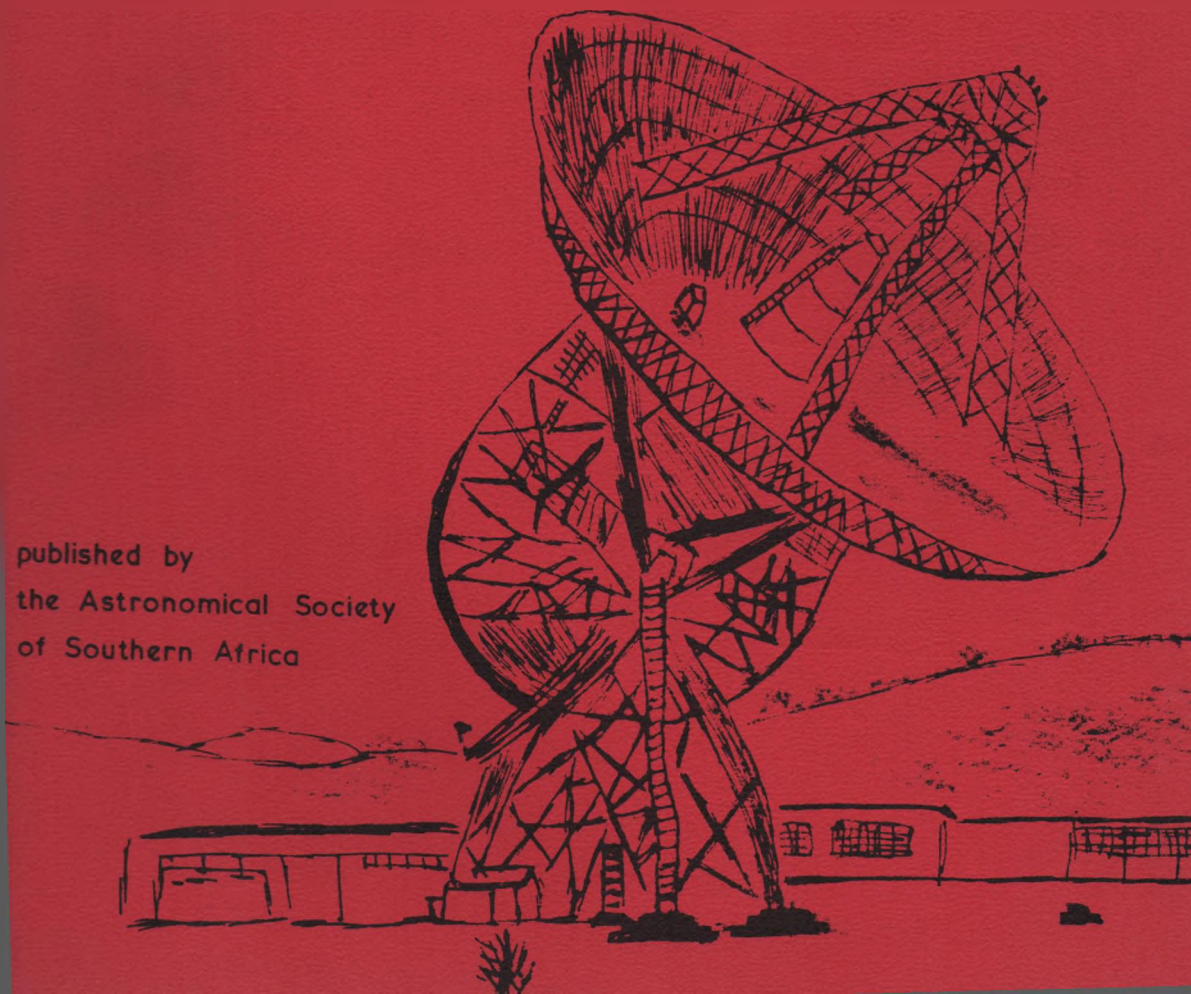
ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1977



published by
the Astronomical Society
of Southern Africa

ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1977

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.

Front Cover: Radio Telescope, Hartebeesthoek.

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 for the Astronomical Society of Southern Africa. Most of the data it contains have been adapted for Southern Africa from the "Astronomical Ephememeris for 1977" 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 and from the Hydrographer, South African Navy.

Thanks are due to Dr A.P. Fairall for his invaluable assistance and advice and to Messrs G and C Larmuth for the preparation of much of the data and to the Printing Department of the University of Cape Town.

All correspondence concerning this booklet should be addressed to the Handbook Editor, Astronomical Society of Southern Africa, 8 Glebe Road, 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 R1 per copy.

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.

R.F. HURLY
EDITOR

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, 25 km from Bloemfontein is operated by the department of Astronomy of the University of The Orange Free State. Observing facilities include the 1,5 m Rockefeller Reflector. The site offers good observing conditions, without being remote from a large centre. Enquiries as to use of the observatory should be addressed to the Director.

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 Research Council has merged their facilities and moved the larger instruments to a new site near Sutherland in the Karroo. Observing continues at Cape Town which is also the Headquarters of the S. A. A. O. The S. A. A. O. outstation at Hartebeespoort continues to share the site with the Leiden Observatory Southern Station which has a 0,9 m. "light collector" reflector.

The 1,9m Radcliffe reflector formerly near Pretoria and the largest telescope in Southern Africa has now been erected in Sutherland.

In the field of Radio Astronomy, the 26 metre dish of the newly created Radio Astronomy Observatory at Hartebeesthoek, near Krugersdorp is devoted entirely to research work, 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

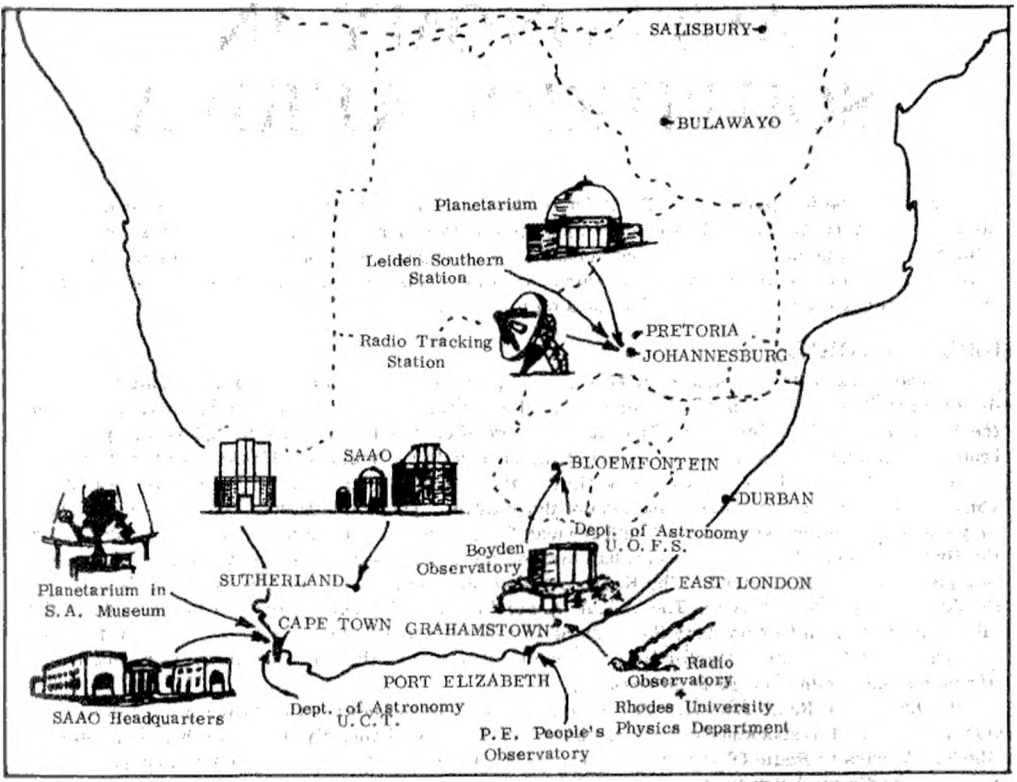
Visiting nights at Boyden Observatory are generally held around the time of first quarter. Enquiries should be made direct to the Observatory. Numbers are restricted to twenty persons on each occasion.

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 3.30 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 "The Monthly Notes of the Astronomical Society of Southern Africa" (MNASSA). 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 R12.00 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, Pietermaritzburg, Pretoria and Salisbury. Visitors are very welcome at meetings and may, if they wish, join a Centre, without becoming a full member (i.e. receiving publications for R12 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 telephone (day time) 69-8531 ext. 256 (evenings) 61-5300.

TRANSVAAL CENTRE (Johannesburg) - Alternate lecture and observing meetings are held each month. There is a very enthusiastic lunar occultation group which observes grazing occultations within a radius of approximately 250 km of Johannesburg. Mirror making classes are held at suitable intervals and the centre has its own aluminising plant. Secretarial address: Box 6896 Johannesburg 2000. Telephone 334-7777.

NATAL CENTRE (Durban) - Monthly meetings are held every third Wednesday at 7.45 p.m. at the Teacher's Centre, 49 Lambert Road, Durban and the Committee meets in private homes on the Monday evening after the general meeting. Secretarial address Box 2704 Durban 4000. Telephone 313021 Office, 723187 Home.

NATAL MIDLANDS CENTRE (Pietermaritzburg) -Meetings are held monthly at various venues. Secretarial address 17 Yalta Rd., Pietermaritzburg 3201. Telephone 54038.

FREE STATE CENTRE (Bloemfontein) - Meetings are held every third Wednesday of the month. For further information contact Mr G.J. Muller at 35 Wilcocks Road, Bloemfontein, telephone 73442 or Mr F.C. Neser telephone 85442 (work).

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

SALISBURY CENTRE - Monthly meetings are held on the 1st Thursday of the month usually at St. George's College. A very enthusiastic lunar occultation group exists. The Centre has a portable 30cm reflecting telescope and also a small refractor. For information contact C. Rijsdijk P.O. Box UA 428. Union Avenue, Salisbury, telephone (evenings) 37599.

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.

Comets and Meteors	see page 28
Grazing Occultations	see page 38
Nova Search Section	see page 33
Ordinary Occultations	see page 35
Variable stars	see page 34

DIARY 1977

JANUARY

1d	04h	Jupiter 0°.8 N of Moon. Occultations not visible in S. A.
3	12	Earth at perihelion 59/60 A. U from Sun
8	02	Saturn 6°N of Moon
12	14	Mercury 6°N of Mars
14	06	Uranus 0°.6S of Moon Occultation not visible in S. A.
15	22	Jupiter stationary
16	14	Neptune 4°S of Moon
18	03	Mercury 2°S of Moon
18	14	Mars 6°S of Moon
23	11	Pluto stationary
23	13	Venus 3°S of Moon
24	14	Venus greatest elongation E 47°
28	12	Jupiter 1°N of Moon
29	02	Mercury greatest elongation W 25°

FEBRUARY

2d	12h	Saturn at opposition. Mag. +0.1
4	06	Saturn 6°N of Moon
10	12	Uranus 0°.9 S of Moon. Occultation not visible in S. A.
11	21	Ceres stationary
12	21	Mercury 0°.1 S of Mars
12	22	Neptune 2°S of Moon
15	00	Uranus stationary
16	14	Mars 6°S of Moon
16	19	Mercury 9°S of Moon
21	19	Venus 3°N of Moon
25	00	Jupiter 2°N of Moon
26	11	Vesta stationary

MARCH

1d	04h	Venus greatest brilliancy Mag – 4.3
3	11	Saturn 6°N of Moon
9	17	Uranus 1°S of Moon
11	09	Pallas stationary
12	04	Neptune 3°S of Moon
14	21	Venus stationary
17	14	Mars 6°S of Moon
18	13	Neptune stationary
20	20	Equinox
21	09	Juno stationary
21	15	Venus 8°N of Moon
24	17	Jupiter 2°N of Moon
24	22	Ceres at opposition
27	21	Venus 8°S of Moon
30	19	Saturn 6°N of Moon

APRIL

2d	18h	Pluto at opposition
4	06	Eclipse of Moon (see page 9)
6	00	Uranus 1°S of Moon
6	08	Venus in inferior conjunction
8	10	Neptune 3°S of Moon
10	18	Mercury greatest elongation E 19°
11	09	Saturn stationary
15	14	Mars 4°S of Moon
16	22	Venus 5°N of Moon
18	13	Partial Eclipse of Sun see p. 7
19	18	Mercury 5°N of Moon
21	11	Jupiter 3°N of Moon
24	23	Venus stationary
27	03	Saturn 6°N of Moon
30	08	Uranus at opposition

MAY

3d	09h	Uranus 1°S of Moon
5	18	Neptune 3°S of Moon
12	01	Venus greatest brilliancy -4,2
13	06	Juno at opposition
13	20	Venus 1°.3 N of Mars
14	13	Venus 1°S of Moon
14	14	Mars 2°S of Moon
16	09	Mercury 2°S of Moon
17	08	Ceres stationary
20	15	Jupiter 5°N of Aldeberan
24	13	Saturn 6°N of Moon
28	01	Mercury greatest elongation W 25°
30	18	Uranus 0°19 S of Moon

JUNE

2d	04h	Neptune 2°S of Moon
3	15	Venus 1°.2 S of Mars
4	12	Jupiter in conjunction with the Sun
5	16	Neptune at opposition
12	13	Mars 0°.1 N of Moon Occultation not visible in S. A.
12	17	Venus 2°S of Moon
15	07	Mercury 2°N of Moon
15	09	Venus greatest elongation W 46°
16	17	Mercury 5°N of Aldeberan
20	09	Mercury 0°.1N of Jupiter
20	23	Saturn 6°N of Moon
21	14	Solstice
27	02	Uranus 1°S of Moon
28	23	Pluto stationary
29	13	Neptune 2°S of Moon

JULY

5d	22h	Earth at aphelion, 1 1/60 AU from Sun
11	13	Mars 2°N of Moon
12	11	Venus 1°N of Moon, occultation visible from S. A.
12	22	Juno stationary
13	21	Jupiter 4°N of Moon
15	21	Venus 3°N of Aldeberan
16	16	Uranus stationary
18	05	Mercury 6°N of Moon
18	11	Saturn 6°N of Moon
20	03	Mercury 0°.4 N of Saturn
24	09	Uranus 1°S of Moon
26	11	Neptune 3°S of Moon
28	05	Mercury 0°.1 S of Regulus
30	08	Venus 1°.8 S of Jupiter

AUGUST

1d	14h	Mars 5°N of Aldeberan
8	22	Mercury greatest elongation E 27°
9	13	Mars 4°N of Moon
10	15	Jupiter 4°N of Moon
11	14	Venus 4°N of Moon
13	08	Saturn in conjunction with the Sun
17	01	Mercury 0°.9 S of Moon
20	15	Uranus 2°S of Moon
23	03	Neptune 3°S of Moon
23	19	Venus 7°S of Pollux
25	17	Neptune stationary

SEPTEMBER

5d	00h	Mars 0°.5 N of Jupiter
7	09	Jupiter 5°N of Moon
7	11	Mars 5°N of Moon
10	23	Venus 5°N of Moon
11	15	Saturn 5°N of Moon
15	10	Vesta in conjunction with Sun
16	23	Uranus 2°S of Moon
18	15	Venus 0°.4 S of Saturn
19	09	Neptune 3° S of Moon
21	10	Mercury greatest elongation W 18°
22	05	Venus 0°.4 N of Regulus
23	06	Equinox
27	10	Penumbral eclipse not visible in S. A.

OCTOBER

4d	23h	Jupiter 5°N of Moon
6	05	Mars 6°N of Moon
7	14	Pluto in conjunction with Sun
9	06	Saturn 5°N of Moon
11	03	Venus 4°N of Moon
12	23	Total Eclipse of Sun not visible in Africa
13	16	Mars 6°S of Pollux
14	19	Uranus 2°S of Moon
19	03	Pallas in conjunction with the Sun
24	13	Jupiter stationary

NOVEMBER

1d	07h	Jupiter 5°N of Moon
3	14	Saturn 0°.8 N of Regulus
3	16	Mars 7°N of Moon
3	22	Venus 4°N of Spica
4	18	Uranus in conjunction with the Sun
5	20	Saturn 5°N of Moon
10	02	Venus 0°.1 N of Moon Occultation not visible in S. A.
13	02	Neptune 3°S of Moon
15	21	Mercury 3°N of Antares
20	10	Mercury 4°S of Neptune
20	12	Venus 0°.9 N of Uranus
23	07	Ceres in conjunction with the Sun
28	10	Jupiter 5°N of the Moon

DECEMBER

1d	15h	Mars 7°N of Moon
3	05	Saturn 5°N of Moon
3	10	Mercury greatest elongation E 21°
8	04	Neptune in conjunction with the Sun
8	12	Uranus 2°S of Moon
11	01	Venus 5°N of Antares
12	02	Mercury 6°S of Moon
12	09	Saturn stationary
13	21	Mars stationary
15	19	Juno in conjunction with the Sun
21	16	Mercury in inferior conjunction
22	01	Solstice
23	03	Jupiter at opposition
25	09	Jupiter 5°N of Moon
28	20	Mars 8°N of Moon
30	11	Saturn 5°N of Moon

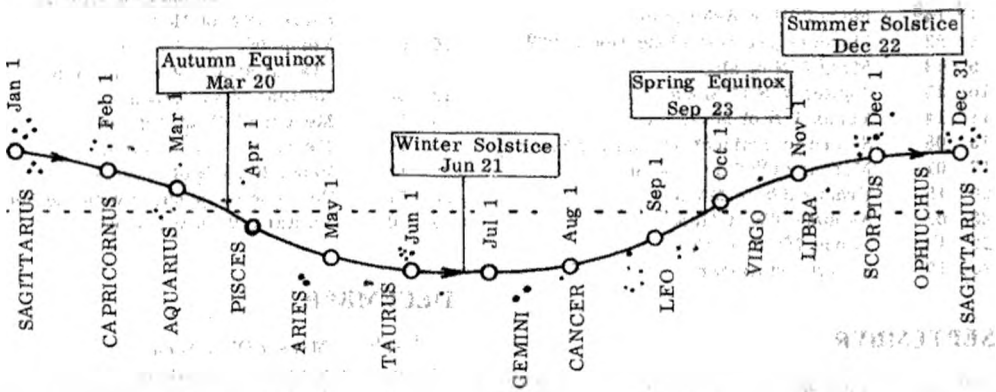
THE SUN 1977

BASIC DATA

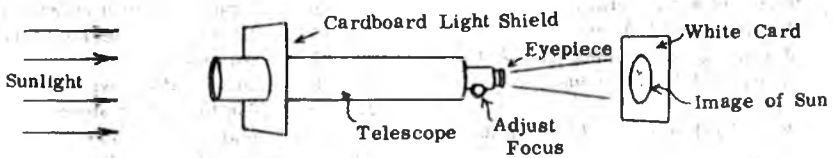
Diameter: 1 392 000 km (109 times Earth diameter)
Mass: $1,99 \times 10^{30}$ kg (330 000 times Earth Mass)
Surface Temperature: Approx. $6000^{o}C$
Temperature at centre: Approx. 10 million^{o}C

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 1977 we will be closest to the Sun on January 3 (perihelion – approx. distance 147 million km.) and furthest from the Sun on July 5 (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	05h 38m	20h 01m	04h 58m	19h 01m	05h 21m	19h 18m	05h 18m	19h 04m	05h 24m	18h 35m
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 46	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

Annular eclipse of the Sun April 18. This eclipse is visible as a partial eclipse from Southern Africa.

	Cape Town	Johannesburg	Salisbury
Eclipse begins (P.A.)	$10^h\ 04^m.0$ (265°)	$10^h\ 21^m.8$ (261°)	$10^h\ 31^m.9$ (251°)
Maximum eclipse (magnitude)	11 36,1 (61%)	12 08,1 (65%)	12 29,8 (80%)
Eclipse ends (P.A.)	13 18,0 (42°)	13 58,6 (46°)	14 26,0 (56°)

The position angle (P.A.) of the point of contact is measured eastwards from the north point of the Sun. The magnitude is the percentage of the Sun's diameter obscured.

The Total eclipse of the Sun on October 12 will not be visible in South Africa.

THE MOON 1977

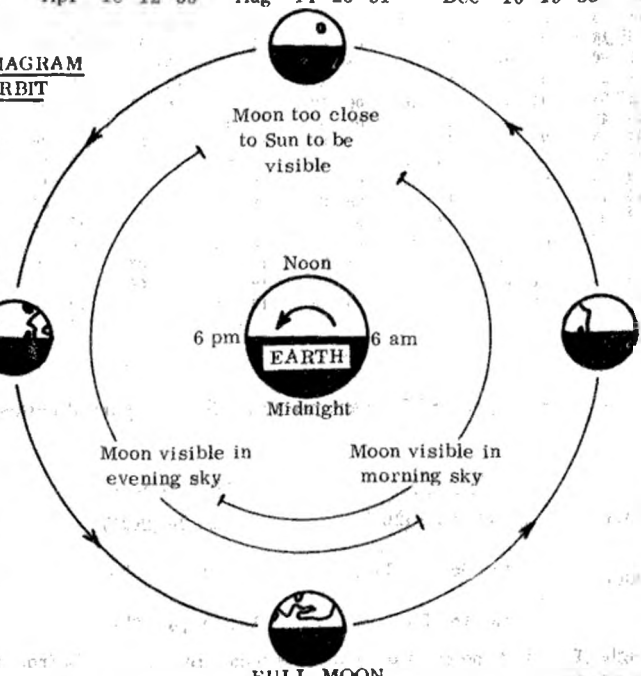
BASIC DATA

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

SCHEMATIC DIAGRAM OF MOON'S ORBIT



SUNLIGHT

NEW MOON

	d	h	m		d	h	m		d	h	m
Jan	19	16	11	May	18	04	51	Sep	13	11	23
Feb	18	05	37	Jun	16	20	23	Oct	12	22	31
Mar	19	20	33	Jul	16	10	37	Nov	11	09	09
Apr	18	12	35	Aug	14	23	31	Dec	10	19	33

FIRST QUARTER

	d	h	m
Jan	27	07	11
Feb	26	04	50
Mar	28	00	27
Apr	26	16	42
May	26	05	20
Jun	24	14	44
Jul	23	21	38
Aug	22	03	04
Sep	20	08	18
Oct	19	14	46
Nov	17	23	52
Dec	17	12	37

LAST QUARTER

	d	h	m
Jan	12	21	55
Feb	11	06	07
Mar	12	13	35
Apr	10	21	15
May	10	06	08
Jun	8	17	07
Jul	8	06	39
Aug	6	22	40
Sep	5	16	33
Oct	5	11	21
Nov	4	05	58
Dec	3	23	16

FULL MOON

	d	h	m		d	h	m		d	h	m
Jan	5	14	10	Jun	1	22	31	Sep	27	10	17
Feb	4	05	56	Jul	1	05	24	Oct	27	01	35
Mar	5	19	13	Jul	30	12	52	Nov	25	19	31
Apr	4	06	09	Aug	28	22	10	Dec	25	14	49
May	3	15	03								

THE MOON'S ORBIT

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	28	Jun	14	Oct	3	Jan	16	Jun	1	Sep	18
Feb	25	Jul	12	Oct	31	Feb	11	Jun	30	Oct	15
Mar	25	Aug	9	Nov	27	Mar	9	Jul	28	Nov	12
Apr	21	Sep	5	Dec	24	Apr	5	Aug	24	Dec	11
May	18					May	4				

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 35) and close to visible planets (details given in Diary pages 4 and 5).

TIMES OF MOONRISE AND MOONSET

Times for Bloemfontein, Cape Town, Durban, Johannesburg and Port Elizabeth can be obtained from the tables on pages 11 to 16.

LUNAR ECLIPSE

Partial eclipse of the Moon, April 4, 20% obscured at maximum.

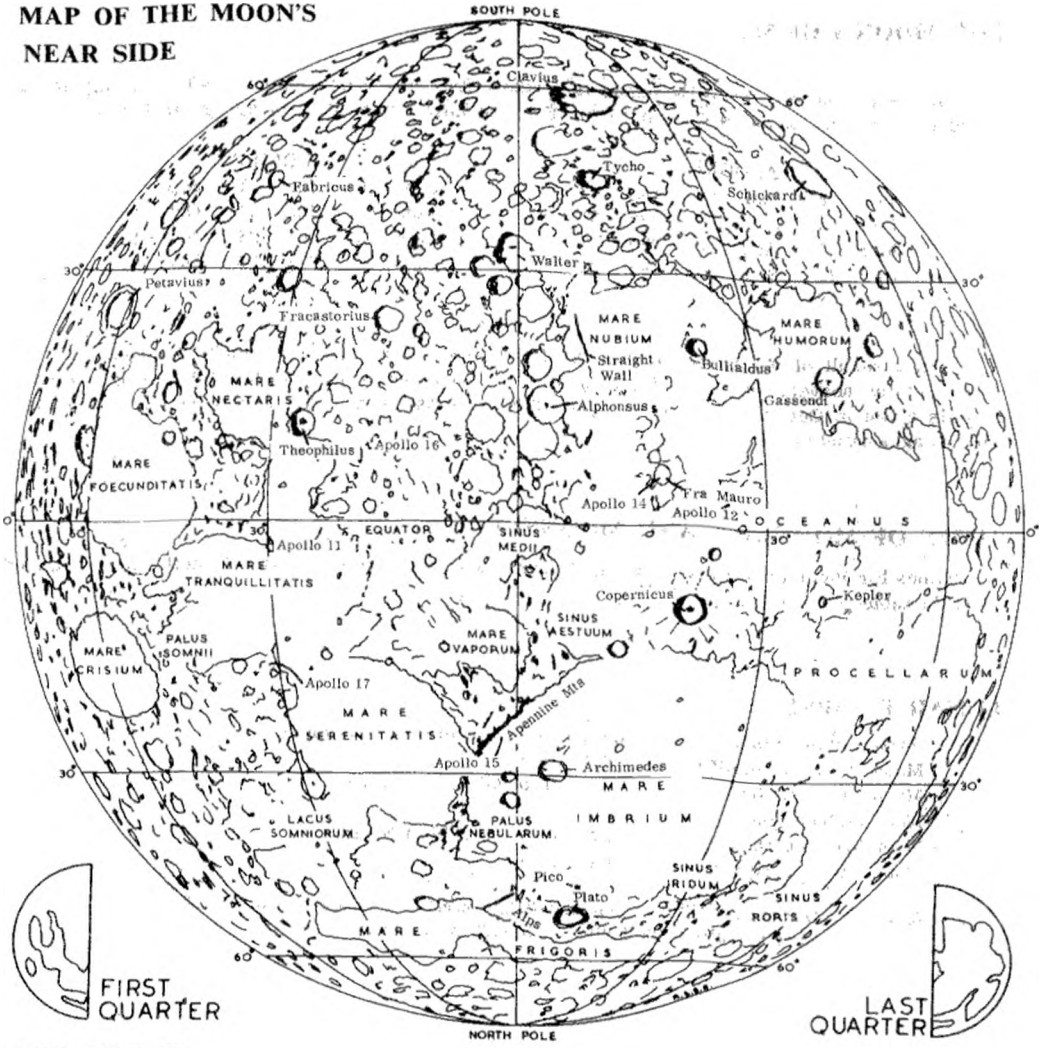
Moon enters penumbra	$04^h\ 05.8^m$	
Moon enters umbra	05 31.0	(at 44°E of North)
Moon mid-eclipse	06 19.0	
Moon leaves umbra	07 07.2	(at 9°W of North)
Moon leaves penumbra	08 32.3	

Moonset Durban 06^h12^m Johannesburg 06^h23^m Cape Town 07^h07^m
Port Elizabeth 06^h39^m Bloemfontein 06^h31^m

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 impacts 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



FIRST QUARTER

LAST QUARTER

LIBRATIONS

Jan 20 Feb 16 Mar 15
Apr 11 May 8 Jun 5
Jul 1/29 Aug 25 Sep 22
Oct 19 Nov 15 Dec 12

Jan 7 Feb 3 Mar 2/29
Apr 26 May 23 Jun 19
Jul 16 Aug 12 Sep 8
Oct 6 Nov 2/29 Dec 26

Dates of Maximum Exposure of Indicated Limbs

Jan 8 Feb 3 Mar 3/31
Apr 28 May 26 Jun 24
Jul 21 Aug 16 Sep 12
Oct 10 Nov 7 Dec 5

Jan 22 Feb 19 Mar 17
Apr 13 May 11 Jun 8
Jul 6 Aug 3/30 Sep 26
Oct 23 Nov 19 Dec 17

	JANUARY		FEBRUARY		MARCH	
	Rise	Set	Rise	Set	Rise	Set
1	15h41m	02h04m	16h50m	03h04m	15h27m	01h46m
2	16 32	02 46	17 36	03 58	16 11	02 40
3	17 21	03 33	18 20	04 53	16 54	03 36
4	18 10	04 21	19 02	05 51	17 37	04 35
5	18 57	05 14	19 43	06 49	18 18	05 35
6	19 41	06 08	20 23	07 49	19 00	06 36
7	20 24	07 03	21 04	08 49	19 43	07 37
8	21 04	08 01	21 46	09 49	20 28	08 41
9	21 44	08 58	22 30	10 51	21 16	09 45
10	22 23	09 56	23 18	11 53	22 07	10 48
11	23 03	10 55		12 55	23 01	11 50
12	23 46	11 56	00 10	13 56	23 58	12 50
13		12 57	01 04	14 55		13 46
14	00 31	14 00	02 03	15 50	00 56	14 37
15	01 20	15 03	03 02	16 41	01 56	15 24
16	02 14	16 05	04 03	17 28	02 55	16 08
17	03 12	17 04	05 03	18 11	03 52	16 49
18	04 14	18 00	06 01	18 51	04 48	17 26
19	05 16	18 50	06 58	19 29	05 43	18 03
20	06 18	19 36	07 53	20 06	06 37	18 40
21	07 18	20 18	08 46	20 42	07 30	19 17
22	08 16	20 56	09 39	21 19	08 23	19 54
23	09 11	21 33	10 32	21 57	09 14	20 34
24	10 05	22 09	11 23	22 38	10 05	21 15
25	10 58	22 46	12 14	23 20	10 56	21 59
26	11 50	23 22	13 04		11 45	22 46
27	12 41		13 53	00 06	12 33	23 36
28	13 32	00 01	14 41	00 54	13 19	
29	14 23	00 42			14 03	00 28
30	15 13	01 26			14 46	01 22
31	16 02	02 14			15 28	02 18

OF MOONRISE AND MOONSET

APRIL		MAY		JUNE	
Rise	Set	Rise	Set	Rise	Set
16h09m	03h16m	16h07m	04h00m	17h18m	06h02m
16 51	04 17	16 53	05 05	18 19	07 07
17 34	05 18	17 44	06 12	19 22	08 10
18 19	06 23	18 38	07 19	20 26	09 08
19 06	07 28	19 37	08 25	21 29	09 59
19 58	08 34	20 39	09 28	22 30	10 45
20 53	09 39	21 40	10 26	23 26	11 27
21 51	10 42	22 42	11 19		12 05
22 51	11 40	23 41	12 06	00 22	12 44
23 51	12 35		12 49	01 15	13 19
	13 23	00 38	13 28	02 08	13 55
00 50	14 08	01 34	14 05	03 00	14 32
01 47	14 48	02 27	14 41	03 51	15 11
02 43	15 27	03 20	15 17	04 41	15 52
03 38	16 03	04 12	15 53	05 32	16 36
04 31	16 39	05 02	16 31	06 21	17 23
05 24	17 15	05 54	17 11	07 09	18 11
06 16	17 53	06 46	17 53	07 55	19 03
07 08	18 31	07 36	18 38	08 39	19 55
07 59	19 13	08 24	19 26	09 20	20 49
08 50	19 55	09 11	20 15	10 00	21 43
09 40	20 41	09 56	21 06	10 38	22 38
10 27	21 29	10 38	21 59	11 16	23 35
11 14	22 20	11 19	22 53	11 55	
11 57	23 12	11 59	23 48	12 36	00 33
12 40		12 37		13 20	01 34
13 21	00 06	13 17	00 45	14 08	02 37
14 02	01 02	13 58	01 44	15 01	03 41
14 42	01 59	14 41	02 45	15 59	04 46
15 23	02 59	15 28	03 49	17 01	05 50
		16 20	04 55		

JOHANNESBURG — TIMES OF

	JULY		AUGUST		SEPTEMBER	
	Rise	Set	Rise	Set	Rise	Set
1	18h05m	06h50m	19h56m	07h56m	21h26m	08h26m
2	19 10	07 46	20 54	08 36	22 19	09 04
3	20 13	08 36	21 50	09 14	23 11	09 44
4	21 14	09 21	22 44	09 52		10 26
5	22 10	10 02	23 37	10 30	00 02	11 09
6	23 07	10 41		11 08	00 52	11 55
7		11 18	00 29	11 48	01 40	12 43
8	00 01	11 54	01 20	12 30	02 26	13 34
9	00 53	12 32	02 11	13 14	03 11	14 26
10	01 45	13 10	03 00	14 02	03 53	15 21
11	02 36	13 51	03 47	14 51	04 34	16 17
12	03 27	14 33	04 33	15 43	05 15	17 13
13	04 17	15 19	05 17	16 37	05 55	18 12
14	05 06	16 07	05 59	17 31	06 35	19 12
15	05 53	16 58	06 39	18 27	07 17	20 12
16	06 38	17 50	07 18	19 25	08 01	21 15
17	07 20	18 44	07 58	20 22	08 47	22 17
18	08 00	19 39	08 38	21 21	09 38	23 19
19	08 40	20 34	09 19	22 21	10 32	
20	09 19	21 30	10 02	23 22	11 29	00 19
21	09 57	22 27	10 49		12 28	01 16
22	10 36	23 26	11 41	00 24	13 30	02 09
23	11 18		12 36	01 25	14 30	02 57
24	12 03	00 27	13 35	02 24	15 29	03 42
25	12 52	01 28	14 36	03 21	16 27	04 25
26	13 46	02 31	15 38	04 13	17 25	05 05
27	14 44	03 34	16 40	05 03	18 21	05 43
28	15 46	04 34	17 41	05 47	19 15	06 21
29	16 50	05 32	18 40	06 29	20 09	07 00
30	17 54	06 24	19 36	07 09	21 02	07 40
31	18 56	07 11	20 32	07 48		

MOONRISE AND MOONSET

OCTOBER		NOVEMBER		DECEMBER	
Rise	Set	Rise	Set	Rise	Set
21h53m	08h20m	22h58m	09h17m	23h00m	09h43m
22 44	09 03	23 42	10 07	23 42	10 36
23 33	09 48		10 59		11 29
	10 35	00 23	11 51	00 16	12 24
00 19	11 25	01 02	12 45	00 54	13 20
01 03	12 15	01 41	13 40	01 34	14 20
01 46	13 08	02 20	14 38	02 16	15 21
02 27	14 02	03 00	15 38	03 02	16 26
03 08	14 59	03 43	16 39	03 53	17 32
03 47	15 57	04 28	17 44	04 49	18 38
04 28	16 56	05 17	18 50	05 50	19 41
05 10	17 58	06 11	19 56	06 54	20 40
05 53	19 00	07 10	20 59	08 00	21 33
06 40	20 05	08 11	21 58	09 04	22 20
07 31	11 09	09 14	22 52	10 07	23 04
08 26	22 12	10 16	23 41	11 05	23 44
09 23	23 11	11 17		12 03	
10 23		12 16	00 25	12 58	00 22
11 24	00 06	13 13	01 05	13 51	01 00
12 24	00 56	14 08	01 43	14 44	01 37
13 23	01 42	15 02	02 21	15 36	02 15
14 21	02 24	15 56	02 58	16 27	02 55
15 17	03 04	16 48	03 36	17 18	03 37
16 12	03 42	17 40	04 15	18 07	04 22
17 07	04 20	18 31	04 56	18 54	05 09
18 01	04 57	19 22	05 39	19 38	05 58
18 54	05 36	20 10	06 25	20 21	06 48
19 46	06 16	20 56	07 12	21 01	07 40
20 37	06 59	21 39	08 02	21 39	08 32
21 26	07 43	22 20	08 51	22 17	09 24
22 14	08 29			22 54	10 17

CAPE TOWN — TIMES OF MOONRISE AND MOONSET
FOR PORT ELIZABETH SUBTRACT 28 MINUTES

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	16h34m	02h32m	17h44m	03h31m	16h20m	02h13m	16h53m	03h52m	16h43m	04h44m	17h45m	06h55m
2	17 25	03 13	18 28	04 25	17 02	03 08	17 31	04 55	17 26	05 52	18 45	08 02
3	18 16	03 58	19 10	05 23	17 43	04 08	18 12	06 00	18 14	07 01	19 49	09 04
4	19 05	04 48	19 49	06 22	18 22	05 08	18 53	07 07	19 06	08 11	20 55	10 00
5	19 50	05 41	20 27	07 24	19 01	06 11	19 38	08 16	20 03	09 18	22 00	10 49
6	20 32	06 36	21 04	08 26	19 39	07 15	20 27	09 25	21 05	10 22	23 03	11 33
7	21 13	07 34	21 42	09 30	20 19	08 20	21 21	10 32	22 08	11 19		12 12
8	21 50	08 33	22 21	10 34	21 00	09 27	22 18	11 36	23 12	12 11	00 04	12 48
9	22 27	09 34	23 02	11 39	21 46	10 34	23 18	12 34		12 55	01 02	13 22
10	23 03	10 35	23 48	12 43	22 35	11 40		13 28	00 13	13 35	01 58	13 55
11	23 40	11 38		13 48	23 28	12 44	00 19	14 14	01 14	14 12	02 53	14 29
12		12 41	00 37	14 50		13 44	01 21	14 57	02 12	14 46	03 47	15 04
13	00 19	13 46	01 31	15 49	00 25	14 39	02 20	15 34	03 08	15 20	04 41	15 40
14	01 02	14 51	02 29	16 43	01 24	15 30	03 19	16 10	04 04	15 52	05 34	16 20
15	01 49	15 56	03 30	17 33	02 25	16 15	04 17	16 44	04 58	16 27	06 25	17 03
16	02 41	16 59	04 33	18 18	03 26	16 56	05 13	17 17	05 52	17 02	07 15	17 49
17	03 38	17 59	05 35	18 58	04 26	17 34	06 08	17 50	06 46	17 40	08 04	18 39
18	04 40	18 53	06 36	19 36	05 25	18 09	07 03	18 26	07 39	18 21	08 48	19 31
19	05 44	19 41	07 36	20 10	06 23	18 43	07 57	19 02	08 29	19 05	09 30	20 24
20	06 48	20 24	08 34	20 44	07 20	19 16	08 51	19 41	09 18	19 52	10 10	21 21
21	07 51	21 03	09 31	21 17	08 15	19 51	09 43	20 23	10 05	20 42	10 47	22 17
22	08 52	21 39	10 26	21 52	09 10	20 26	10 33	21 08	10 49	21 35	11 23	23 16
23	09 51	22 13	11 21	22 28	10 05	21 03	11 22	21 56	11 29	22 29	11 58	
24	10 48	22 46	12 14	23 06	10 58	21 43	12 07	22 48	12 09	23 26	12 35	00 15
25	11 44	23 20	13 07	23 47	11 49	22 26	12 50	23 41	12 45		13 12	01 17
26	12 37	23 54	13 57		12 38	23 13	13 31		13 22	00 24	13 52	02 20
27	13 31		14 47	00 32	13 27		14 09	00 37	13 58	01 23	14 38	03 26
28	14 24	00 30	15 35	01 21	14 12	00 03	14 47	01 35	14 36	02 26	15 29	04 33
29	15 16	01 10			14 54	00 56	15 24	02 36	15 16	03 30	16 26	05 40
30	16 07	01 52			15 36	01 52	16 02	03 39	16 00	04 37	17 27	06 45
31	16 56	02 40			16 14	02 51			16 49	05 46		

CAPE TOWN — TIMES OF MOONRISE AND MOONSET
FOR PORT ELIZABETH SUBTRACT 28 MINUTES

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	18h33m	07h44m	20h33m	08h40m	22h13m	09h01m	22h46m	08h50m	23h52m	09h45m	23h49m	10h14m
2	19 40	08 38	21 34	09 18	23 09	09 37	23 37	09 31		10 36		11 09
3	20 45	09 25	22 33	09 54		10 15		10 15	00 33	11 28	00 24	12 05
4	21 49	10 08	23 30	10 29	00 03	10 54	00 26	11 02	01 13	12 23	01 00	13 03
5	22 50	10 46		11 04	00 55	11 36	01 13	11 52	01 50	13 19	01 35	14 02
6	23 49	11 21	00 25	11 40	01 45	12 22	01 56	12 44	02 26	14 18	02 12	15 04
7		11 56	01 20	12 17	02 34	13 10	02 37	13 39	03 02	15 18	02 50	16 09
8	00 46	12 29	02 13	12 58	03 19	14 02	03 17	14 35	03 40	16 21	03 34	17 16
9	01 40	13 05	03 04	13 41	04 02	14 55	03 54	15 34	04 18	17 26	04 22	18 25
10	02 35	13 41	03 53	14 28	04 44	15 52	04 32	16 35	05 00	18 33	05 16	19 32
11	03 28	14 19	04 41	15 19	05 22	16 50	05 08	17 38	05 47	19 42	06 16	20 35
12	04 20	15 00	05 26	16 11	06 00	17 51	05 47	18 42	06 39	20 50	07 22	21 32
13	05 11	15 45	06 08	17 07	06 37	18 52	06 28	19 49	07 36	21 53	08 29	22 23
14	06 00	16 34	06 48	18 04	07 15	19 55	07 12	20 55	08 38	22 51	09 35	23 09
15	06 46	17 26	07 26	19 03	07 53	20 59	08 00	22 02	09 42	23 44	10 40	23 48
16	07 30	18 19	08 03	20 03	08 34	22 04	08 53	23 06	10 46		11 42	
17	08 11	19 15	08 39	21 03	09 18	23 08	09 50		11 49	00 30	12 42	00 26
18	08 49	20 12	09 16	22 05	10 06		10 50	00 05	12 51	01 11	13 41	01 02
19	09 25	21 10	09 54	23 08	10 59	00 12	11 52	00 59	13 51	01 49	14 37	01 38
20	10 01	22 09	10 35		11 56	01 13	12 55	01 47	14 49	02 24	15 32	02 11
21	10 37	23 10	11 20	00 11	12 56	02 09	13 56	02 31	15 46	02 59	16 27	02 47
22	11 14		12 09	01 16	13 58	03 01	14 57	03 10	16 42	03 33	17 20	03 25
23	11 52	00 11	13 03	02 18	15 01	03 48	15 56	03 47	17 37	04 09	18 11	04 05
24	12 34	01 15	14 01	03 18	16 03	04 31	16 55	04 22	18 32	04 46	19 00	04 49
25	13 21	02 19	15 04	04 14	17 05	05 10	17 52	04 57	19 24	05 25	19 48	05 35
26	14 13	03 24	16 08	05 06	18 05	05 47	18 48	05 32	20 15	06 07	20 31	06 25
27	15 11	04 28	17 12	05 52	19 04	06 23	19 44	06 09	21 04	06 51	21 12	07 16
28	16 13	05 28	18 16	06 34	20 01	06 58	20 38	06 47	21 49	07 39	21 51	08 09
29	17 19	06 24	19 18	07 13	20 58	07 33	21 30	07 27	22 32	08 29	22 26	09 04
30	18 24	07 14	20 18	07 50	21 53	08 11	22 19	08 10	23 11	09 21	23 02	09 58
31	19 30	08 00	21 17	08 26			23 08	08 56			23 35	10 55

DURBAN — TIMES OF MOONRISE AND MOONSET
FOR BLOEMFONTEIN ADD 19 MINUTES

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	15h34m	01h48m	16h44m	02h47m	15h21m	01h29m	15h59m	03h02m	15h53m	03h49m	17h00m	05h55m
2	16 25	02 30	17 29	03 40	16 04	02 23	16 39	04 04	16 38	04 55	18 01	07 01
3	17 15	03 15	18 12	04 37	16 46	03 20	17 21	05 06	17 28	06 03	19 05	08 03
4	18 04	04 04	18 53	05 35	17 27	04 20	18 05	06 12	18 21	07 11	20 09	09 01
5	18 51	04 56	19 33	06 35	18 07	05 21	18 51	07 19	19 19	08 18	21 13	09 51
6	19 34	05 51	20 12	07 36	18 48	06 23	19 42	08 26	20 21	09 21	22 15	10 37
7	20 16	06 47	20 52	08 37	19 29	07 26	20 36	09 32	21 23	10 20	23 13	11 17
8	20 55	07 46	21 32	09 38	20 13	08 31	21 33	10 35	22 26	11 12		11 55
9	21 33	08 44	22 15	10 41	21 00	09 36	22 33	11 34	23 26	11 58	00 10	12 31
10	22 12	09 44	23 02	11 45	21 50	10 40	23 34	12 28		12 40	01 04	13 06
11	22 51	10 44	23 53	12 48	22 44	11 43		13 16	00 24	13 18	01 58	13 41
12	23 31	11 45		13 49	23 40	12 43	00 34	14 00	01 21	13 54	02 51	14 17
13		12 48	00 47	14 49		13 40	01 32	14 39	02 15	14 29	03 43	14 55
14	00 15	13 52	01 45	15 44	00 39	14 30	02 29	15 17	03 09	15 04	04 34	15 36
15	01 04	14 56	02 45	16 34	01 39	15 17	03 25	15 52	04 02	15 39	05 25	16 19
16	01 57	15 58	03 47	17 21	02 39	16 00	04 20	16 27	04 55	16 16	06 15	17 05
17	02 54	16 58	04 48	18 02	03 37	16 39	05 13	17 02	05 47	16 55	07 03	17 54
18	03 56	17 53	05 47	18 41	04 35	17 16	06 07	17 38	06 39	17 36	07 49	18 46
19	04 59	18 42	06 45	19 19	05 31	17 52	07 00	18 16	07 29	18 21	08 32	19 38
20	06 02	19 28	07 41	19 54	06 26	18 27	07 52	18 57	08 18	19 08	09 12	20 33
21	07 03	20 08	08 36	20 29	07 20	19 03	08 43	19 39	09 05	19 58	09 51	21 28
22	08 02	20 46	09 30	21 05	08 14	19 40	09 35	20 24	09 50	20 50	10 29	22 25
23	08 59	21 22	10 23	21 42	09 06	20 18	10 21	21 12	10 31	21 43	11 06	23 23
24	09 54	21 57	11 15	22 22	09 58	20 59	11 08	22 03	11 11	22 38	11 44	
25	10 48	22 32	12 07	23 03	10 49	21 42	11 51	22 56	11 50	23 34	12 23	00 25
26	11 41	23 07	12 57	23 48	11 38	22 29	12 35	23 50	12 28		13 05	01 24
27	12 33	23 45	13 46		12 26	23 19	13 13		13 06	00 32	13 52	02 28
28	13 25		14 35	00 37	13 13		13 52	00 47	13 45	01 33	14 44	03 33
29	14 16	00 26			13 56	00 11	14 32	01 46	14 27	02 34	15 41	04 39
30	15 07	01 09			14 38	01 05	15 11	02 47	15 13	03 40	16 43	05 43
31	15 56	01 56			15 19	02 03			16 04	04 47		

DURBAN — TIMES OF MOONRISE AND MOONSET
FOR BLOEMFONTEIN ADD 19 MINUTES

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	17h47m	06h44m	19h43m	07h46m	21h17m	08h13m	21h46m	08h05m	22h52m	09h00m	22h52m	09h28m
2	18 53	07 39	20 42	08 26	22 11	08 50	22 37	08 46	23 35	09 51	23 30	10 21
3	19 57	08 28	21 39	09 03	23 04	09 29	23 26	09 31		10 43		11 15
4	21 00	09 12	22 35	09 40	23 55	10 09		10 18	00 15	11 35	00 07	12 11
5	21 59	09 52	23 28	10 16		10 52	00 13	11 08	00 53	12 30	00 43	13 09
6	22 56	10 30		10 53	00 45	11 38	00 57	11 59	01 32	13 27	01 22	14 10
7	23 51	11 06	00 21	11 33	01 33	12 26	01 39	12 52	02 10	14 26	02 02	15 12
8		11 41	01 13	12 14	02 20	13 17	02 19	13 47	02 48	15 27	02 47	16 18
9	00 44	12 17	02 04	12 57	03 04	14 09	02 59	14 45	03 29	16 29	03 37	17 25
10	01 37	12 55	02 53	13 44	03 46	15 05	03 38	15 44	04 13	17 35	04 31	18 31
11	02 29	13 35	03 41	14 34	04 26	16 02	04 17	16 45	05 01	18 42	05 32	19 34
12	03 20	14 17	04 27	15 26	05 05	17 00	04 57	17 47	05 54	19 49	06 37	20 33
13	04 10	15 02	05 10	16 20	05 44	18 00	05 39	18 51	06 52	20 52	07 42	21 25
14	04 59	15 50	05 51	17 16	06 24	19 01	06 25	19 57	07 53	21 52	08 48	22 12
15	05 47	16 41	06 30	18 13	07 03	20 02	07 15	21 02	08 57	22 45	09 52	22 54
16	06 31	17 33	07 09	19 12	07 46	21 06	08 08	22 05	10 00	23 33	10 52	23 33
17	07 13	18 28	07 47	20 11	08 32	22 09	09 05	23 05	11 02		11 51	
18	07 52	19 24	08 26	21 11	09 21	23 12	10 05	23 59	12 02	00 16	12 47	00 11
19	08 30	20 20	09 06	22 12	10 14		11 07		13 00	00 55	13 41	00 47
20	09 09	21 18	09 47	23 13	11 11	00 12	12 08	00 48	13 56	01 33	14 35	01 23
21	09 46	22 16	10 33		12 11	01 09	13 08	01 34	14 52	02 09	15 28	02 01
22	10 24	23 16	11 24	00 16	13 13	02 02	14 07	02 15	15 46	02 45	16 20	02 40
23	11 04		12 18	01 18	14 14	02 50	15 05	02 54	16 40	03 22	17 11	03 21
24	11 47	00 17	13 17	02 18	15 15	03 34	16 01	03 31	17 33	04 00	18 00	04 05
25	12 36	01 20	14 19	03 14	16 14	04 15	16 57	04 07	18 24	04 40	18 48	04 51
26	13 29	02 24	15 22	04 06	17 13	04 54	17 52	04 44	19 15	05 22	19 32	05 41
27	14 26	03 27	16 25	04 55	18 10	05 32	18 46	05 22	20 03	06 07	20 14	06 31
28	15 29	04 27	17 27	05 38	19 06	06 09	19 39	06 01	20 50	06 55	20 53	07 23
29	16 33	05 25	18 27	06 19	20 00	06 46	20 30	06 42	21 33	07 45	21 31	08 16
30	17 37	06 16	19 25	06 58	20 54	07 25	21 19	07 26	22 13	08 36	22 08	09 09
31	18 41	07 03	20 22	07 36			22 08	08 12			22 44	10 04

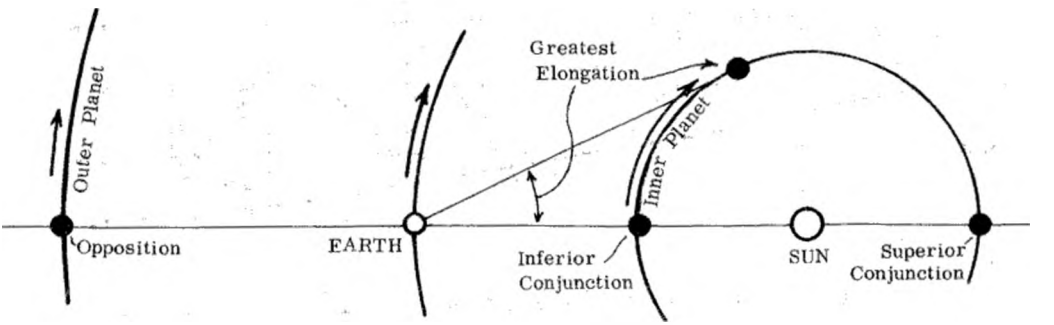
THE PLANETS 1977

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

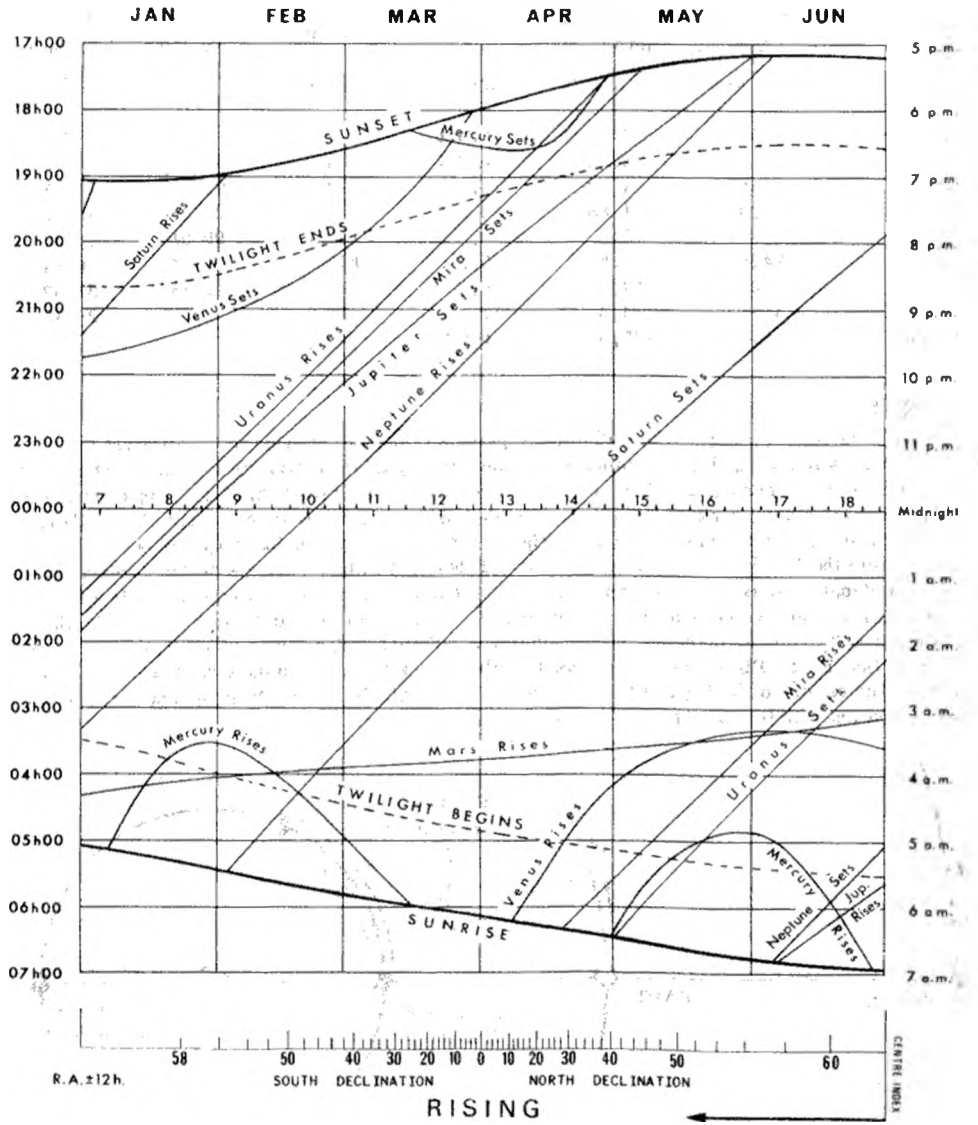
Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Unlike the distant stars, their relative positions do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the 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 occuring in 1977 are listed chronologically in the Diary (pages 4 and 5) and are also mentioned in the text below.



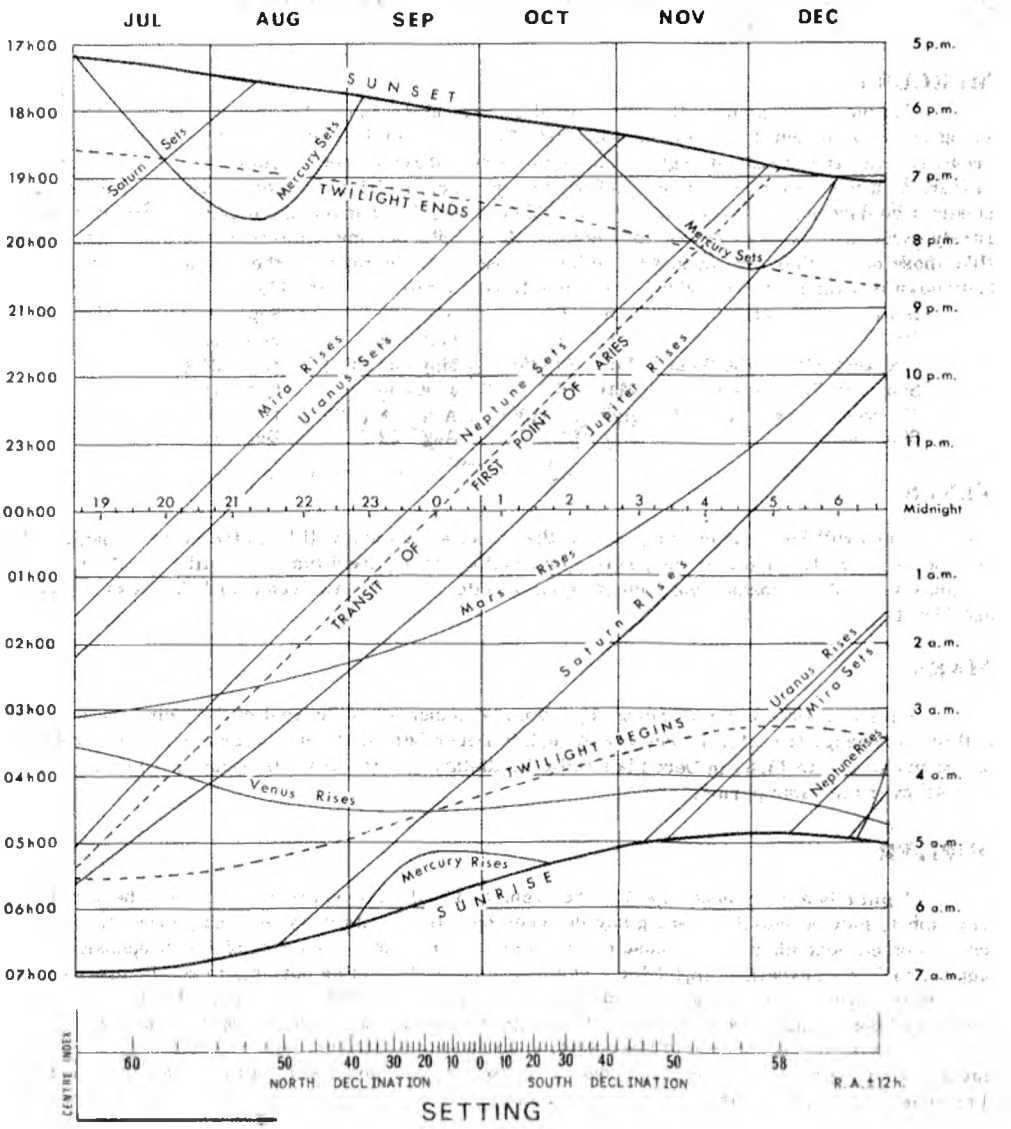
TIMES OF RISING AND SETTING

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 44.

The scales at the bottom of these pages are for finding rising or setting times of any object of which the 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 objects 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 measure in the opposite direction to that first used.) Through the point established draw a line parallel to the First Point of Aries transit line (indicated by the dashed line on the chart).



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, resolves around the Sun faster than any of the other planets. Being close to the Sun it can only be seen just after sunset or just before sunrise, when it is near greatest elongation (greatest angle between Mercury and Sun as seen from the Earth). Except when in transit, it can never be seen near inferior conjunction (passing between Earth and Sun) or near superior conjunction (passing round the far side of Sun). The angular diameter of Mercury's disc rarely exceeds 10 seconds of arc so it is difficult to make out any features on the disc, but phases (like those of the Moon) might just be visible. Close up photography by the Mariner 10 spacecraft has shown that the planet's surface is incredibly similar to that of the Moon.

Inferior conjunction	Jan 6	Apr 30	Sep 5	Dec 21
Stationary	Jan 17	May 13	Sep 13	Dec 31
Greatest Elongation West	Jan 29 (25°)	May 28 (25°)	Sep 21 (18°)	
Superior Conjunction	Mar 16	June 30	Oct 19	
Greatest Elongation East	Apr 10 (19°)	Aug 8 (27°)	Dec 3 (21°)	
Stationary	Apr 20	Aug 22	Dec 12	

VENUS

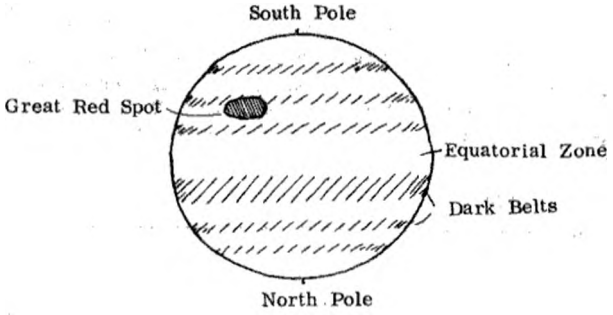
Venus will be in the evening sky till the end of March and will be in the morning sky for the rest of the year after inferior conjunction on April 6. Its apparent diameter will increase from 19" in January to 59" at closest approach on April 6 while it reaches two peaks of brightness on March 1 and May 11.

MARS

Mars is visible in the morning sky from mid-January for the rest of the year. Its magnitude will slowly change from 1.5 in January to -0.8 in December and its diameter from 3.86 seconds of arc in January to 13.60 in December while its distance from the Earth changes from 2.4 AU, to 0.7 All over the same period.

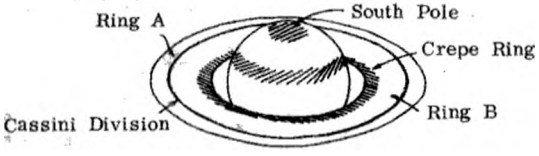
JUPITER

Jupiter is a prominent object in the evening sky till May and from July it will be a morning sky object, moving into the evening sky in December. It is at its brightest (magnitude -2.3) at opposition on December 23. Because of its large angular size (44 seconds of arc at opposition), Jupiter makes an excellent object for a small telescope. It is often possible to see features on the disc: 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 below. The Great Red Spot is not always visible because of the rotation of the planet. Also clearly visible are four of Jupiter's fourteen moons. An entire section of this Handbook is devoted to the movements of these satellites and the Phenomena associated with them (see page 23).



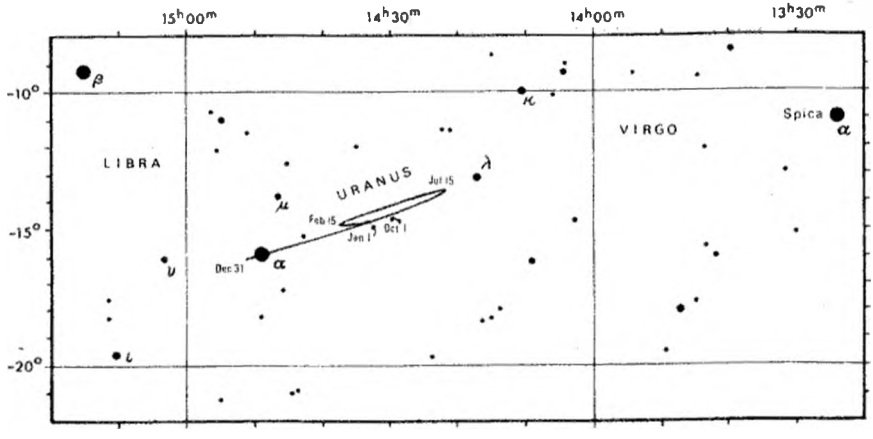
SATURN

Saturn will be clearly seen in the evening sky till July and in the morning sky from mid September until the end of the year. Unfortunately it will never be very high above the horizon because of its northerly declination - as it moves between the constellations of Cancer and Leo. It is at its greatest brightness (magnitude (0.1) at opposition on February 2. The diagram below shows its appearance through a small telescope (the scale is the same as for the Jupiter diagram) - including the spectacular ring system.



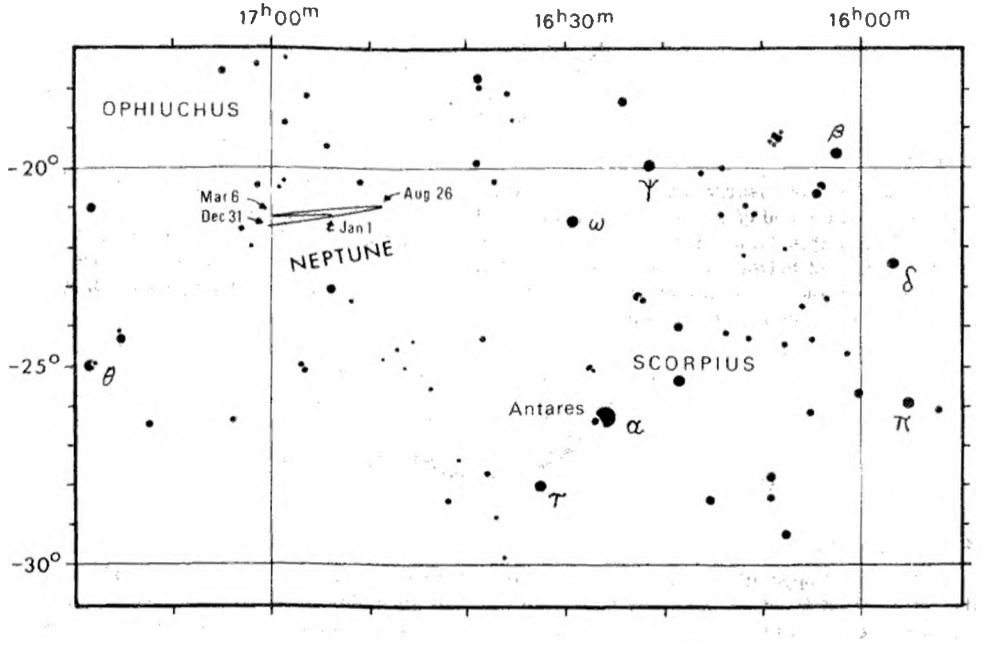
URANUS

Uranus at opposition on April 30 and conjunction on November 4, is in the constellation of Libra all year. It is on the border of naked eye visibility (magnitude 5.7 at opposition) and may be found with the aid of binoculars and references to the accompanying finding chart, which shows all of the stars in the region down to the same faintness. With a small telescope, its disc (angular diameter 4 seconds of arc) may just be distinguished.



NEPTUNE

Neptune lies in the constellation of Ophiuchus 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 6 - 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.



PLUTO

During the year Pluto moves in the constellation of Virgo between the coordinates RA 13^h17^m Dec + 10°09' and $13^h26'$ Dec + 9°20'. Since it is very faint, magnitude 14, it can only be found using a large telescope and specially prepared finding charts.

THE MOONS OF JUPITER AND SATURN 1977

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 fourteen 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, 3½ 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 III - Ganymede
II - Europa 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

Jan	1	20^h46^m	I	Oc D	Jan	13	23^h03^m	II	Sh I	Jan	23	23^h26^m	I	Tr I
		23 57	I	Ec R			23 13	II	Tr E		24	00 41	I	Tr E
	2	20 03	I	Tr E		15	19 47	II	Ec R			20 45	I	Oc D
		21 05	I	Sh E		16	00 26	I	Oc D		25	00 12	I	Ec R
	4	23 09	II	Oc D			20 32	III	Sh I			20 04	I	Tr E
	5	22 17	III	Oc D			21 34	I	Tr I			21 20	I	Sh E
	6	00 29	III	Oc R			22 46	I	Sh I		29	19 49	II	Oc D
		20 26	II	Sh I			22 46	III	Sh E			22 25	II	Oc R
		20 46	II	Tr E			23 44	I	Tr E			22 29	II	Ec D
		22 56	II	Sh E		17	00 56	I	Sh E		30	23 15	III	Tr I
	8	22 35	I	Oc D			22 17	I	Ec R		31	20 03	II	Sh E
	9	20 50	I	Sh I		18	19 25	I	Sh E			22 39	I	Oc D
		21 53	I	Tr E		20	23 10	II	Tr I	Feb	1	21 06	I	Sh I
		23 00	I	Sh E		22	22 25	II	Ec R			21 58	I	Tr E
	10	20 21	I	Ec R		23	19 25	III	Tr I			23 16	I	Sh E
	13	20 42	II	Tr I			21 42	III	Tr E		2	20 36	I	Ec R

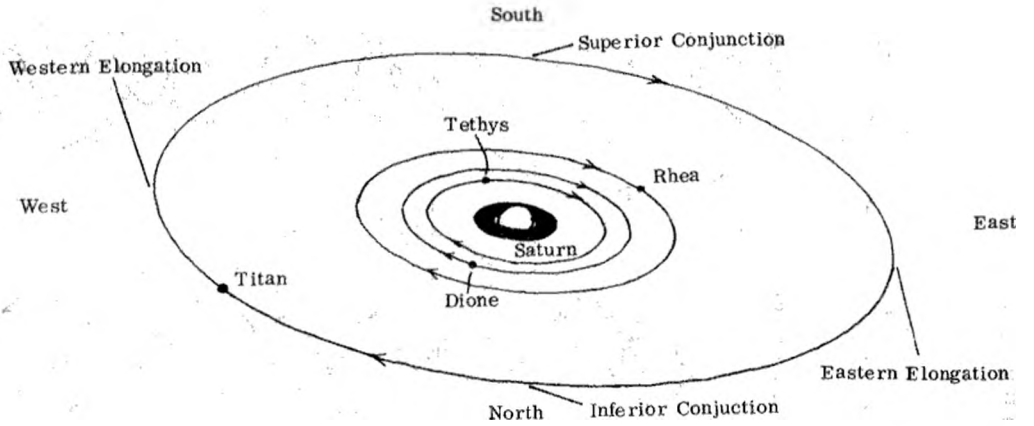
Feb 3	21h01m	III	Ec R
5	22 24	II	Oc D
7	20 03	II	Tr E
	20 11	II	Sh I
	22 40	II	Sh E
8	21 42	I	Tr I
	23 02	I	Sh I
9	19 02	I	Oc D
	22 32	I	Ec R
10	19 41	I	Sh E
	19 41	III	Oc R
	22 44	III	Ec D
14	20 08	II	Tr I
	22 40	II	Tr E
	22 47	II	Sh I
16	19 40	II	Ec R
	20 57	I	Oc D
17	19 27	I	Sh I
	20 18	I	Tr E
	21 19	III	Oc D
	21 37	I	Sh E
21	22 46	II	Tr I
23	19 39	II	Oc R
	19 43	II	Ec D
	22 18	II	Ec R
24	20 04	I	Tr I
	21 23	I	Sh I
	22 15	I	Tr E
25	20 51	I	Ec R
28	20 41	III	Sh I
Mar 2	19 44	II	Oc D
4	19 21	I	Oc D
	19 46	II	Sh E
5	19 58	I	Sh E
7	19 37	III	Tr I
11	19 53	II	Sh I
	20 00	II	Tr E
12	19 43	I	Sh I
	20 42	I	Tr E
13	19 11	I	Ec R
18	20 12	II	Tr I
	21 12	III	Ec R
19	20 30	I	Tr I
20	19 33	II	Ec R
27	19 48	I	Oc D

Mar 28	19h13m	I	Tr E
	20 15	I	Sh E
Apr 3	20 14	II	Oc D
4	19 02	I	Tr I
	19 59	I	Sh I
5	19 09	III	Sh E
	19 25	I	Ec R
	19 27	II	Sh E
12	19 33	II	Sh I
	19 49	III	Tr E

Oct 20	01 22	I	Sh I
28	23 54	I	Sh E
29	01 02	I	Tr E
	01 11	II	Tr E
Nov 4	22 49	II	Sh I
	23 36	I	Sh I
5	00 38	I	Tr I
	00 57	II	Tr I
	01 28	II	Tr E
	01 48	I	Sh E
6	00 06	I	Oc R
	23 36	III	Tr E
12	22 42	I	Ec D
13	22 10	I	Sh E
	23 03	I	Tr E
	23 26	III	Sh E
14	00 14	III	Tr I
	00 28	II	Oc R
20	00 37	I	Ec D
	21 51	I	Sh I
	22 37	I	Tr I
	22 39	II	Ec D
21	00 03	I	Sh E
	00 33	III	Sh I
	00 49	I	Tr E
	22 06	I	Oc R
22	21 30	II	Tr E
27	23 45	I	Sh I
28	00 22	I	Tr I
	21 00	I	Ec D
	23 51	I	Oc R
29	21 00	I	Tr E
	21 08	II	Tr I
	22 37	II	Sh E

Nov 29	23h48m	II	Tr E
Dec 1	23 43	III	Oc R
5	22 54	I	Ec D
6	20 32	I	Tr I
	22 20	I	Sh E
	22 34	II	Sh I
	22 44	I	Tr E
	23 24	II	Tr I
8	20 23	II	Oc R
	22 38	III	Ec D
13	00 49	I	Ec D
	22 01	I	Sh I
	22 15	I	Tr I
14	00 14	I	Sh E
	00 28	I	Tr E
	21 45	I	Oc R
15	19 38	II	Ec D
	22 37	II	Oc R
19	19 25	III	Sh E
	19 45	III	Tr E
20	23 55	I	Sh I
	23 58	I	Tr I
21	21 12	I	Ec D
	23 29	I	Oc R
22	20 36	I	Sh E
	20 37	I	Tr E
	22 13	II	Ec D
23	00 49	II	Oc R
24	19 42	II	Tr E
	19 48	II	Sh E
26	20 06	III	Tr I
	20 28	III	Sh I
	23 00	III	Tr E
	23 26	III	Sh E
28	22 58	I	Oc D
29	20 07	I	Tr I
	20 18	I	Sh I
	22 20	I	Tr E
	22 31	I	Sh E
30	00 27	II	Oc D
	19 50	I	Ec R
31	19 17	II	Tr I
	19 44	II	Sh I
	21 57	II	Tr E
	22 25	II	Sh E

SATURN'S MOONS

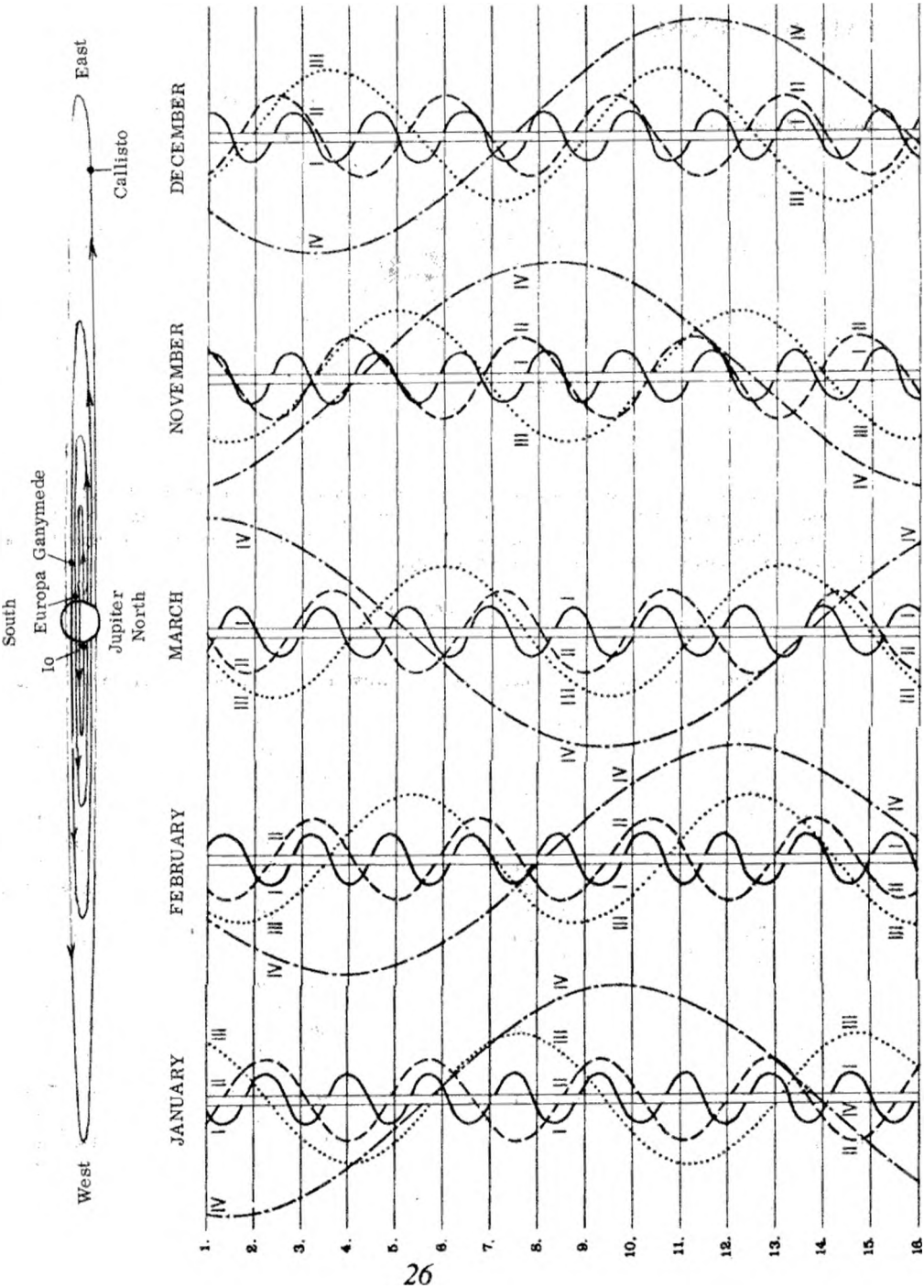


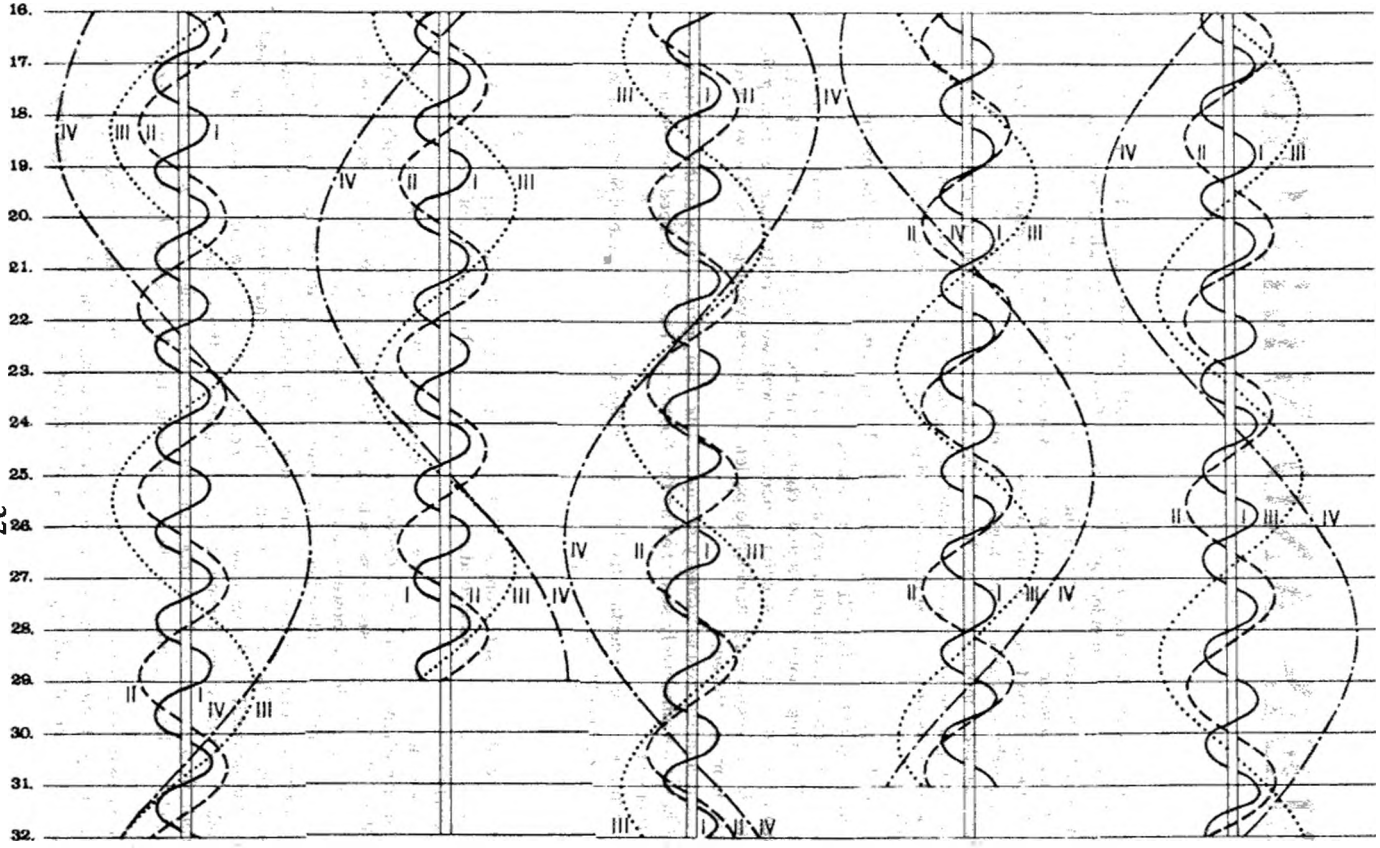
Saturn's moons are considerably fainter than the four Galilean moons of Jupiter. The diagram shows the orbits of four of Saturn's ten moons. The easiest to find is Titan (magnitude 8,5), according to the diagram and the information in the table below (which covers the period when Saturn is clearly visible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

TITAN 1977

Eastern Elongation	Inferior Conjunction	Western Elongation	Superior Conjunction
Jan 2	Jan 6	Jan 10	Jan 14
18	22	26	30
Feb 3	Feb 7	Feb 11	Feb 15
19	23	26	Mar 3
Mar 7	Mar 11	Mar 14	18
23	26	30	Apr 3
Apr 8	Apr 11	Apr 15	19
24	27	May 1	May 5
May 9	May 13	17	21
25	29	Jun 2	Jun 6
Jun 10	Jun 14	18	22
26	30	Jul 4	Jul 8
----	----	----	----
----	Sep 18	Sep 22	Sep 27
Oct 1	Oct 4	Oct 8	Oct 13
17	20	24	29
Nov 2	Nov 5	Nov 9	Nov 14
18	21	25	29
Dec 4	Dec 7	Dec 11	Dec 15
20	23	27	31

CHANGING CONFIGURATIONS OF JUPITER'S MOONS





The four bright moons of Jupiter always appear close to a straight line passing through the planet since, as shown in the drawing at the top, their orbits are seen nearby edge on. The main part of the diagram then shows how their positions along such a straight line change during the five months when Jupiter is prominent in the evening sky. For each month, time increases downward; the disk of Jupiter is stretched to make the central column and horizontal lines, representing 2 a.m. (0 hrs. Universal time), are shown for every day of the month. The wavy lines show how the Moons appear to oscillate from one side of the planet to the other.

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.

While they are believed to be true members of the solar system, comets differ radically from the planets in that their orbits, besides being highly eccentric, are inclined at all angles to the plane of the ecliptic, and their motion may be direct (like that of the planets) or retrograde. Compared with that of a planet, a comet's mass is almost negligible; nearly all this mass is concentrated in the nucleus, which is believed to be not one solid piece but composed of many separate particles of various sizes.

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 perseverance, is also well within the scope of the equipment mentioned.

Many of the fainter comets are undoubtedly escaping detection, particularly in the Southern skies which are not being as intensively searched as the Northern. There is a need for more amateurs to undertake this work.

Interested persons are asked to contact the Director of the Comet and Meteor Section at 90 Malan Street, Riviera, Pretoria 0084.

METEORS

Meteors or "shooting stars" result from small bodies entering the Earth's upper atmosphere, and 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, such a shower can be expected. A list of these predicted showers is given in the table opposite.

The term "shower" is perhaps misleading (as the table indicates); the most prolific of these showers normally yields an average of less than one meteor per minute. On rare occasions however, as in the case of the Leonids, there is a phenomenal rise in the number of meteors observed.

There is always the possibility of new showers occurring, and any large-scale meteor activity observed on dates other than those mentioned should be reported without delay.

Reports by a reliable observer of the number of meteors seen coming from a particular radiant in a given period are always useful, but the best work is done by organised teams making a full sky coverage.

"Fireballs" are meteors of a luminosity equalling or exceeding that of the brightest planets. Accurate reports of their path among the stars, or their altitude and azimuth, at specific times, are of great value, particularly if made by observers at different places along the trajectory.

PREDICTED METEOR SHOWERS 1977

Date	Shower	Radiant R.A.	Radiant Dec.	Maximum Date	Maximum Hourly Rate	Transit Radiant (approx)	Recommended Time of Watch	Conditions at Maximum
Mar 14 - Mar 18	Corona Australids	16h 20m	-48°	Mar 16	5	04h 45m	02h30m - dawn	Unfavourable
Mar 12 - Apr 25	Hydraids	12 16	-27	Mar 25	?	00 10	23h - 02h	Favourable
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	22h - 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 13(?)	8	23 30	21h -02h	Favourable
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	00h -02h	Unfavourable
Jul 15 - Aug 24	Iota Aquarids	22 04 22 32	- 6 -15	Aug 6	12	01 20 01 30	22h -24h	Favourable
Oct 16 - Oct 27	Orionids	06 24	+15	Oct 21	35	04 30	02h -dawn	Favourable
Oct 10 - Dec 5	Taurids	03 44 03 44	+14 +21	Nov 8	16	00 50 00 50	22h -02h	Favourable
Nov 14 - Nov 20	Leonids	10 08	+22	Nov 17	10	06 30	02h -dawn	Favourable
Dec 4 - 5	Phoenicids	01 00	-55	Dec 4	?	20 10	21h -24h	Favourable
Dec 7 - Dec 15	Geminids	07 28	+32	Dec 14	55	02 00	01h -dawn	Favourable
Dec 5 - Jan 7	Velaids	09 56	-51	Dec 29	?	03 30	01h -dawn	Unfavourable

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 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.

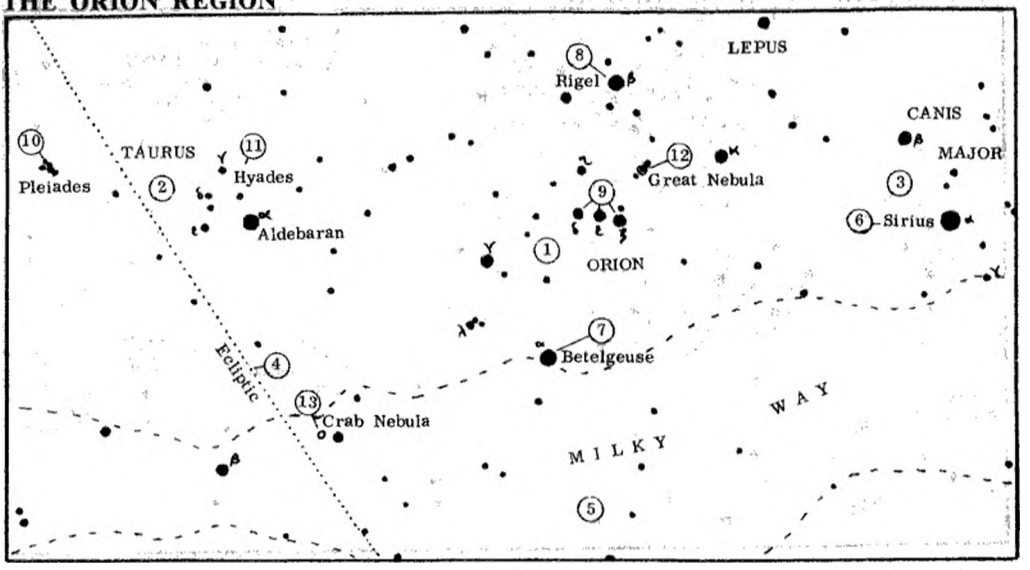
NEBULAE

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. 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.

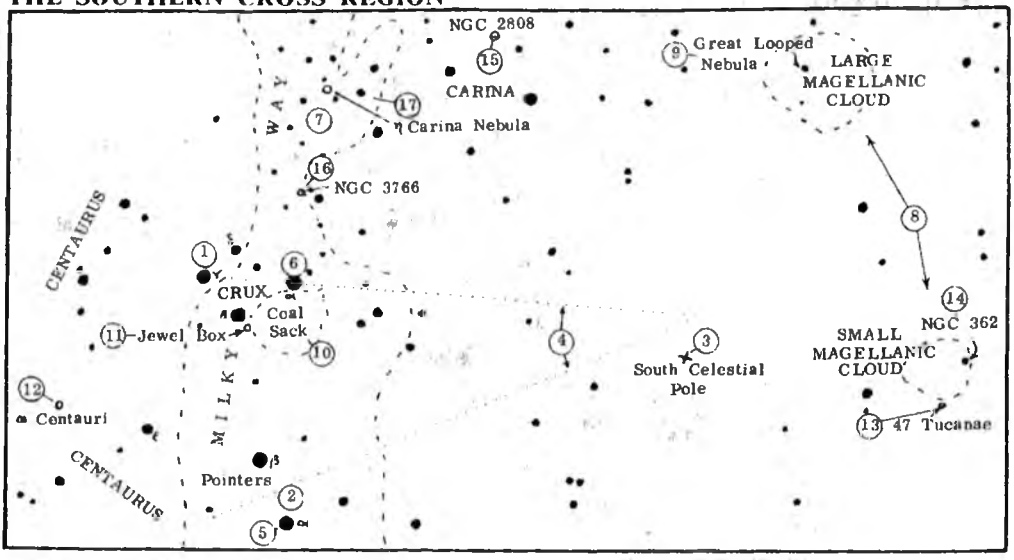
(10) The Pleiades or Seven Sisters form the best known nearby star cluster. Six or seven stars are visible to the naked eye, binoculars or a small telescope show more.

(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).

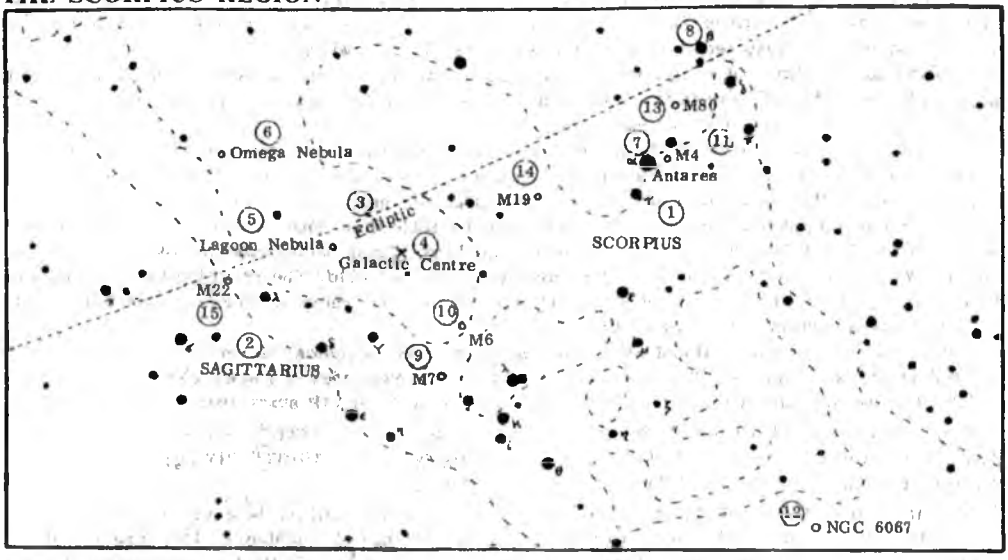
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).

(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 light increasing tremendously. The result is that a "new" star appears where previously no star was visible to the naked eye, or even with a small telescope. The light of the nova may fluctuate for a time, then gradually fades over a period of days, weeks or months.

Even observers having no telescopes can perform a useful task in keeping a watch for such novae in an allocated area of the sky. A good knowledge of the constellations is a recommendation, since part of the procedure is to scan the whole sky for bright novae before the more detailed search in the allocated area is begun. However, anyone can be given training in star recognition.

Interested persons should contact the Director of the Nova Search Section, Mr. J.C. Bennett, 90 Malan Street, Riviera, Pretoria 0084.

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 from southern observers.

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 Section of the 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. Some of these VIP stars are:

111661	RS Cen	131953	DY Cen	145971	S Aps	183423	V348 Sgr
123753	UW Cen	132554	BV Cen	174406	RS Oph	191033	RY Sgr
124728	EX Hya	135870b	Z Aps	181824	GU Sgr		

Most of the above stars could be observed every night and would still not be over-observed.

Many long period variable stars vary through a large range of brightness. This means that even approximate estimates by beginners can generate quite acceptable light curves. Some of these stars are relatively easy to locate and identify and this makes them very suitable for new observers. Examples of this class of stars are:

025050	R Hor	043262	R Ret	134236	RT Cen	174162	W Pav
034625	U Eri	054331	S Col	161122 a	R Sco	180222a	VX Sgr
035124	T Eri	091868	RW Car	161122 b	S Sco	180363	R Pav
040725	W Eri	094953	Z Vel	165030 a	RR Sco	191019	R Sgr
						214247	R Gru

Several variable stars are situated near the South Celestial Pole and can be observed throughout the year during the evening hours. Three such stars are:

055686 R Oct 131283 U Oct 172486 S Oct

Others will need early morning observing sessions for fuller coverage.

Certain stars have such fast variations that they need to be monitored continuously, preferably by several observers working independently. Amateurs were asked to monitor 013418 UV Ceti in this way during the 1975 Appollo- Soyuz space mission. It is possible that the Variable Star Section will again be asked to participate in exercises of this nature.

A few variables are so bright that they can be monitored throughout their cycles without optical aid. 071044 L^2 Puppis is such a star. Nortons's Star Atlas names several more.

"Beginners are encouraged to practice variable star observings by following the easy-to-observe stars listed below through the brighter parts of their variations, using naked eye or binoculars

Star		Approximate magnitude		Approximate dates of maxima 1977
		Max	Min	
021403	o Ceti (Mira)	1.7	9.6	Jan 17, Dec 14
092962	R Car	4.5	10.3	March 17
100661	S Car	4.5	9.0	Jan 11, June 8, Nov. 4

From the above it can be seen that there are variable stars to suit amateurs with different amounts of experience, ability, optical aid and spare time. Amateurs who want to start observing stars in any of the above categories should contact the Director, c/o SAAO, P.O. Box 9, Observatory, 7935. 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.

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 43) 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, no matter how carefully determined.

Timings of occultations are very valuable in determining the moon's shape and motion and constitute 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° = New Moon, 90° = First Quarter, 180° = Full Moon, 270° = 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

$$\text{Predicted time} + a.\Delta\lambda + b.\Delta\phi$$

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 A - Moon at very low altitude

S - sunlight interferes G - grazing occultation

Date	Z.C. No.	Mag.	P.	El. of Moon	CAPE TOWN E. 18.5 , S. 33.9				JOHANNESBURG E. 28.0 , S. 26.2				SALISBURY E. 31.1 , S. 17.7			
					U.T.	a	b	P	U.T.	a	b	P	U.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
Jan. 8	1465	6.3	2	220		A				A			19 42.6	-0.6	-1.2	288
8	1468	4.9	2	220		N			20 53.1	-1.2	+0.6	236	20 56.7	-1.4	-0.5	266
15	2213	5.9	2	299		N				N			0 24.2	-0.6	+0.3	245
15	2218	5.6	2	300		N				N			1 16.4	.	.	218
23	3477	6.6	1	51		S			17 36.7	-0.5	+3.6	14		N		
26	290	6.1	1	85		N			18 46.8	.	.	135	18 46.9	-1.8	+0.1	103
27	403	5.8	1	96		S				S			17 02.9	.	.	17
27	413	6.8	1	97	18 40.1	-2.3	+1.3	71	19 13.6	-2.0	+2.1	55	19 45.1	.	.	22
29	654	6.0	1	118		S				S			17 34.6	-3.0	+1.3	62
29	668	3.6	1	119	19 48.6	-2.4	+0.4	94	20 18.0	-2.3	+1.4	73	20 44.2	-2.7	+3.5	40
30	796	6.8	1	130		N			20 41.5	-1.8	+1.3	133	20 42.6	-2.3	-0.1	103
30	798	6.4	1	130	20 30.3	-2.4	+0.2	98	20 59.1	-2.4	+1.4	73	21 29.0	.	.	34
31	940	5.7	1	141	19 43.7	-2.6	+1.7	45		N				N		
31	947d	5.2	1	142		N			22 24.1	-0.6	-2.1	151	22 17.8	-1.5	-0.5	116
Feb. 8	1787	6.0	2	229		N				N			0 31.0	-3.3	+0.2	264
11	2193	6.1	2	270	2 38.1	-0.6	-3.6	338		N				N		
14	2647	6.4	2	309	1 34.8	-1.1	+2.0	207	1 44.3	-0.6	-0.3	253	1 40.1	-0.4	-1.0	284
14	2653d	6.4	2	310		N			2 06.1	-1.6	+2.0	214	2 15.4	-1.0	-0.1	255
25	617	6.6	1	88	20 08.1	-1.1	+0.8	102	20 26.8	-1.0	+1.5	72		A		
28	1038	6.8	1	122	21 35.5	.	.	44		N				N		
28	1040d	6.2	1	122		N			22 41.5	+0.1	-1.6	151	22 35.6	-0.5	-0.2	115
Mar. 2	1271	5.9	1	145		N			19 57.2	.	.	170	19 38.6	-2.3	-2.0	134
10	2271	4.3	2	251		A			21 04.8	-0.1	-0.9	273	.	A		
11	2441	6.5	2	265	23 51.1	-0.7	-0.8	262	23 48.3	-0.7	-1.7	296	23 30.2	+0.1	-3.3	333
15	2913	5.0	2	305		N				N			1 25.7	-1.0	+1.4	222
25	697	7?-7?	1	67		N				N			16 59.2	.	.	160
27	985d	6.9	1	90	20 54.8	-0.6	+0.3	115		A				A		
31	1454	7.1	1	138		N				N			22 00.8	-0.9	-1.9	148
31	1465	6.3	1	139	23 43.0	-1.5	+2.1	70		N				N		
Apr. 1	1468	4.9	1	139	0 50.9	-0.7	+1.5	82		N				N		
1	1565d	6.3	1	150	18 24.1	-1.3	-2.2	140	18 25.6	-2.0	-1.3	112	18 26.5	-2.9	0.0	83
7	2399	5.0	2	234	23 35.8	-0.8	-2.9	321		K				N		
11	2880	5.1	2	275		N				N			0 23.6	-1.5	+1.6	224
11	2883	5.5	2	275	1 04.4	-0.7	-2.3	300		N				N		
21	643	6.7	1	36		S			16 17.0	-1.1	+0.4	105	16 27.1	-1.2	+1.2	76
24	1057	6.9	1	70		N				N			18 53.1	-0.3	-1.1	136
25	1176	7.4	1	81	17 32.7	-2.1	-0.2	111	17 58.7	-2.6	+1.5	75		N		
27	1410d	5.3	1	106		N			21 18.8	+0.2	-2.8	168	21 06.8	-0.6	-0.8	128
28	1518	6.3	1	118	20 13.6	.	.	53		N				N		
28	1519	6.5	1	118		N				K			21 17.2	-0.5	-2.3	155
29	1624	6.8	1	130	18 46.0	-2.3	-0.6	98		G				N		
29	1637	6.0	1	131	22 18.2	-1.7	+1.1	86		N				N		
May 6	2508	6.3	2	217	2 49.9	-2.0	+0.2	279	3 07.3	-2.1	-0.8	301		N		
6	2647	6.4	2	229		N				N			21 13.1	-1.3	+0.4	246
6	2653d	6.4	2	229		N				N			21 29.3	.	.	198
7	2674	6.0	2	231	2 49.2	-2.6	-2.2	310		N				N		
9	3104	6.5	2	269	23 25.5	-0.3	-1.0	267	23 16.6	-0.4	-2.5	302		N		
22	1141	5.6	1	51	17 38.1	-1.3	+1.0	93	18 06.9	-2.0	+4.0	46		N		
23	1257	7.5	1	62	17 39.6	-1.6	+0.6	99	18 10.0	-2.4	+3.7	52		N		
24	1364	6.5	1	73		N			17 01.7	-0.6	-2.8	162	16 50.1	-1.8	-1.2	127
25	1468	4.9	1	85	17 11.6	.	.	188	16 58.2	-1.7	-1.6	137	16 56.1	-2.6	-0.5	106
25	1478	7.2	1	86	20 05.1	.	.	41		N				N		
June 4	2913	5.0	2	224		N			23 12.6	-2.0	+1.5	228	23 26.4	-2.5	+0.2	259
5	3045	6.0	2	237		A			20 37.7	-0.5	+0.2	237	20 37.5	-0.4	-0.6	270
26	2025	6.8	1	118		N			17 42.8	-0.8	-4.5	169	17 23.1	-2.1	-1.9	129

Date	Z.C. No.	Mag.	P.	El. of Moon	CAPE TOWN E. 18.5 , S. 33.9				JOHANNESBURG E. 28.0 , S. 26.2				SALISBURY E. 31.1 , S. 17.7			
					U.T.	a	b	P	U.T.	a	b	P	U.T.	a	b	P
				o	h m	m	m	o	h m	m	m	o	h m	m	m	o
June 26	2036	6.9	1	120	20 12.0	-2.0	+0.2	98	20 40.8	-1.9	+2.5	61		N		
28	2193	6.1	1	135	0 28.6	-0.7	+0.2	115	0 36.4	-0.2	+0.6	96		A		
July 3	3002	6.2	2	206		N			1 12.0	-0.6	+4.4	193	1 42.2	-1.3	+2.4	221
20	1624	6.8	1	49		N			16 38.4	-1.0	-1.2	140	16 36.8	-1.4	-0.1	106
20	1635	5.4	1	50	18 31.3	-0.4	-1.2	150	18 31.4	-0.4	0.0	115		A		
22	1865	7.2	1	75	17 37.3	-2.3	+1.4	78		N				N		
24	2114d	5.8	1	101		N				G			18 14.1	42.2	-1.6	129
25	2271	4.3	1	116	20 50.4	-1.7	-0.6	122	21 05.9	-1.4	+0.5	98	21 18.0	-1.0	+1.5	69
26	2291	5.5	1	117	0 01.4	+0.1	+2.1	55		A				N		
26	2441	6.5	1	130	23 10.1	-1.3	-0.1	119	23 21.8	-0.8	+0.4	102	23 29.5	-0.4	+0.9	78
27	2578	6.4	1	143		N			20 06.0	.	.	149	19 55.8	-2.8	-0.9	108
Aug. 3	3508	5.8	2	226	2 42.4	.	.	171	3 21.2	.	.	184		S		
8	577	6.0	2	283	2 46.4	-1.6	-0.7	260	3 00.6	-2.5	-0.6	269	3 00.3	-3.6	-1.9	293
22	2399	5.0	1	99	22 44.5	-0.8	-0.6	137		A				A		
24	2686d	5.2	1	124		N				N			16 35.6	.	.	146
24	2690	7.0	1	124		N				N			17 40.2	.	.	141
25	2722	7.1	1	127	0 07.6	-0.9	-0.1	124	0 14.8	-0.4	+0.2	110		A		
25	2856	6.6	1	138	17 34.6	-1.6	-2.0	115	17 44.2	-2.2	-0.3	85	17 57.0	-2.5	+1.7	53
25	2876d	5.4	1	139		N				N			22 20.0	.	.	145
25	2880	5.1	1	140		N				N			23 13.2	-2.4	-2.2	134
25	2883	5.5	1	140	23 23.2	-0.5	+2.7	35	23 47.7	+0.2	+3.2	22		N		
26	3002	6.2	1	152	18 21.5	-1.7	-3.3	128	18 25.1	-2.2	-0.9	96	18 31.8	-2.4	+0.8	67
31	136	6.3	2	216	20 37.7	-0.2	+1.6	204	20 51.0	-0.8	+0.9	224	20 59.2	+1.4	+0.3	250
Sept. 5	658d	4.2	1	263	1 38.8	.	.	142	1 42.9	.	.	124	1 38.3	-3.0	-0.9	98
5	658d	4.2	2	263	2 13.0	.	.	188	2 48.1	.	.	207	3 15.5	-2.9	+1.8	234
16	2060	6.3	1	41	19 01.5	-0.1	+1.6	73		A				N		
17	2196	6.7	1	55	20 09.3	-0.6	-0.9	144		A				A		
18	2341	7.2	1	67		N				N			18 48.6	-1.4	-1.4	135
18	2352	6.7	1	68	20 21.7	-0.4	+0.9	94		A				A		
19	2485	7.4	1	80	17 06.2	-2.1	+1.8	61	17 46.4	.	.	29		N		
19	2495d	6.0	1	81	19 17.9	.	.	17		N				N		
23	3093	4.5	1	133		S			16 34.9	-1.7	+1.0	53	17 00.2	.	.	16
Oct. 1	590	6.3	2	230	22 03.6	-1.1	-1.4	277	22 05.5	-2.0	-1.9	290		N		
15	2291	5.5	1	36	18 15.8	-0.8	-0.6	136		A				A		
16	2454	7.2	1	51	19 34.7	+0.4	+3.0	33		N				N		
20	3065	7.5	1	104	18 00.8	-2.3	+0.7	77	18 29.9	-2.1	+1.4	67	18 51.3	-1.5	+2.3	46
20	3075	7.1	1	105	20 41.9	-2.0	+0.1	112	21 00.2	-1.3	+0.5	101	21 09.8	-0.9	+0.9	80
22	3344d	6.8	1	130		N				N			22 01.0	.	.	132
29	684d	6.2	2	211	21 23.7	0.0	+2.0	202	21 42.4	-1.1	+1.6	216	21 57.6	-2.1	+0.9	240
31	943	6.2	2	232		A			21 34.3	-0.6	+0.2	240	21 36.2	-1.2	-0.4	263
Nov. 14	2722	7.1	1	46	19 00.1	-1.4	-1.7	145	19 02.4	-0.5	+0.3	125		A		
15	2876d	5.4	1	59		N				N			16 28.1	.	.	135
15	2880	5.1	1	59		N				N			17 25.9	-2.3	-1.5	126
15	2883	5.5	1	60	17 39.8	-0.6	+2.9	32	18 06.9	+0.2	+3.7	18		N		
21	132	6.9	1	135	18 03.3	-0.8	+2.5	19	18 34.7	.	.	9		N		
21	136	6.3	1	135		N				N			19 26.0	.	.	119
28	1040d	6.2	2	213		N				N			20 34.1	-0.9	+1.2	230
Dec. 21	469	7.3	1	139	19 56.6	-2.2	+1.2	56	20 31.8	-2.4	+2.3	45	21 09.5	.	.	13
22	590	6.3	1	150		S			17 49.4	-1.9	0.0	71	18 01.0	-1.9	+1.4	50
22	610d	6.2	1	151		N			24 01.1	.	.	158	23 50.8	-1.0	-0.4	115
23	730	5.1	1	161	18 25.7	-0.8	+0.7	43	18 45.1	-1.1	+2.2	30		N		

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 2194, so that they may be informed of all favourable grazes occurring within their neighbourhood.

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.

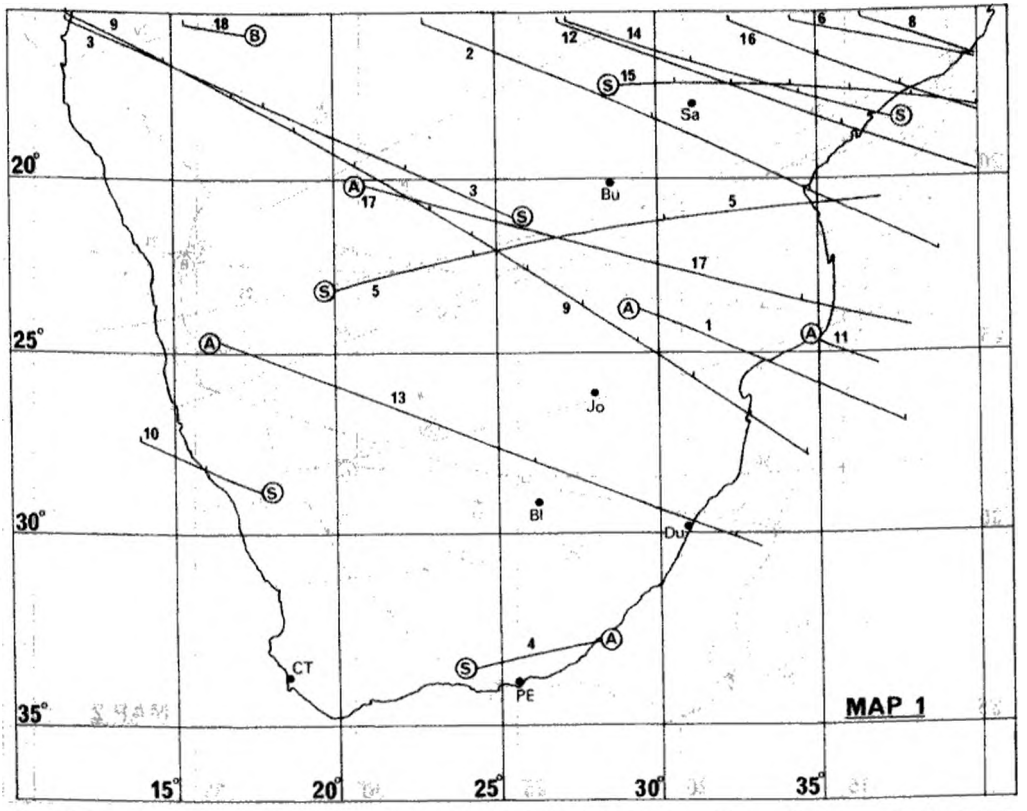
Date

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)

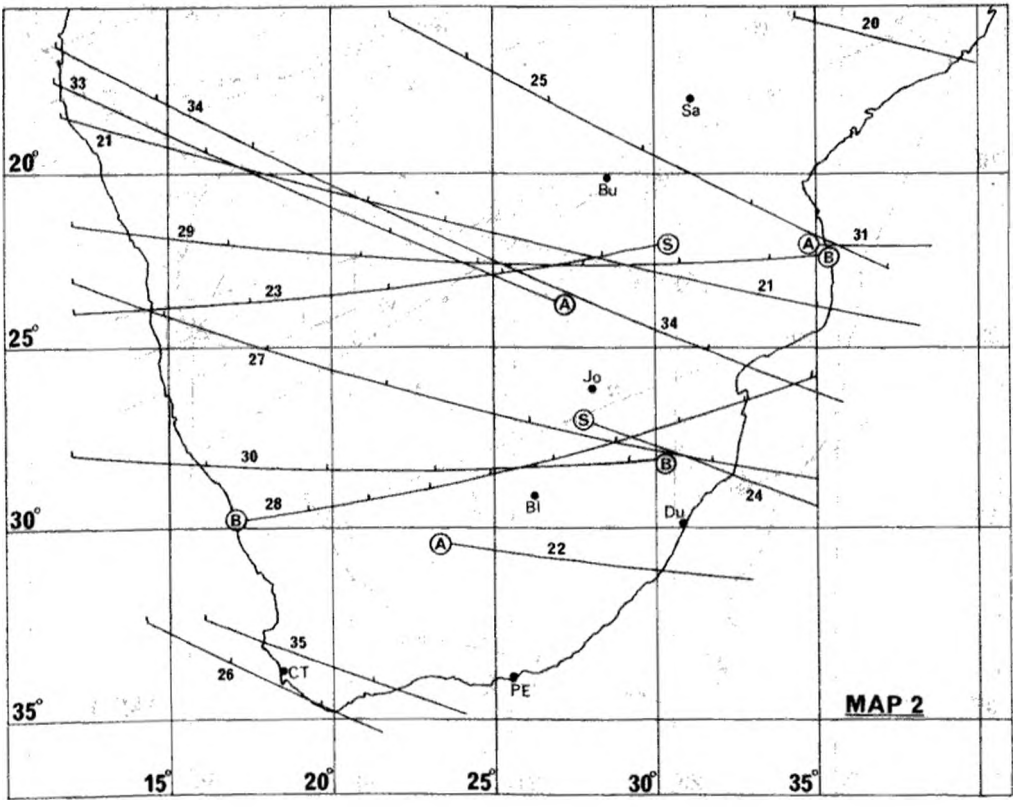
JANUARY TO MARCH



No	ZC	Mag.	Date	Beginning	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
1+	2213	5.9	Jan 15	$2^h\ 9^m$	25	S	11	2640	6.1	Feb 14	$2^h\ 28^m$	18	S
2	2218	5.6	Jan 15	3 1	25	S	12+	2649	6.6	Feb 14	3 20	18	S
3	2391	7.1	Jan 16	5 10	15	S	13+	2653	6.4	Feb 14	3 46	18	S
4	3340	7.5	Jan 22	20 2	12	N	14	2658	5.4	Feb 14	4 59	17	S
5	3477	6.6	Jan 23	19 55	19	N	15	736	6.2	Feb 26	18 54	57	N
6	413	6.8	Jan 27	22 12	56	N	16	2448	6.4	Mar 12	2 28	53	S
8	668	3.6	Jan 29	23 19	74	N	17	2913	5.0	Mar 15	3 2	21	S
9	1787	6.0	Feb 8	1 18	82	S	18	2927	7.2	Mar 15	5 40	20	S
10	2065	6.6	Feb 10	5 53	60	S							

Track No	ZC	
2	2218	is a spectroscopic binary
12	2649	is the brightest component of the triple star Aitken 11232. The brighter companion is magnitude 9.6; separation 54" in p.a. 12°. The second companion is of magnitude 10.1; separation from the primary is 10".4 in p.a. 132°.
13	2653	is the mean of the brightest components of the triple star Aitken 11240. Their magnitudes are 6.9 and 7".4; separation 0".4 in p.a. 131°. The third component, of magnitude 9.4, is separated from the mean position by 17".2 in p.a. 52°.

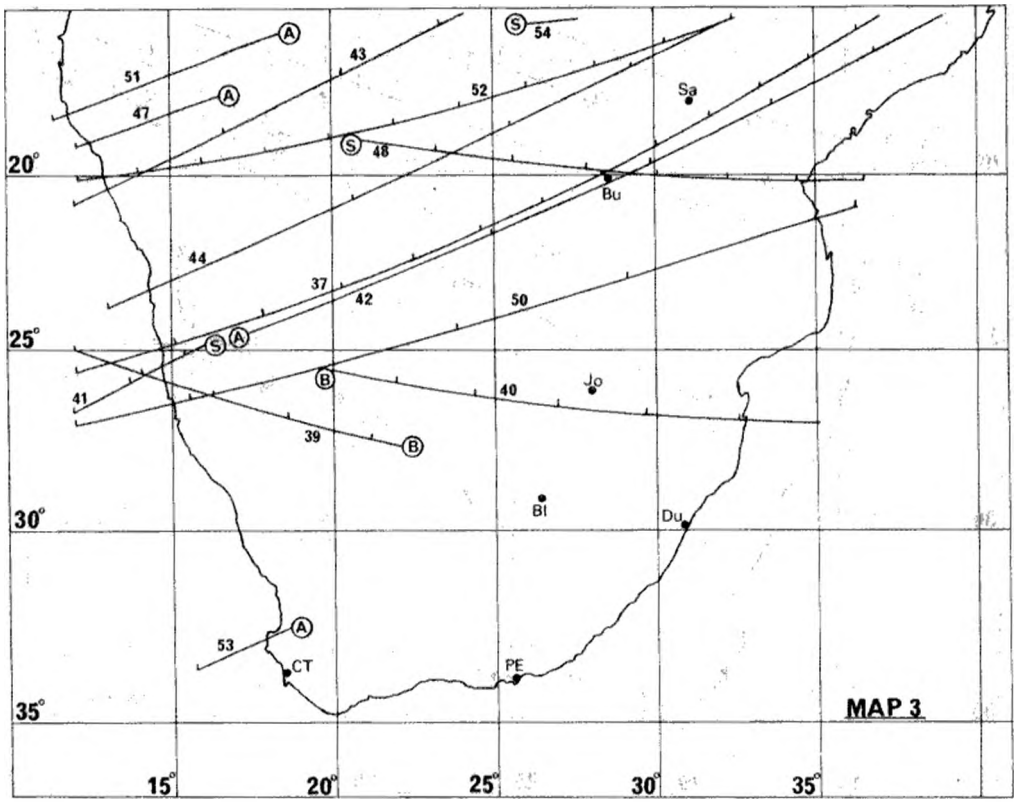
APRIL TO JUNE



No	ZC	Mag.	Date	Beginning	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
20+	2876	5.4	Apr 11	$1^h\ 4^m$	46	S	28	2674	6.0	May 7	$4^h\ 19^m$	81	N
21	2880	5.1	Apr 11	1 49	45	S	29	2972	6.7	May 9	2 13	61	S
22	3154	7.4	Apr 13	2 55	25	S	30	2975	7.0	May 9	2 43	61	S
23	3290	7.3	Apr 14	5 25	15	N	31+	3366	6.6	May 12	1 52	29	S
24	639	6.0	Apr 21	18 10	10	N	33	1141	5.6	May 22	20 9	19	N
25	1176	7.4	Apr 25	20 18	43	N	34	1257	7.5	May 23	20 5	27	N
26	1635	5.4	Apr 29	23 28	83	N	35	1478	7.2	May 25	22 12	47	N
27	1637	6.0	Apr 30	0 38	83	N							

Track No	ZC	
20	2876	is th brightest component of the triple star Aitken 12767. The brighter companion is of magnitude 8.9; separation 46" in p.a. 42°. The second companion is 12th magnitude.
31	3366	is the brighter component of the double star Aitken 16382. The companion is of magnitude 10.6; separation 10.4 in p.a. 117°.

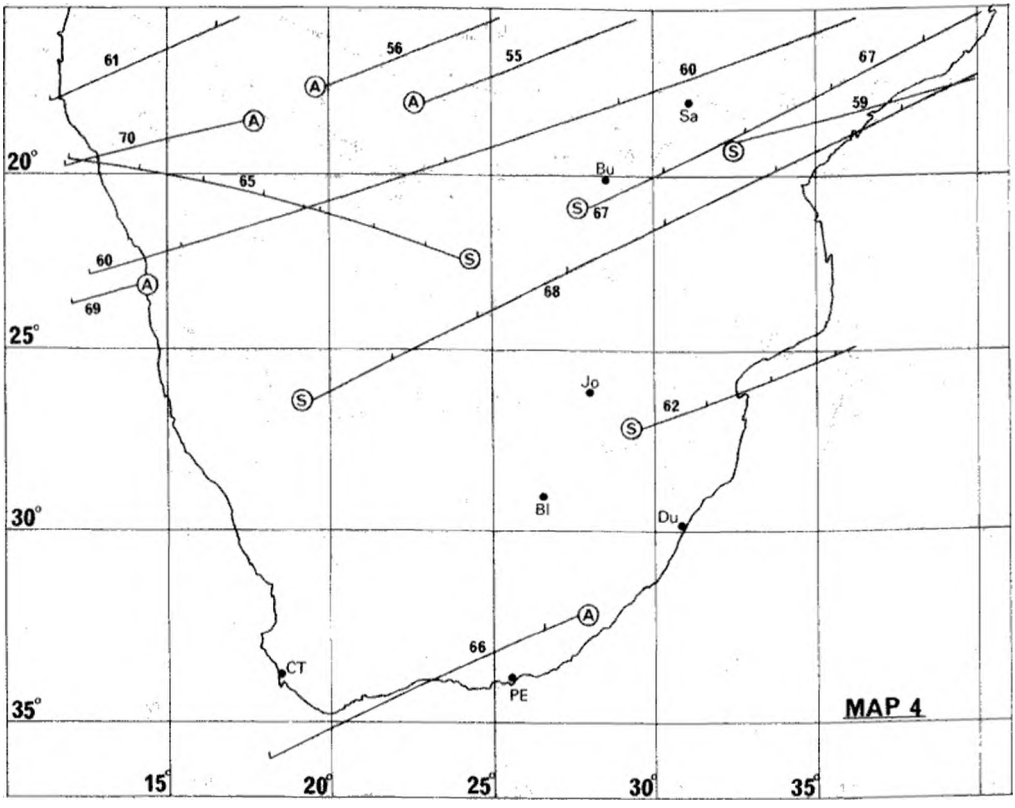
JULY TO SEPTEMBER



No	ZC	Mag.	Date	Beginning	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
37	3420	7.1	Jul 6	$2^h\ 12^m$	71	N	47	2396	6.6	Aug 23	$1^h\ 6^m$	59	S
39	1865	7.2	Jul 22	19 53	37	N	48	2686	5.2	Aug 24	18 37	78	S
40+	2114	5.8	Jul 24	20 31	60	S	50	2341	7.2	Sep 18	20 46	31	S
41	340	7.1	Aug 6	6 54	57	N	51	2508	6.3	Sep 19	23 48	44	S
42	445	7.3	Aug 7	2 3	49	N	52	2647	6.4	Sep 20	19 35	54	S
43	577	6.0	Aug 8	3 57	39	N	53	2674	6.0	Sep 21	1 8	56	S
44	710	7.1	Aug 9	4 1	30	N	54	2808	7.4	Sep 21	18 33	65	S

Track No	ZC	
40	2114	is the brighter component of the double star Aitken 9396. The companion is of magnitude 6.7; separation 1".9 in p.a. 359°.

SEPTEMBER TO DECEMBER



No	ZC	Mag.	Date	Beginning	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
55	862	7.5	Oct 4	$0^h\ 30^m$	65	N	65+	1428	3.8	Nov 5	$4^h\ 53^m$	42	S
56	863	6.7	Oct 4	0 41	65	N	66	2722	7.1	Nov 14	21 8	16	S
59	2271	4.3	Oct 15	18 1	9	S	67+	2876	5.4	Nov 15	18 36	24	S
60	2441	6.5	Oct 16	19 42	18	S	68	2880	5.1	Nov 15	19 20	25	S
61	2789	7.3	Oct 18	22 40	40	S	69	3184	7.1	Nov 18	0 30	49	S
62	2913	5.0	Oct 19	18 22	50	S	70	3185	5.3	Nov 18	0 35	49	S

Track No	ZC	
65	1428	is the brighter component, itself a spectroscopic binary, of the double star Aitken 7480. The companion is of magnitude 9.9; separation 85" in p.a. 44°.
67	2876	is th brightest component of the triple star Aitken 12767. The brighter companion is of magnitude 8.9; separation 46" in p.a. 42°. The second companion is 12th magnitude.

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	12h	03m	35s	May	11	11h	56m	18s	Sep	18	11h 54m 11s
	11	12	07	57		21	11	56	30		28	11 50 42
	21	12	11	21		31	11	57	34	Oct	8	11 47 36
	31	12	13	20	Jun	10	11	59	19		18	11 45 13
Feb	10	12	14	16		20	12	01	27		28	11 43 50
	20	12	13	47		30	12	03	33	Nov	7	11 43 43
Mar	2	12	12	12	Jul	10	12	05	17		17	11 44 59
	12	12	09	48		20	12	06	17		27	11 47 37
	22	12	06	56		30	12	06	23	Dec	7	11 51 27
Apr	1	12	03	55	Aug	9	12	05	26		17	11 56 06
	11	12	01	04		19	12	03	37		27	12 01 08
	21	11	58	43		29	12	00	54		31	12 03 04
May	1	11	57	04	Sep	8	11	57	42			

SIDEREAL TIME ON THE 30° MERIDIAN

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

	At 0 hrs SAST	At 21 hrs SAST		At 0 hrs SAST	At 21 hrs SAST		At 0 hrs SAST	At 21 hrs SAST
Jan 1	$6^h\ 42^m$	$3^h\ 45^m$	May 11	$15^h\ 14^m$	$12^h\ 18^m$	Sep 18	$23^h\ 47^m$	$20^h\ 50^m$
11	7 21	4 24	21	15 54	12 57	28	0 26	21 30
21	8 01	5 04	31	16 33	13 37	Oct 8	1 06	22 09
31	8 40	5 44	Jun 10	17 13	14 16	18	1 45	22 50
Feb 10	9 19	6 23	20	17 52	14 55	28	2 25	23 28
20	9 59	7 02	30	18 31	15 35	Nov 7	3 04	0 07
Mar 2	10 38	7 42	Jul 10	19 11	16 15	17	3 43	0 47
12	11 18	8 21	20	19 50	16 54	27	4 23	1 26
22	11 57	9 01	30	20 30	17 33	Dec 7	5 02	2 06
Apr 1	12 36	9 40	Aug 9	21 09	18 13	17	5 41	2 45
11	13 16	10 19	19	21 49	18 52	27	6 21	3 25
21	13 55	10 59	29	22 28	19 31	31	6 37	3 40
May 1	14 35	11 38	Sep 8	23 07	20 11			

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	$1^h36^m,8$	$-57^o21'$	0,6	B5	Procyon	$7^h38^m,1$	$+5^o\ 17'$	0,5	F5
Aldebaran	4 34 ,6	+16 28	1,1	K5	Regulus	10 07 ,1	+12 05	1,3	B8
Rigel	5 13 ,4	- 8 14	0,3	B8	Spica	13 24 ,0	-11 02	1,2	B2
Betelgeuse	5 53 ,9	+ 7 24	0,4	M0	Arcturus	14 14 ,6	+19 18	-0,2	K0
Canopus	6 23 ,4	-52 41	-0,9	F0	Antares	16 28 ,0	-26 23	1,2	M1
Sirius	6 44 ,1	-16 41	-1,6	A0	Altair	19 49 ,7	+8 48	0,9	A5

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1936-37	H.E. Houghton	1954-55	P. Kirchhoff	1972-73	K.J. Sterling
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1938-39	T. Mackenzie	1956-57	S.C. Venter	1974-75	C. Papadopoulos
1939-40	R.A. Rossiter	1957-58	M.W. Feast	1976-77	P.A.T. Wild

HONORARY SECRETARIES

1922	H.W. Schonegevel	1923	H.E. Houghton	1934	H.W. Schonegevel
1922	T. Mackenzie	1930	S. Skewes	1935	A. Menzies
1923	C.L. O'Brien Dutten	1931	H. Horrocks	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 J Schilt
Dr R.H. Stoy
Dr A.G. Velghe
Sir Richard Woolley

GILL MEDALLISTS

1956	H. Knox Shaw	1960	W.H. van den Bos	1967	W.S. Finsen
1957	W.P. Hirst	1963	A.W.J. Cousins	1970	J.C. Bennett
1958	J. Jackson	1965	R.H. Stoy	1976	A.D. Thackeray

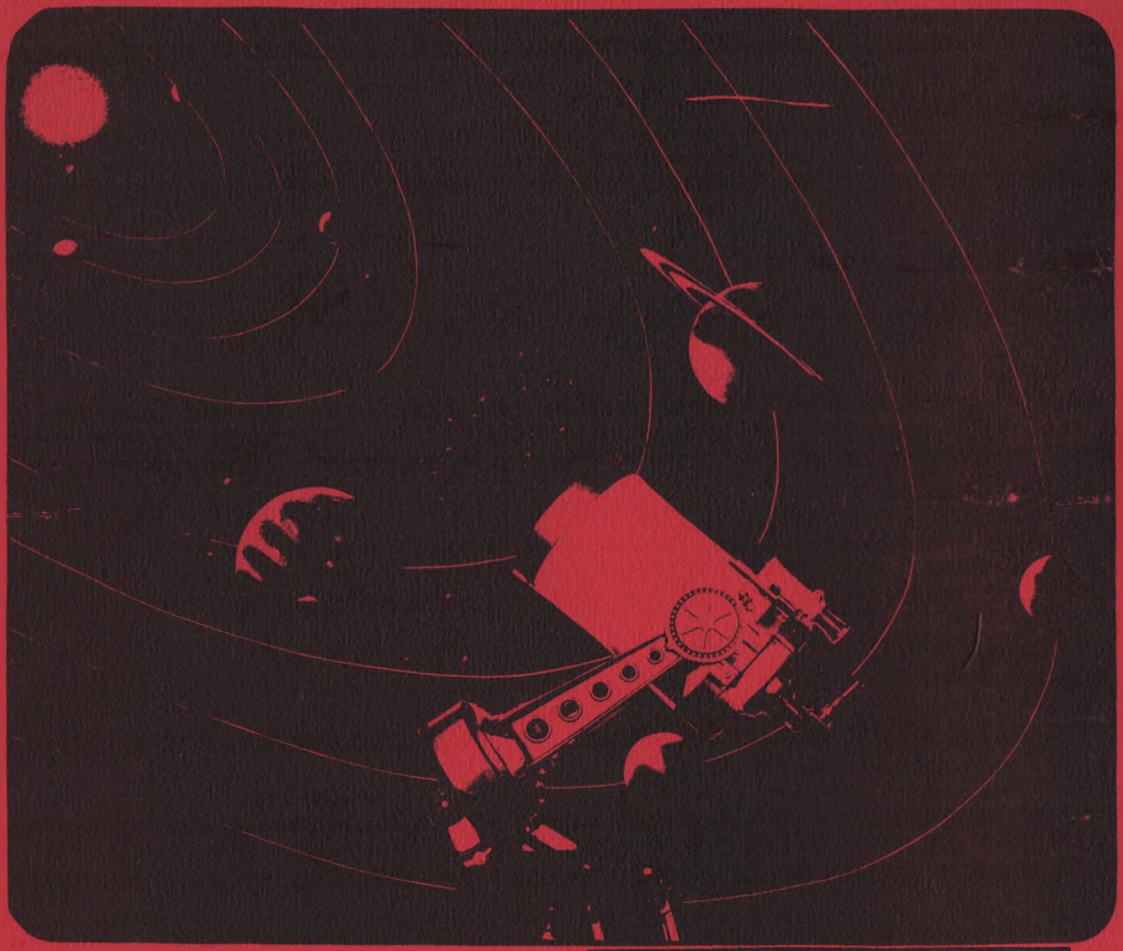
JULIAN DATE AT 1400 HOURS

	Jan 2443	Feb 2443	Mar 2443	Apr 2443	May 2443	Jun 2443	Jul 2443	Aug 2443	Sep 2443	Oct 2443	Nov 2443	Dec 2443
1	145	176	204	235	265	296	326	357	388	418	449	479
2	146	177	205	236	266	297	327	358	389	419	450	480
3	147	178	206	237	267	296	328	359	390	420	451	481
4	148	179	207	238	268	299	329	360	391	421	452	482
5	149	180	208	239	269	300	330	361	392	422	453	483
6	150	181	209	240	270	301	331	362	393	423	454	484
7	151	182	210	241	271	302	332	363	394	424	455	485
8	152	183	211	242	272	303	333	364	395	425	456	486
9	153	184	212	243	273	304	334	365	396	426	457	487
10	154	185	213	244	274	305	335	366	397	427	458	488
11	155	186	214	245	275	306	336	367	398	428	459	489
12	156	187	215	246	276	307	337	368	399	429	460	490
13	157	188	216	247	277	308	338	369	400	430	461	491
14	158	189	217	248	278	309	339	370	401	431	462	492
15	159	190	218	249	279	310	340	371	402	432	463	493
16	160	191	219	250	280	311	341	372	403	433	464	494
17	161	192	220	251	281	312	342	373	404	434	465	495
18	162	193	221	252	282	313	343	374	405	435	466	496
19	163	194	222	253	283	314	344	375	406	436	467	497
20	164	195	223	254	284	315	345	376	407	437	468	498
21	165	196	224	255	285	316	346	377	408	438	469	499
22	166	197	225	256	286	317	347	378	409	439	470	500
23	167	198	226	257	287	318	348	379	410	410	471	501
24	168	199	227	258	288	319	349	380	411	441	472	502
25	169	200	228	259	289	320	350	381	412	442	472	503
26	170	201	229	260	290	321	351	382	413	443	474	504
27	171	202	230	261	291	322	352	383	414	444	475	505
28	172	203	231	262	292	323	353	384	415	445	476	506
29	173		232	263	293	324	354	385	416	446	477	507
30	174		233	264	294	325	355	386	417	447	478	508
31	175		234		295		356	387		448		509

PLANETARIUM

UNIVERSITY OF THE WITWATERSRAND

YALE RD. MILNER PARK, JOHANNESBURG



NIGHTLY: Wednesday to Saturday at $20^{h}\ 30^{m}$
Wednesday in Afrikaans.

MATINEES: Saturday at $15^{h}\ 00^{m}$.
Sunday at $16^{h}\ 00^{m}$.

CLOSED ON MONDAYS & PUBLIC HOLIDAYS

Programmes change every month.

Celestron

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BRAAMFONTEIN,
2017

TELEPHONE 724-2853

PD UCT