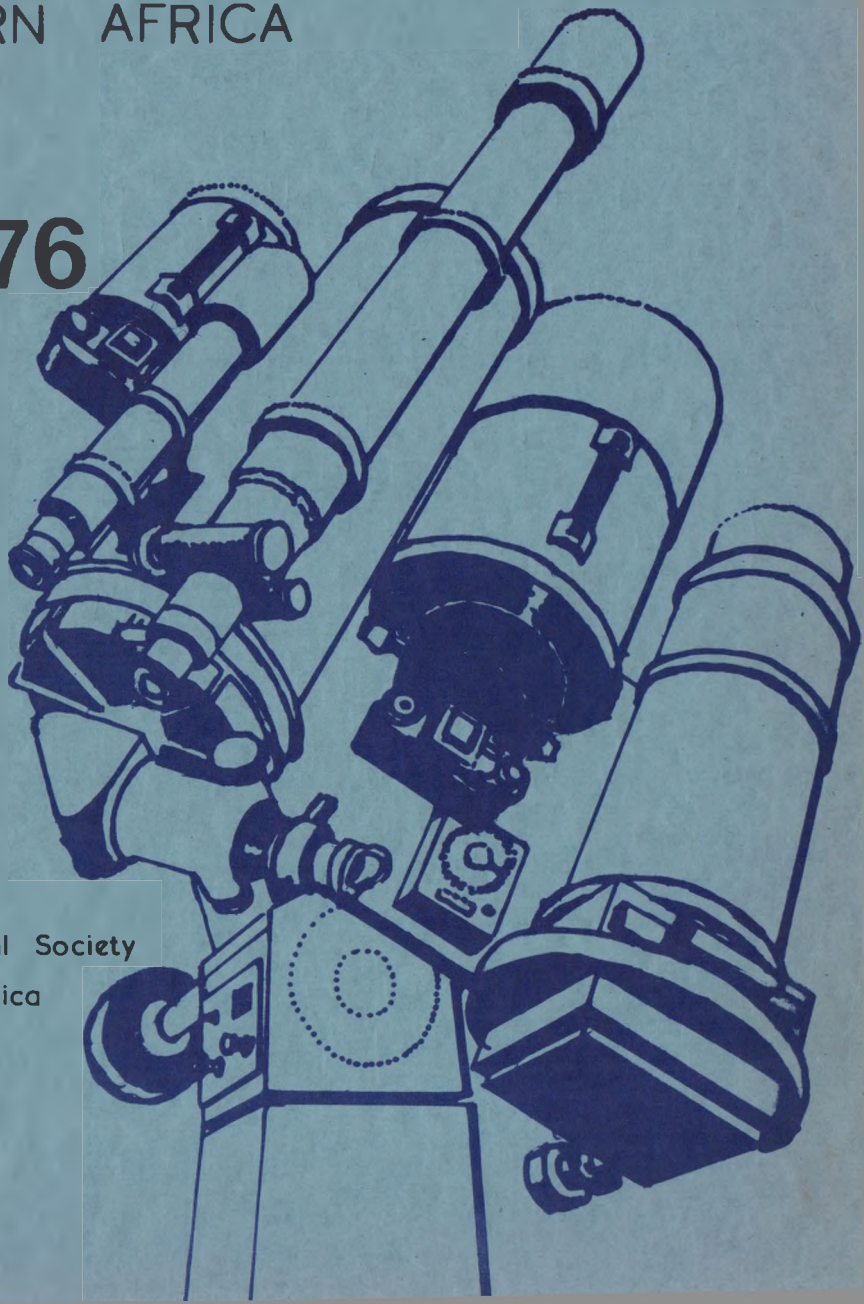
ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1976



published by
the Astronomical Society
of Southern Africa

ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1976

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: The multiple photographic telescope array belonging to Mr. C. Papadopoulos.

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 1976" 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, just outside Bloemfontein, is operated by an international consortium representing Belgian , Irish and South African interests. Thus many astronomers come from overseas to make use of its observing facilities which include the 1,5 m Rockefeller Reflector and the 0,9 m ADH Baker Schmidt. Its site offers good oberving conditions, without being remote from a large centre.

On the other hand, the observatory sites in the hearts of Cape Town and Johannesburg have become unsuitable with the rapid expansion of those cities. The South African Astronomical Observatory - a joint venture between the South African Council for Scientific and Industrial Research and the British Science Council-has merged their facilities and moved the larger instruments to a new site near Sutherland in the Karroo. 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 25 m dish of the Deep Space Tracking Station near Krugersdorp is used for research work when not required for tracking spacecraft, while the Rhodes University Radio Observatory just outside Grahamstown, has a number of arrays for receiving radio emission from the planet Jupiter.

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

OBSERVATORIES OPEN TO THE PUBLIC

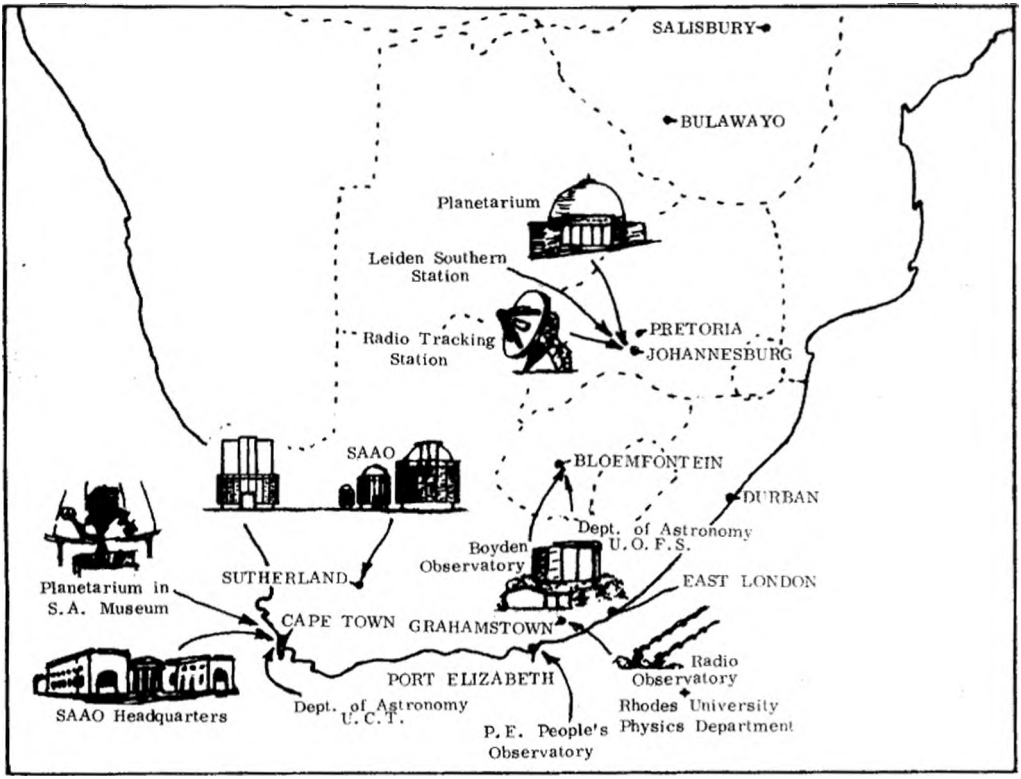
Visiting nights at Boyden Observatory are held twice per month usually around the time of first quarter. Intending visitors should contact the Information Office in Hoffman Square, Bloemfontein for tickets (gratis). Numbers are restricted to twenty persons on each visiting night.

SAAO Headquarters, Observatory, Cape are open to visitors on the second Saturday each month at 8. 00 p. m. No tickets are necessary but parties of more than ten persons should contact the observatory in advance.

PLANETARIA

The major planetarium in South Africa is that situated on the grounds of the University of the Witwatersrand (entrance in Yale Road - alongside M1). It is equipped with a highly complex Zeiss projector and seats over 400 persons.

A smaller planetarium, with a Spitz projector and seating approximately 70, is located within the South African Museum, Cape Town. Shows are given each Saturday at 3. 00 p. m. , each Sunday at 3. 30 p. m. , and at 11. 00 a. m. and 3. 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 R8.00 and there is an entrance fee of R2.50. Information can be obtained from the Honorary Secretary, Astronomical Society of Southern Africa, c/o The South African Astronomical Observatory, P.O. Box 9, Observatory 7935, Cape.

LOCAL CENTRES OF THE SOCIETY

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

CAPE CENTRE (Cape Town) - Meetings on 2nd Wednesday of the month (except Jan. and Dec.) at the South African Astronomical Observatory at 8.00 p.m. The Centre possesses a small observatory housing the twelve inch Ron Atkins Telescope. There is also an active occultation section. Secretarial address: 4 Chalfont Road, Newlands 7700. Information on meetings also available from 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: P.O. Box 5595, Johannesburg 2001.

NATAL CENTRE (Durban) - Monthly meetings are held at the Teacher's Centre. Occultation and telescope making sessions. The Centre has a portable twelve inch reflecting telescope. Secretarial address: Box 2704, Durban 4000. Telephone (evenings) 72-3187.

NATAL MIDLANDS CENTRE (Pietermaritzburg) - Meetings usually on the first Thursday of the month either in a private home. Secretarial address: 17 Yalta Rd., Pietermaritzburg 3201. Telephone 54038

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

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

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 40
Nova Search Section	see page 33
Ordinary Occultations	see page 35
Variable stars	see page 34

DIARY 1976

JANUARY

4^{d}	13^{h}	Earth at perihelion
7	7	Mercury at greatest elongation E (19^{o})
8	14	Venus 7^{o} N of Antares
12	6	Venus 0^{o}.4 N of Neptune
13	4	Ceres 0^{o}.3 N of Moon (mag 7.6)
14	5	Mars 5^{o} N of Moon
17	15	Saturn 5^{o} N of Moon
20	13	Saturn at opposition
20	12	Sun overhead at Bulawayo
23	9	Spica occulted
24	9	Uranus 2^{o}N of Moon
26	23	Neptune (mag 7.8) occulted
28	10	Venus 2^{o} S of Moon
30	12	Sun overhead at Salisbury

FEBRUARY

6	5	Jupiter 4^{o}S of Moon
10	18	Mars 5^{o}N of Moon
13	21	Saturn 5^{o}N of Moon
16	17	Mercury greatest elongation W 26^{o}
17	0	Juno occulted
19	15	Spica occulted
20	15	Uranus 1^{o} N of Moon
23	6	Neptune 0^{o}.9 S at Moon
27	16	Venus 6^{o} S of Moon
28	2	Mercury 7^{o} S of Moon

MARCH

4	22	Jupiter 3^{o}S of Moon
9	21	Mars 6^{o} N of Moon
12	5	Saturn 5^{o} N of Moon
18	1	Spica 0^{o}3 S of Moon
18	22	Uranus 1^{o}N of Moon
20	14	Equinox
29	2	Venus 6^{o} S of Moon

APRIL

1	16	Jupiter 2^{o} S of Moon
7	5	Mars 7^{o}N of Moon
8	14	Saturn 6^{o} N of Moon
12	20	Mercury 1^{o}.9 N of Jupiter

APRIL (contd.)

14^{d}	12^{h}	Spica 0^{o}.3 S of Moon
15	8	Uranus 1^{o} N of Moon
27	22	Jupiter in conjunction with the Sun
28	4	Mercury greatest elongation E 21^{o}
29	12	Annular eclipse of the sun visible North Africa, Greece, Turkey, Tibet

MAY

5	6	Mars 5^{o}S of Pollux
5	16	Mars 7^{o} N of Moon
5	22	Saturn 6^{o} N of Moon
11	16	Venus 0^{o}.2 S of Jupiter
11	22	Spica 0^{o}.3 S of Moon
12	4	Mars 1^{o}.3 N of Saturn
27	6	Jupiter 0^{o}.8 S of Moon

JUNE

2	8	Saturn 6^{o} N of Moon
3	4	Mars 7^{o} N of Moon
8	7	Spica 0^{o}.4 S of Moon
9	0	Uranus 1^{o} N of Moon
15	11	Mercury greatest elongation W 23^{o}
21	8	Winter solstice
22	19	Mercury 3^{o} N of Aldebaran
24	1	Jupiter 0^{o}.1 S of Moon
26	0	Mercury 1^{o}N of Moon
29	20	Saturn 6^{o} N of Moon

JULY

1	16	Mars 6^{o} N of Moon
3	6	Earth at aphelion
5	13	Spica 0^{o}. 6 S of Moon
5	20	Mars 0^{o}.7 N of Regulus
6	6	Uranus 1^{o} N of Moon
8	23	Neptune 1^{o} S of Moon
21	19	Jupiter 0^{o}.5 N of Moon
24	16	Mercury 0^{o}.4 N of Venus
29	16	Saturn in conjunction with Sun
30	04	Mars 5^{o}N of Moon

AUGUST

1d	18h	Spica 0°.8 S of Moon
3	8	Mercury 0°.7N of Regulus
7	18	Venus 1°.1 N of Regulus
18	11	Jupiter 1° N of Moon
24	1	Saturn 6°N of Moon
26	12	Mercury greatest elongation E 27°
27	2	Venus 5° N of Moon
27	17	Mars 4° N of Moon
29	1	Spica 1° S of Moon
29	19	Uranus 0°6 N of Moon

SEPTEMBER

6	6	Mercury 5°S of Venus
11	0	Venus 0°.4 N of Mars
14	21	Jupiter 1°N of Moon
20	3	Venus 3°N of Spica
20	17	Saturn 6° N of Moon
25	7	Mars 2°N of Moon
25	20	Venus 0°.7 N of Moon
27	21	Mars 3°N of Spica
30	24	Venus 0°.5 S of Uranus

OCTOBER

7d	18h	Mercury greatest elongation W 18°
12	3	Jupiter 1° N of Moon
18	7	Saturn 6°N of Moon
19	0	Mars 0°.4 S of Uranus
23	7	Total eclipse of the sun, seen in Southern Africa as a partial eclipse
25	15	Venus 4° S of Moon
28	3	Venus 3° N of Antares
31	8	Venus 3°S of Neptune

NOVEMBER

7	1	Penumbrial eclipse of the Moon
8	3	Jupiter 1° N of Moon
14	17	Saturn 6° N of Moon
18	10	Jupiter at opposition
19	7	Spica 1°S of Moon
20	8	Uranus 0°.05 S of Moon. Occultation
24	15	Venus 7°S of Moon
25	3	Mars in conjunction with the Sun
25	17	Mercury 3° S of Neptune

DECEMBER

5d	2h	Jupiter 0°.8 North of Moon. Occultation
5	19	Neptune in Conjunction with the sun.
11	23	Saturn 6° N of Moon
16	16	Spica 1° S of Moon
20	12	Mercury greatest elongation East 20°
22	17	Mercury 6°S of Moon
24	17	Venus 7°S of Moon

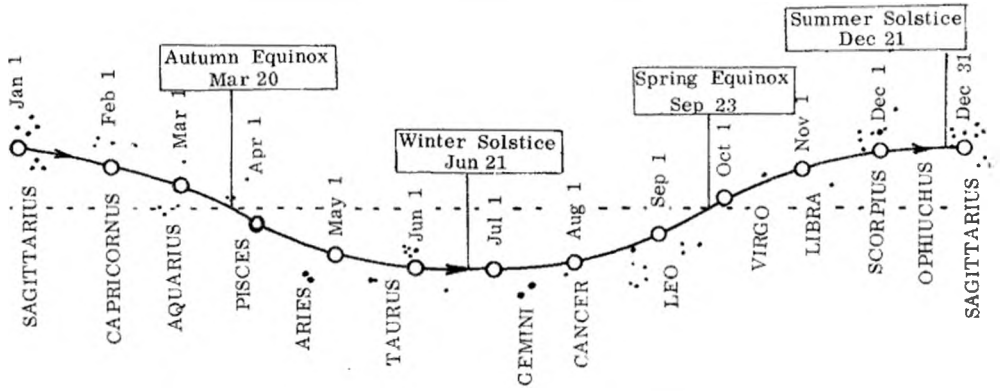
THE SUN 1975

BASIC DATA

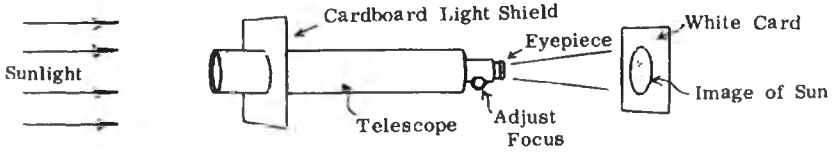
Diameter: 1 392 000 km (109 times Earth diameter)
Mass: $1,99 \times 10^{30}$ kg (330 000 times Earth Mass)
Surface Temperature: Approx. 6000°C
Temperature at centre: Approx. 10 million°C

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 1976 we will be closest to the Sun on January 4 (perihelion - approx. distance 147 million km.) and furthest from the Sun on July 3 (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 45	18 22	05 39	18 12	05 30	17 57
21	05 58	19 04	05 12	18 09	05 33	18 27	05 27	18 17	05 23	17 59
Nov 1	05 46	19 13	05 02	18 17	05 24	18 35	05 19	18 24	05 16	18 03
11	05 38	19 23	04 55	18 26	05 17	18 44	05 13	18 32	05 14	18 08
21	05 31	19 33	04 49	18 34	05 12	18 52	05 08	18 39	05 11	18 13
Dec 1	05 29	19 43	04 48	18 42	05 11	19 00	05 07	18 46	05 12	18 19
11	05 28	19 50	04 48	18 50	05 11	19 07	05 08	18 53	05 14	18 25
21	05 32	19 57	04 52	18 57	05 15	19 14	05 12	19 00	05 18	18 31

SOLAR ECLIPSES

Annular eclipse of the Sun, April 29. This eclipse is not visible from Southern Africa.

Total eclipse of the Sun, October 23. From Southern Africa this eclipse will be seen as a partial eclipse in the early morning. Predictions are as follows:

	Cape Town		Johannesburg		Salisbury	
Eclipse begins (P.A.)	$5^h\ 37^m,05$	(341^o)	$5^h\ 14^m,73$	(325^o)	$4^h\ 58^m,98$	(311^o)
Maximum eclipse (magnitude)	6 08,17	(19%)	5 57,49	(41%)	5 47,77	(63%)
Eclipse ends (P.A.)	6 40,59	(56^o)	6 43,28	(74^o)	6 40,87	(88^o)

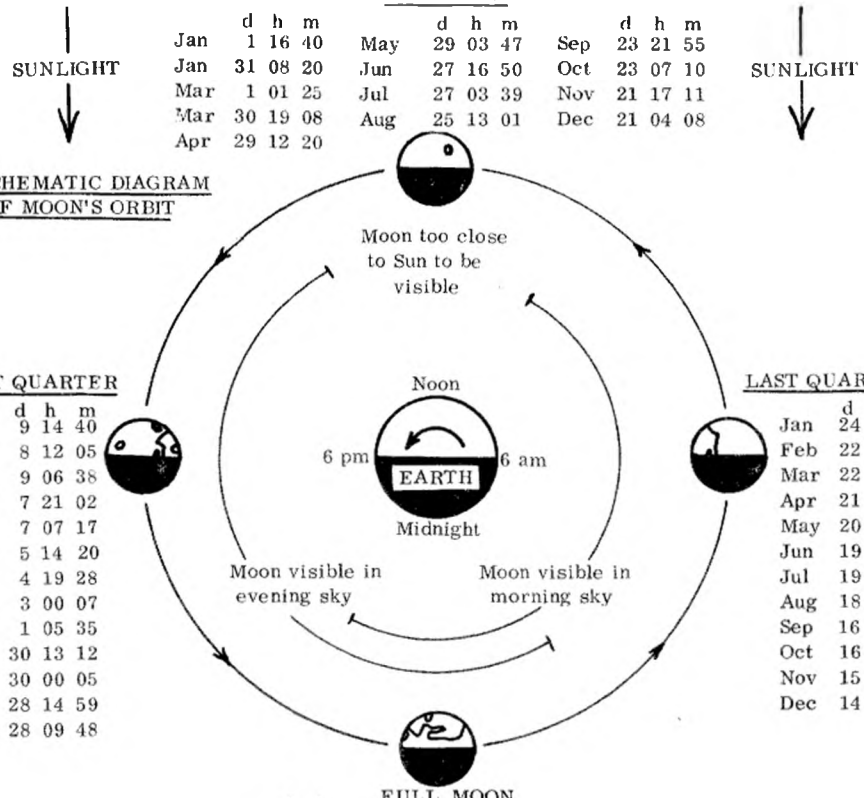
The position angle (P.A.) of the point of contact is measured eastwards from the north point of the Sun. The magnitude is the percentage of the Sun's Diameter obscured.

THE MOON 1976

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



NEW MOON

	d	h	m		d	h	m		d	h	m
Jan	1	16	40	May	29	03	47	Sep	23	21	55
Jan	31	08	20	Jun	27	16	50	Oct	23	07	10
Mar	1	01	25	Jul	27	03	39	Nov	21	17	11
Mar	30	19	08	Aug	25	13	01	Dec	21	04	08
Apr	29	12	20								

FIRST QUARTER

	d	h	m
Jan	9	14	40
Feb	8	12	05
Mar	9	06	38
Apr	7	21	02
May	7	07	17
Jun	5	14	20
Jul	4	19	28
Aug	3	00	07
Sep	1	05	35
Sep	30	13	12
Oct	30	00	05
Nov	28	14	59
Dec	28	09	48

LAST QUARTER

	d	h	m
Jan	24	01	04
Feb	22	10	16
Mar	22	20	54
Apr	21	09	14
May	20	23	22
Jun	19	15	15
Jul	19	08	29
Aug	18	02	13
Sep	16	19	20
Oct	16	10	59
Nov	15	00	39
Dec	14	12	14

FULL MOON

	d	h	m		d	h	m		d	h	m
Jan	17	06	47	May	13	22	04	Sep	8	14	52
Feb	15	18	43	Jun	12	06	15	Oct	8	06	55
Mar	16	04	53	Jul	11	15	09	Nov	7	01	15
Apr	14	13	49	Aug	10	01	44	Dec	6	20	15

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 8	May 25	Oct 10	Jan 20	Jun 9	Sep 25
Feb 5	Jun 21	Nov 6	Feb 17	Jul 7	Oct 23
Mar 4	Jul 19	Dec 3	Mar 16	Aug 1	Nov 21
Mar 31	Aug 16	Dec 31	Apr 14	Aug 28	Dec 19
Apr 27	Sep 13		May 12		

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

Partial eclipse of the Moon, May 13. Details of this eclipse are as follows:

Moon enters penumbra	May	13^{d}	$19^{h}\ 46^{m},6$	
Moon enter umbra		13	21 15,7	(at 168^{o} East of North point)
Middle of eclipse		13	21 54,3	(12% of Moon's diameter obscured)
Moon leaves umbra		13	22 32,9	(at 150^{o} West of North point)
Moon leaves penumbra		14	00 02,0	

Penumbral eclipse of the Moon, November 6-7. Details are as follows:

Moon enters penumbra	November	6^{d}	$22^{h}\ 45^{m},6$	(at 34^{o} East of North point)
Middle of eclipse		7	01 01,1	(86% of Moon's diameter obscured)
Moon leaves penumbra		7	03 16,5	(at 57^{o} West of North point)

THE SURFACE OF THE MOON

In common with the inner planets of our solar system, the Moon's surface suffered bombardment by numerous minor bodies during the period 4,5 to 3,0 billion years ago. This has produced the heavily cratered topography now visible. Some particularly large 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

LIBRATIONS

Jan 5 Feb 1/28 Mar 26
Apr 22 May 19 Jun 16
Jul 13 Aug 9 Sep 5
Oct 2/30 Nov 26 Dec 23

Jan 19 Feb 15 Mar 13
Apr 10 May 7 Jun 3/30
Jul 27 Aug 24 Sep 20
Oct 17 Nov 13 Dec 11

Dates of Maximum Exposure of Indicated Limbs

Jan 15 Feb 12 Mar 11
Apr 8 May 6 Jun 2/29
Jul 26 Aug 22 Sep 19
Oct 17 Nov 15 Dec 13

Jan 2/29 Feb 24 Mar 23
Apr 20 May 19 Jun 16
Jul 14 Aug 10 Sep 8
Oct 2/30 Nov 27 Dec 25

JOHANNESBURG — TIMES OF

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

MOONRISE AND MOONSET

Apr				May				June			
RISE		SET		RISE		SET		RISE		SET	
07^h	38^m	19^h	04^m	08^h	09^m	19^h	10^m	09^h	24^m	20^h	35^m
08	29	19	44	09	00	19	58	10	08	21	33
09	21	20	25	09	50	20	49	10	50	22	32
10	13	21	12	10	39	21	44	11	32	23	31
11	04	22	01	11	24	22	40	12	11		
11	53	22	53	12	09	23	38	12	52	00	32
12	42	23	49	12	51			13	34	01	33
13	28			13	32	00	38	14	18	02	37
14	12	00	48	14	13	01	39	15	07	03	41
14	55	01	49	14	55	02	42	16	00	04	47
15	38	02	51	15	40	03	46	16	57	05	52
16	21	03	56	16	28	04	53	17	57	06	53
17	06	05	01	17	21	06	01	18	58	07	50
17	53	06	09	18	16	07	07	19	59	08	41
18	43	07	17	19	15	08	11	20	57	09	26
19	38	08	24	20	16	09	10	21	53	10	08
20	34	09	29	21	16	10	03	22	47	10	46
21	32	10	29	22	14	10	51	23	39	11	21
22	31	11	24	23	10	11	33			11	55
23	29	12	13			12	12	00	31	12	29
		12	57	00	04	12	48	01	22	13	04
00	24	13	36	00	56	13	22	02	13	13	40
01	18	14	13	01	47	13	55	03	05	14	20
02	11	14	47	02	38	14	29	03	57	15	02
03	02	15	21	03	28	15	05	04	49	15	49
03	52	15	55	04	20	15	42	05	41	15	38
04	43	16	29	05	11	16	22	06	32	17	32
05	34	17	05	06	04	17	07	07	21	18	28
06	25	17	44	06	56	17	54	08	07	19	27
07	17	18	24	07	47	18	45	08	51	20	26
				08	37	19	39				

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

MOONRISE AND MOONSET

Oct				Nov				Dec			
RISE		SET		RISE		SET		RISE		SET	
12^h	18^m	01^h	06^m	13^h	55^m	01^h	52^m	14^h	25^m	01^h	38^m
13	16	01	53	14	47	02	28	15	16	02	13
14	11	02	35	15	38	03	03	16	07	02	50
15	06	03	14	16	30	03	37	16	58	03	28
15	59	03	52	17	21	04	13	17	50	04	08
16	51	04	27	18	12	04	50	18	40	04	52
17	43	05	01	19	03	05	29	19	29	05	40
18	34	05	31	19	54	06	10	20	17	06	29
19	25	06	12	20	43	06	55	21	02	07	22
20	17	06	50	21	31	07	43	21	44	08	16
21	07	07	30	22	18	08	33	22	25	09	11
21	58	08	12	23	02	09	26	23	05	10	08
22	47	08	58	23	44	10	20	23	44	11	04
23	35	09	46			11	16			12	03
		10	38	00	25	12	14	00	24	13	03
00	20	11	32	01	05	13	13	01	05	14	06
01	05	12	28	01	46	14	14	01	50	15	10
01	47	13	27	02	28	15	18	02	38	16	15
02	30	14	27	03	12	16	23	03	32	17	21
03	12	15	30	04	00	17	31	04	30	18	24
03	54	16	34	04	53	18	38	05	32	19	22
04	39	17	41	05	51	19	44	06	35	20	16
05	26	18	48	06	51	20	44	07	38	21	03
06	17	19	56	07	53	21	39	08	38	21	47
07	12	21	02	08	56	22	28	09	36	22	26
08	10	22	03	09	56	23	12	10	32	23	03
09	10	22	59	10	54	23	52	11	26	23	38
10	10	23	49	11	49			12	18		
11	09			12	42	00	29	13	10	00	13
12	06	00	35	13	34	01	03	14	01	00	49
13	01	01	15					14	52	01	26

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

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

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

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

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

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

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

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

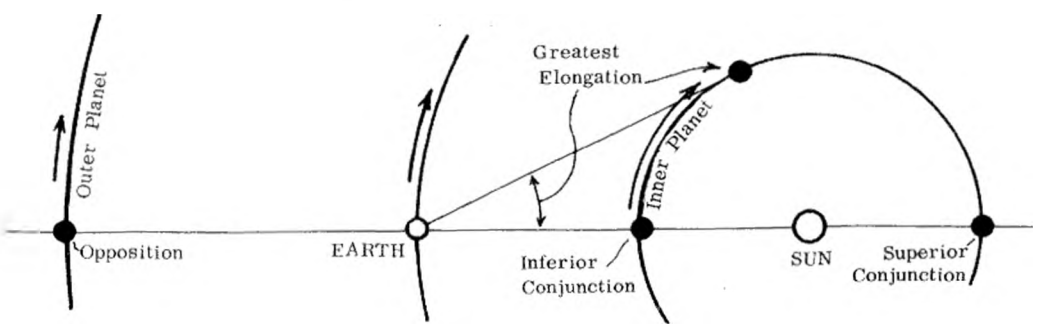
THE PLANETS 1976

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

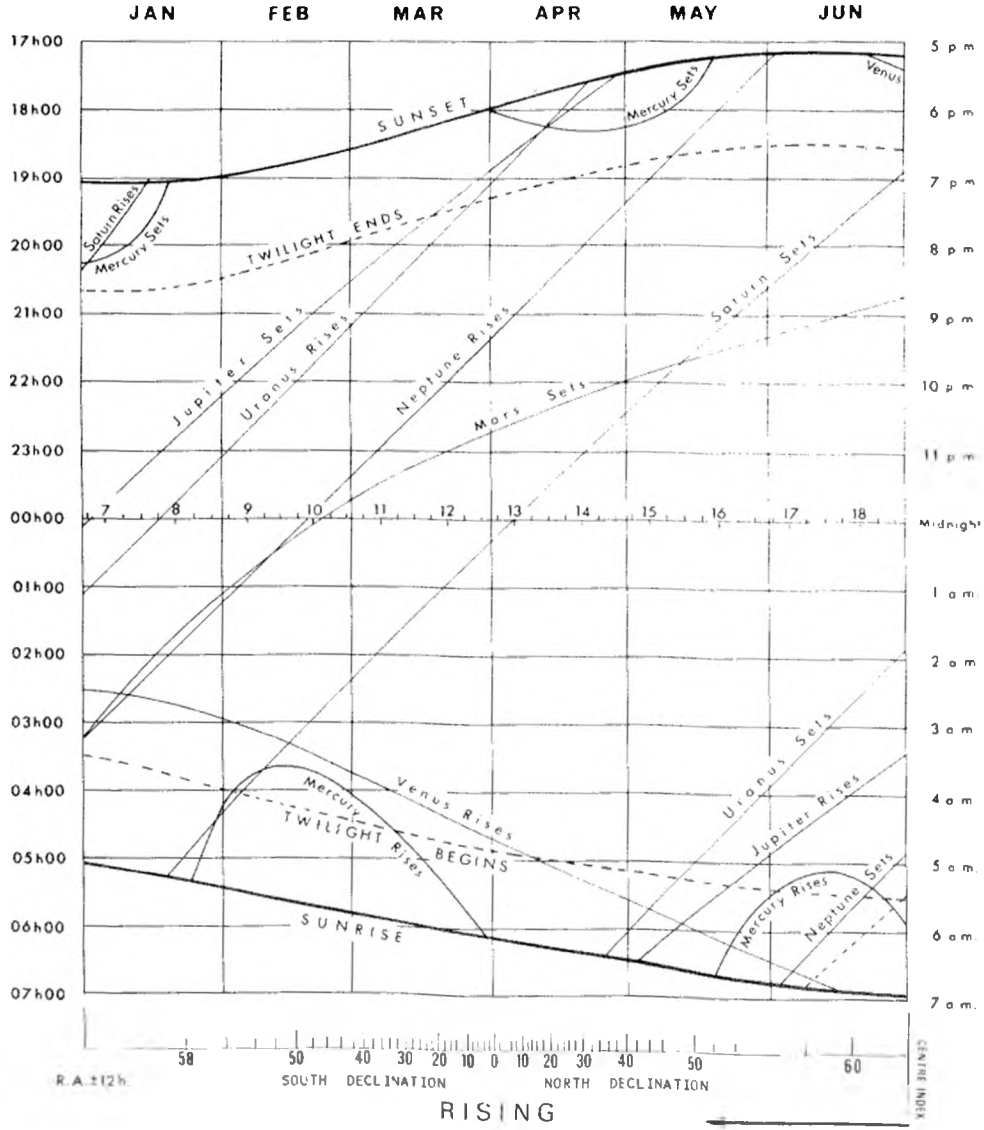
Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Unlike the distant stars, their relative positions do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the 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 1976 are listed chronologically in the Diary (pages 4 and 5) and are also mentioned in the text below.



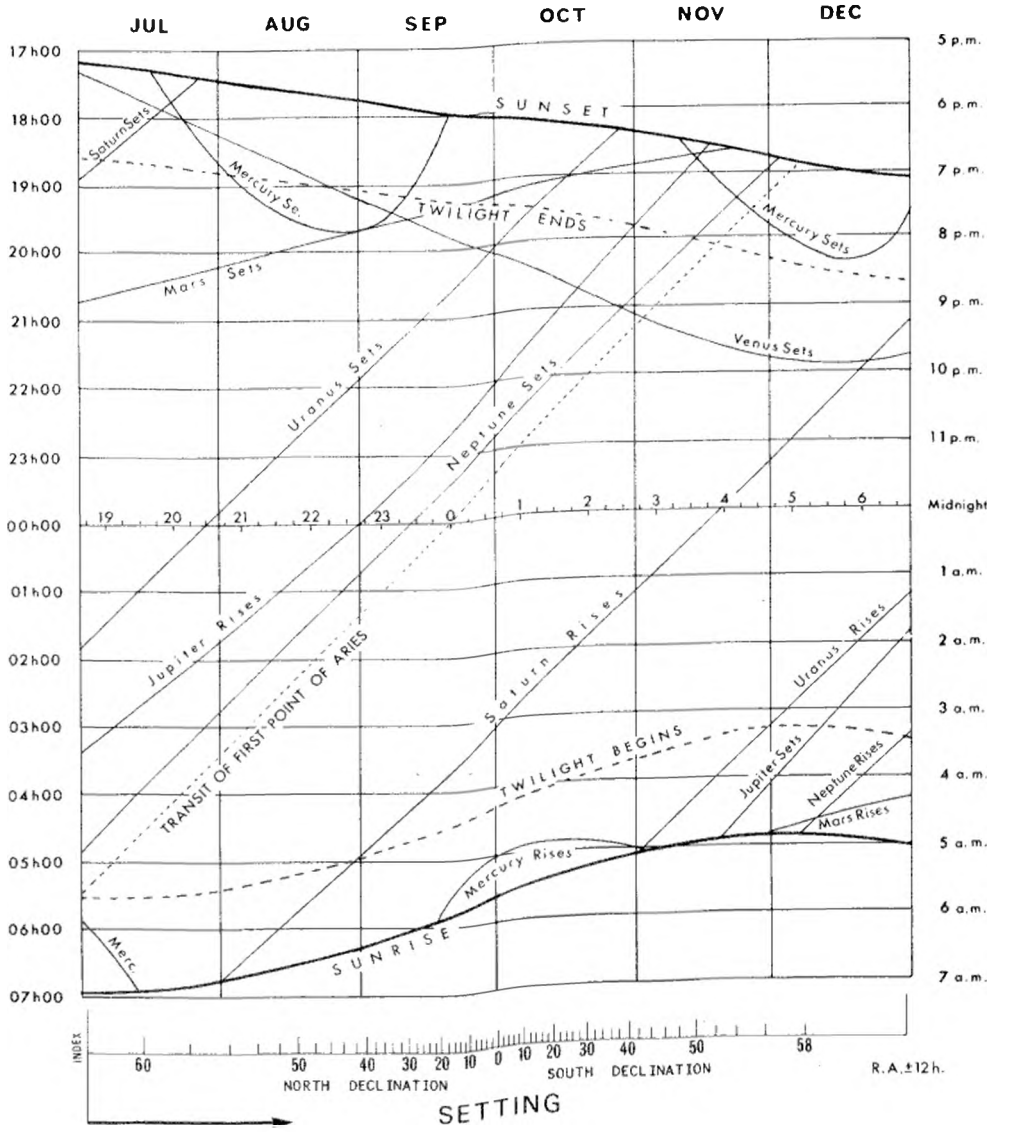
TIMES OF RISING AND SETTING

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

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, revolves 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). 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.

Greatest Elongation East	Jan 7 (19°)	Apr 28 (21°)	Aug 26 (27°)	Dec 20 (20°)
Inferior Conjunction	Jan 23	May 20	Sept 22	
Greatest Elongation West	Feb 16 (26°)	Jun 15 (23°)	Oct 7 (18°)	
Superior Conjunction	Apr 1	July 15	Nov 7	

VENUS

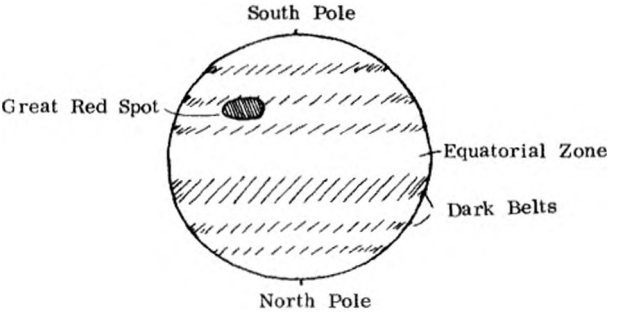
During the early months of the year, Venus will appear in the morning sky (above the eastern horizon). On June 18, it passes around the far side of the Sun and thereafter appears in the evening sky. As its distance from the Earth decreases it grows brighter and for the latter part of the year will be prominent in the western sky. If observed through a telescope over this period, its angular diameter will be seen to increase only slightly. Virtually no details can be seen on the disc of the planet because of the dense cloud covering.

MARS

Mars can be seen only in the evening sky until November when it passes behind the Sun. Its greatest angular diameter is only about 15 seconds of arc (about 1/100 of the Moon's diameter) at the beginning of the year and gradually decreases to 3 seconds of arc when it passes behind the Sun. Through a telescope it may be possible to glimpse the white polar caps and darker markings contrasting against the general "desert" orange colour of the disc. Regrettably Earth based telescopes cannot show the craters, conical volcanos and gigantic canyons that have been found on this planet. Mars has two tiny moons but a very large telescope is required to see these.

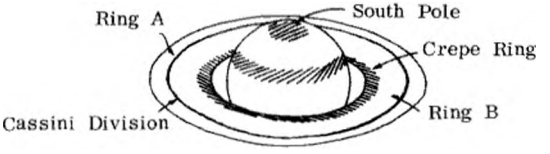
JUPITER

Jupiter is a prominent object in the evening sky in January and February, and from October onwards. It is at its brightest (magnitude -2,4) at opposition on November 18. Because of its large angular size (45 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 thirteen moons. An entire section of this Handbook is devoted to the movements of these satellites and the phenomena associated with them (see page 23)



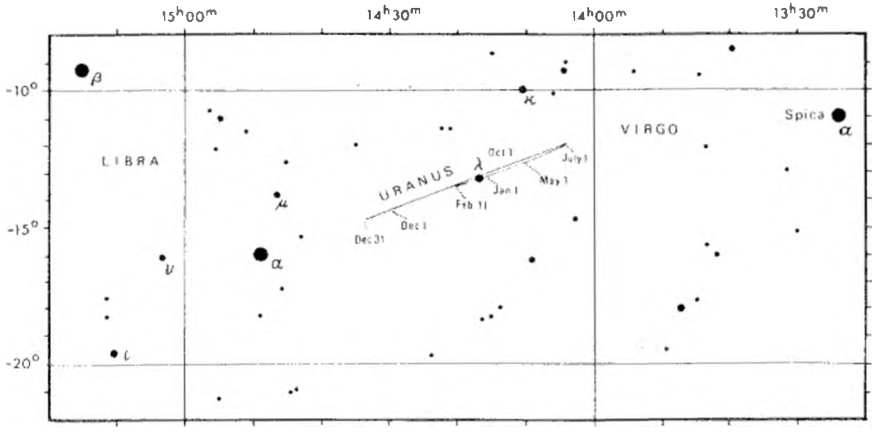
SATURN

Saturn will be clearly seen in the evening sky for the first six months of 1976 and again at the end of the year in the late evening. Unfortunately it will never be very high above the horizon because of its northerly declination - as it moves between the constellations of Cancer and Gemini. It is at greatest brightness (magnitude -0,1) at opposition on January 20. 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.



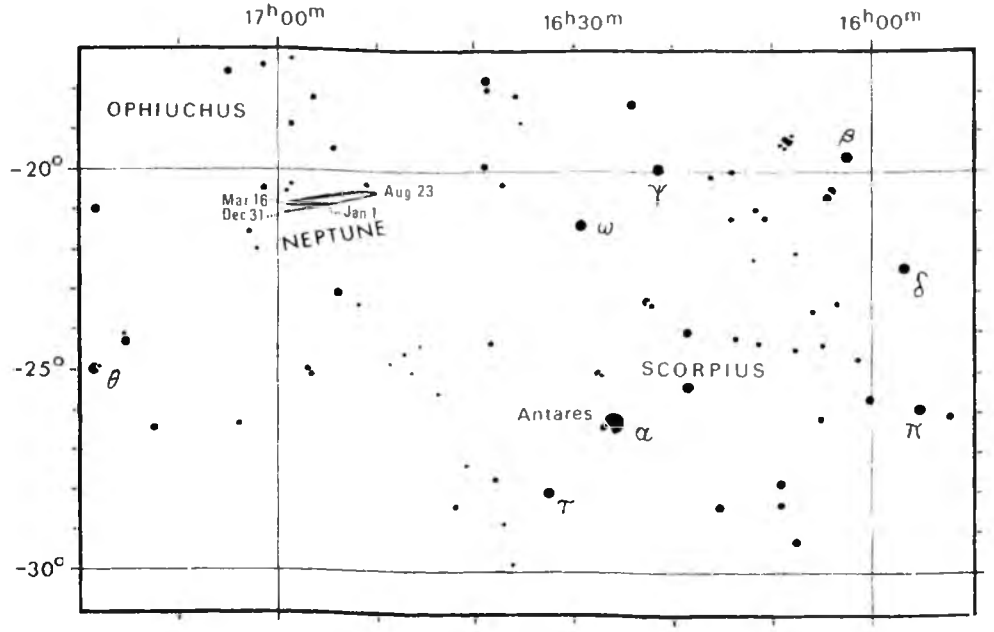
URANUS

Uranus at opposition on April 25 and conjunction on October 30, moves from the constellation of Virgo to the constellation of Libra early in the year. It is on the borderline of naked eye visibility (magnitude 5,7 at opposition) and may be found with the aid of binoculars and reference to the accompanying finding chart, which shows all stars in the region down to the same faintness. With a small telescope, its 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 3 – 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 12^h58^m Dec + 12 24' and RA 13^h17^m Dec - 10 09'. 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 1976

JUPITER'S MOONS

One of the most popular sights for an observer with a small telescope is Jupiter and its moons. Four of Jupiter's thirteen moons are large enough to be seen very easily – they would even be visible to the naked eye were it not for the glare of the mother planet. In order of increasing distance from Jupiter, the four moons are Io, which orbits once around Jupiter in less than 2 days; Europa, 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

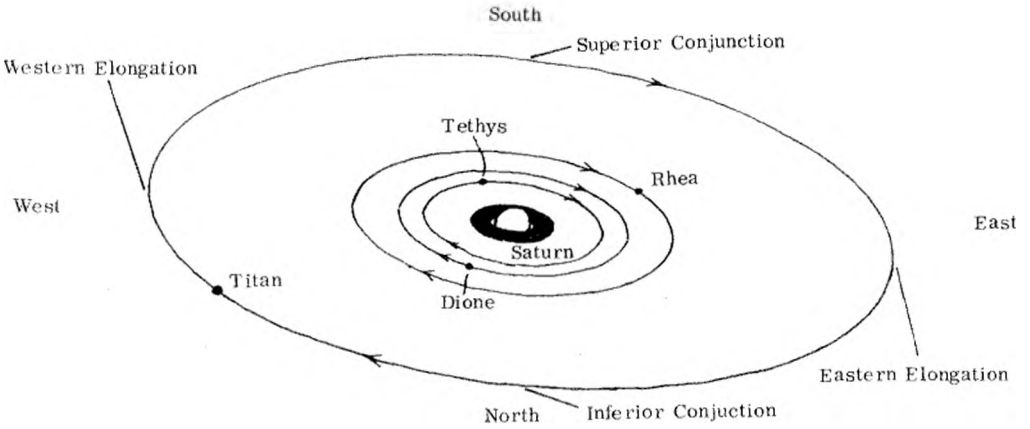
Tr. – Transit: the satellite crosses the disk of Jupiter I – Ingress
Sh. – Shadow transit: the shadow of the satellite transits the disk E – Egress

Jan 2	20h36m	III	Tr	E
	23 32	III	Sh	I
4	20 17	II	Oc	D
	23 01	II	Oc	R
	23 05	II	Ec	D
5	22 58	I	Sh	I
	23 49	I	Tr	E
6	20 29	II	Sh	E
	22 26	I	Ec	R
9	21 59	III	Tr	I
11	22 57	II	Oc	D
13	20 02	III	Ec	R
	20 30	II	Tr	E
	20 33	II	Sh	I
	20 50	I	Oc	D
	23 05	II	Sh	E
Jan 14	20h15m	I	Tr	E
	21 34	I	Sh	E
20	20 32	II	Tr	I
	21 42	III	Ec	D
	22 47	I	Oc	D
21	20 00	I	Tr	I
	21 19	I	Sh	I
	22 12	I	Tr	E
22	20 22	II	Ec	R
	20 45	I	Ec	R
27	20 21	III	Oc	D
28	21 59	I	Sh	I
Feb 5	20 29	II	Oc	D
	21 13	I	Oc	D
6	20 40	I	Tr	E
	21 51	I	Sh	E
Feb 17	20h11m	II	Sh	E

Sept 7	23 55	II	Sh	I
8	00 48	I	Tr	I
9	00 12	I	Oc	R
16	23 12	I	Tr	E
	23 37	II	Ec	R
	23 38	II	Oc	D
17	00 20	III	Sh	I
23	00 30	I	Ec	D
	22 55	I	Tr	I
	23 41	II	Ec	D
	23 52	I	Sh	E
24	22 20	I	Oc	R
25	23 20	II	Tr	E
27	23 12	III	Oc	D

Sep	30	23^h38^m	I	Sh	I	Nov	4	00^h09^m	II	Tr	E	Dec		20^h45^m	III	Tr	E
	1	00 43	I	Tr	I		8	22 04	I	Sh	I			22 37	III	Sh	E
	2	00 08	I	Oc	R		8	22 20	I	Tr	I		5	20 39	II	Sh	I
		23 16	II	Tr	I		9	00 13	I	Sh	E			22 15	II	Tr	E
		23 39	II	Sh	E			00 28	I	Tr	E			23 11	II	Sh	E
	4	22 25	III	Ec	D			21 24	III	Oc	R		8	23 40	I	Tr	I
	8	22 47	I	Ec	D			21 47	I	Oc	R		9	00 11	I	Sh	I
	9	23 03	I	Tr	E		10	23 29	II	Sh	I			20 59	I	Oc	D
		23 42	II	Sh	I			23 55	II	Tr	I			23 43	I	Ec	R
	11	22 22	II	Oc	R		12	20 30	II	Oc	R		10	20 15	I	Tr	E
	15	21 38	III	Tr	E		15	23 58	I	Sh	I			20 50	I	Sh	E
	16	21 54	I	Sh	I		16	00 03	I	Tr	I		12	00 25	III	Sh	I
		22 42	I	Tr	I			21 18	I	Ec	D			22 02	II	Tr	I
	17	00 02	I	Sh	E			22 29	III	Ec	D			23 16	II	Sh	I
		22 08	I	Oc	R			23 31	I	Oc	R		13	00 32	II	Tr	E
	22	22 31	III	Sh	E		17	20 37	I	Tr	E		16	22 45	I	Oc	D
		23 15	III	Tr	I			20 37	I	Sh	E		17	20 35	I	Sh	I
	23	23 47	I	Sh	I		19	20 17	II	Oc	D			22 01	I	Tr	E
	24	00 26	I	Tr	I			22 51	II	Ec	R			22 45	I	Sh	E
		21 05	I	Ec	D		23	23 05	I	Oc	D		18	20 07	I	Ec	R
		23 53	I	Oc	R		24	20 12	I	Tr	I		20	00 20	II	Tr	I
	25	21 00	I	Tr	E			20 22	I	Sh	I		21	22 35	II	Ec	R
		23 16	II	Ec	D			22 20	I	Tr	E		22	20 49	III	Ec	R
	27	21 53	II	Tr	E			22 31	I	Sh	E		24	21 39	I	Tr	I
	31	23 00	I	Ec	D		25	19 52	I	Ec	R			22 30	I	Sh	I
Nov	1	20 10	I	Sh	I		26	22 30	II	Oc	D			23 48	I	Tr	E
		20 36	I	Tr	I		28	20 35	II	Sh	E		25	22 02	I	Ec	R
		22 19	I	Sh	E	Dec	1	21 56	I	Tr	I		28	20 46	II	Oc	D
		22 44	I	Tr	E			22 16	I	Sh	I		29	20 53	III	Oc	R
	2	20 03	I	Oc	R		2	00 04	I	Tr	E			22 36	III	Ec	D
	3	20 52	II	Sh	I			00 26	I	Sh	E		30	20 20	II	Sh	E
		21 41	II	Tr	I			21 47	I	Ec	R		31	23 27	I	Tr	I
		23 26	II	Sh	E		4	20 24	III	Sh	I		32	00 26	I	Sh	I

SATURN'S MOONS

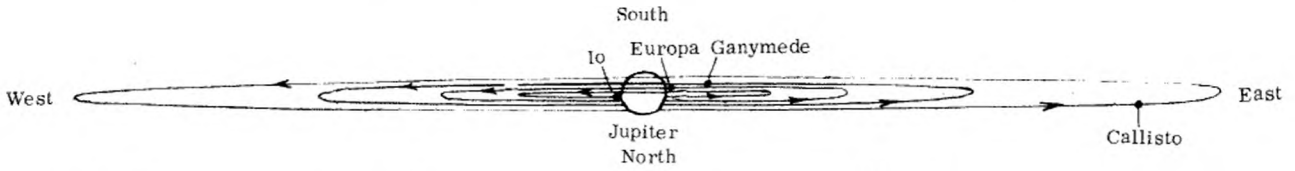


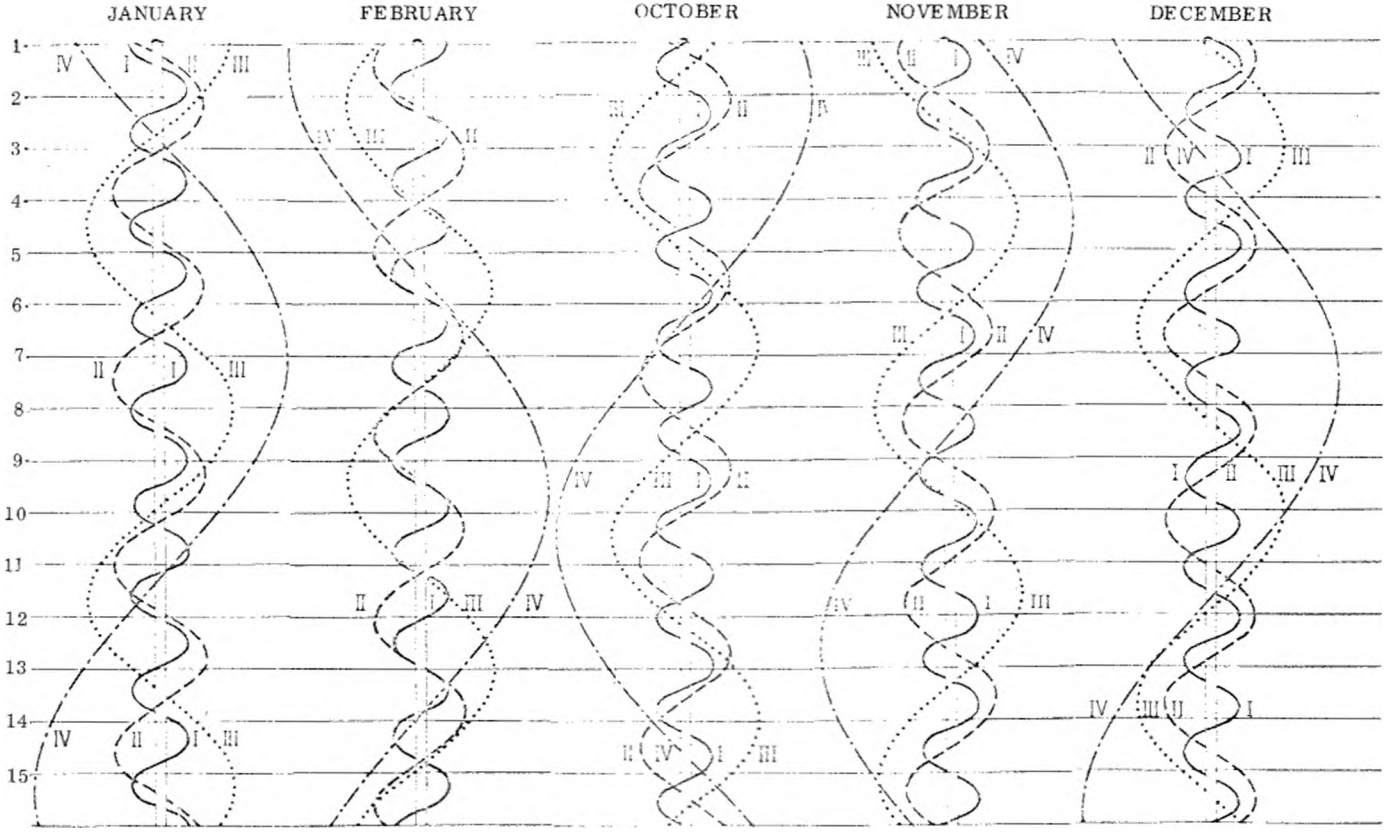
Saturn's moons are considerably fainter than the four Galilean moons of Jupiter. The diagram shows the orbits of four of Saturn's ten moons. The easiest to find is Titan (magnitude 8.5), according to the diagram and the information in the table below (which covers the period when Saturn is clearly visible in the evening sky).

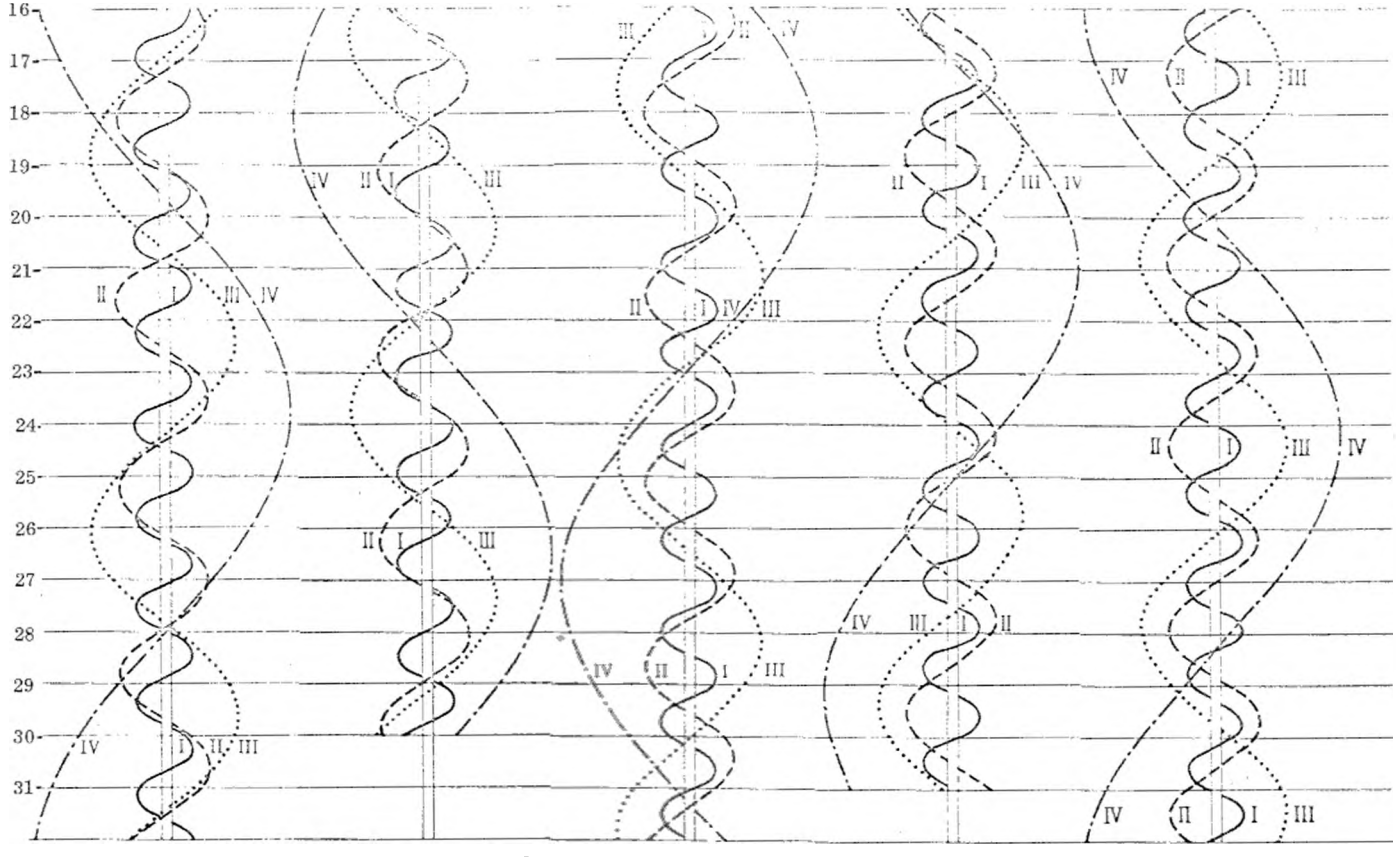
TITAN 1976

Eastern Elongation	Inferior Conjunction	Western Elongation	Superior Conjunction
Jan 1	Jan 5	Jan 8	Jan 12
Jan 17	Jan 20	Jan 24	Jan 28
Feb 2	Feb 5	Feb 9	Feb 13
Feb 17	Feb 21	Feb 25	Feb 29
Mar 4	Mar 8	Mar 12	Mar 16
Mar 20	Mar 24	Mar 28	Apr 1
Apr 5	Apr 9	Apr 13	Apr 17
Apr 21	Apr 25	Apr 29	May 3
May 7	May 11	May 15	May 19
May 23	May 27	May 31	June 4
June 8	June 12	--	--
--	--	--	--
Nov 15	Nov 19	Nov 23	Nov 27
Dec 1	Dec 5	Dec 9	Dec 13
Dec 17	Dec 21	Dec 25	Dec 29

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 0002.

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 1976

Date	Shower	Radiant		Maximum		Transit Radiant (approx)	Recommended Time of Watch	Conditions at Maximum
		R.A.	Dec.	Date	Hourly Rate			
		h m	°			h m		
Mar 14 - Mar 18	Corona Australids	16 20	-48	Mar 16	5	04 45	02h30m - dawn	Unfavourable
Mar 12 - Apr 25	Hydraids	12 16	-27	Mar 25	?	00 10	22h - 02h	Favourable
Apr 19 - Apr 24	April Lyrids	18 08	+32	Apr 22	15	04 15	03h - dawn	Unfavourable
May 1 - May 8	Eta Aquarids	22 24	00	May 5	18	07 30	03h - dawn	Favourable
Apr 20 - July 30	Sco-Sgr System	18 00	-30	Jun 14	?	00 30	20h - 24h	Unfavourable
Jun 10 - Jun 21	June Lyrids	18 32	+35	Jun 16	8	01 00	00h - 03h	Unfavourable
Jun 17 - Jun 26	Ophiuchids	17 20	-20	Jun 13(?)	8	23 30	21h -02h	Unfavourable
Jul 10 - Aug 5	Capricornids	21 00	-15	Jul 25	8	00 50	23h -02h	Favourable
Jul 15 - Aug 15	Delta Aquarids	22 36	-17 00	Jul 27	35	02 10	00h -04h	Favourable
Jul 15 - Aug 20	Pisces Australids	22 40	-30	Jul 30	11	02 10	00h -04h	Favourable
Jul 15 - Aug 25	Alpha Capricornids	20 36	-10	Aug 2	10	00 00	00h -02h	Favourable
Jul 15 - Aug 24	Iota Aquarids	22 04 22 32	- 6 -15	Aug 6	12	01 20 01 30	00h -02h	Favourable
Oct 16 - Oct 27	Orionids	06 24	+15	Oct 21	25	04 30	02h -dawn	Favourable
Oct 10 - Dec 5	Taurids	03 44 03 44	+14 +21	Nov 8	16	00 50 00 50	00h -03h	Unfavourable
Nov 14 - Nov 20	Leonids	10 08	+22	Nov 17	10	05 30	02h -dawn	Unfavourable
Dec 4 - 5	Phoenicids	01 00	-55	Dec 4	?	20 10	21h -23h	Unfavourable
Dec 7 - Dec 15	Geminids	07 28	+32	Dec 14	55	02 00	01h -dawn	Unfavourable
Dec 5 - Jan 7	Velaids	09 56	-51	Dec 29	?	02 30	01h -dawn	Favourable

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.

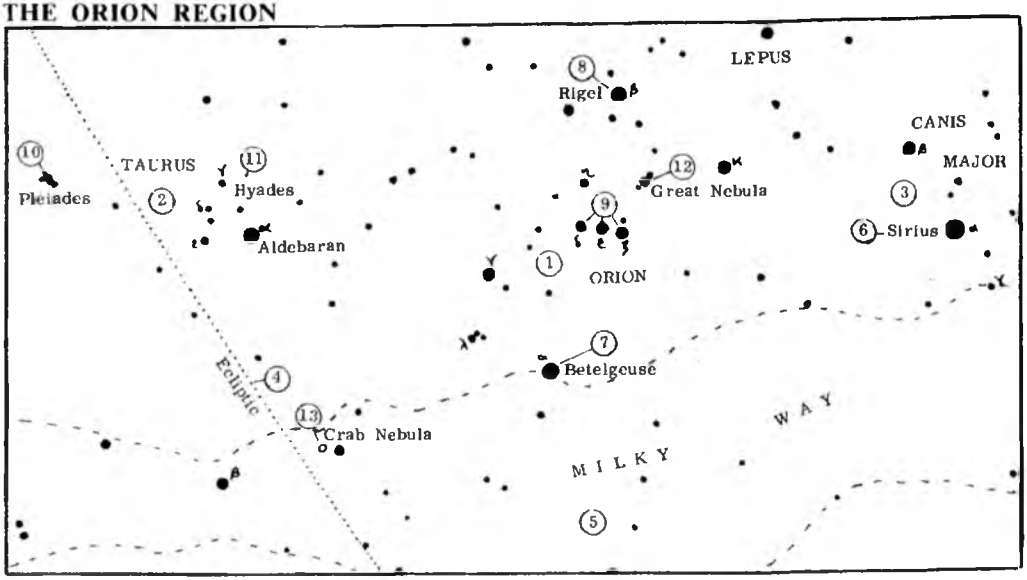
NEBULAE

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.

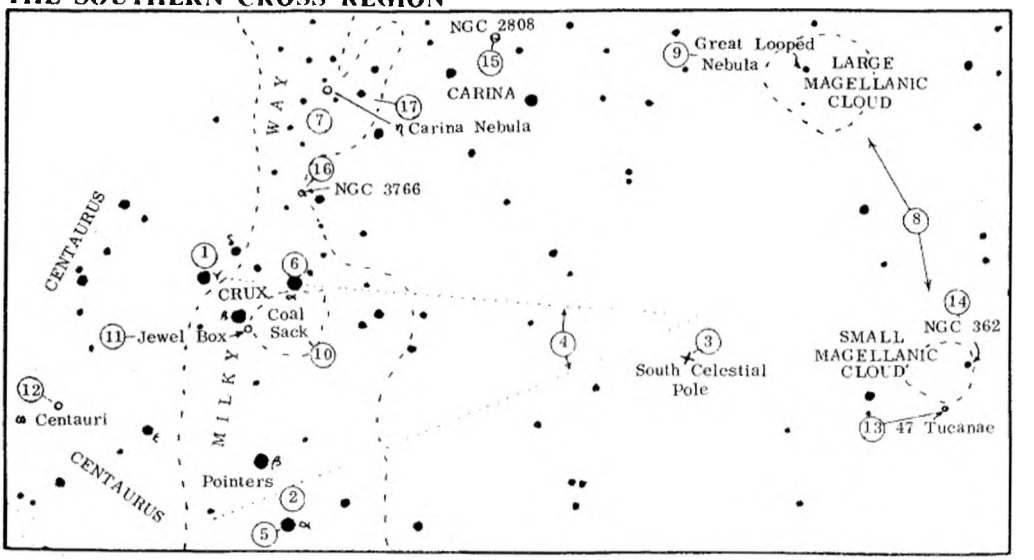
(10) The Pleiades or Seven Sisters form the best known nearby star cluster. Six or seven stars are visible to the naked eye, binoculars or a small telescope show more.

(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).

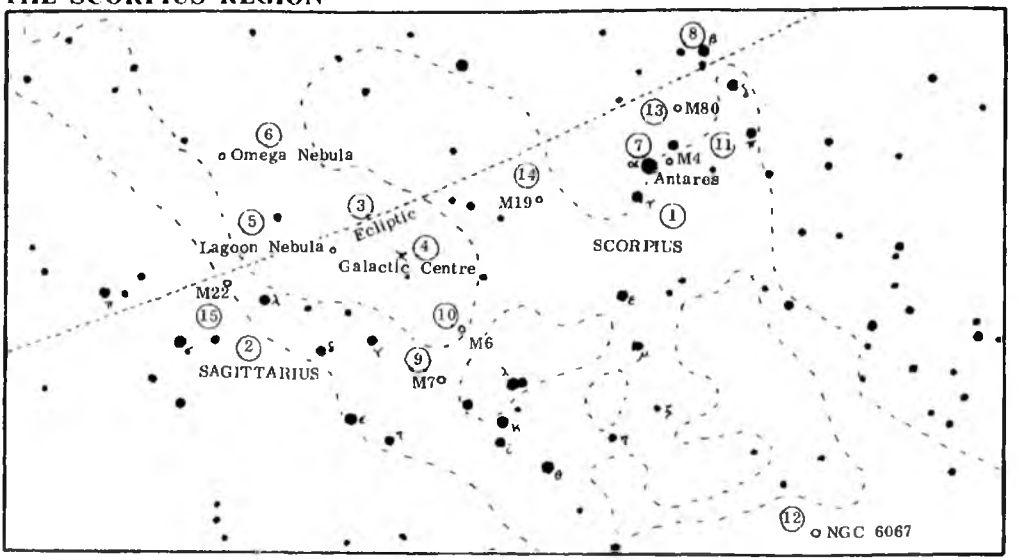
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).

(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 0002.

VARIABLE STAR OBSERVING

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

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

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

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

Some of these VIP stars are:

111661	RS Cen	145971	S Aps
123753	UW Cen	174406	Rs Oph
124728	Ex Hya	181824	Gu Sgr
131953	Dy Hya	183423	V348 Sgr
132554	Bv Cen	191033	Ry Sgr
135870b	Z Aps		

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	134236	RT Cen
034625	U Eri	161122 a and b	R and S Sco
035124	T Eri	165030a	Rr Sco
040725	W Eri	174162	W Pav
043262	R Ret	180222a	VX Sgr
054331	S Col	180363	R Pav
091868	Rw Car	191019	R Sgr
094953	Z Vel	214247	R Gru
100661	S Car		

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.

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, Mr. M.D. Overbeek, 60 Edward Drive, Glendower, Edenvale, 1610. New observers will be given charts of a few easy objects and (if possible) a certain amount of instruction at the eyepiece. When writing, prospective observers should give brief details of their equipment.

ORDINARY OCCULTATIONS

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

The essential record of a occultation observation consists of

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

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

The telescope position must be to an accuracy of 1" or better in latitude and longitude and 30 metres or better in altitude. An observer can usually read his position off a 1/50 000 map published by the Director General of Trig. Survey, Mowbray, or his equivalent in other countries. Positions determined astronomically are NOT acceptable, 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^{o} = New Moon, 90^{o} = First Quarter, 180^{o} = Full Moon, 270^{o} = Last Quarter.

U.T. - The predicted time in Universal Time which is exactly two hours behind South African Standard Time. For example $0^{h}55^{m},9$ UT is $2^{h}55^{m},9$ a.m. SAST.

a,b - the approximate time of an occultation at a place $\Delta\lambda$ degrees west and $\Delta\phi$ degrees north of the city concerned is

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

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. 18.500, S. 33.900 U.T.					JOHANNESBURG E. 28.000, S. 26.200 U.T.					SALISBURY E. 31.100, S. 17.700 U.T.				
								a	b	P			a	b	P			a	b	P
					o	h	m	m	m	o	h	m	m	m	o	h	m	m	m	o
Jan.	7	3501	5.3	1	71	19	45.2	-1.1	-0.2	125	19	54.4	-0.5	+0.6	103			A		
	11	416	5.4	1	114			S					S			16	50.3	-1.7	+3.0	28
	11	429	6.9	1	115	20	17.1	-2.1	+0.6	97	20	43.0	-1.8	+1.3	78	21	02.7	-1.8	+2.2	52
	11	433	5.6	1	116	21	31.5	-1.7	+2.5	45			N					N		
	12	531	5.5	1	126			S			17	22.4	-2.3	+0.6	65	17	40.3	-2.4	+2.0	44
	12	533	6.3	1	126			S			18	26.2	-3.0	-0.1	93	18	38.7	-3.1	+0.9	73
	13	700	5.7	1	138			N					N			18	57.8	.	.	136
	14	847	3.0	1	150	20	20.7	-2.4	-0.9	113	20	41.5	-2.7	+0.1	93	20	55.8	-3.1	+1.3	67
	14	847	3.0	2	150	21	45.8	-2.4	+0.9	255	22	12.0	-2.0	+0.2	282	22	14.0	-1.5	-1.2	310
	15	995	4.1	1	162			S					S			16	44.1	-0.8	+0.1	70
	19	1410	5.3	2	204			N			1	02.8	-2.5	+0.4	271	1	06.9	-1.9	-1.0	302
	19	1519	6.5	2	216	21	48.1	-1.2	-1.4	284	21	48.2	-1.4	-1.9	308	21	32.7	-1.1	-2.9	335
	21	1649	6.3	2	231	0	51.9	-1.4	-2.0	319	0	37.6	.	.	5			N		
	22	1886	5.7	2	257	22	19.0	+0.1	-2.3	332			N					N		
	22	1887	6.4	2	257			N			22	53.9	-1.0	-0.6	260	22	49.4	-0.8	-1.1	287
	23	1925	1.2	1	261	7	38.7	-1.1	-0.8	135	7	46.8	-0.9	+0.3	106	7	55.3	-0.6	+1.3	75
	23	1925	1.2	2	261	8	37.9	-0.6	+1.6	259	8	49.6	-0.3	+0.4	283	8	48.9	-0.4	-0.9	313
	27	2456	6.2	2	311			N					N			2	23.4	-2.0	+1.9	224
Feb.	3	3453	4.9	1	39			N					N			17	25.2	-0.9	-1.5	128
	8	497	6.4	1	95	20	34.8	-0.9	+0.1	122	20	47.0	-0.8	+0.9	92			A		
	9	628	4.8	1	106	19	16.9	-2.4	+1.7	56			G					N		
	20	2118	2.9	1	254	23	41.4	-0.4	-2.1	132	23	36.3	-1.2	-1.1	99	23	38.0	-2.3	+0.7	66
	21	2117	5.3	2	254	0	38.5	-1.4	-1.1	275	0	39.3	-1.2	-2.1	310	0	16.9	0.0	-4.3	348
	21	2118	2.9	2	254	0	45.1	-1.5	-0.9	269	0	48.7	-1.4	-1.9	305	0	29.6	-0.5	-3.7	341
Mar.	6	455	6.1	1	64	18	18.3	-1.5	+1.6	72	18	47.3	-1.3	+2.8	42			N		
	10	1025	7.4	1	110	18	35.8	-2.4	0.0	96	19	06.1	-3.0	+1.7	66			N		
	12	1271	5.9	1	135			N					N			16	44.1	.	.	168
	13	1410	5.3	1	150	20	48.1	-0.6	-3.2	171	20	44.7	-1.8	-1.3	130	20	44.5	-2.6	-0.3	100
	23	2680	5.8	2	276	2	43.3	-1.6	-1.8	290	2	33.9	.	.	335			N		
	28	3326	6.4	2	334			N					N			3	11.5	-0.5	+1.4	219
Apr.	5	808	6.8	1	67			S			17	13.5	-2.2	+1.5	71			G		
	6	971	7.3	1	79	18	37.9	-1.8	+1.1	86	19	14.2	.	.	38			N		
	9	1364	6.5	1	117	21	45.3	.	.	49			N					N		
	11	1489	6.8	1	132	0	26.0	0.0	-1.5	158			A					A		
	15	2117	5.3	2	200			N					N			18	30.2	-1.6	+1.6	229
	15	2118	2.9	1	200			N					N			18	14.8	.	.	185
	15	2118	2.9	2	200			N					N			18	29.5	.	.	215
	17	2436	6.3	2	228			N			19	47.6	-0.5	+0.1	242	19	45.9	-0.3	-0.7	274
	21	2913	5.0	2	268			N			0	14.1	-1.4	+1.4	222	0	23.6	-1.5	0.0	257
	22	3054	6.4	2	281	2	50.4	-2.0	-3.8	306			N					N		
May	3	913	5.2	1	48			N					N			16	56.3	-0.3	-1.6	142
	3	915	4.7	1	48	16	24.8	-1.7	+0.6	99	16	51.3	-2.0	+2.1	63			N		
	5	1190	7.1	1	73	18	37.2	-0.7	-0.9	142	18	44.1	-1.0	+0.4	104	18	56.1	-1.6	+1.8	68
	6	1320	6.8	1	86	19	48.6	+0.1	-2.6	170	19	43.6	-0.7	-0.4	125	19	47.0	-1.1	+0.6	92
	7	1429	6.8	1	98	18	46.0	-2.2	+0.3	96			N					N		

Date	Z.C. No.	Mag.	P.	El. of Moon	CAPE TOWN E. 18.500, S. 33.900				JOHANNESBURG E. 28.000, S. 26.200				SALISBURY E. 31.100, S. 17.700			
				o	n	m	m	m	o	h	m	m	m	o	h	m	m	m	o
May 8	1546	7.2	1	110	17	01.5	-1.7	-1.6	129	17	13.7	-2.7	-0.3	95			G		
10	1779	6.7	1	138	17	14.4	-2.1	-0.1	70			N					N		
16	2686	5.2	2	222	19	42.9	+0.1	-1.4	287	19	24.7	+0.6	-3.3	328			N		
18	2876	5.4	2	237	1	56.7	-1.7	+3.2	209	2	34.4	-2.0	+2.2	229	2	55.2	-2.5	+1.1	253
18	2880	5.1	2	238	3	17.4	-1.6	+2.8	216	3	51.4	-1.5	+2.3	229			S		
20	3133	5.8	2	262			N			2	04.3	.	.	184	2	39.0	-2.1	+2.5	218
22	3371	6.4	2	285	1	44.3	-1.0	-1.0	265	1	46.3	-2.0	-2.3	290			N		
24	68	5.7	2	307	4	10.2	-1.3	0.0	244			S					S		
June 7	1886	5.7	1	122	22	52.3	-0.9	+4.2	46			N					N		
7	1887	6.4	1	122	23	30.3	-0.8	-3.0	168	23	25.6	-0.5	-0.6	132	23	25.3	-0.3	+0.2	102
17	3326	6.4	2	253			N			23	54.7	.	.	183	24	22.5	-1.6	+2.0	219
19	3455	6.4	2	265	0	36.9	-1.3	-1.6	277	0	35.8	.	.	304			N		
30	1364	6.5	1	37			S			16	30.9	.	.	52			N		
July 4	1843	6.9	1	91	20	42.3	-0.9	-0.1	122	20	52.4	-0.6	+0.8	93	21	05.6	-0.3	+2.4	56
6	2105	6.6	1	118	22	04.3	-1.2	+0.8	97	22	21.7	-0.6	+1.5	73	22	42.5	+0.3	+4.1	34
7	2232	7.2	1	130	17	55.9	-2.1	-0.4	87	18	33.0	.	.	38			N		
8	2259	6.7	1	132	0	20.3	-0.2	+2.2	56	0	38.4	+0.7	+3.2	33			N		
13	3133	5.8	2	208	19	16.0	-0.3	-0.2	242	19	15.9	-0.6	-1.0	272	19	01.7	-0.4	-3.6	314
14	3272	5.8	2	220	20	41.7	-0.6	-1.3	273	20	32.3	-1.1	-3.9	309			N		
15	3287	5.8	2	222	1	24.4	-1.6	+2.1	218	1	57.2	-1.8	+2.3	224	2	20.1	-2.2	+1.7	241
16	3512	5.8	2	244			A			21	21.7	-0.6	-1.0	272	21	06.0	.	.	315
29	1564	6.6	1	33			N			17	25.9	-0.2	-1.0	143			A		
30	1685	4.5	1	46	17	15.2	-1.3	+1.2	86			N					N		
31	1792	7.1	1	59			N			17	26.0	.	.	174	17	11.0	-1.2	-1.1	131
Aug. 3	2241	7.2	1	101			C			22	05.7	-0.8	-0.9	137	22	04.4	-0.4	0.0	108
4	2345	6.9	1	112			S			16	30.1	-2.5	-0.3	89	16	47.1	-3.6	+2.8	50
5	2497	6.6	1	125	17	01.8	-2.0	+0.1	70			G					N		
6	2649	6.6	1	138			S			16	32.9	.	.	19			N		
6	2658	5.8	1	139	18	00.6	-1.9	-0.4	83	18	27.0	-2.5	+1.9	50			N		
6	2680	5.8	1	141	23	39.1	-2.2	-1.4	134	23	50.4	-1.4	-0.3	119	23	55.1	-0.8	+0.5	94
7	2686	5.2	1	141	0	09.9	-0.7	+1.6	72	0	26.6	-0.2	+1.6	62	0	42.0	+0.3	+2.1	39
16	299	6.3	2	248	2	52.2	-2.6	+0.3	259	3	22.3	-3.0	+0.5	266			S		
16	403	5.8	2	257			N					A			22	22.4	-0.1	+1.2	221
17	517	6.4	2	268			A					A			22	56.8	-0.9	-1.1	281
19	668	3.6	1	280			N					N			0	11.6	.	.	139
19	668	3.6	2	280			N					N			0	43.7	.	.	191
20	798	6.4	2	291			N					A			1	07.1	-0.3	+1.0	229
27	4001	0.5	1	25	10	28.5	-1.2	-2.6	146	10	28.9	-2.2	-1.4	112	10	31.6	-3.5	+0.3	81
27	4001	0.5	2	25	11	43.2	-2.6	-0.3	270	11	58.5	-2.1	-1.6	308	11	42.8	-1.2	-3.7	342
28	1886	5.7	1	41			N			16	58.8	.	.	175	16	44.5	-1.0	-1.0	130
30	2159	5.3	1	69	17	29.5	-1.7	-3.1	156	17	34.3	-1.7	-0.6	121	17	39.2	-1.6	+0.5	91
30	2160	6.6	1	69			N					N			17	59.5	-1.7	-1.9	141
30	2170	6.8	1	70	19	53.1	-0.6	+1.1	89	20	06.6	-0.1	+1.5	69			A		
31	2301	6.8	1	82			N			17	12.8	.	.	155	17	02.4	-2.5	-0.9	115
31	2313	7.0	1	83	18	16.2	-1.9	+0.5	95	18	40.1	-1.4	+1.5	72	19	02.9	-0.5	+3.5	38
31	2316	6.4	1	83	19	19.7	-1.5	+0.1	111	19	35.7	-1.0	+0.8	92	19	47.7	-0.6	+1.5	65
Sep. 1	2463	6.9	1	96			N			20	21.4	-2.1	-2.2	142	20	19.1	-1.4	-0.2	109
2	2640	6.1	1	111	23	23.1	-0.6	+0.3	115			A					A		
3	2647	6.4	1	111	0	11.9	0.0	+1.0	90			A					A		
3	2789	7.3	1	122	20	44.6	-1.6	+1.8	61	21	13.4	-1.0	+2.3	49	21	38.9	-0.1	+3.5	23

OCCULTATION PREDICTIONS

Date	Z.C. No.	Mag.	P.	El. of Moon	CAPE TOWN E. 18.500, S. 33.900				JOHANNESBURG E.28.000, S. 26.200				SALISBURY E. 31.100, S. 17.700			
					U.T.	a	b	P	U.T.	a	b	P	U.T.	a	b	P
				o	h	m	m	o	h	m	m	o	h	m	m	o
4	2913	5.0	1	134	17	52.0	. .	138	17	55.7	-2.8	-1.3 104	18	02.0	-2.8	+0.6 74
5	3045	6.0	1	146		N				N			17	53.8	-2.9	-1.3 104
13	374	6.1	2	228	1	26.6	-2.2	+0.9 239	1	58.5	-2.7	+1.3 247	2	15.6	-3.1	+0.5 266
16	760	6.5	2	261	3	01.0	. .	203		S				S		
16	888	6.0	2	271		A			23	59.3	-1.3	-1.8 294	23	41.8	. .	328
17	895	5.9	2	272	1	24.1	-0.9	-0.2 241	1	34.9	-1.7	-0.2 253	1	37.5	-2.3	+0.7 275
27	2259	6.7	1	52		N				N			18	48.6	-1.2	-2.5 151
29	2573	7.3	1	79		N				G			19	33.2	-1.3	+0.4 116
29	2578	6.4	1	80	20	54.0	-0.8	+0.3 115	21	02.4	-0.3	+0.5 103		A		
Oct. 1	2880	5.1	1	103		N			17	04.6	. .	124	17	05.5	-3.2	0.0 92
4	3272	5.8	1	140	18	09.0	-1.7	+0.8 54	18	37.2	-1.9	+2.1 41	19	07.1	-1.1	+4.0 16
5	3287	5.8	1	141		N				N			0	06.6	-1.0	-0.2 110
18	1364	6.5	2	289	2	35.0	-1.2	-0.3 246		S				S		
25	2361	4.8	1	33	18	11.0	-0.7	-0.3 132		A				A		
27	2686	5.2	1	60		N				N			19	22.5	. .	146
30	3111	6.8	1	98		N			20	13.6	. .	129	20	16.3	-.6	+0.2 100
30	3125	6.9	1	100	22	46.3	-0.2	+1.6 70		A				A		
31	3229	5.6	1	110		S			17	45.1	-2.5	+1.2 66	18	07.1	-2.1	+2.3 47
Nov. 1	3371	6.4	1	123	23	19.5	-0.6	+2.1 52		A				A		
2	3477	6.6	1	132		S				S			16	28.8	-1.1	-2.8 24
8	668	3.6	1	199	21	20.8	. .	135	21	27.0	-3.1	-2.3 120	21	24.0	-2.9	-0.7 96
8	668	3.6	2	199	22	06.6	. .	199	22	39.0	-2.1	+2.4 215	23	03.1	-3.1	+1.4 240
9	793	6.2	2	210	21	55.5	. .	327		N				N		
9	798	6.4	2	211	23	15.7	-1.8	+0.9 229	23	45.0	-2.8	+0.9 245	23	59.2	-3.3	+0.1 268
10	940	5.7	2	222	22	39.8	. .	330		N				N		
11	947	5.2	2	222		N				N			1	16.5	. .	213
13	1197	6.0	2	245		N				N			0	08.3	-2.5	+0.8 244
29	3444	6.5	1	102		S			17	25.1	-2.7	+0.9 74	17	45.0	-2.4	+1.8 57
29	3455	6.4	1	103	20	39.2	-0.6	+3.6 13		G				N		
Dec. 1	143	6.8	1	126	22	26.1	-1.5	+0.6 106	22	44.4	-1.0	+1.1 88	22	58.0	-0.8	+1.5 64
1	145	6.7	1	126	22	49.2	-1.1	+2.6 38		A				N		
3	374	6.1	1	147	19	27.6	-2.1	+0.5 64	19	56.7	-2.5	+1.4 58	20	21.7	-2.4	+2.8 37
5	4005	-2.4	1	160	0	43.3	-1.5	+1.7 69	1	13.8	-1.4	+3.2 36		N		
5	4005	-2.4	2	160	1	54.3	-0.5	+0.8 282		A				N		
25	3272	5.8	1	59		S				S			17	26.5	-0.6	+2.9 26

INDEX OF OCCULTED STARS BRIGHTER THAN FIFTH MAGNITUDE

Z.C.	Name	Mag.	Sp
628	Omega Tauri	4,8	A3
668	Epsilon Tauri	3,6	K0
847	Zeta Tauri	3,0	B3p
915	Chi 2 Orionis	4,7	B2p
995	Mu Geminorum	4,1	B5
1685	Upsilon Leonis	4,5	K0
1925	Alpha Virginis (Spica)	1,2	B2
2118	Alpha Librae	2,9	A3
2361	Chi Ophiuchi	4,8	B3p
2913	61 Sagi Harii	5,0	A0
3453	Kappa Piscium	4,9	A2p
"4001"	Mercury		
"4005"	Jupiter		

"STOP PRESS" Information on Comet West has been received as this handbook goes to press. It is included on this page because of space available.

Predictions:

Date	R.A.	Dec.	Magnitude
Jan 3	$21^h\ 11^m,8$	$-34^\circ\ 50'$	10,0
Jan 23	21 52,7	-31 09	8,2
Feb 12	22 48,9	-23 17	4,5
Feb 22	23 11,1	-12 50	0,5
Mar 3	22 04,0	+ 4 09	1,6
Mar 13	21 19,4	+ 9 36	4,6
Mar 23	21 00,4	+11 59	6,3
Apr 12	20 36,4	+15 11	8,4
May 2	20 06,1	+17 30	9,6

(Information obtained from I.A.U. Circular 2871)

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^{o} above the observer's horizon (2^{o} in the case of bright stars). Each track starts in the West at some arbitrary time given in the key and ends beyong the area of interest, except where the letters "A", "B", or "S" are given. "A" denotes that the Moon is at a low altitude, "B" that the bright limb interferes, and "S" that sunlight interferes. The tick marks along the tracks denote 5 minute intervals of time which, when added to the time at the beginning of the track, give the approximate time of the graze at places along the tracks.

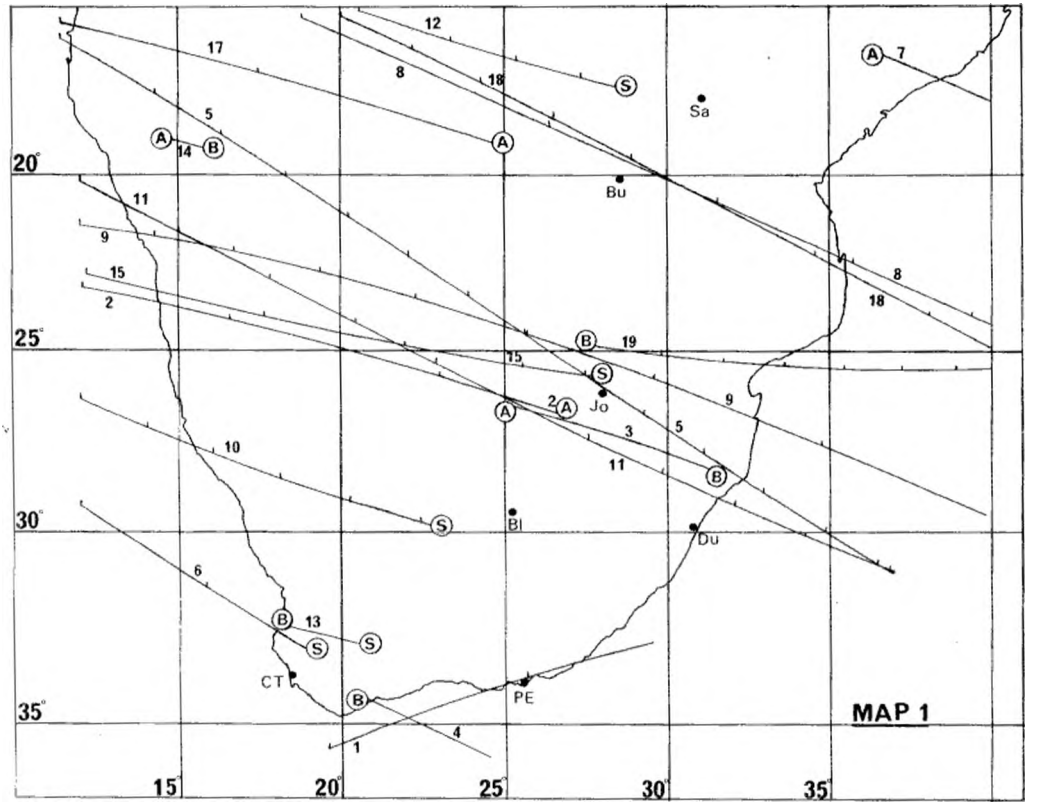
The tracks as shown on the maps are approximate only. Since the observer's location is very critical, successful observations call for very accurate predictions. With the aid of the IBM computer of the CSIR at Pretoria such predictions are at present prepared at 6-monthly intervals for a number of centres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

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

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

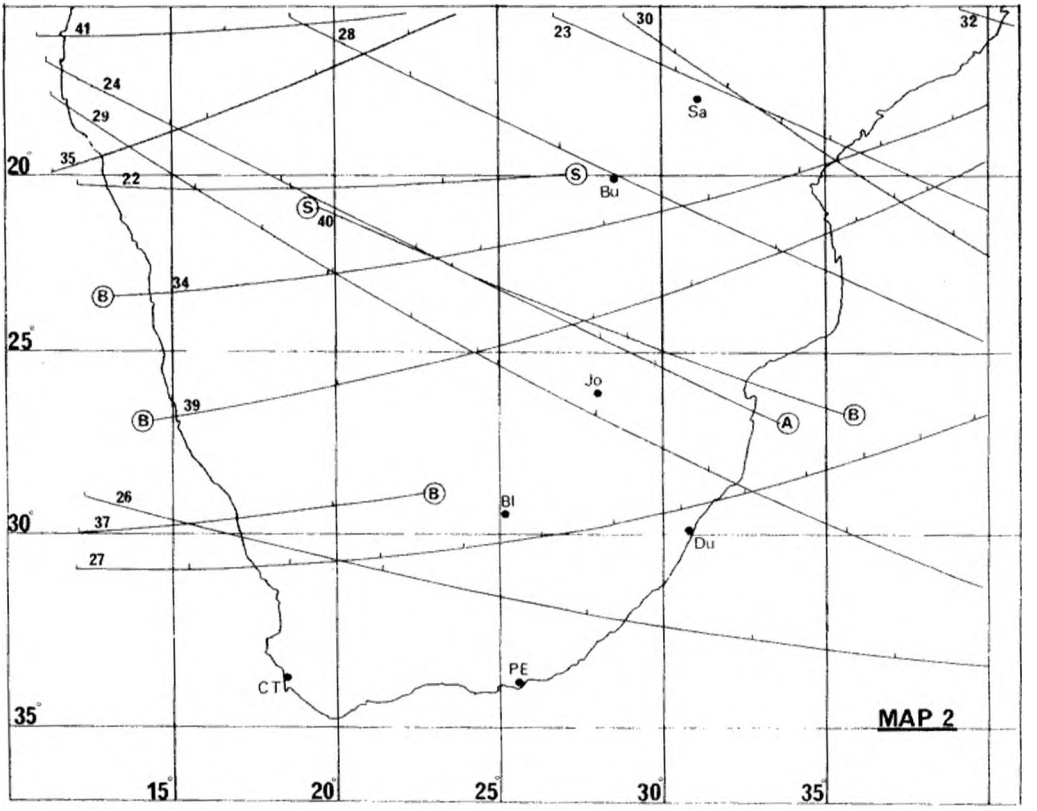
Observers in other parts of southern Africa - especially the more distant regions - who may be interested, are therefore invited to contact the coordinator for grazing occultations: Mr. J. Hers, 48, Central Road, Linden Extension, Randburg 2001, so that they may be informed of all favourable grazes occurring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

JANUARY 1 TO MARCH 23



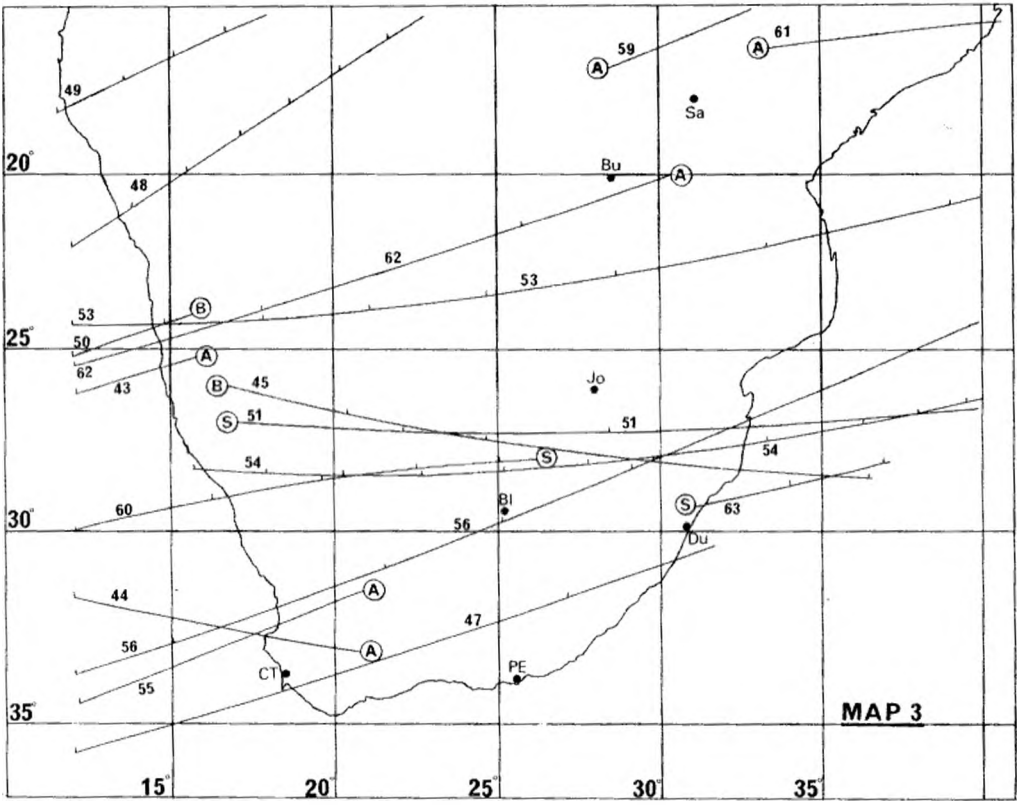
No	ZC	Mag.	Date	Beginning	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
1	3260	6.4	Jan 5	20h 32m	17	N	10	2132	7.1	Feb 21	5h 23m	62	S
2	433	5.6	Jan 12	0 7	72	N	11	2264	7.4	Feb 22	3 13	51	S
3	1886	5.7	Jan 22	23 48	61	N	12	2425	5.9	Feb 23	5 23	40	S
4	1887	6.4	Jan 23	0 37	61	S	13	2571	6.9	Feb 24	5 51	29	N
5	1900	7.2	Jan 23	3 16	59	S	14	2871*	7.1	Feb 26	4 40	13	S
6	1908	7.2	Jan 23	5 12	59	S	15	2876	5.4	Feb 26	5 32	12	N
7	2446	7.2	Jan 27	2 30	18	S	17	455	6.1	Mar 6	21 8	28	N
8	2456	6.2	Jan 27	3 58	17	S	18	1025	7.4	Mar 10	21 19	68	N
9	628*	4.8	Feb 9	21 49	64	N	19	2680	5.8	Mar 23	4 16	45	N

MARCH 27 TO JULY 5



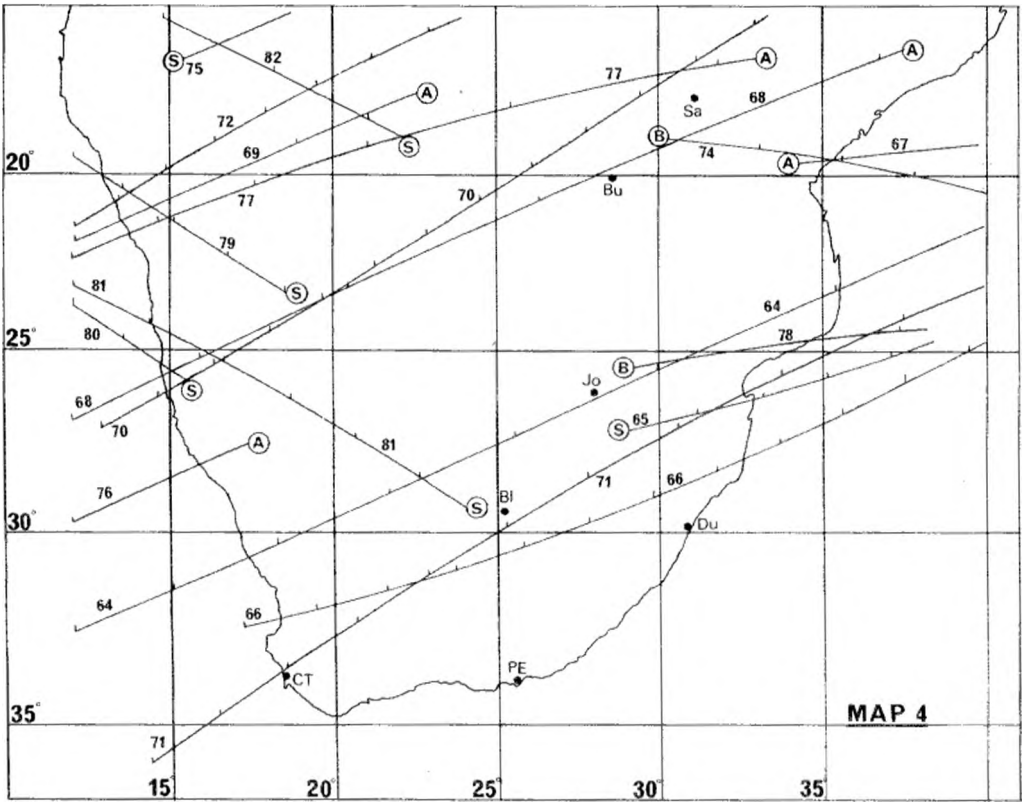
No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
22*	3212	7.5	Mar 27	5h 40m	10	N
23	808	6.8	Apr 5	19 51	31	N
24	971	7.3	Apr 6	21 8	41	N
26	2913	5.0	Apr 21	01 39	51	S
27	3054	6.4	Apr 22	4 15	40	N
28	915	4.7	May 3	19 10	17	N
29*	1429	6.8	May 7	20 59	57	N
30	1546	7.2	May 8	19 39	68	N
32*	1925	1.2	May 11	23h 29m	95	S
34	3371	6.4	May 22	3 4	37	N
35*	68	5.7	May 24	5 27	19	N
37*	3326	6.4	Jun 18	01 23	64	S
39	3455	6.4	Jun 19	02 1	54	N
40	1364	6.5	Jun 30	18 36	10	N
41*	1971	5.8	Jul 5	23 38	63	S

JULY 7 TO SEPTEMBER 28



No	ZC	Mag.	Date	Beginning	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
43*	2118	2.9	Jul 7	2h 59m	75	S	54	2301	6.8	Aug 31	19h 7m	44	S
44*	1564	6.6	Jul 29	19 44	8	S	55	2331	6.4	Sep 1	0 2	45	S
45	1792	7.1	Jul 31	19 28	25	S	56	2463	6.9	Sep 1	22 12	56	S
47	2211	7.2	Aug 4	0 12	60	S	59	888	6.0	Sep 17	01 24	48	N
48	299	6.3	Aug 16	4 1	69	N	60	1176	7.4	Sep 19	5 18	27	S
49	423	6.4	Aug 17	6 4	59	N	61*	1410	5.3	Sep 21	4 3	11	S
50	971	7.3	Aug 21	6 26	21	N	62	2259	6.7	Sep 27	20 49	19	S
51	1886	5.7	Aug 28	19 1	13	S	63	2408	6.9	Sep 28	18 18	29	S
53	2160	6.6	Aug 30	19 55	33	S							

SEPTEMBER 29 TO DECEMBER 17



No	ZC	Mag.	Date	Beginning	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning	Sunlit %	Limit
				^{h} ^{m}							^{h} ^{m}		
64	2573	7.3	Sep 29	21 25	41	S	74*	1429	6.8	Nov 15	2 25	50	S
65	2876	5.4	Oct 1	18 15	62	S	75	2596	7.3	Nov 23	19 39	6	S
66	2880	5.1	Oct 1	19 4	62	S	76	2789	7.3	Nov 24	21 28	13	S
67	1468	4.9	Oct 19	2 25	24	N	77*	3326	6.4	Nov 28	22 52	52	S
68	2686	5.2	Oct 27	21 13	26	S	78	3455	6.4	Nov 29	23 26	62	N
69	2690	7.0	Oct 27	22 7	26	S	79*	1410	5.3	Dec 12	5 21	74	S
70	3104	6.5	Oct 30	19 50	57	S	80	1519	6.5	Dec 13	5 26	64	S
71	3111	6.8	Oct 30	21 55	58	S	81	1744	6.5	Dec 15	4 22	43	S
72	3494	4.6	Nov 2	23 33	85	S	82	2000	7.1	Dec 17	5 13	21	S

EXPLANATION OF COLUMN HEADINGS IN TABLES

No. - the number of the track on the map. An asterisk denotes that the same is double - notes are given below.

Z.C. - the number of the star in the Zodiacal Catalogue.

Date

Beginning - an arbitrary time of the beginning of the track in the west.

Sunlit - the percentage of the Moon's disk lit by the Sun

Limit - N = northern limit (a complete occultation takes place south of the track)
S = southern limit (complete occultation north of the track)

NOTES ON DOUBLE STARS

Track No.	ZC	
9	628	is possibly a close double star. The components are magnitude 5.0 and 7.0 with an estimated separation of 0".05.
14	2871	is the brighter component of the double star Aitken 12728. The companion is 7.6 magnitude; separation 10" in p.a. 236°.
22	3212	is the brighter component of the double star Aitken 15459. The companion is 10th magnitude; separation 0".9 in p.a. 47°.
27, 74	1429	is possibly a close double star. The components are estimated to be magnitude 7.6 with a separation of 0".02 in p.a. 34°.
32	1925	is a spectroscopic binary.
35	58	is the brighter component of the double star Aitken 449. The companion is 9.7 magnitude; separation 27" in p.a. 83°.
37, 77	3326	is a close double star: the components are magnitude 6.7 and 7.8 with a separation of 0".06 in p.a. 254°.
41	1971	is the brightest component of the triple system Aitken 9018. One component is 10th magnitude; separation 1".1 in p.a. 304°. (The other component is fainter than 10th magnitude).
43	2118	is a close double star. The components are magnitude 3.4 and 3.8 with a separation of 0".01 in p.a. 110°.
44	1564	is the mean of a double star Aitken 7896. The components are 6.7 and 8.8 magnitude; separation 0".5 in p.a. 180°.
61, 79	1410	is the brighter component of the double star Aitken 7416. The companion is 8.3 magnitude; separation 38" in p.a. 74°.

TIME SYSTEMS AND TELESCOPE SETTING

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

TIME SIGNALS FROM RADIO STATION ZUO

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

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

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

SOUTH AFRICAN STANDARD TIME

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

TIME OF SUN'S TRANSIT OVER THE 30° MERIDIAN

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

Jan	1	$12^h\ 03^m\ 13^s$	May	11	$11^h\ 56^m\ 20^s$	Sep	18	$11^h\ 54^m\ 04^s$
	11	12 07 40		21	11 56 32		28	11 50 36
	21	12 11 08		31	11 57 38	Oct	8	11 47 31
	31	12 13 22	Jun	10	11 59 23		18	11 45 08
Feb	10	12 14 16		20	12 01 32		28	11 43 49
	20	12 13 51		30	12 03 36	Nov	7	11 43 43
Mar	2	12 12 09	Jul	10	12 05 18		17	11 45 01
	12	12 09 46		20	12 06 17		27	11 47 41
	22	12 06 52		30	12 06 22	Dec	7	11 51 33
Apr	1	12 03 51	Aug	9	12 05 26		17	11 56 12
	11	12 01 01		19	12 03 31		27	12 01 11
	21	11 58 40		29	12 00 50		31	12 03 07
May	1	11 57 03	Sep	8	11 57 36			

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
		h m	h m			h m	h m			h m	h m
Jan	1	6 39	3 42	May	11	15 15	12 19	Sep	18	23 48	20 51
	11	7 18	4 22		21	15 55	12 58		28	0 27	21 30
	21	7 58	5 01		31	16 34	13 38	Oct	8	1 07	22 10
	31	8 37	5 41	Jun	10	17 13	14 17		18	1 46	22 50
Feb	10	9 17	6 20		20	17 53	14 56		28	2 26	23 29
	20	9 56	6 59		30	18 32	15 36	Nov	7	3 05	0 09
Mar	2	10 39	7 43	Jul	10	19 12	16 15		17	3 44	0 48
	12	11 19	8 22		20	19 51	16 54		27	4 24	1 27
	22	11 58	9 02		30	20 31	17 34	Dec	7	5 03	2 07
Apr	1	12 38	9 41	Aug	9	21 10	18 14		17	5 43	2 46
	11	13 17	10 20		19	21 50	18 53		27	6 22	3 25
	21	13 56	11 00		29	22 29	19 32		31	6 38	3 41
May	1	14 36	11 39	Sep	8	23 08	20 12				

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

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	1h36m,8	-57°21'	0,5	B5	Procyon	7h38m,0	+5° 17'	0,4	F5
Aldebaran	4 34,5	+16 28	0,9	K5	Regulus	10 07,1	+12 06	1,4	B7
Rigel	5 13,3	- 8 14	0,1	B8	Spica	13 23,8	-11 02	0,9	B1
Betelgeuse	5 53,8	+ 7 24	0,4	M2	Arcturus	14 14,5	+19 19	-0,1	K2
Canopus	6 23,4	-52 41	0,7	F0	Antares	16 27,9	-26 23	0,9	M1
Sirius	6 44,0	-16 41	-1,4	A1	Altair	19 49,5	+8 48	0,8	A7

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

1974-75 C. Papadopoulos

HONORARY SECRETARIES

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

1965 T.W. Russo

HONORARY MEMBERS

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

Sir Richard Woolley

GILL MEDALLISTS

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

JULIAN DATE AT 1400 HOURS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	2442	2442	2442	2442	2442	2442	2442	2442	2443	2443	2443	2443
1	779	810	839	870	900	931	961	992	023	053	084	114
2	780	811	840	871	901	932	962	993	024	054	085	115
3	781	812	841	872	902	933	963	994	025	055	086	116
4	782	813	842	873	903	934	964	995	026	056	087	117
5	783	814	843	874	904	935	965	996	027	057	088	118
6	784	815	844	875	905	936	966	997	028	058	089	119
7	785	816	845	876	906	937	967	998	029	059	090	120
8	786	817	846	877	907	938	968	999	030	060	091	121
9	787	818	847	878	908	939	969	*000	031	061	092	122
10	788	819	848	879	909	940	970	*001	032	062	093	123
11	789	820	849	880	910	941	971	*002	033	063	094	124
12	790	821	850	881	911	942	972	*003	034	064	095	125
13	791	822	851	882	912	943	973	*004	035	065	096	126
14	792	823	852	883	913	944	974	*005	036	066	097	127
15	793	824	853	884	914	945	975	*006	037	067	098	128
16	794	825	854	885	915	946	976	*007	038	068	099	129
17	795	826	855	886	916	947	977	*008	039	069	100	130
18	796	827	856	887	917	948	978	*009	040	070	101	131
19	797	828	857	888	918	949	979	*010	041	071	102	132
20	798	829	858	889	919	950	980	*011	042	072	103	133
21	799	830	859	890	920	951	981	*012	043	073	104	134
22	800	831	860	891	921	952	982	*013	044	074	105	135
23	801	832	861	892	922	953	983	*014	045	075	106	136
24	802	833	862	893	923	954	984	*015	046	076	107	137
25	803	834	863	894	924	955	985	*016	047	077	108	138
26	804	835	864	895	925	956	986	*017	048	078	109	139
27	805	836	865	896	926	957	987	*018	049	079	110	140
28	806	837	866	897	927	958	988	*019	050	080	111	141
29	807	838	867	898	928	959	989	*020	051	081	112	142
30	808		868	899	929	960	990	*021	052	082	113	143
31	809		869		930		991	*022		083		144

*2443

PLANETARIUM

UNIVERSITY OF THE WITWATERSRAND

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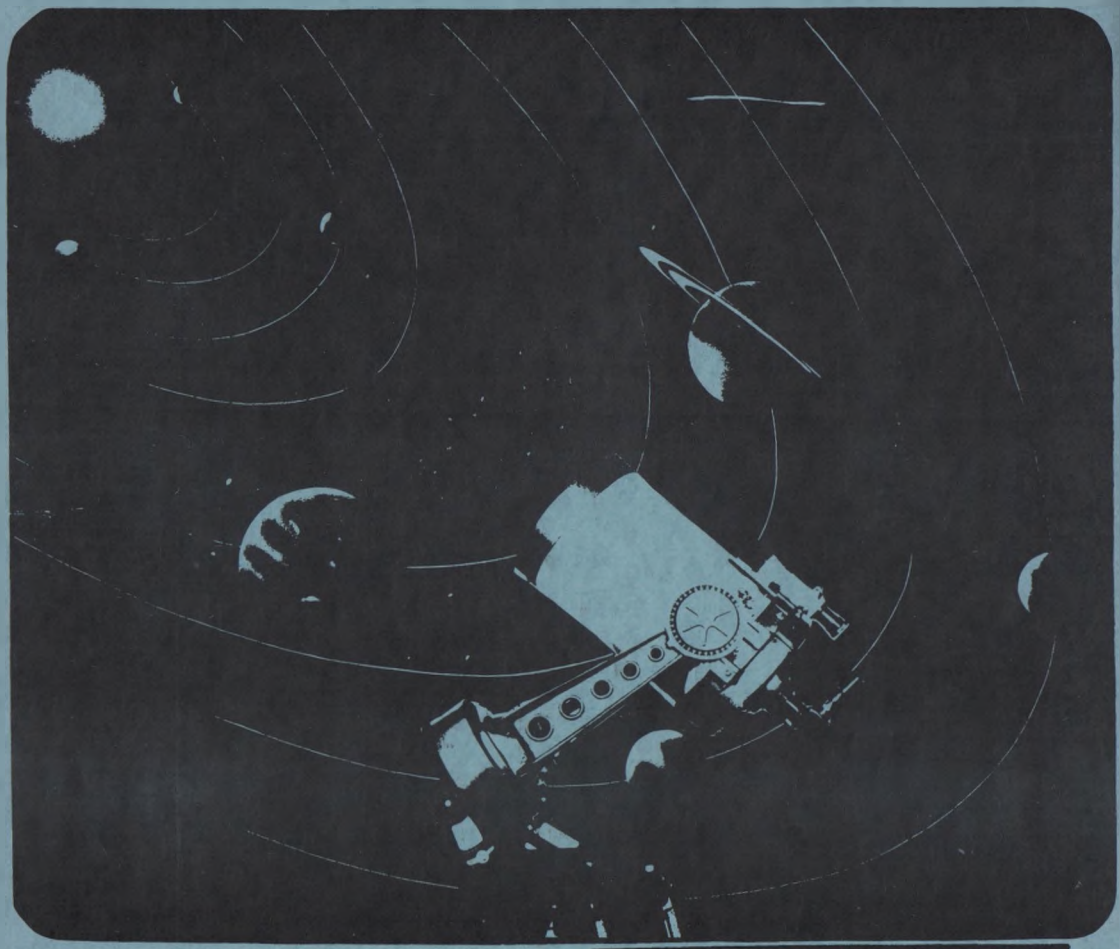

NIGHTLY: Tuesday to Saturday at $20^h\ 30^m$.
Wednesday in Afrikaans.

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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