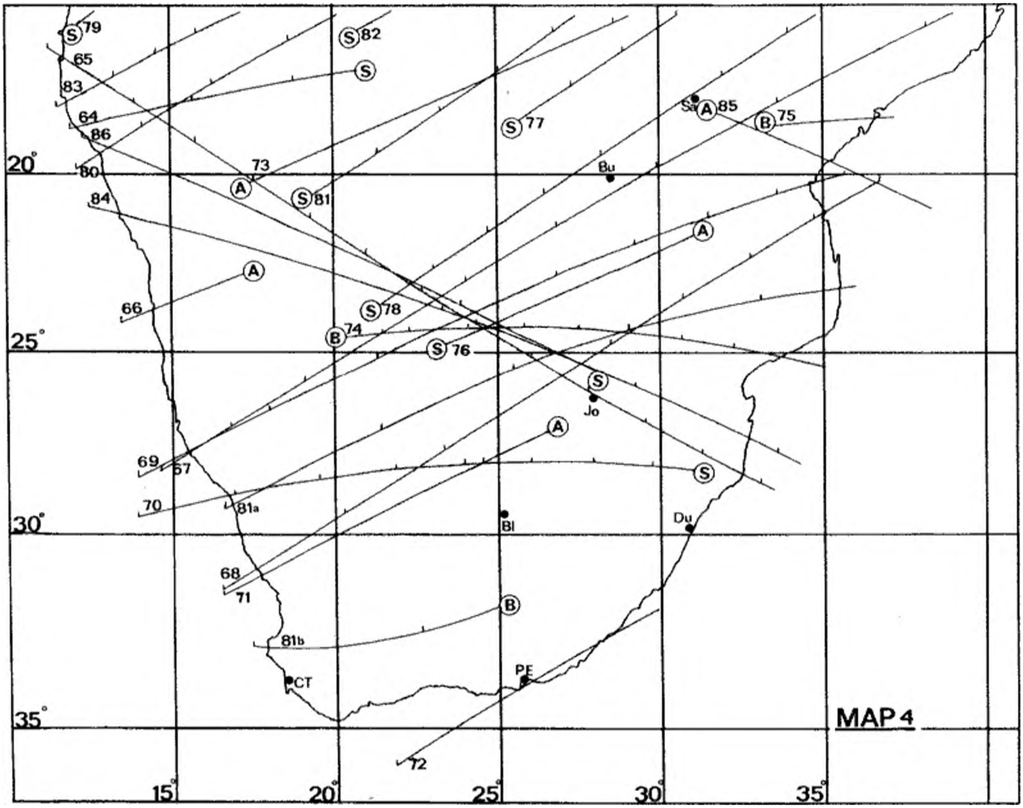
JUNE 16 TO SEPTEMBER 1



No.	Z.C.	Mag.	Date	Beginning h m	Sunlit %	Limit
42	1688	6.3	Jun 16	18 52	51	N
43	1705	7.5	Jun 17	0 3	53	S
44	1815	4.8	Jun 17	23 0	64	N
45*	1949	5.8	Jun 18	23 58	75	S
46	2063	6.7	Jun 19	19 46	83	N
47*	3524	6.9	Jun 30	23 53	57	N
48	631	5.6	Jul 6	6 47	10	N
49*	1410	5.3	Jul 11	17 53	8	N
50	1662	6.3	Jul 13	21 8	27	S
51	2307	4.1	Jul 18	21 46	80	S
52	2310	4.6	Jul 18	22 4	80	S
53	197	7.0	Jul 30	6 23	62	N
54	297	6.8	Jul 31	0 34	54	N
55	313	7.5	Jul 31	4 27	53	N
56	432	5.9	Aug 1	2 39	44	N
57	1853	4.9	Aug 11	17 47	22	S
58	2119	6.7	Aug 13	19 30	45	S
59*	2267	5.1	Aug 14	22 15	57	S
60	2710	6.8	Aug 17	21 2	84	S
61	2724	6.6	Aug 18	1 34	85	S
62	642	6.9	Aug 30	1 11	51	N
63*	969	7.1	Sep 1	4 38	29	N

Explanation of map - see text on page 48
Explanation of column headings of table - see page 53
An asterisk denotes the star is double - see page 53

SEPTEMBER 2 TO DECEMBER 30



No.	Z. C.	Mag.	Date		Beginning h m	Sunlit %	Limit		Z. C.	Mag.	Date		Beginning h m	Sunlit %	Limit
64	1114	6.8	Sep	2	6 7	19	S	76	2394	6.5	Nov	5	19 18	5	S
65*	1925	1.2	Sep	8	13 25	10	N	77	2972	6.7	Nov	9	18 51	38	S
66	2233	5.5	Sep	10	23 21	31	S	78	2975	7.0	Nov	9	19 16	38	S
67	2826	4.0	Sep	14	23 27	72	S	79	3104	6.5	Nov	10	19 46	48	S
68	467	6.7	Sep	25	0 56	84	N	80	3111	6.8	Nov	10	22 7	49	S
69	752	4.7	Sep	27	2 37	66	N	81	29	7.2	Nov	14	19 24	84	S
70	1060	7.4	Sep	29	4 36	45	S	82	2927	7.2	Dec	6	19 23	14	S
71*	2629	6.3	Oct	10	23 4	36	S	83*	230	7.4	Dec	13	22 1	78	S
72	2913	5.0	Oct	12	23 32	56	S	84*	1925	1.2	Dec	27	2 9	34	S
73*	847	3.0	Oct	24	22 57	81	N	85	2192	6.2	Dec	29	3 5	14	S
74	1025	7.4	Oct	26	3 5	71	S	86	2353	4.6	Dec	30	4 53	7	S
75	1271	5.9	Oct	28	2 6	50	S								

Explanation of map - see text on page 48
Explanation of column headings of table - see page 53
An asterisk denotes the star is double - see page 53

EXPLANATION OF COLUMN HEADINGS IN TABLES

No. - the number of the track on the map. An asterisk denotes that the same is double - notes are given below.
Z.C. - the number of the star in the Zodiacal Catalogue.
Date
Beginning-an arbitrary time of the beginning of the track in the west.
Sunlit - the percentage of the Moon's disk lit by the Sun
Limit - N = northern limit (a complete occultation takes place south of the track)
S = southern limit (complete occultation north of the track)

NOTES ON DOUBLE STARS

TRACK NO.	ZC	
2	411	is the brighter component of the double star Aitken 2122. The companion is 8.2 magnitude; separation 3".6 in p.a. 309°.
4	709	is a spectroscopic binary star
7,45	1949	is the mean of the double star Aitken 8954. The components are 6.5 and 6.9 magnitude; separation 0".6.
9	2214	is the brighter component of the double star Aitken 9681. The companion is 8.5 magnitude; separation 11".1 in p.a. 281°.
19	843	is the brighter component of the double star Aitken 4200. The companion is 7.8 magnitude; separation 3".8 in p.a. 269°.
21,49	1410	is the brighter componnet of the double star Aitken 7416. The companion is 8.4 magnitude; separation 37" in p.a. 75°.
24	2773	is the brighter component of the double star Aitken 11972. The companion is 9.5 magnitude; separation 7".5 in p.a. 88°.
29,63	969	is the brighter component of the multiple system Aitken 4962. The four companions, with wide separations, are 9th, 11th, 8th and 10th magnitudes.
34	2871	is the brighter component of the double star Aitken 12728. The companion is 8.5 magnitude; separation 10" in p.a. 234°.
35	2969	is a spectroscopic binary star.
42	1688	is the brighter component of the double star Aitken 8247. The companion is 10th magnitude; separation 5".2 in p.a. 279°.
47	3524	is the mean of the double star Aitken 17111. The components are 7.5 and 8.0 magnitude; separation 0".4 in p.a. 220°.
59	2267	is a spectroscopic binary star.
65,84	1925	is a spectroscopic binary star.
71	2629	is the mean of the double star Aitken 11127. The components are 6.9 and 7.3 magnitude; separation 1".0 in p.a. 204°.
73	847	is a spectroscopic binary star.
83	230	is the brightest component of the system Aitken 1238. The brightest companion is 8.4 magnitude; separation 16" in p.a. 79°.

OCCULTATIONS DURING LUNAR ECLIPSE

During the lunar eclipse on Nov. 18/19, it will be possible to observe grazes of two stars fainter than the normal limit. These are:

No.	Name	Mag.	Beginning	Limit
81a	SAO 093498	8,8	$23^h\ 38^m$	N
81b	SAO 093518	9,3	0 53	S

Tracks are shown on map 4.

TIME SYSTEMS AND TELESCOPE SETTING

This section is intended to serve established amateurs and professional astronomers - i.e. those having some knowledge of time and coordinate systems. Space in the booklet does not permit full explanation, which in any case would appear complicated to the layman.

TIME SIGNALS FROM RADIO STATION ZUO

Radio signals of mean solar time are generated by the Precise Physical Measurements Division of the National Physical Research Laboratory in Pretoria and broadcast by the Post Office transmitting station at Olifantsfontein

Carrier Frequency	Radiated Power	Time of Transmission
2,5 MHz	4 Kw	2000 - 0600 SAST
5 MHz	4 Kw	Continuous
100 MHz	80 w	Continuous

The signals consist of one pulse per second, each pulse consisting of 5 cycles of 1000 Hz tone. The first pulse in every minute is lengthened to 500 milliseconds. Morse code announcements are made during the minute preceding every fifth minute. They consist of the call sign ZUO (repeated 3 times) and the Universal Time (formally known as Greenwich Mean Time) at the next minute. (A special coding indicating UT1 minus UTC is also indicated in the first 15 seconds of the minute by slightly lengthened second pulses)

SOUTH AFRICAN STANDARD TIME

South African Standard Time (as in everyday use) is mean solar time for the 30° East meridian (which runs east of Johannesburg and just west of Durban) and is exactly 2 hours ahead of Universal Time.

TIME OF SUN'S TRANSIT OVER THE 30° MERIDIAN

The table below gives the SAST when the Sun transits the 30° meridian - and a sundial on that meridian reads noon.

Jan 1	12^h	03^m	22^s	May 11	11^h	56^m	21^s	Sep 18	11^h	54^m	21^s
11	12	07	46	21	11	56	29	28	11	50	52
21	12	11	13	31	11	57	31	Oct 8	11	47	43
31	12	13	27	Jun 10	11	59	13	18	11	45	18
Feb 10	12	14	18	20	12	01	19	28	11	43	52
20	12	13	52	30	12	03	27	Nov 7	11	43	40
Mar 2	12	12	21	Jul 10	12	05	11	17	11	44	52
12	12	10	00	20	12	06	14	27	11	47	27
22	12	07	08	30	12	06	24	Dec 7	11	51	12
Apr 1	12	04	07	Aug 9	12	05	32	17	11	55	50
11	12	01	15	19	12	03	43	27	12	00	48
21	11	58	50	29	12	01	05				
May 1	11	57	10	Sep 8	11	57	52				

RISING AND SETTING TIMES AT 30°S ON THE 30° MERIDIAN

The scale at the bottom of pages 24 and 25 is for finding rising or setting times of any object who right ascension and declination are known. Set dividers or a strip of paper from the index at the centre of the scale to the object's declination and in the direction desired for either rising or setting. Measure this same distance and direction along the midnight line, beginning at the object's right ascension indicated by the numerals. (Should this end point fall outside the chart, 12 hours should be added to or subtracted from the right ascension. Reset the dividers using the end of the scale instead of the centre index, and measuring in the opposite direction to that first used.) Through the point established draw a line parallel to the March Equinox transit line (indicated by the dashed line on the chart). This line will show the time of rising or setting of the object at position 30°E and 30°S.

SIDEREAL TIME ON THE 30° MERIDIAN

Sidereal Time is given by the line of Right Ascension coinciding with the meridian.

Date	At 0 hrs SAST	At 21 hrs SAST	Date	At 0 hrs SAST	At 21 hrs SAST	Date	At 0 hrs SAST	At 21 hrs SAST
Jan 1	$6^h\ 40^m$	$3^h\ 43^m$	May 11	$15^h\ 12^m$	$12^h\ 16^m$	Sep 18	$23^h\ 45^m$	$20^h\ 48^m$
11	7 19	4 23	21	15 52	12 55	28	0 24	21 28
21	7 59	5 02	31	16 31	13 35	Oct 8	1 04	22 07
31	8 38	5 41	Jun 10	17 10	14 14	18	1 43	22 46
Feb 10	9 17	6 21	20	17 50	14 53	28	2 22	23 26
20	9 57	7 00	30	18 29	15 33	Nov 7	3 02	0 05
Mar 2	10 36	7 40	Jul 10	19 09	16 12	17	3 41	0 45
12	11 16	8 19	20	19 48	16 52	27	4 21	1 24
22	11 55	8 59	30	20 28	17 31	Dec 7	5 00	2 04
Apr 1	12 34	9 38	Aug 9	21 07	18 10	17	5 40	2 43
11	13 14	10 17	19	21 46	18 50	27	6 19	3 22
21	13 53	10 57	29	22 26	19 29			
May 1	14 33	11 36	Sep 8	23 05	20 08			

CORRECTION FOR PLACES NOT ON THE 30° MERIDIAN

Approximate longitude corrections from the 30° East Meridian are provided below.

To find time of Sun's transit over local meridian, apply the longitude corrections to the data in the table above.

To find the sidereal times at SAST 0 hrs and SAST 21 hrs apply the corrections with the sign reversed to the data in the table.

Bloemfontein	$+15^m$	East London	-8^m	Port Elizabeth	$+18^m$
Bulawayo	$+6^m$	Grahamstown	$+14^m$	Pretoria	$+7^m$
Cape Town	$+46^m$	Johannesburg	$+8^m$	Salisbury	-4^m
Durban	-4^m	Kimberley	$+21^m$	Windhoek	$+52^m$

TELESCOPE SETTING

When a telescope equipped with setting circles is aimed on the meridian, its R.A. circle should read the sidereal time. Thus one can calculate the sidereal time and then set the circle, but is is usually simpler to aim the telescope at one of the well known stars given below and then to adjust the R.A. circle.

A LIST OF BRIGHT STARS FOR CHECKING TELESCOPE CIRCLES

Star	R.A.	Dec.	Mag.	Sp.	Star	R.A.	Dec.	Mag.	Sp.
Achernar	$1^h36^m\!,8$	$-57°21'$	0,5	B5	Procyon	$7^h38^m\!,0$	$+15°17'$	0,4	F5
Aldebaran	4 34,5	+16 28	0,9	K5	Regulus	10 07,1	+12 06	1,4	B7
Rigel	5 13,3	- 8 14	0,1	B8	Spica	13 23,8	-11 02	0,9	B1
Betelgeuse	5 53,8	+ 7 24	0,4	M2	Arcturus	14 14,5	+19 19	-0,1	K2
Canopus	6 23,4	-52 41	0,7	F0	Antares	16 27,9	-26 33	0,9	M1
Sirius	6 44,0	-16 41	-1,4	A1	Altair	19 49,5	+8 48	0,8	A7

ASSA OFFICE BEARERS

COUNCIL

President: Mr. C. Papadopoulos
Vice-Presidents: Mr. G.A. Harding, Dr. P.A.T. Wild, Mr. S. Booysen
Members: Prof. A.D. Thackeray, Mr. R.F. Hurly, Mr. M.D. Overbeek, Mr. M. Gray
Hon. Secretary: Mr. T.W. Russo
Hon. Treasurer: Mr. G. Orpen
Business Manager: Mr. W. Bentley

NATAL CENTRE

Chairman: Mr. M. A. Gray
Vice-Chairman: Mr. J. Barker
Secretary/Treasurer: Mr. R. Garside
Librarian: Miss I. Schumann
Council Representative: Mr. G. Hobson
P.R. Officer: Mr. S. Booysen
Social Convenor: Mrs. B. Don
Satellite Tracking: Mr. W. Spiers
Mirror Making: Mr. E. Malan
Astro-photography: Mr. R. S. Bond

NATAL MIDLANDS CENTRE

Chairman: Mr. G.B. McNulty
Secretary/Treasurer: Mr. S.B. Dale
Committee: Dr. G.L. Prosser, Messrs. R.H. Dale, B.K. Peckham and V. Duveen.

CAPE CENTRE

Chairman: Mr. C. Turk
Vice-Chairman: Mr. B. Molyneux
Secretary: Mr. C. Larmuth
Treasurer: Mr. N. Saville
Auditor: Mr. G. Orpen
Committee Members: Messrs. R. Hurly, W. Grimwood, G. Larmuth, R. de Kock, J. Churms, and G. van Dugteren
Council Representative: Mr. J. Bondietti,

FREE STATE CENTRE

Chairman: Mr. G.J. Muller
Vice-Chairman: Mr. J. Rhodes
Secretary/Treasurer: Mr. F.C. Neser
Committee Members: Messrs. G.N. Walker and D.P. de Leeuw
Council Representative: Mr. G. J. Muller

TRANSVAAL CENTRE

Chairman: Mr. F. de J. Bateman
Vice- Chairman: Mr. M. D. Overbeek
Secretary: Mrs. M.M. Fitzgerald
Treasurer: Mr. C. Papadopoulos
Curator of Instruments: Mr. T.E. Geary
Committee Members: Messrs. L. Pazzi, G. Roberts, A. Voorvelt, L.R. Kinnear, G. Pulik, R. Williams and V. Righthouse

PRETORIA CENTRE

(No information received at time of going to press)

PAST PRESIDENTS

1922-23	S.S. Hough
1923-24	R.T.A. Innes
1924-25	J.K.E. Halm
1925-26	W. Reid
1926-27	H. Spencer Jones
1927-28	A.W. Roberts
1928-29	A.W. Long
1929-30	H.E. Wood
1930-31	D. Cameron-Swan
1931-32	H.L. Alden
1932-33	H. Spencer Jones
1933-34	D.G. McIntyre
1934-35	J.K.E. Halm
1935-36	J. Jackson
1936-37	H.E. Houghton
1937-38	J.S. Paraskevopoulos
1938-39	T. Mackenzie
1939-40	R.A. Rossiter
1940-41	E.B. Ford
1941-42	H. Knox Shaw
1942-43	A.F.I. Forbes
1943-44	W.H. van den Bos
1944-45	A.W.J. Cousins
1945-46	R.H. Stoy
1946-47	W.P. Hirst
1947-48	J. Jackson
1948-49	A.E.H. Bleksley
1949-50	W.S. Finsen
1950-51	H.E. Krumm
1951-52	A.D. Thackeray
1952-53	J.C. Bentley
1953-54	David S. Evans
1954-55	P. Kirchhoff
1955-56	W.H. van den Bos
1956-57	S.C. Venter
1957-58	M.W. Feast
1958-59	H. Haffner
1959-60	P. Smits
1960-61	G.G. Cillie
1961-62	M.D. Overbeek
1962-63	A.J. Wesselink
1963-64	A.G.F. Morrisby
1964-65	H.C. Lagerwey
1965-66	A. Menzies
1966-67	G.R. Atkins
1967-68	J. Hers
1968-69	J.C. Bennett
1969-70	J. Churms
1970-71	W.C. Bentley
1971-72	A.H. Jarrett
1972-73	K.J. Sterling
1973-74	G.A. Harding

HONORARY SECRETARIES

1922	H.W. Schonegevel
1922	T. Mackenzie
1923	C.L. O'Brien Dutten
1923	H.E. Houghton
1930	S. Skewes
1931	H. Horrocks
1934	H.W. Schonegevel
1935	A. Menzies
1965	T.W. Russo

HONORARY MEMBERS

Prof. A.E. Bleksley
Mr R.P. de Kock
Dr D.S. Evans
Prof. Ch. Fehrenbach
Dr W.S. Finsen
Dr H. Haffner
Dr J.H. Oort
Dr R.O. Redman
Dr J Schilt
Dr R.H. Stoy
Dr A.G. Velghe
Sir Richard Woolley

GILL MEDALLISTS

1956	H. Knox Shaw
1957	W.P. Hirst
1958	J. Jackson
1960	W.H. van den Bos
1963	A.W.J. Cousins
1965	R.H. Stoy
1967	W.S. Finsen
1970	J.C. Bennett

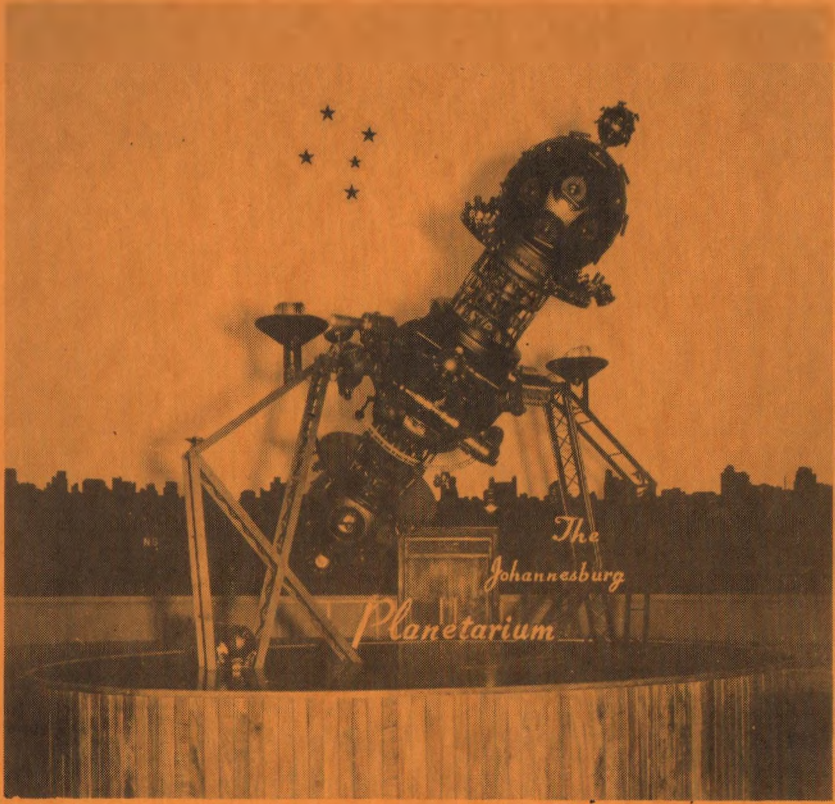
JULIAN DATE AT 1400 HOURS

The Julian Calendar is generally used for recording the time of variable star observations. It numbers the days consecutively from the beginning of the Julian era in 4713 B. C. The Julian day begins at Greenwich mean noon, that is, at 1400 hrs. (2 p.m.) SAST. The Julian date on 1975 Jan. 1, at 1400 hrs. is 2442 414,0 - the first digits are not repeated for each entry in the table below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2442	2442	2442	2442	2442	2442	2442	2442	2442	2442	2442	2442
1	414,0	445,0	473,0	504,0	534,0	565,0	595,0	626,0	657,0	687,0	718,0	748,0
2	415,0	446,0	474,0	505,0	535,0	566,0	596,0	627,0	658,0	688,0	719,0	749,0
3	416,0	447,0	475,0	506,0	536,0	567,0	597,0	628,0	659,0	689,0	720,0	750,0
4	417,0	448,0	476,0	507,0	537,0	568,0	598,0	629,0	660,0	690,0	721,0	751,0
5	418,0	449,0	477,0	508,0	538,0	569,0	599,0	630,0	661,0	691,0	722,0	752,0
6	419,0	450,0	478,0	509,0	539,0	570,0	600,0	631,0	662,0	692,0	723,0	753,0
7	420,0	451,0	479,0	510,0	540,0	571,0	601,0	632,0	663,0	693,0	724,0	754,0
8	421,0	452,0	480,0	511,0	541,0	572,0	602,0	633,0	664,0	694,0	725,0	755,0
9	422,0	453,0	481,0	512,0	542,0	573,0	603,0	634,0	665,0	695,0	726,0	756,0
10	423,0	454,0	482,0	513,0	543,0	574,0	604,0	635,0	666,0	696,0	727,0	757,0
11	424,0	455,0	483,0	514,0	544,0	575,0	605,0	636,0	667,0	697,0	728,0	758,0
12	425,0	456,0	484,0	515,0	545,0	576,0	606,0	637,0	668,0	698,0	729,0	759,0
13	426,0	457,0	485,0	516,0	546,0	577,0	607,0	638,0	669,0	699,0	730,0	760,0
14	427,0	458,0	486,0	517,0	547,0	578,0	608,0	639,0	670,0	700,0	73 ,0	761,0
15	428,0	459,0	487,0	518,0	548,0	579,0	609,0	640,0	671,0	701,0	732,0	762,0
16	429,0	460,0	488,0	519,0	549,0	580,0	610,0	641,0	672,0	702,0	733,0	763,0
17	430,0	461,0	489,0	520,0	550,0	581,0	611,0	642,0	673,0	703,0	734,0	764,0
18	431,0	462,0	490,0	521,0	551,0	582,0	612,0	643,0	674,0	704,0	735,0	765,0
19	432,0	463,0	491,0	522,0	552,0	583,0	613,0	644,0	675,0	705,0	736,0	766,0
20	433,0	464,0	492,0	523,0	553,0	584,0	614,0	645,0	676,0	706,0	737,0	767,0
21	434,0	465,0	493,0	524,0	554,0	585,0	615,0	646,0	677,0	707,0	738,0	768,0
22	435,0	466,0	494,0	525,0	555,0	586,0	616,0	647,0	678,0	708,0	739,0	769,0
23	436,0	467,0	495,0	526,0	556,0	587,0	617,0	648,0	679,0	709,0	740,0	770,0
24	437,0	468,0	496,0	527,0	557,0	588,0	618,0	649,0	680,0	710,0	741,0	771,
25	438,0	469,0	497,0	528,0	558,0	589,0	619,0	650,0	681,0	711,0	742,0	772,0
26	439,0	470,0	498,0	29,0	559,0	590,0	620,0	651,0	682,0	712,0	743,0	773,0
27	440,0	471,0	499,0	530,0	560,0	591,0	621,0	652,0	683,0	713,0	744,0	774,0
28	441,0	472,0	500,0	531,0	561,0	592,0	622,0	653,0	684,0	714,0	745,0	775,0
29	442,0		501,0	532,0	562,0	593,0	623,0	654,0	685,0	715,0	746,0	776,0
30	443,0		502,0	533,0	563,0	594,0	624,0	655,0	686,0	716,0	747,0	777,0
31	444,0		503,0		564,0		625,0	656,0		717,0		778,0

P L A N E T A R I U M

University
of the
Witwatersrand.



EXPLORE THE FASCINATION OF THE UNIVERSE SEATED IN THE ARMCHAIR COMFORT OF AFRICA'S ONLY MAJOR ZEISS PLANETARIUM AND THEATRE OF THE STARS.

NIGHTLY: TUESDAY TO SATURDAY 20^{H} 30^{M} .

MATINEES: SATURDAY 15^{H} 00, SUNDAY 16^{H} 00.

TEN DIFFERENT PROGRAMMES ARE PRESENTED EVERY YEAR.

TELESCOPES: A MOST COMPREHENSIVE RANGE OF TELESCOPES IS DISPLAYED AND SOLD AT THE PLANETARIUM, FOYER BOOKSHOP.

ENQUIRIES: TELEPHONE 724 - 2853.

POSTAL ADDRESS:

P.O. Box 31149,
BRAAMFONTEIN, JOHANNESBURG, 2017.