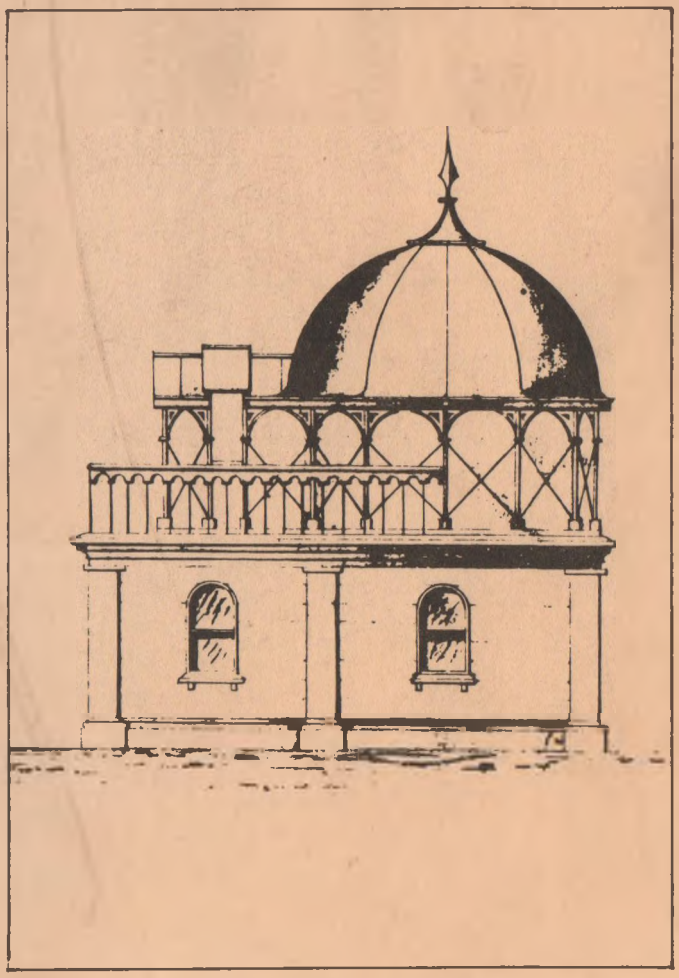
ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1978

published by the Astronomical Society of Southern Africa



Proposed Durban Observatory
1881

ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1978

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: Edmund (Nelson) Nevill's Durban Observatory, 1822-1912 (Demolished late 1957)

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JULIAN DATE ..... Inside back cover

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 1978" 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 Messrs G and C Larmuth for the preparation of much of the data.

All correspondence concerning this booklet should be addressed to the Handbook Editor, Astronomical Society of S.A 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 is om hierdie handboek in Afrikaans te laat druk nie.

R.F. HURLY
EDITOR

ASTRONOMY IN SOUTHERN AFRICA

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

OBSERVATORIES

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

On the other hand, the observatory sites in the hearts of Cape Town and Johannesburg have become unsuitable with the rapid expansion of those cities. The South African Astronomical Observatory - a joint venture between the South African Council for Scientific and Industrial Research and the British Science Research Council, has merged their facilities and moved the larger instruments to a new site near Sutherland in the Karroo, Observing continues at Cape Town which is also the Headquarters of the S.A.A.O. The S.A.A.O. outstation at Hartebeespoort continues to share the site with the Leiden Observatory Southern Station which has a 0,9 m. "light collector" reflector.

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

The Radio Astronomy Observatory at Hartebeesthoek, near Krugersdorp is used by the National Institute for Telecommunications Research for observations on extragalactic radio sources while the Rhodes University Radio Astronomy Group uses the same facilities to study Ionized Hydrogen regions associated with star formation and supernova remnants within the galaxy at a wavelength of 2,3 GHz. The Rhodes group results are reduced in Grahamstown.

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

OBSERVATORIES OPEN TO THE PUBLIC

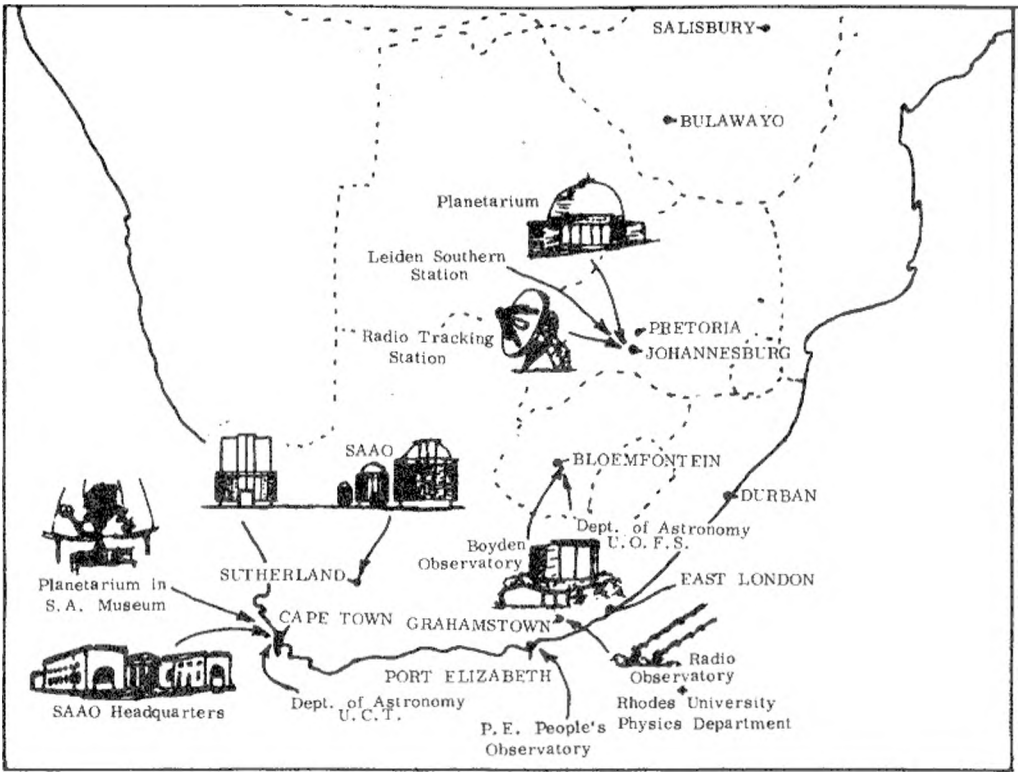
Visiting nights at Boyden Observatory are generally held around the time of first quarter. Enquiries should be made direct to the Observatory. Numbers are restricted to twenty persons on each occasion.

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

PLANETARIA

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

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



TEACHING DEPARTMENTS

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

THE ASTRONOMICAL SOCIETY OF SOUTHERN AFRICA

The Astronomical Society of Southern Africa is a body consisting of both amateur and professional astronomers. Membership is open to all interested persons, regardless of knowledge or experience. In addition to this handbook, the Society issues "The Monthly Notes of the Astronomical Society of Southern Africa" (MNASSA). Members also receive copies of "Sky and Telescope", an excellent and very popular monthly magazine published in the United States. It provides up to date information on both professional and amateur activities, together with news of space research and other related subjects. The Society's annual subscription is R12.00 and there is an entrance fee of R2.50. Information can be obtained from the Honorary Secretary, Astronomical Society of Southern Africa, c/o The South African Astronomical Observatory, P.O. Box 9, Observatory 7935, Cape.

LOCAL CENTRES OF THE SOCIETY

Autonomous local Centres of the Society hold regular meetings in Cape Town, Bloemfontein, Durban, Pietermaritzburg, Pretoria and Salisbury. Visitors are very welcome at meetings and may, if they wish, join a Centre, without becoming a full member (i.e. receiving publications for R12 subscription) of the Society.

CAPE CENTRE (Cape Town) - Meetings on 2nd Wednesday of the month (except Jan. and Dec.) at the South African Astronomical Observatory at 8.00 p.m. The Centre possesses a small observatory housing the twelve inch Ron Atkins Telescope. There is also an active occultation section. Secretarial address: c/o S.A.A.O. Box 9 Observatory 7935. Information on meetings also available from telephone (day time) 69-8531 ext. 256, 41-3471 ext. 286 evenings 43-2255.

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

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

NATAL MIDLANDS CENTRE (Pietermaritzburg) - Meetings are held monthly at various venues. Secretarial address 17 Yalta Rd., Pietermaritzburg 3201. Telephone 5-4038.

FREE STATE CENTRE (Bloemfontein) - Meetings are held every third Wednesday of the month. For further information contact Mr F.C. Neser telephone 22-1142, 108 Japie Neser St, Uitsig Bloemfontein.

PRETORIA CENTRE - Meetings are held on the 3rd Wednesday of each month (except December) at 8 p.m., the venue alternating between the University of South Africa and the Christian Brothers' College, Silverton Road. The Centre's observatory containing a 32cm reflector is situated on the latter site. For information contact the Secretary, Mr W.R. Windisch, 932 Crots Street, Rietfontein, Pretoria 0084.

SALISBURY CENTRE - The Centre holds fairly frequent meetings, usually at eight o'clock in the evening at which talks on various subjects are given and/or films shown. In addition, social "star-gazing" sessions are arranged at intervals, at which telescopes are set up by those members who possess them and made available for observing by all members present.

The address of the Salisbury Centre is P.O. Box UA. 428, Union Avenue Salisbury and the Hon. Secretary (to whom communications should be addressed) is Mr. W.L. Stedman telephone number 5-0921.

OBSERVING SECTIONS OF THE SOCIETY

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

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

DIARY 1978

JANUARY

2^d	01^h	Earth at perihelion
5	00	Uranus 3° S. of Moon
7	04	Neptune 3° S. of Moon
7	15	Mercury 3° S. of Moon
11	11	Mercury greatest elong. W. (23°)
19	05	Earth nearest to Mars
19	21	Aldebaran 1° S. of Moon Occ^n. (Not visible in S.A.)
20	14	Saturn 1° N. of Regulus
21	09	Jupiter 5° N. of Moon
22	02	Mars at opposition
22	07	Venus in superior conjunction
24	08	Mars 9° N. of Moon
26	14	Saturn 5° N. of Moon

FEBRUARY

1	07	Uranus 3° S. of Moon
3	14	Neptune 3° S. of Moon
16	04	Aldebaran $0^\circ.9$ S. of Moon Occ^n. (Not visible in S.A.)
16	06	Saturn at opposition
17	07	Mars 3° S. of Pollux
17	13	Jupiter 5° N. of Moon
19	19	Uranus stationary
19	22	Mars 9° N. of Moon
20	04	Jupiter stationary
22	16	Saturn 5° N. of Moon
27	05	Mercury in superior conjunction
28	14	Uranus 3° S. of Moon

MARCH

2	23	Mars stationary
10	01	Venus 2° S. of Moon
13	00	Mercury $1^\circ.3$ N. of Venus
15	12	Aldebaran $0^\circ.8$ S. of Moon Occn. (Not visible in S.A.)
16	23	Jupiter 5° N. of Moon
17	07	Mars 4° S. of Pollux
19	08	Mars 8° N. of Moon
21	02	Equinox
21	21	Saturn 5° N. of Moon
24	18	FULL MOON Eclipse
24	19	Mercury greatest elong. E. (19°)
27	19	Uranus 3° S. of Moon
28	21	Mercury 4° N. of Venus
30	03	Neptune 4° S. of Moon

APRIL

1^d	16^h	Mercury stationary
7	17	New Moon Eclipse (Not visible in S.A.
9	05	Venus 3° N. of Moon
11	19	Mercury in inferior conjunction
11	20	Aldebaran $0^\circ.8$ S. of Moon Occ^n.
13	13	Jupiter 5° N. of Moon
16	09	Mars 7° N. of Moon
18	04	Saturn 5° N. of Moon
24	01	Uranus 3° S. of Moon
24	04	Mercury stationary
25	21	Saturn stationary
26	09	Neptune 3° S. of Moon

MAY

5	04	Mercury 2° S. of Moon
5	08	Uranus at opposition
5	23	Venus 6° N. of Aldebaran
9	04	Aldebaran $0^\circ.9$ S. of Moon Occ^n. (Not visible in S.A.)
9	13	Venus 6° N. of Moon
9	17	Mercury greatest elong. W. (26°)
11	07	Jupiter 5° N. of Moon
14	17	Mars 6° N. of Moon
15	13	Saturn 5° N. of Moon
21	09	Uranus 3° S. of Moon
29	04	Venus $1^\circ.6$ N. of Jupiter

JUNE

5	02	Mars $0^\circ.1$ S. of Saturn
8	02	Jupiter 5° N. of Moon
9	01	Venus 7° N. of Moon
11	02	Venus 5° S. of Pollux
11	23	Saturn 5° N. of Moon
12	05	Mars 4° N. of Moon
12	19	Mars $0^\circ.8$ N. of Regulus
14	14	Mercury in superior conjunction
17	18	Uranus 3° S. of Moon
19	17	Vesta $0^\circ.9$ N. of Moon Occ^n. (Not visible in S.A.)
20	02	Neptune 3° S. of Moon
21	20	Solstice
24	10	Mercury $1^\circ.8$ N. of Jupiter
29	12	Mercury 5° S. of Pollux

JULY

2^d	17^h	Aldebaran $0^o.8$ S. of Moon Occ^n. (Not visible in S.A.)
5	02	Earth at aphelion
7	16	Mercury 5^o N. of Moon
9	07	Venus 4^o N. of Moon
9	10	Saturn 4^o N. of Moon
10	13	Jupiter in conjunction with the Sun
10	14	Venus $0^o.1$ N. of Saturn
10	18	Mars 2^o N. of Moon
11	10	Venus $1^o.1$ N. of Regulus
15	02	Uranus 3^o S. of Moon
17	12	Neptune 3^o S. of Moon
19	08	Saturn $1^o.0$ N. of Regulus
21	16	Uranus stationary
22	02	Mercury greatest elong. E. (27^o)
28	04	Mercury 3^o S. of Regulus
29	22	Aldebaran $0^o.7$ S. of Moon Occ^n. (Not visible in S.A.)

AUGUST

1	00	Mercury 5^o S. of Saturn
2	16	Jupiter 5^o N. of Moon
4	05	Mercury stationary
4	07	Mercury 5^o S. of Saturn
5	21	Mercury 2^o S. of Moon
5	22	Saturn 4^o N. of Moon
7	16	Jupiter 7^o S. of Pollux
8	03	Venus $0^o.4$ S. of Moon Occ^n. (Not visible in S.A.)
8	08	Mars 0^o .004 N. of Moon Occ^n. (Not visible in S.A.)
11	00	Mercury 5^o S. of Regulus
11	09	Uranus 3^o S. of Moon
13	20	Neptune 4^o S. of Moon
14	17	Venus $1^o.2$ S. of Mars
26	05	Aldebaran $0^o.5$ S. of Moon Occ^n. (Not visible in S.A.)
27	17	Saturn in conjunction with Sun
27	23	Mercury stationary
29	22	Venus greatest elong. E. (46^o)
30	10	Jupiter 5^o N. of Moon
31	11	Venus $0^o.3$ S. of Spica

SEPTEMBER

1	07	Mercury 2^o N. of Moon
4	23	Mercury greatest elong. W. (18^o)
5	23	Mars 2^o S. of Moon
6	12	Venus 6^o S. of Moon
7	16	Uranus 4^o S. of Moon
8	23	Mars 2^o N. of Spica
9	10	Mercury $0^o.5$ N. of Regulus
13	17	Mercury $0^o.1$ N. of Saturn
22	13	Aldebaran $0^o.4$ S. of Moon Occ^n. (Not visible in S.A.)
23	11	Equinox
27	04	Jupiter 5^o N. of Moon
28	02	Venus 6^o S. of Uranus
30	01	Saturn 3^o N. of Moon
30	17	Mercury in superior conjunction

OCTOBER

4	00	Venus greatest brilliancy
4	16	Mars 4^o S. of Moon
5	00	Uranus 4^o S. of Moon

OCTOBER

5^d	06^h	Venus 10^o S. of Moon
7	08	Neptune 4^o S. of Moon
12	04	Mars $0^o.6$ S. of Uranus
18	03	Venus stationary
19	22	Aldebaran $0^o.5$ S. of Moon Occ^n. (Not visible in S.A.)
20	10	Venus 7^o S. of Mars
24	19	Jupiter 4^o N. of Moon
24	20	Mercury $1^o.7$ S. of Uranus
27	06	Mercury 5^o N. of Venus
27	15	Saturn 3^o N. of Moon

NOVEMBER

2	07	Mercury 7^o S. of Moon
2	11	Mars 5^o S. of Moon
3	16	Neptune 4^o S. of Moon
5	10	Mercury $1^o.9$ S. of Mars
7	23	Venus in inferior conjunction
9	14	Uranus in conjunction with Sun
10	08	Mercury 2^o N. of Antares
14	08	Mars 4^o N. of Antares
16	04	Mercury greatest elong. E. (23^o)
16	07	Aldebaran $0^o.6$ S. of Moon Occ^n. (Not visible in S.A.)
18	01	Mercury 4^o S. of Neptune
21	07	Jupiter 4^o N. of Moon
24	03	Saturn 3^o N. of Moon
26	02	Mercury stationary
26	05	Jupiter stationary
26	09	Mars 2^o S. of Neptune
26	18	Venus stationary
28	05	Venus 3^o S. of Moon
28	23	Uranus 4^o S. of Moon
29	21	Mercury 0^o .1 N. of Mars

DECEMBER

4	17	Juno 0^o .4 N. of Moon
5	23	Mercury in inferior conjunction
10	13	Neptune in conjunction with Sun
13	14	Aldebaran $0^o.6$ S. of Moon Occ^n. (Not visible in S.A.)
14	07	Venus greatest brilliancy
15	18	Mercury stationary
18	12	Jupiter 4^o N. of Moon
21	13	Saturn 3^o N. of Moon
22	07	Solstice
22	08	Mercury 7^o N. of Antares
24	17	Venus 3^o N. of Uranus
24	23	Mercury greatest elong. W. (22^o)
25	23	Saturn stationary
26	12	Uranus 4^o S. of Moon
26	15	Venus 0^o .8 S. of Moon Occ^n. (Not visible in S.A.)
28	08	Mercury 3^o S. of Moon
31	21	Mercury $0^o.3$ S. of Neptune

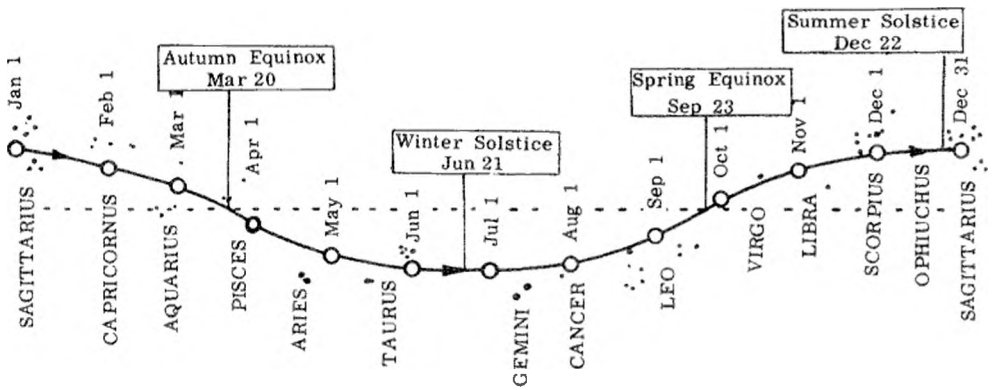
THE SUN 1978

BASIC DATA

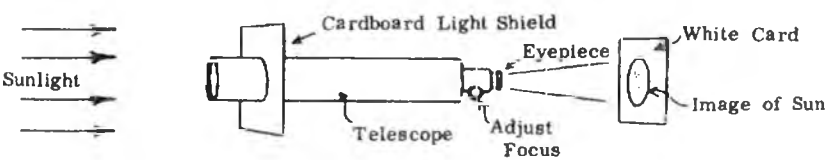
Diameter: 1 392 000 km (109 times Earc
Diameter: 1 392 000 km (109 times Earth diameter)
Mass: $1,99 \times 10^{30}$ kg (330 000 times Earth Mass)
Surface Temperature: Approx. 6000° C
Temperature at centre: Approx. 10 million°C

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 1978 we will be closest to the Sun on January 2 (perihelion - approx. distance 147 million km.) and furthest from the Sun on July 5 (aphelion - approx. 152 million km.) During the year, the Sun appears to us to make a complete circuit of the sky (i.e. relative to the starry background) as indicated in the diagram.



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



TIMES OF SUNRISE AND SUNSET

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

Partial Eclipse of the Sun April 7. The eclipse begins at $15^{h}02.^{m}7$; Greatest eclipse is at $17^{h}03.^{m}8$.

Eclipse ends at $19^{h}05.^{m}2$. Magnitude of eclipse 0,79.

As seen from South Africa only a very small part of the Sun's diameter will be obscured and from Rhodesia nothing will be seen.

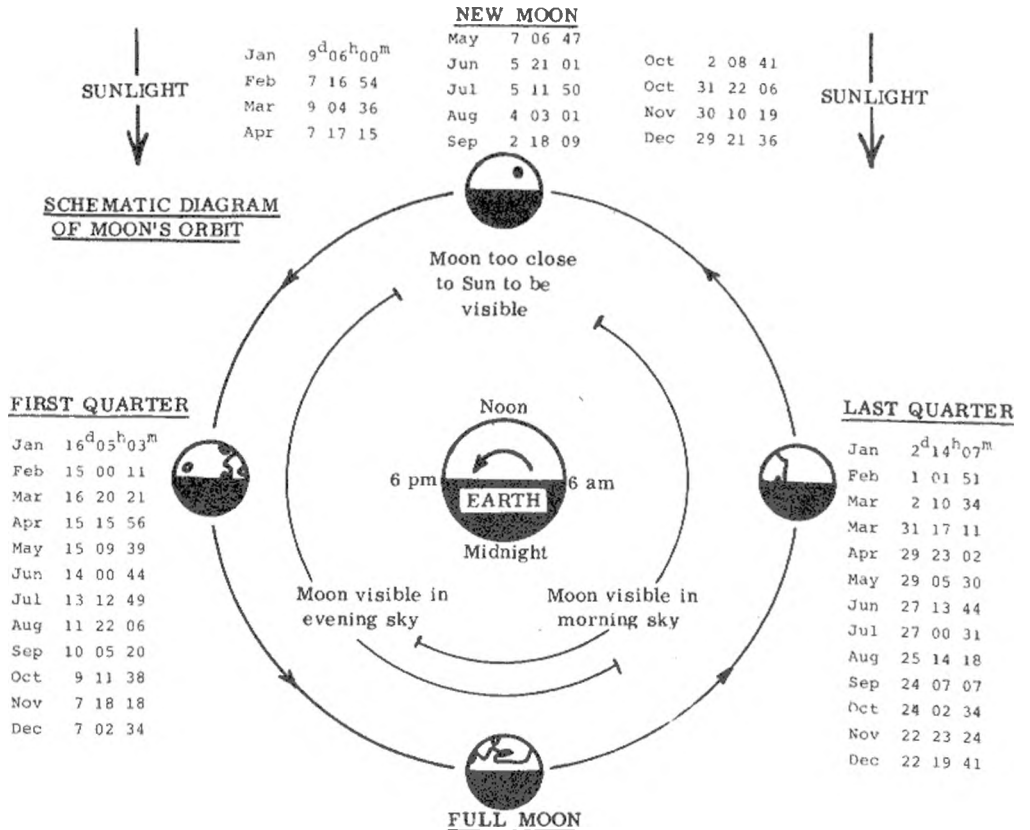
The Partial Eclipse on October 2 is centred on Central Russia and will not be seen from Southern Africa.

THE MOON 1978

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



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.

MOON AT PERIGEE						MOON AT APOGEE					
Jan	8	May	24	Oct	11	Jan	21	May	12	Sep	26
Feb	5	Jun	21	Nov	5	Feb	17	Jun	8	Oct	24
Mar	5	Jul	19	Dec	2	Mar	17	Jul	6	Nov	21
Mar	31	Aug	17	Dec	31	Apr	14	Aug	2	Dec	18
Apr	26	Sep	14					Aug	29		

As a result of its motion around the Earth, the Moon appears to make a complete circuit of the heavens in just under a month. It occasionally passes in front of bright stars (details given in Occultation section - page 35) and close to visible planets (details given in Diary pages 4 and 5).

TIMES OF MOONRISE AND MOONSET

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

LUNAR ECLIPSE

Total eclipse of the Moon on March 24.

Moon enters penumbra	$15^h29.0^m$
Moon enters umbra	16 33.6
Total eclipse begins	17 37.5
Middle of eclipse	18 23.2
Total eclipse ends	19 08.8
Moon leaves umbra	20 12.8
Moon leaves penumbra	21 17.2

As seen from South Africa or Rhodesia the Moon will be fully eclipsed when it rises.

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

MAP OF THE MOON'S NEAR SIDE

FIRST QUARTER

LAST QUARTER

LIBRATIONS

Jan 9 Feb 5 Mar 4/31
Apr 28 May 25 Jun 21
Jul 18 Aug 15 Sep 11
Oct 8 Nov 4 Dec 1/29

Jan 22 Feb 18 Mar 18
Apr 14 May 11 Jun 7
Jul 4/31 Aug 28 Sep 24
Oct 21 Nov 17 Dec 14

Dates of Maximum Exposure of Indicated Limbs

Jan 2/30 Feb 26 Mar 24
Apr 21 May 19 Jun 16
Jul 14 Aug 11 Sep 7
Oct 4/30 Nov 27 Dec 25

Jan 15 Feb 11 Mar 11
Apr 8 May 4/31 Jun 28
Jul 26 Aug 23 Sep 20
Oct 18 Nov 14 Dec 10

	JANUARY		FEBRUARY		MARCH	
	Rise	Set	Rise	Set	Rise	Set
1	23h36m	11h16m	h m	13h01m	23h14m	11h56m
2		12 12	00 26	14 03		12 56
3	00 15	13 10	01 19	15 04	00 09	13 55
4	00 57	14 11	02 17	16 05	01 07	14 32
5	01 44	15 14	03 18	17 03	02 08	15 46
6	02 55	16 18	04 23	17 57	03 10	16 36
7	03 32	17 22	05 28	18 47	04 14	17 23
8	04 34	18 23	06 32	19 33	05 17	18 07
9	05 40	19 21	07 35	20 16	06 18	18 49
10	06 46	20 13	08 36	20 57	07 17	19 29
11	07 51	21 00	09 35	21 36	08 15	20 09
12	08 55	21 43	10 31	22 16	09 12	20 50
13	09 55	22 24	11 25	22 56	10 07	21 31
14	10 52	23 03	12 19	23 37	11 00	22 15
15	11 48	23 41	13 10		11 52	22 59
16	12 42		14 01	00 20	12 42	23 45
17	13 35	00 19	14 49	01 05	13 29	
18	14 28	00 59	15 35	01 52	14 14	00 34
19	15 17	01 40	16 19	02 41	14 57	01 23
20	16 07	02 23	17 02	03 32	15 38	02 15
21	16 54	03 09	17 42	04 24	16 18	03 07
22	17 40	03 57	18 21	05 17	16 56	04 01
23	18 24	04 47	18 59	06 11	17 35	04 55
24	19 05	05 39	19 38	07 06	18 14	05 51
25	19 44	06 31	20 17	08 02	18 54	06 49
26	20 22	07 24	20 57	08 58	19 37	07 48
27	21 00	08 18	21 39	09 56	20 22	08 48
28	21 37	09 11	22 25	10 56	21 11	09 49
29	22 15	10 06			22 05	10 50
30	22 56	11 03			23 02	11 50
31	23 39	12 02				12 48

HE MOONRISE AND MOONSET

APRIL		MAY		JUNE	
Rise	Set	Rise	Set	Rise	Set
00^h01^m	13^h41^m	00^h59^m	14^h01^m	02^h45^m	14^h41^m
01 02	14 31	01 59	14 43	03 40	15 20
02 04	15 18	02 56	15 22	04 34	16 01
03 05	16 02	03 53	16 01	05 27	16 43
04 05	16 43	04 50	16 40	06 20	17 27
05 04	17 23	05 45	17 20	07 10	18 13
06 02	18 03	06 40	18 02	07 59	19 02
06 59	18 44	07 33	18 46	08 44	19 51
07 54	19 25	08 25	19 31	09 28	20 42
08 49	20 17	09 15	20 18	10 08	21 32
09 42	20 52	10 03	21 07	10 46	22 24
10 33	21 38	10 47	21 57	11 24	23 16
11 22	22 26	11 29	22 48	12 00	
12 08	23 15	12 09	23 39	12 37	00 09
12 52		12 48		13 15	01 03
13 33	00 05	13 25	00 32	13 56	02 00
14 12	00 55	14 02	01 25	14 40	02 59
14 51	01 49	14 40	02 20	15 29	04 01
15 29	02 43	15 21	03 17	16 23	05 05
16 08	03 38	16 05	06 16	17 23	06 10
16 48	04 34	16 52	05 18	18 26	07 13
17 30	05 33	17 44	06 22	19 32	08 12
18 15	06 34	18 41	07 26	20 38	09 07
19 04	07 37	19 42	08 30	21 42	09 56
19 58	08 40	20 45	09 30	22 43	10 42
20 55	09 42	21 49	10 25	23 43	11 24
21 55	10 42	22 52	11 15		12 03
22 56	11 39	23 53	12 01	00 40	12 42
23 58	12 30		12 44	01 36	13 21
	13 17	00 52	13 23	02 30	14 01
		01 49	14 03		

	JULY		AUGUST		SEPTEMBER	
	Rise	Set	Rise	Set	Rise	Set
1	03h24m	14h42m	04h40m	15h44m	05h25m	17h02m
2	04 16	15 26	05 25	16 33	06 03	17 54
3	05 07	16 11	06 07	17 25	06 40	18 47
4	05 56	16 58	06 38	18 16	07 17	19 41
5	06 42	17 47	07 26	19 07	07 54	20 35
6	07 26	18 37	08 03	19 59	08 33	21 32
7	08 08	19 28	08 39	20 52	09 14	22 29
8	08 47	20 19	09 16	21 45	09 58	23 28
9	09 25	21 11	09 53	22 40	10 46	
10	10 01	22 03	10 32	23 37	11 40	00 27
11	10 38	22 56	11 14		12 37	01 25
12	11 14	23 50	12 00	00 35	13 38	02 23
13	11 52		12 52	01 35	14 42	03 17
14	12 34	00 46	13 48	02 36	15 46	04 09
15	13 18	01 45	14 49	03 36	16 51	04 57
16	14 08	02 46	15 54	04 34	17 54	05 42
17	15 03	03 49	17 00	05 29	18 56	06 26
18	16 05	04 52	18 06	06 20	19 57	07 08
19	17 09	05 53	19 11	07 07	20 55	07 50
20	18 17	06 51	20 14	07 52	21 52	08 32
21	19 23	07 44	21 15	08 35	22 47	09 15
22	20 28	08 34	22 13	09 16	23 39	10 00
23	21 30	09 18	23 09	09 58		10 46
24	22 30	10 01		10 39	00 30	11 34
25	23 28	10 41	00 04	11 22	01 17	12 23
26		11 21	00 57	12 06	02 01	13 12
27	00 24	12 01	01 48	12 52	02 43	14 03
28	01 19	12 42	02 36	13 40	03 23	14 55
29	02 11	13 25	03 22	14 29	04 01	15 47
30	03 03	14 09	04 06	15 19	04 39	16 40
31	03 53	14 56	04 46	16 10		

MOONRISE AND MOONSET

OCTOBER		NOVEMBER		DECEMBER	
Rise	Set	Rise	Set	Rise	Set
05h16m	17h34m	05h51m	19h12m	06h13m	20h01m
05 53	18 29	06 38	20 13	07 13	21 01
06 32	19 25	07 30	21 14	08 15	21 56
07 14	20 23	08 26	22 13	09 19	22 47
07 57	21 22	09 25	23 09	10 22	23 34
08 44	22 21	10 26		11 24	
09 36	23 21	11 27	00 01	12 25	00 17
10 32		12 29	00 49	13 24	00 58
11 30	00 18	13 30	01 34	14 21	01 39
12 32	01 12	14 30	02 16	15 18	02 18
13 34	02 03	15 29	02 57	16 14	02 58
14 36	02 50	16 28	03 37	17 09	03 40
15 38	03 36	17 26	04 18	18 03	04 25
16 40	04 18	18 22	05 00	18 55	05 10
17 41	05 00	19 17	05 44	19 44	05 58
18 39	05 42	20 11	06 29	20 30	06 48
19 37	06 24	21 02	07 16	21 13	07 38
20 34	07 07	21 50	08 05	21 53	08 29
21 29	07 52	22 34	08 55	22 31	09 19
22 21	08 38	23 16	09 45	23 07	10 10
23 10	09 25	23 55	10 36	23 43	11 01
	10 14		11 27		11 53
	11 04	00 32	12 18	00 18	12 46
00 39	11 54	01 09	13 10	00 55	13 40
01 19	12 45	01 45	14 03	01 34	14 37
01 58	13 37	02 22	14 59	02 16	15 37
02 36	14 29	03 01	15 55	03 03	16 38
03 12	15 22	03 42	16 55	03 56	17 41
03 49	16 17	04 28	17 57	04 54	18 43
04 27	17 14	05 19	18 59	05 56	19 43
05 08	18 12			07 02	20 38

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

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
	h m	11^h52^m	00^h07^m	13^h47^m	23^h39^m	12^h43^m	00^h24^m	14^h30^m	01^h28^m	14^h43^m	03^h25^m	15^h12^m
1		12 51	00 52	14 51		13 45	01 27	15 18	02 31	15 22	04 22	15 49
2	00 11	13 52	01 43	15 54	00 32	14 45	02 31	16 02	03 31	15 58	05 19	16 27
3	00 47	14 56	02 39	16 55	01 29	15 41	03 35	16 42	04 32	16 35	06 15	17 08
4	01 26	16 01	03 41	17 51	02 32	16 34	04 38	17 21	05 31	17 11	07 08	17 51
5	02 11	17 08	04 47	18 44	03 36	17 21	05 40	17 59	06 29	17 49	07 59	18 36
6	03 00	18 12	05 55	19 32	04 42	18 06	06 41	18 36	07 26	18 28	08 48	19 25
7	03 55	19 13	07 03	20 14	05 48	18 47	07 41	19 13	08 21	19 10	09 34	20 15
8	04 57	20 09	08 08	20 54	06 52	19 25	08 39	19 52	09 14	19 54	10 15	21 07
9	06 03	20 58	09 12	21 32	07 55	20 03	09 36	20 33	10 04	20 41	10 55	22 00
10	07 11	21 43	10 14	22 09	08 56	20 40	10 30	21 16	10 52	21 31	11 31	22 54
11	08 20	22 23	11 12	22 45	09 55	21 19	11 22	22 01	11 36	22 22	12 06	23 48
12	09 26	23 00	12 10	23 23	10 53	21 58	12 11	22 49	12 16	23 14	12 40	
13	10 29	23 36	13 06		11 48	22 39	12 57	23 39	12 55		13 14	00 44
14	11 30		13 59	00 02	12 41	23 22	13 39		13 31	00 08	13 49	01 41
15	12 29		14 50	00 44	13 31		14 19	00 30	14 06	01 02	14 26	02 41
16	13 25	00 11	15 39	01 28	14 19	00 08	14 57	01 23	14 40	01 58	15 08	03 43
17	14 20	00 48	16 25	02 15	15 03	00 57	15 33	02 18	15 16	02 56	15 55	04 47
18	15 14	01 25	17 08	03 05	15 44	01 48	16 09	03 14	15 53	03 56	16 47	05 53
19	16 06	02 05	17 49	03 57	16 24	02 40	16 44	04 12	16 33	04 58	17 45	06 59
20	16 56	02 47	18 27	04 51	17 01	03 35	17 22	05 12	17 18	06 03	18 49	08 02
21	17 44	03 32	19 04	05 46	17 37	04 31	18 00	06 14	18 08	07 09	19 57	09 01
22	18 29	04 20	19 40	06 42	18 13	05 29	18 43	07 18	19 04	08 16	21 04	09 54
23	19 11	05 12	20 15	07 40	18 50	06 27	19 30	08 23	20 04	09 20	22 12	10 41
24	19 51	06 04	20 51	08 39	19 27	07 28	20 21	09 28	21 09	10 19	23 16	11 23
25	20 28	06 58	21 28	09 38	20 06	08 30	21 18	10 32	22 15	11 13		12 02
26	21 04	07 53	22 08	10 39	20 50	09 33	22 17	11 32	23 20	12 01	00 19	12 39
27	21 39	08 50	22 51	11 41	21 37	10 36	23 21	12 27		12 44	01 19	13 15
28	22 13	09 47			22 28	11 39		13 17	00 24	13 24	02 17	13 51
29	22 49	10 45			23 25	12 40	00 25	14 02	01 26	14 01	03 15	14 29
30	23 26	11 44							02 26	14 37		
31		12 45				13 37						

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

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	04h10m	15h08m	05h30m	16h07m	06h10m	17h32m	05h53m	18h10m	06h19m	19h58m	06h36m	20h51m
2	05 04	15 49	06 14	16 58	06 45	18 26	06 29	19 08	07 04	21 01	07 35	21 50
3	05 56	16 34	06 55	17 50	07 20	19 22	07 04	20 07	07 54	22 04	08 39	22 44
4	06 45	17 21	07 34	18 43	07 54	20 18	07 42	21 08	08 49	23 03	09 45	23 33
5	07 32	18 11	08 10	19 37	08 29	21 16	08 24	22 09	09 47	23 57	10 50	
6	08 15	19 02	08 45	20 32	09 04	22 15	09 10	23 10	10 50		11 55	00 17
7	08 55	19 54	09 18	21 27	09 43	23 15	10 00		11 54	00 48	12 58	00 57
8	09 33	20 48	09 52	22 23	10 25		10 55	00 10	12 58	01 34	14 01	01 36
9	10 08	21 41	10 26	23 21	11 11	00 15	11 54	01 07	14 02	02 16	15 01	02 13
10	10 42	22 37	11 02		12 03	01 16	12 57	02 00	15 05	02 56	16 01	02 49
11	11 15	23 32	11 42	00 20	13 00	02 15	14 01	02 49	16 07	03 33	17 00	03 27
12	11 49		12 26	01 21	14 02	03 12	15 06	03 35	17 08	04 11	17 57	04 07
13	12 24	00 30	13 16	02 23	15 07	04 05	16 11	04 16	18 09	04 48	18 52	04 49
14	13 03	01 28	14 11	03 25	16 14	04 54	17 16	04 56	19 08	05 28	19 44	05 33
15	13 45	02 30	15 12	04 25	17 22	05 40	18 20	05 35	20 05	06 10	20 33	06 21
16	14 33	03 33	16 15	05 23	18 28	06 22	19 22	06 14	21 00	06 53	21 19	07 11
17	15 27	04 38	17 26	06 16	19 34	07 02	20 23	06 53	21 51	07 40	22 01	08 02
18	16 27	05 42	18 36	07 04	20 37	07 42	21 21	07 34	22 39	08 28	22 40	08 54
19	17 33	06 43	19 44	07 49	21 39	08 20	22 17	08 16	23 23	09 19	23 15	09 47
20	18 41	07 39	20 50	08 31	22 38	09 00	23 10	09 01		10 10	23 49	10 40
21	19 51	08 30	21 54	09 10	23 35	09 41	23 59	09 48	00 03	11 02		11 33
22	20 59	09 16	22 55	09 48		10 24		10 37	00 40	11 56	00 22	12 28
23	22 05	09 58	23 54	10 27	00 28	11 09	00 45	11 28	01 15	12 49	00 55	13 23
24	23 08	10 37		11 06	01 19	11 57	01 26	12 19	01 49	13 44	01 29	14 21
25		11 15	00 51	11 47	02 06	12 46	02 06	13 13	02 22	14 40	02 05	15 21
26	00 08	11 52	01 45	12 30	02 50	13 37	02 42	14 07	02 57	15 38	02 44	16 23
27	01 08	12 30	02 37	13 15	03 30	14 29	03 17	15 01	03 32	16 38	03 29	17 26
28	02 05	13 08	03 26	14 03	04 08	15 23	03 51	15 58	04 11	17 40	04 20	18 31
29	02 59	13 49	04 11	14 53	04 44	16 17	04 25	16 55	04 55	18 44	05 17	19 33
30	03 52	14 33	04 53	15 44	05 19	17 13	05 01	17 54	05 42	19 49	06 19	20 31
31	04 42	15 19	05 33	16 37			05 38	18 56			07 26	21 25

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

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	23h20m	11h00m	h m	12h49m	22h54m	11h44m	h m	13h30m	00h40m	13h48m	02h31m	14h24m
2	23 58	11 57	00 06	13 51	23 47	12 45	00 41	14 20	01 41	14 28	03 27	15 02
3		12 57	00 58	14 53		13 45	01 44	15 06	02 40	15 07	04 22	15 42
4	00 38	13 58	01 55	15 54	00 45	14 42	02 46	15 48	03 38	15 45	05 16	16 23
5	01 24	15 02	02 57	16 52	01 47	15 35	03 48	16 28	04 36	16 23	06 09	17 06
6	02 15	16 07	04 01	17 46	02 50	16 24	04 48	17 08	05 32	17 02	06 59	17 52
7	03 10	17 11	05 07	18 35	03 54	17 10	05 47	17 47	06 28	17 42	07 48	18 41
8	04 13	18 12	06 13	19 20	04 58	17 53	06 45	18 26	07 22	18 25	08 34	19 31
9	05 18	19 10	07 17	20 01	06 01	18 33	07 42	19 06	08 14	19 10	09 17	20 22
10	06 25	20 00	08 20	20 41	07 02	19 13	08 37	19 47	09 04	19 57	09 57	21 13
11	07 31	20 47	09 20	21 20	08 01	19 52	09 31	20 31	09 53	20 46	10 35	22 05
12	08 36	21 29	10 17	21 58	08 59	20 32	10 22	21 17	10 37	21 37	11 11	22 58
13	09 38	22 09	11 13	22 37	09 55	21 12	11 11	22 05	11 18	22 28	11 47	23 52
14	10 37	22 47	12 07	23 18	10 49	21 54	11 58	22 54	11 57	23 20	12 22	
15	11 34	23 24	12 59	23 59	11 41	22 38	12 41	23 45	12 35		12 59	00 48
16	12 29		13 50		12 31	23 24	13 21		13 12	00 13	13 39	01 46
17	13 23	00 01	14 38	00 44	13 19		14 00	00 37	13 48	01 07	14 21	02 46
18	14 15	00 40	15 25	01 31	14 04	00 13	14 38	01 30	14 25	02 04	15 09	03 49
19	15 06	01 20	16 09	02 20	14 46	01 03	15 16	02 25	15 05	03 02	15 02	04 54
20	15 56	02 02	16 51	03 12	15 26	01 55	15 53	03 21	15 46	04 03	17 01	05 59
21	16 44	02 48	17 30	04 05	16 05	02 47	16 32	04 19	16 32	05 05	18 05	07 02
22	17 30	03 36	18 08	04 58	16 43	03 42	17 12	05 19	17 23	06 10	19 10	08 01
23	18 13	04 27	18 46	05 53	17 21	04 38	17 56	06 21	18 19	07 15	20 17	08 55
24	18 53	05 19	19 23	06 49	17 59	05 35	18 44	07 24	19 20	08 19	21 23	09 44
25	19 32	06 11	20 01	07 46	18 38	06 34	19 36	08 28	20 24	09 19	22 26	10 28
26	20 10	07 05	20 40	08 44	19 18	07 34	20 33	09 31	21 28	10 14	23 27	11 09
27	20 46	08 00	21 20	09 43	20 03	08 35	21 33	10 31	22 32	11 03		11 48
28	21 22	08 55	22 05	10 43	20 51	09 37	22 35	11 28	23 35	11 49	00 25	12 26
29	21 59	09 51			21 44	10 39	23 38	12 18		12 30	01 22	13 04
30	22 39	10 49			22 40	11 39		13 05	00 35	13 09	02 18	13 42
31	23 20	11 49			23 40	12 37			01 33	13 47		

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

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	03h12m	14h23m	04h30m	15h23m	05h13m	16h43m	05h01m	17h18m	05h32m	19h00m	05h51m	19h50m
2	04 05	15 05	05 15	16 13	05 51	17 36	05 38	18 14	06 18	20 02	06 51	20 50
3	04 56	15 50	05 56	17 05	06 27	18 30	06 15	19 12	07 09	21 03	07 54	21 45
4	05 45	16 37	06 36	17 57	07 02	19 25	06 55	20 11	08 04	22 03	08 58	22 35
5	06 32	17 26	07 14	18 48	07 38	20 21	07 37	21 11	09 03	22 58	10 02	23 21
6	07 16	18 17	07 50	19 41	08 16	21 19	08 24	22 11	10 05	23 49	11 06	
7	07 57	19 09	08 25	20 35	08 56	22 17	09 15	23 10	11 07		12 08	00 03
8	08 35	20 01	09 01	21 30	09 38	23 17	10 10		12 10	00 37	13 08	00 43
9	09 13	20 53	09 37	22 26	10 26		11 09	00 07	13 12	01 21	14 07	01 23
10	09 48	21 45	10 15	23 24	11 18	00 16	12 11	01 01	14 14	02 02	15 05	02 01
11	10 23	22 40	10 55		12 15	01 15	13 14	01 51	15 14	02 42	16 02	02 40
12	10 58	23 35	11 40	00 23	13 17	02 12	14 17	02 38	16 14	03 21	16 58	03 21
13	11 36		12 31	01 23	14 21	03 06	15 21	03 22	17 13	04 01	17 52	04 04
14	12 16	00 33	13 26	02 24	15 26	03 56	16 23	04 03	18 10	04 41	18 44	04 49
15	12 58	01 33	14 28	03 25	16 32	04 44	17 25	04 44	19 06	05 24	19 33	05 37
16	13 48	02 34	15 32	04 23	17 37	05 28	18 26	05 24	20 00	06 08	20 20	06 27
17	14 42	03 38	16 39	05 18	18 40	06 10	19 25	06 05	20 51	06 55	21 02	07 17
18	15 43	04 41	17 47	06 08	19 42	06 51	20 23	06 47	21 39	07 44	21 42	08 09
19	16 47	05 42	18 53	06 54	20 42	07 32	21 18	07 31	22 24	08 34	22 19	09 00
20	17 55	06 40	19 57	07 38	21 40	08 13	22 10	08 17	23 05	09 25	22 55	09 51
21	19 03	07 32	20 59	08 19	22 36	08 55	22 59	09 04	23 43	10 17	23 29	10 44
22	20 09	08 21	21 59	09 00	23 29	09 39	23 45	09 53		11 08		11 36
23	21 13	09 04	22 57	09 40		10 25		10 43	00 20	12 00	00 03	12 30
24	22 15	09 45	23 53	10 20	00 19	11 13	00 28	11 34	00 55	12 53	00 39	13 26
25	23 14	10 25		11 01	01 07	12 02	01 08	12 26	01 30	13 47	01 17	14 24
26		11 04	00 46	11 45	01 51	12 52	01 46	13 18	02 06	14 44	01 57	15 24
27	00 11	11 43	01 37	12 31	02 32	13 44	02 23	14 11	02 44	15 42	02 43	16 27
28	01 07	12 23	02 26	13 19	03 11	14 36	02 58	15 06	03 24	16 43	03 35	17 30
29	02 00	13 04	03 12	14 08	03 49	15 28	03 34	16 02	04 08	17 45	04 32	18 32
30	02 52	13 48	03 55	14 59	04 26	16 22	04 11	17 00	04 57	18 48	05 34	19 32
31	03 42	14 35	04 35	15 51			04 51	17 59			06 40	20 26

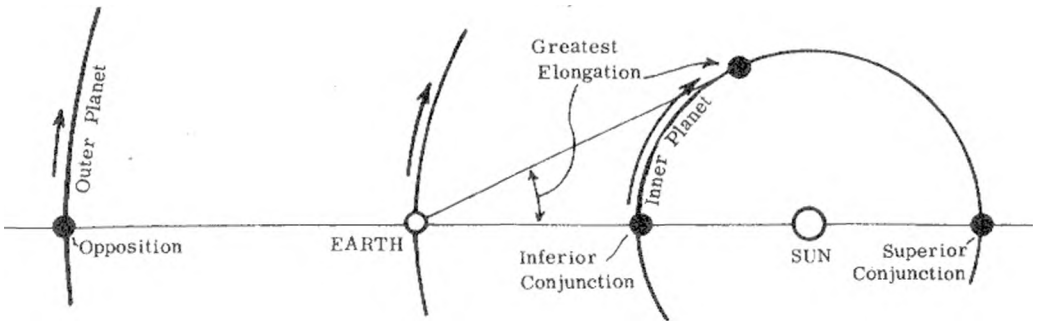
THE PLANETS 1978

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

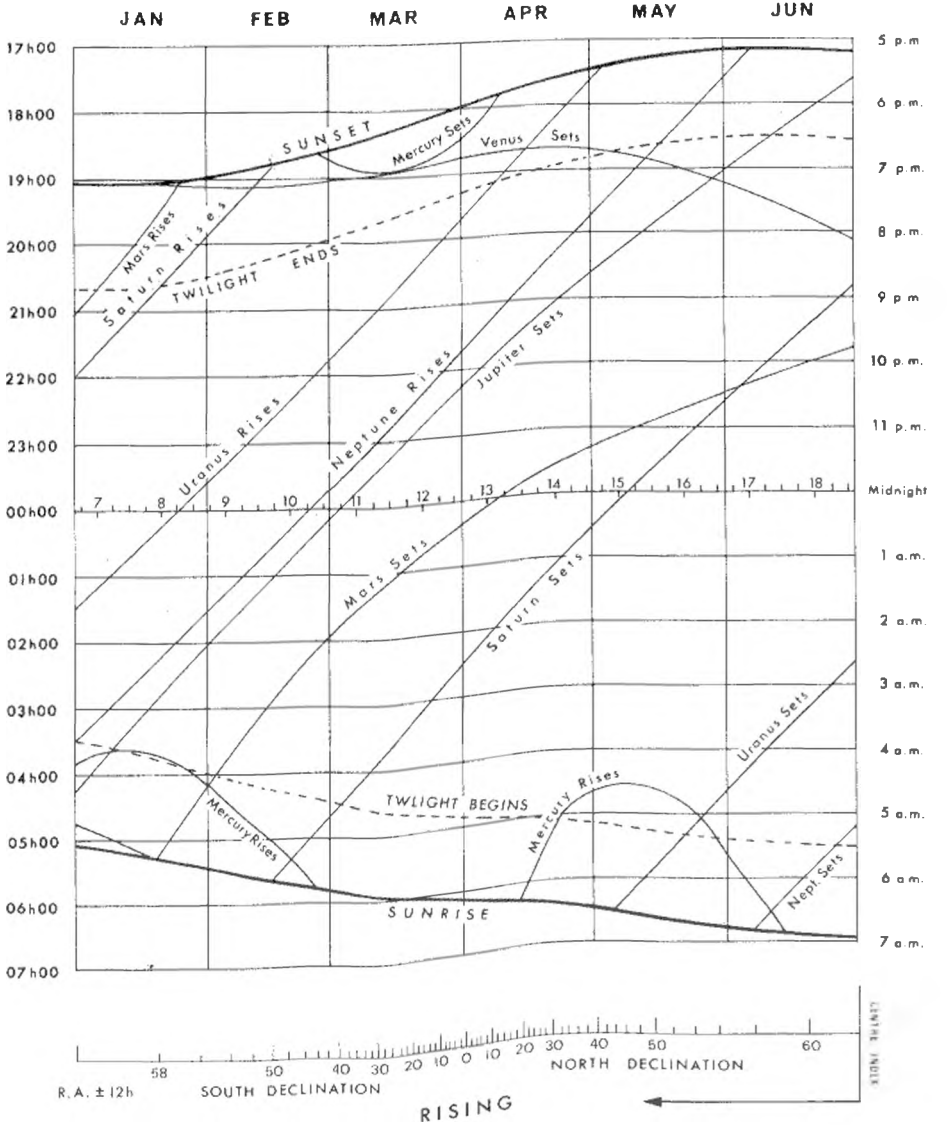
Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Unlike the distant stars, their relative positions do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the 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 1978 are listed chronologically in the Diary (pages 4 and 5) and are also mentioned in the text below.



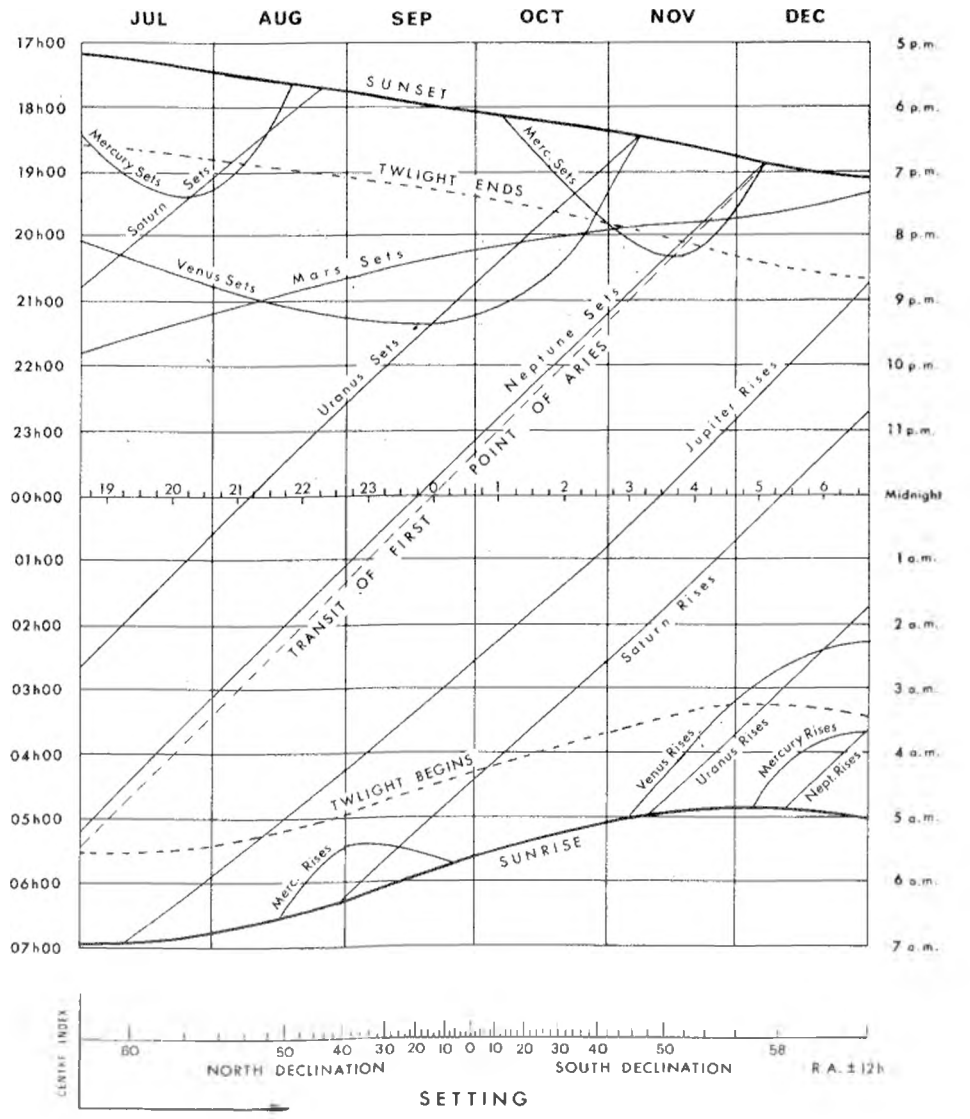
TIMES OF RISING AND SETTING

The times of rising and setting given by the diagram are accurate for position 30° East, 30° South, and approximately correct for other places in Southern Africa. Strictly speaking, corrections for latitude and longitude should be applied, but the latitude correction is, in general sufficiently small to be ignored and in no case will exceed 15 minutes. Longitude corrections are given on page 44.

The scales at the bottom of these pages are for finding rising or setting times of any object of which the right ascension and declination are known. Set dividers or a strip of paper from the index at the centre of the scale to the object's declination and in the direction desired for either



rising or setting. Measure this same distance and direction along the midnight line, beginning at the objects right ascension indicated by the numerals. (Should this end point fall outside the chart, 12 hours should be added to or subtracted from the right ascension. Reset the dividers using the end of the scale instead of the centre index, and measure in the opposite direction to that first used). Through the point established draw a line parallel to the First Point of Aries transit line (indicated by the dashed line on the chart).



OBSERVING THE PLANETS

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

MERCURY

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

Greatest Elongation West	Jan 11 11 (23°)	May 9 17 (26°)	
	Sep 4 23 (18°) [1]	May 9 23 (22°)	
Superior conjunction	Feb 27 05	Jun 14 14	Sept 30 17
Greatest Elongation East	Mar 24 19(19°)	July 22 02 (27°)	Nov 16 04
Stationary	Apr 1 16	Aug 4 05	Nov 26 02
Inferior conjunction	Apr 11 19	Aug 18 22	Dec 5 23
Stationary	Apr 24 04	Aug 27 23	Dec 15 18

VENUS

Venus will be too close to the sun for viewing till about the beginning of March but will then be in the evening sky till the beginning of November and after a short disappearance it will be seen in the morning sky for the rest of the year. Its apparent diameter will change from 10" in January to 62" in November and to 31" at the end of the year. It will reach greatest brilliancy at the beginning of October and in mid-December.

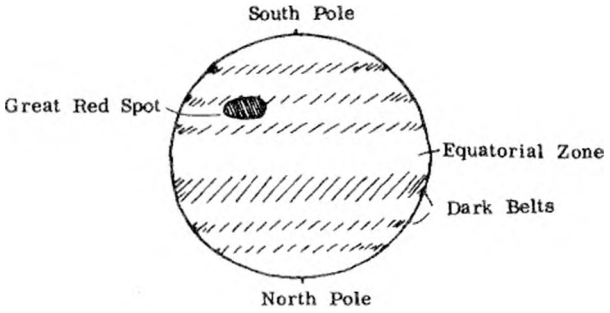
MARS

Mars is a morning star until opposition on January 22 when it will become an evening star until December.

Its magnitude will change from -1.0 in January to +1.8 in September and back to +1.4 in December, while its apparent diameter varies from 14" to 4", and its distance from the earth varies between 0.7 AU and 2.4 AU.

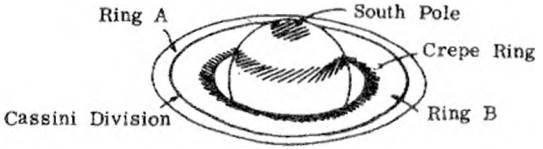
JUPITER

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



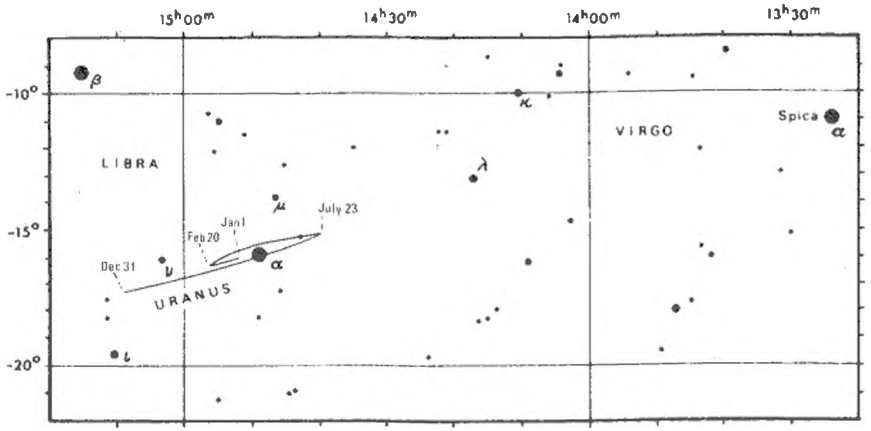
SATURN

Saturn in the constellation of Leo will be clearly seen in the evening sky till August and in the morning sky from October until the end of the year. Unfortunately it will never be very high above the horizon because of its northerly declination. It is at its greatest brightness (magnitude (0.6) at opposition on February 16. 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. The angle of the rings varies from 10^{o} in January to 13^{o} in May and to only 4^{o} in December.



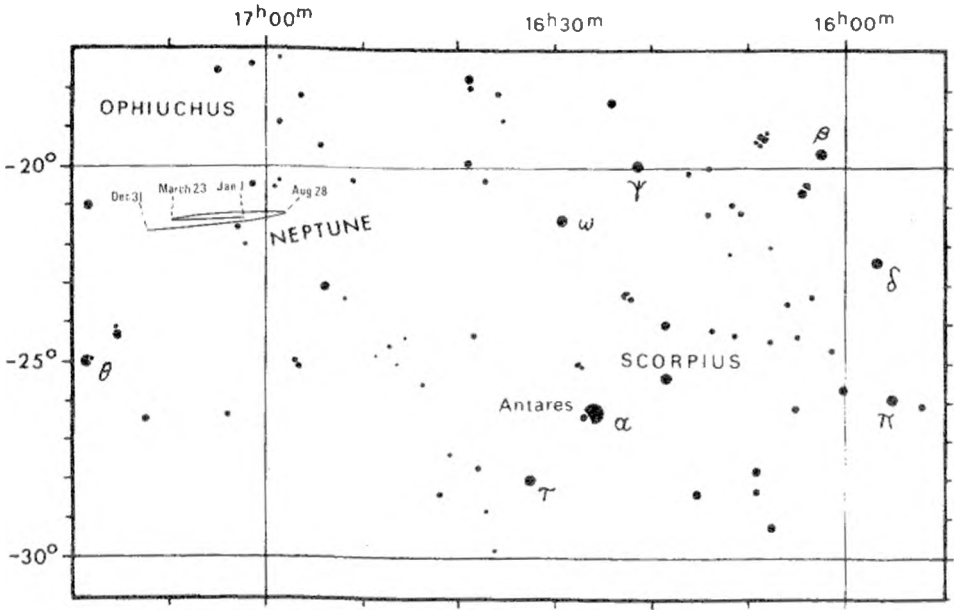
URANUS

Uranus at opposition on May 5 and conjunction on November 9, is in the constellation of Libra all year. It is on the border of naked eye visibility (magnitude 5.7 at opposition) and may be found with the aid of binoculars and references to the accompanying finding chart, which shows all of the stars in the region down to the same faintness. With a small telescope, its disc (angular diameter 4 seconds of arc) may just be distinguished. On April 27 it will be 4' North of a Librae.



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 8 - but may be located using the finding chart below (which shows all stars down to magnitude 7,7) and a small telescope. Its angular diameter is only 2,5 seconds of arc, but its non-stellar appearance should aid in identification.



PLUTO

During the year Pluto moves in the constellation of Virgo between the coordinates RA 13^h26^m Dec + $9^o20'$ and $13^h35'$ Dec + $8^o27'$. 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 continued from page 24

May	23	18	48	IV	Ec	D			22	32	I	Tr	I	Dec	18	21	58	I	Sh	E
	25	18	07	I	Sh	I			23	43	I	Sh	E			22	48	I	Tr	E
		19	39	I	Tr	E		3	00	47	I	Tr	E		24	00	08	II	Ec	D
	26	17	39	I	Ec	R		5	23	30	III	Sh	E			00	33	III	Oc	R
Nov	16	23	13	I	Sh	I		6	00	10	III	Tr	I		25	00	18	I	Ec	D
	17	00	26	I	Tr	I		8	00	02	II	Sh	I			21	24	II	Sh	E
		23	53	I	Oc	R		9	23	21	I	Sh	I			21	36	I	Sh	I
	22	00	37	II	Ec	D			23	46	II	Oc	R			22	17	I	Tr	I
	24	00	05	II	Tr	E		10	00	19	I	Tr	I			22	51	II	Tr	E
		00	50	IV	Ec	D			23	14	IV	Ec	R			23	52	I	Sh	E
	25	22	58	I	Tr	E			23	47	I	Oc	R		26	00	33	I	Tr	E
	29	00	07	III	Tr	E		12	23	57	III	Sh	I			21	46	I	Oc	R
	30	23	40	II	Tr	I		16	21	06	III	Oc	R		27	23	45	IV	Oc	R
Dec	1	00	17	II	Sh	E			21	35	II	Ec	D		30	21	56	III	Ec	D
	2	00	08	I	Ec	D		17	22	24	I	Ec	D							

THE MOONS OF JUPITER AND SATURN 1978

JUPITER'S MOON

One of the most popular sights for an observer with a small telescope is Jupiter and its moons. Four of Jupiter's fourteen moons are large enough to be seen very easily - they would even be visible to the naked eye were it not for the glare of the mother planet. In order of increasing distance from Jupiter, the four moons are Io, which orbits once around Jupiter in less than 2 days; Europa, 3½ days; Ganymede, 7 days; and Callisto which takes 17 days for a full circuit. All the orbits lie in Jupiter's equatorial plane and the system is seen almost edge on. As the moons circle Jupiter, they appear to oscillate from side to side alternatively passing in front of and behind the planet. Their configurations change from night to night and are shown in the diagrams on pages 26 and 27.

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	23^h22^m	III	Tr I		21	37	III	Ec R		27	23	14	III	Oc D
	3	00 28	III	Sh I		23	40	I	Ec R		28	00	25	I	Oc D
	5	00 42	I	Oc D	14	20	15	I	Tr E			21	34	I	Tr I
		21 51	I	Tr I		20	49	I	Sh E			22	25	I	Sh I
		22 12	I	Sh I		23	49	II	Tr I			23	49	I	Tr E
	6	00 04	I	Tr E	15	00	59	II	Sh I		29	00	38	I	Sh E
		00 25	I	Sh E	16	21	53	II	Ec R			18	52	I	Oc D
		19 08	I	Oc D	20	19	49	III	Oc D			22	00	I	Ec R
		21 45	I	Ec R		22	38	I	Oc D		30	19	07	I	Sh E
	7	21 32	II	Tr I	21	20	30	I	Sh I			22	59	II	Oc D
		22 21	II	Sh I		22	00	I	Tr E		31	19	28	III	Sh E
	8	00 12	II	Tr E		22	43	I	Sh E	Feb	1	19	31	II	Sh I
	9	19 17	II	Ec R	22	20	04	I	Ec R			20	19	II	Tr E
	12	23 36	I	Tr I	23	20	20	II	Oc D			22	12	II	Sh E
	13	00 07	I	Sh I	24	00	29		Ec R		3	23	29	IV	Sh E
		20 53	I	Oc D	25	19	35		Sh E						

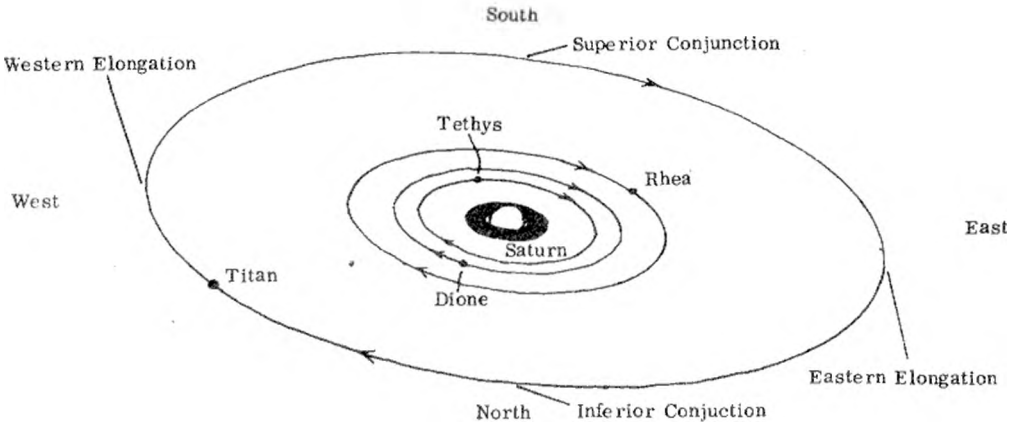
Feb	4	00h29m	IV	Sh	E
		23 22	I	Tr	I
	5	00 20	I	Sh	I
		20 40	I	Oc	D
		23 55	I	Ec	R
	6	18 49	I	Sh	I
		20 02	I	Tr	E
		21 02	I	Sh	E
	7	18 24	I	Ec	R
		19 18	III	Tr	E
		20 27	III	Sh	I
		23 29	III	Sh	E
	8	20 03	II	Tr	I
		22 09	II	Sh	E
		22 42	II	Tr	E
	9	00 49	II	Sh	E
	10	19 00	II	Ec	R
	12	22 30	I	Oc	D
	13	20 44	I	Sh	I
		21 51	I	Tr	E
		22 57	I	Sh	E
	14	19 59	III	Tr	I
		20 19	I	Ec	R
		22 56	III	Tr	E
	15	00 28	III	Sh	I
		22 29	II	Tr	I
	16	00 46	II	Sh	I
	17	21 36	II	Ec	R
	20	00 20	I	Oc	D
		18 51	IV	Sh	E
		21 29	I	Tr	I
		22 39	I	Sh	I
		23 42	I	Tr	E
	21	00 52	I	Sh	E
		18 48	I	Oc	D
		22 14	I	Ec	R
		23 41	III	Tr	I
	22	19 21	I	Sh	E
	23	00 58	II	Tr	I
	24	19 06	II	Oc	D
	25	00 13	II	Ec	R
		18 38	III	Ec	D
		21 44	III	Ec	R
	26	19 21	II	Sh	E
	27	23 21	I	Tr	I
	28	00 34	I	Sh	I
		20 40	I	Oc	D
Mar	1	00 10	I	Ec	R
	1	00 44	IV	Ec	D
		19 03	I	Sh	I
		20 02	I	Tr	E
		21 16	I	Sh	E
	2	18 39	I	Ec	R
	3	21 37	II	Oc	D

Mar	4	20h32m	III	Oc	R
		22 38	III	Ec	D
	5	19 18	II	Sh	I
		19 24	II	Tr	E
		21 57	II	Sh	E
	7	22 33	I	Oc	D
	8	19 42	I	Tr	I
		20 58	I	Sh	I
		21 55	I	Tr	E
		23 12	I	Sh	E
	9	20 34	I	Ec	R
	11	00 10	II	Oc	D
		21 25	III	Oc	D
	12	00 27	III	Oc	R
		19 19	II	Tr	I
		21 55	II	Sh	I
		21 58	II	Tr	E
	13	00 34	II	Sh	E
	14	18 46	II	Ec	R
	15	00 28	I	Oc	D
		19 34	III	Sh	E
		21 37	I	Tr	I
		22 54	I	Sh	I
		23 50	I	Tr	E
	16	18 56	I	Oc	D
		22 29	I	Ec	R
	17	18 43	IV	Ec	D
		19 36	I	Sh	E
		20 36	IV	Ec	R
	19	21 55	II	Tr	I
	20	00 31	II	Sh	I
		00 34	II	Tr	E
	21	21 24	II	Ec	R
	22	20 29	III	Sh	I
		23 32	I	Tr	I
		23 36	III	Sh	E
	23	00 49	I	Sh	I
		20 52	I	Oc	D
	24	00 25	I	Ec	R
		19 18	I	Sh	I
		20 14	I	Tr	E
		21 32	I	Sh	E
	25	18 36	IV	Tr	E
		18 53	I	Ec	R
	27	00 33	II	Tr	I
	28	18 42	II	Oc	D
	29	00 01	II	Ec	R
		19 20	III	Tr	I
		22 22	III	Tr	E
	30	00 30	III	Sh	I
		19 05	II	Sh	E
		22 48	I	Oc	D
	31	19 58	I	Tr	I
		21 13	I	Sh	I

Mar		22 11	I	Tr	E
		23 27	I	Sh	E
Apr	1	20 49	I	Ec	R
	4	21 22	II	Oc	D
	6	19 02	II	Sh	I
		19 12	II	Tr	E
		21 41	II	Sh	E
	7	21 55	I	Tr	I
	8	19 15	I	Oc	D
	9	18 38	I	Tr	E
		18 39	III	Ec	D
		19 52	I	Sh	E
		21 50	III	Ec	R
	13	19 15	II	Tr	I
		21 38	II	Sh	I
		21 53	II	Tr	E
	15	18 36	II	Ec	R
		21 13	I	Oc	D
	16	18 23	I	Tr	I
		19 33	I	Sh	I
		20 37	I	Tr	E
		21 01	III	Oc	R
		21 48	I	Sh	E
		22 40	III	Ec	D
	17	19 08	I	Ec	R
	19	20 05	IV	Oc	D
		21 41	IV	Oc	R
	20	21 58	II	Tr	I
	22	21 14	II	Ec	R
	24	17 42	I	Oc	D
		21 03	I	Ec	R
	25	18 12	I	Sh	E
	27	19 42	III	Sh	E
	28	19 56	IV	Sh	E
	29	18 58	II	Oc	D
May	1	18 46	II	Sh	E
	1	19 41	I	Oc	D
	2	17 53	I	Sh	I
		19 06	I	Tr	E
		20 08	I	Sh	E
	4	19 37	III	Tr	E
		20 31	III	Sh	I
	6	17 42	IV	Oc	R
	8	18 42	II	Sh	I
		19 28	II	Tr	E
	9	18 52	I	Tr	I
		19 48	I	Sh	I
	10	19 21	I	Ec	R
	15	17 54	III	Ec	R
		19 35	II	Tr	I
	17	18 11	I	Oc	D
		18 27	II	Ec	R
	18	17 38	I	Tr	E
		18 28	I	Sh	E

The Moons of Jupiter continued on page 22

SATURN'S MOONS

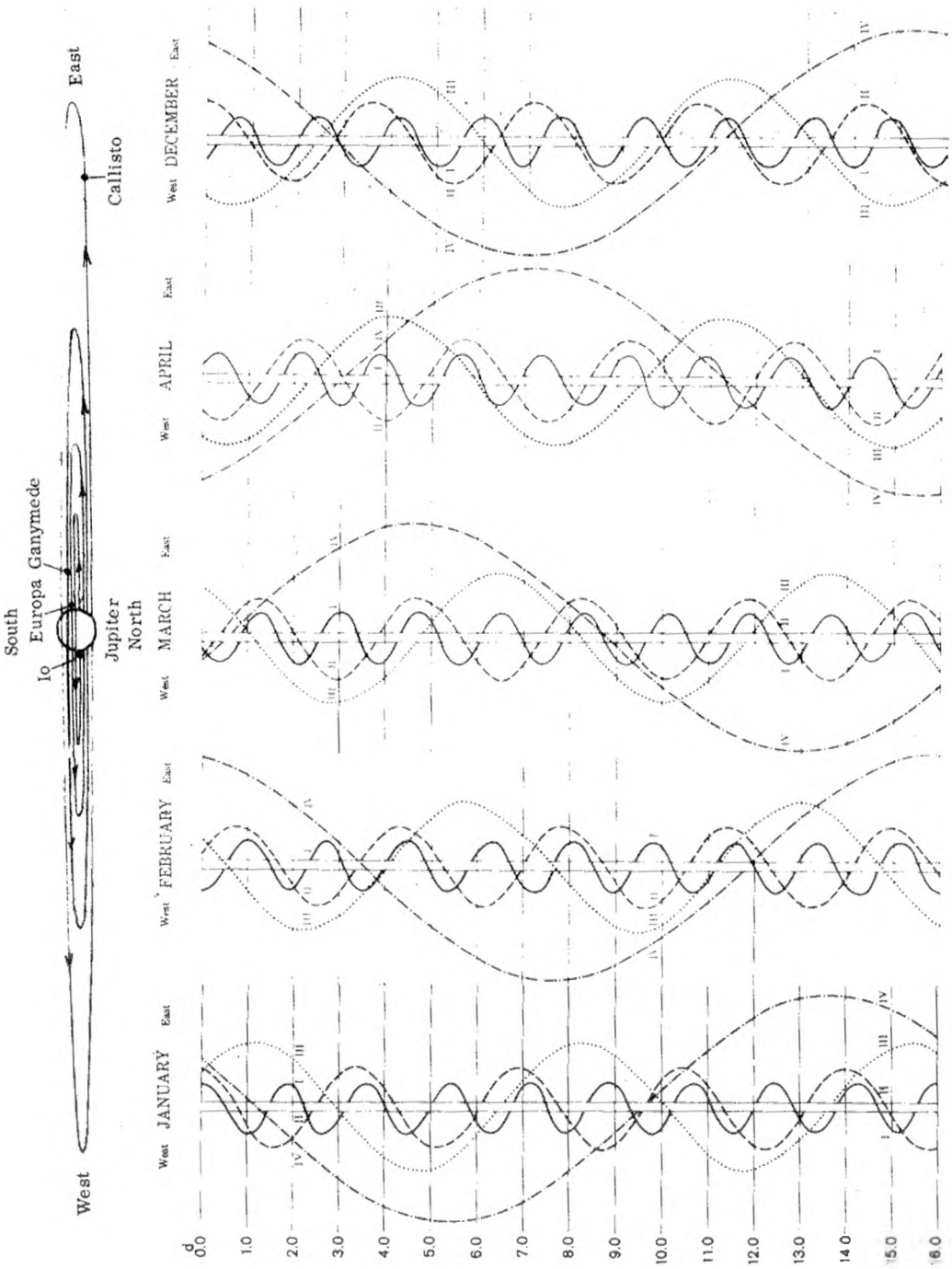


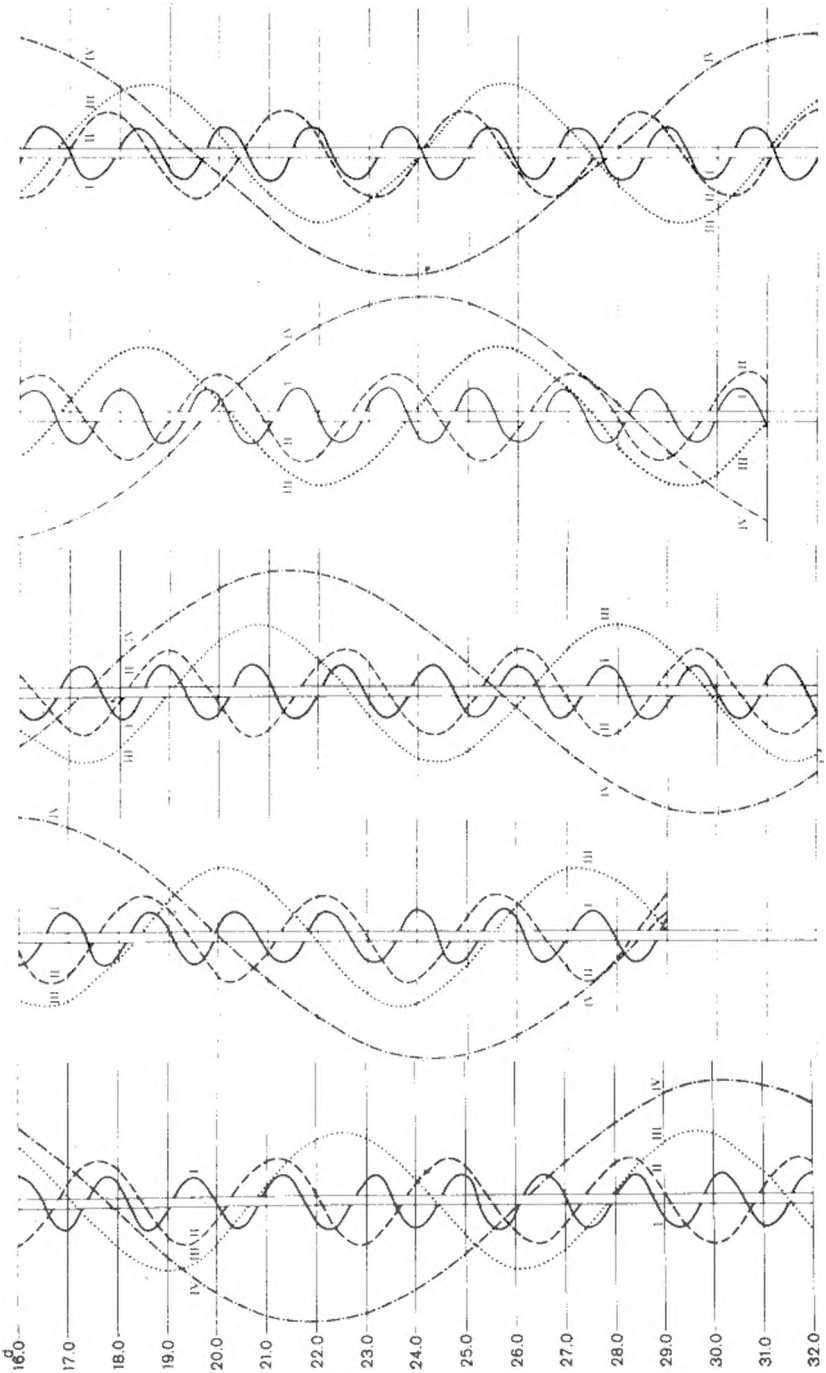
Saturn's moons are considerably fainter than the four Galilean moons of Jupiter. The diagram shows the orbits of four of Saturn's ten moons. The easiest to find is Titan (magnitude 8,5), according to the diagram and the information in the table below (which covers the period when Saturn is clearly visible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

TITAN 1978

Eastern Elongation	Inferior Conjunction	Western Elongation	Superior Conjunction
Jan 4	Jan 8	Jan 12	Jan 16
20	24	28	Feb 1
Feb 5	Feb 9	Feb 13	17
21	25	Mar 1	Mar 5
Mar 9	Mar 13	17	21
25	29	Apr 2	Apr 6
Apr 10	Apr 14	18	22
26	30	May 4	May 8
May 12	May 16	19	24
28	Jun 1	Jun 4	Jun 9
Jun 13	17	20	25
29	Jul 3	Jul 6	Jul 11
Jul 15	19	22	- - -
- - -	- - -	- - -	- - -
Oct 3	Oct 7	Oct 11	Oct 15
19	23	27	31
Nov 4	Nov 8	Nov 12	Nov 16
20	24	28	Dec 2
Dec 6	Dec 10	Dec 14	18
22	26	30	

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 nearly edge on. The main part of the diagram then shows how their positions along such a straight line chang 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 tial stretching away from the sun. Faint comets, several of which are discovered each year, usually appear only as fuzzy patches without nucleus or tail, though there may be a central condensation.

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

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

Observers with quite modest equipment, say a refracting telescope of not less than 7.5 cm, can do useful work by following known comets and reporting on their appearance. The ability to make accurate brightness estimates is especially useful and well worth cultivating. Sweeping the sky for new comets, though requiring considerable patience and perseverance, is also well within the scope of the equipment mentioned.

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

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

METEORS

Meteors or "shooting stars" result from small bodies entering the Earth's upper atmosphere, and are generally seen in greater abundance after midnight (due to the direction of the Earth's motion) than in the early evening.

There are two categories of meteors - the sporadic ones and the showers. A meteor shower comes from a certain direction in space (the Radiant) and is thought to be associated with the remains of a comet. When the Earth passes close to the comet's original orbit, such a shower can be expected. A list of these predicted showers is given in the table opposite.

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

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

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

"Fireballs" are meteors of a luminosity equilling 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. Details of brightness (compared with Venus, Moon etc.) size and form, colours and any train or streak, are also important.

PREDICTED METEOR

Date	Shower	Radiant R.A.	Radiant Dec.
Mar 14 - Mar 18	Corona Australids	16^h20^m	-48^o
Apr 19 - Apr 24	April Lyrids	18 08	+32
May 1 - May 8	Eta Aquarids	22 24	00
Apr 20 - Jul 30	Sco-Sgr System	18 00	-30
Jun 10 - Jun 21	June Lyrids	18 32	+35
Jun 17 - Jun 26	Ophiuchids	17 20	-20
Jul 10 - Aug 5	Capricornids	21 00	-15
Jul 15 - Aug 15	Delta Aquarids	22 36	{-17 { 00
Jul 15 - Aug 20	Pisces Australids	22 40	-30
Jul 15 - Aug 25	Alpha Capricornids	20 36	-10
Jul 15 - Aug 24	Iota Aquarids	{22 04 {22 32	- 6 -15
Oct 16 - Oct 27	Orionids	06 24	+15
Oct 10 - Dec 5	Taurids	{03 44 {03 44	+14 +21
Nov 14 - Nov 20	Leonids	10 08	+22
Dec 4 - 5	Phoenicids	01 00	-55
Dec 7 - Dec 15	Geminids	07 28	+32
Dec 5 - Jan 7	Velaids	09 56	-51

SHOWERS 1978

Date	Maximum Hourly Rate	Transit Radiant (approx)	Recommended Time of Watch	Conditions at Maximum
Mar 16	5	04^h45^m	02^h30^m–dawn	Favourable
Apr 22	15	04 15	03^h –dawn	Unfavourable
May 5	18	07 30	03^h –dawn	Favourable
Jun 14	?	00 30	00^h –04^h	Favourable
Jun 16	8	01 00	02^h –04^h	Favourable
Jun 13(?)	8	23 30	00^h –03^h	Favourable
Jul 25	8	00 50	23^h –02^h	Unfavourable
Jul 27	35	02 10	00^h –04^h	Unfavourable
Jul 30	11	02 10	00^h –02^h	Favourable
Aug 2	10	00 00	00^h –04^h	Favourable
Aug 6	12	{01 20 {01 30	22^h –03^h	Favourable
Oct 21	35	04 30	02^h –dawn	Unfavourable
Nov 8	16	{00 50 {00 50	01^h –04^h	Favourable
Nov 17	10	06 30	02^h –dawn	Unfavourable
Dec 4	?	20 10	23^h –24^h	Favourable
Dec 14	55	02 00	01^h –dawn	Unfavourable
Dec 29	?	03 30	01^h –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.

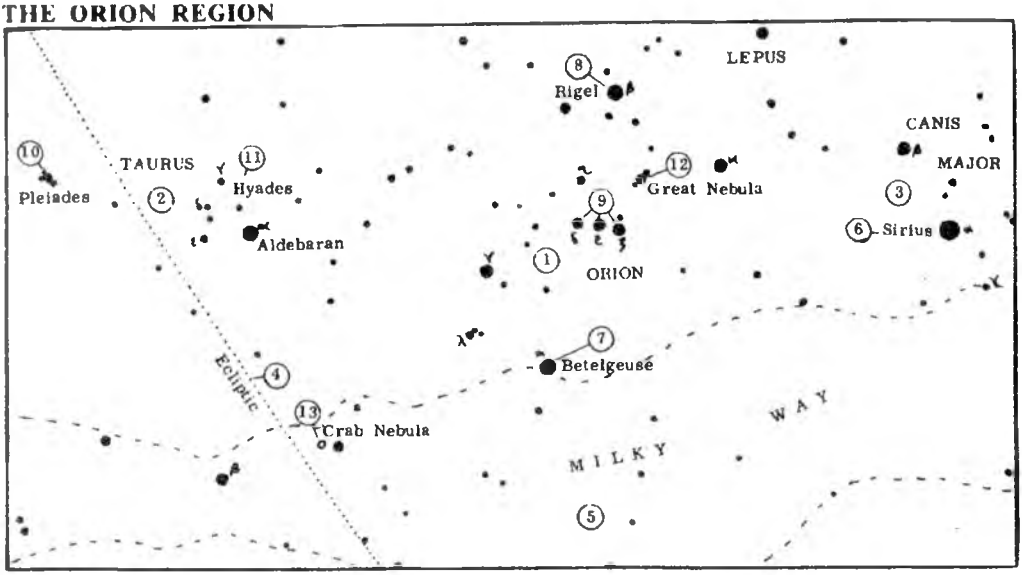
NEBULAE

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.

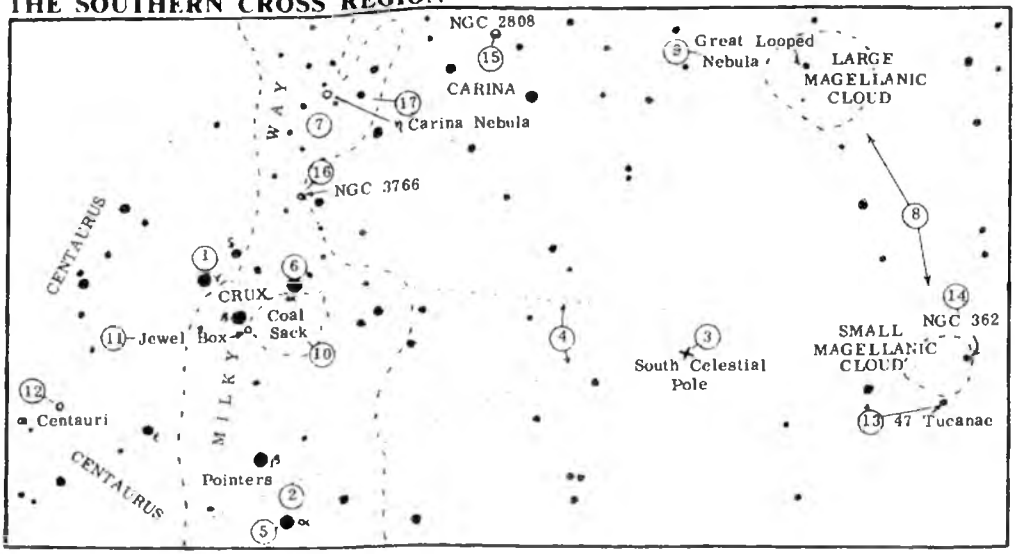
(10) The Pleiades or Seven Sisters form the best known nearby star cluster. Six or seven stars are visible to the naked eye, binoculars or a small telescope show more.

(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).

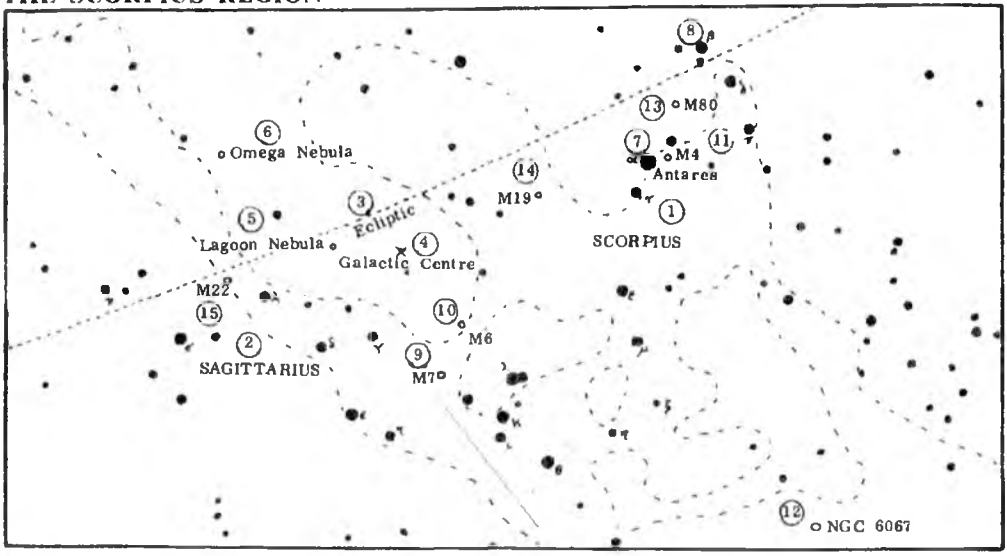
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).

(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 0084.

VARIABLE STAR OBSERVING

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

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

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

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

R Coronae Borealis variables (decrease in brightness):

123753	UW Cen	181146	RS Tel	191033	RY Sgr
145971	S Aps	181824	GU Sgr		

Increase in brightness:

U Geminorum variables:		040971	VW Hyi	132554	BV Cen
Novae:		063462a	RR Pic	174406	RS Oph
Flare star:		013418	UV Ceti		

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 makest them very suitable for new observers. Examples of this class of stars are:

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

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

055686	R Oct	131283	U Oct	172486	S Oct

Others will need early morning observing sessions for fuller coverage.

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. Norton's Star Atlas names several more.

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

		Approximate magnitude range	Approximate dates of maxima 1978
021403	o Ceti (Mira)	2.0 - 10.1	November 1
092962	R Carinae	3.9 - 10.0	Jan. 24, Nov. 28
100661	S Carinae	4.5 - 9.9	April 11, Sept. 9

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 catagories whould contact the Director of the Variable Star Section, Mr J. Hers, 48 Central Road, Linden Extension, Randburg 2194. New observers will be given charts of a few easy objects and (if possible) a certain amount of instruction at the eyepiece. When writing, prospective observers should give brief details of their equipment.

ORDINARY OCCULTATIONS

An occultation occurs when the moon passes in front of a star. The disappearance or reappearance of the star is an instantaneous event, or almost so, and is therefore easily timed. Time signals are broadcast continuously through the 24 hours from station ZUO (see page 43) and, radio propagation permitting, occultation timings can be made, either by eye and ear or by stop watch.

The essential record of a occultation observation consists of

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

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

The telescope position must be to an accuracy of 1" or better in latitude and longitude and 30 metres or better in altitude. An observer can usually read his position off a 1/50 000 map published by the Director General of Trig. Survey, Mowbray, or his equivalent in other countries. Positions determined astronomically are NOT acceptable, no matter how carefully determined.

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

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

Explanation of Table:

Z.C. - the number of the star in the "Catalogue of 3539 Zodiacal Stars for the Equinox 1950.0" by James Robertson (U.S. Naval Observatory, 1939). A short index of the brighter stars is given on page 47.

Mag. - the visual magnitude of the star

P - Phase. 1 = Disappearance 2 = Reappearance

El. of Moon - the elongation of the Moon. 0° = New Moon, 90° = First Quarter, 180° = Full Moon, 270° = Last Quarter.

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

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

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

where a and b are in minutes of time.

P - the position angle on the Moon's limb, measured eastward from the north point.

N - no occultation
S - sunlight interferes
A - Moon at very low altitude
G - grazing occultation

Date	Z.C. No.	Mag.	P.	El. of Moon	CAPE TOWN E. 18.500, S. 33.900 U.T.	a	b	P	JOHANNESBURG E. 28.000, S. 26.200 U.T.	a	b	P	SALISBURY E. 31.100, S. 17.700 U.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
Jan. 4	2028	6.5	2	287	1 50.4	-0.9	-1.1	269	1 48.5	-0.9	-1.7	299	1 33.4	-0.5	-2.6	328
11	3199	6.8	1	35		S			17 46.1	-0.7	-0.4	122	17 48.5	-0.3	+0.4	95
12	3344d	6.8	1	49	18 42.7	-0.4	+1.9	52		A				A		
19	697	7.2-7.4	1	131	16 50.5	.	.	19		N				N		
27	1549	5.2	2	211	2 30.0	-0.6	-2.9	347		N				N		
Feb. 1	2110	6.4	2	272		N				56.6	-2.8	+0.7	245	2 02.1	-2.2	-0.9	281
2	2245	6.4	2	284	1 01.6	-0.2	-1.9	306	0 42.2	+0.5	-3.9	346		K		
2	2247	5.6	2	285		N				N			1 24.3	-1.9	+0.5	246
9	3411d	7.2	1	28		S				S			17 06.5	-0.4	+0.6	91
11	136	6.3	2	54		S			16 47.2	.	.	333		N		
15	648	3.9	1	101	20 01.4	-1.4	-1.2	139	20 12.0	-1.3	+0.3	107	20 22.0	-1.5	+1.1	79
15	653	4.8	1	101		N			21 05.7	-0.3	-1.0	136	21 05.0	-0.7	+0.2	102
15	658d	4.2	1	101	21 38.4	-1.4	+2.9	46		N				K		
18	1057	6.9	1	134						N			22 55.3	.	.	173
Mar. 1	2223d	4.0	1	256	3 54.4	-2.7	+1.2	69		N				N		
2	2372d	4.4	1	268	2 21.8	-2.4	+1.1	54		N				N		
2	2372d	4.4	2	268	3 14.1	-1.2	-3.8	333		N				N		
4	2674	6.0	2	294	1 37.0	-1.0	+0.5	228	1 44.7	-1.0	-0.7	266	1 37.9	-0.7	-1.6	298
16	862	7.5	1	91	17 34.9	-2.7	+1.1	69	18 18.7	.	.	38		N		
16	863	6.7	1	91	17 53.9	-2.6	+1.1	71	18 37.8	.	.	37		N		
16	871	6.9	1	92	19 41.2	-1.2	-0.3	127	19 54.9	-1.3	+0.7	95	20 09.5	-1.6	+1.9	63
18	1176	7.4	1	113	17 58.3	-2.2	-2.6	147	18 07.8	-2.7	-1.0	118	18 12.7	-3.3	+0.1	91
26	2033	4.3	1	210	21 10.7	-0.4	-2.8	152	21 00.9	-1.2	-1.7	118	20 55.5	-1.8	-0.5	90
26	2033	4.3	2	210	22 06.2	-2.0	-0.3	254	22 18.3	-1.9	-1.4	291	22 07.3	-1.4	-2.6	322
29	2460	6.1	2	250	23 06.3	-1.4	+0.7	228	23 17.5	-1.3	-0.7	268	23 11.2	-1.0	-1.7	299
Apr. 11	684d	6.2	1	49	18 05.0	-1.4	+2.6	49		N				N		
13	943	6.2	1	71	17 57.2	-1.8	-0.9	132	17 22.8	-1.9	+0.3	102	17 36.4	-2.3	+1.5	72
13	951	6.8	1	71		N				N			19 11.3	-0.1	-1.4	140
14	1072	6.2	1	82		N				N			16 46.0	-2.1	-2.2	138
15	1190d	7.1	1	93		N				N			18 32.8	-0.5	-3.5	161
16	1197	6.0	1	94		N				K			20 34.4	+0.1	-2.2	155
17	1409	5.1	1	115	17 30.6	-1.8	-2.3	142	17 38.7	-2.6	-1.0	112	17 44.8	-3.7	+0.4	83
19	1539	7.4	1	129	0 14.3	-0.7	+1.7	76		N				K		
29	2913	5.0	2	261	1 51.3	-1.7	-0.6	263	2 02.3	-2.4	-1.7	292		N		
May 11	1040d	6.2	1	51	18 03.3	.	.	171	17 54.8	-0.5	-0.2	122	17 58.7	-0.8	+0.6	90
24	2674	6.0	2	214	21 09.9	-0.9	-1.2	276	21 04.9	-0.8	-2.5	312		N		
24	2686d	5.2	2	214		N				N			22 55.3	.	.	214
26	2876a	5.4	2	230	2 45.3	-2.1	+0.8	256	3 10.8	-2.2	+0.4	271	3 16.0	-3.0	-1.4	300
26	2880	5.1	2	231	3 50.8	-1.9	+0.7	267		S				S		
29	3308	6.2	2	270	1 29.7	-1.2	0.0	244	1 41.5	-1.9	-0.6	266	1 36.6	-2.9	-2.9	300
June	153	6.2	2	307		N			1 35.5	-0.1	+1.4	210	1 43.8	-0.5	+0.4	241
10	1344	6.8	1	54		N				N			18 18.1	+0.1	-1.9	152
12	1549	5.2	1	76	18 04.2	-0.9	-1.8	153	18 09.1	-1.5	-0.2	114	18 18.6	-2.1	+1.3	78
13	1660d	6.2	1	89	20 47.2	-1.3	+2.4	68		N				K		
13	1663	5.2	1	89	21 27.6	-0.7	+1.8	77		N				N		
15	1874	7.5	1	112	19 33.8	-1.8	-1.1	128	19 51.0	-2.7	+0.7	91	20 19.1	.	.	40
15	1893d	4.4	1	114	23 16.4	-0.5	+1.4	82		A				N		
16	1996	6.9	1	125		N				N			20 01.1	.	.	170
23	2968d	6.2	2	212	4 14.1	-0.7	+2.7	229		S				S		
23	2969	3.2	1	212	3 17.0	-1.8	+0.5	97	3 37.7	-1.3	+0.9	87	3 50.5	-0.9	+1.3	66
23	2969	3.2	2	212	4 20.0	-0.6	+2.2	226		S				S		
25	3269	4.3	1	240	1 53.6	-2.1	+0.1	79	2 19.5	-2.3	+1.1	67	2 39.6	-1.9	+2.1	46
25	3269	4.3	2	240	3 3.7	-1.7	+1.6	231	3 43.4	-1.8	+1.7	239	4 00.6	-2.1	+0.9	258
29	257	4.5	1	290	2 46.6	-0.1	+2.5	13		G				N		
29	257	4.5	2	290	3 34.6	-2.6	-2.6	296		S				N		
30	384	5.7	2	302	4 37.8	-1.6	0.0	247		S				S		
July 8	1409	5.1	1	35		N				N			16 41.8	-0.1	-1.9	150
11	1716	6.4	1	68		N			17 03.0	.	.	182	16 41.0	-1.6	-1.8	138
11	1730d	6.5	1	69	19 35.1	-1.0	+1.6	81		N				N		
12	1830d	6.8	1	81		N				N			19 04.3	-0.9	-2.7	157

Date	Z.C. No.	Mag.	ℙ.	El. of Moon	CAPE TOWN E. 18.500, S. 33.900 U.T.	a	b	P	JOHANNESBURG E. 28.000, S. 26.200 U.T.	a	b	P	SALISBURY E. 31.100, S. 17.700 U.T.	a	b	P
				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
July 13	1947	7.1	1	92	N				N				17 32.4	-1.2	-4.1	165
13	1951d	7.1	1	93	N				20 14.7	-0.9	-3.4	165	20 03.4	-1.1	-0.8	125
16	2223d	4.0	1	121	0 17.6	-0.5	-0.3	132	A				A			
16	2352	6.7	1	132	N				N				16 04.4	-1.7	-3.9	152
16	2372d	4.4	1	133	22 20.2	-1.3	+2.5	56	22 57.7	.	.	18	N			
18	2686d	5.2	1	160	N				N				18 51.9	-1.9	-2.2	126
Aug. 9	1920	6.7	1	63	18 36.3	-1.1	0.0	116	18 49.4	-0.9	+1.0	88	19 07.3	-0.4	+3.5	47
10	2032	7.3	1	75	18 08.7	-1.5	-1.2	137	18 20.0	-1.5	+0.2	105	18 31.9	-1.4	+1.6	71
10	2033	4.3	1	75	N				N				19 02.5	-1.2	-2.5	152
11	2156	7.3	1	87	18 19.7	-2.2	+2.0	68	N				N			
11	2167	7.5	1	88	21 14.4	-0.2	+4.4	37	N				N			
13	2454	7.2	1	114	19 41.1	-2.1	-0.2	106	20 03.8	-1.8	+1.0	81	20 23.5	-1.3	+2.6	50
13	2460	6.1	1	115	21 54.0	-1.5	-0.7	129	22 04.7	-1.0	+0.2	109	22 11.5	-0.6	+0.8	84
17	2969	3.2	1	158	0 37.7	-1.4	+0.7	98	0 54.5	-0.9	+0.9	86	1 05.5	-0.5	+1.2	67
17	2969	3.2	2	158	1 35.6	-0.3	+2.1	226	1 51.9	-0.1	+1.6	237	2 02.7	-0.1	+0.9	258
21	35	6.4	2	215	3 46.5	-0.5	+3.6	191	S				S			
21	153	6.2	2	226	23 45.1	-2.6	-2.3	294	23 53.1	.	.	314	N			
22	167	5.7	2	227	1 46.1	-0.9	+2.9	196	2 19.6	-1.4	+3.0	204	2 46.4	-1.9	+2.3	226
Sept. 10	2548	7.5	1	96	18 26.5	-2.0	+1.3	73	18 58.9	-1.4	+2.7	48	N			
10	2555d	7.5	1	97	N				N				20 49.9	-1.2	-0.6	119
11	2722	7.1	1	110	18 55.9	-2.1	+0.9	77	19 25.7	-1.7	+2.0	58	19 53.9	-0.6	+4.2	25
11	2737	6.8	1	111	22 16.4	-0.3	+2.6	42	22 37.5	+0.4	+3.2	25	N			
13	2913	5.0	1	126	0 50.1	-0.2	+0.9	93	A				A			
13	3027	7.0	1	137	N				N				17 32.8	-2.6	-1.2	106
13	3051	7.0	1	139	22 06.5	-1.7	+1.0	81	22 30.1	-1.3	+1.3	72	22 46.6	-0.8	+1.8	51
25	1040d	6.2	2	277	A				0 30.1	-0.3	+1.1	222	0 37.2	-1.0	+0.2	249
Oct. 6	2372d	4.4	1	53	18 38.1	-1.0	-0.2	125	18 46.4	-0.5	+0.3	106	18 52.6	-0.2	+0.9	81
7	2527	6.9	1	67	20 16.5	-0.2	+1.7	65	A				A			
8	2674	6.0	1	79	17 54.3	-1.9	+0.6	91	18 18.5	-1.4	+1.3	74	18 37.2	-0.8	+2.3	46
9	2856	6.6-7.6	1	94	21 31.6	-0.7	+1.1	99	21 44.4	-0.2	+1.1	78	A			
10	3002	6.2	1	107	22 34.1	+0.6	+4.0	9	N				N			
11	3146	6.5	1	120	N				N				20 40.6	.	.	127
12	3276	5.4	1	132	S				17 14.9	-1.7	+1.4	46	17 41.6	-1.2	+4.2	14
12	3285	6.1	1	133	19 47.4	.	.	357	N				A			
12	3294	6.9	1	134	21 12.8	.	.	126	21 33.2	-2.6	-0.5	114	21 41.1	-1.9	+0.6	89
12	3308	6.2	1	135	23 59.6	-0.6	+1.8	60	24 17.3	-0.2	+1.9	48	A			
13	3311	7.0	1	135	0 36.2	-0.4	+1.6	67	A				A			
13	3416	5.6	1	146	S				17 23.6	-1.1	+2.1	28	N			
20	832	4.7	2	234	A				21 15.8	-1.0	-1.3	282	21 03.2	-1.8	-3.1	312
20	836	5.5	2	234	A				22 01.2	-1.0	-0.4	255	21 59.9	-1.6	-1.0	278
24	1238	6.1	2	269	2 57.0	.	.	335	N				N			
26	1442	5.0-10.5	2	290	1 44.5	-1.1	-4.0	342	K				N			
Nov. 5	2808	7.4	1	62	N				19 24.4	.	.	154	19 1 .5	-0.7	-0.2	114
8	3247	7.0	1	103	20 30.2	.	.	353	N				N			
9	3380	6.2	1	115	18 04.4	-2.2	+0.5	73	18 32.5	-2.2	+1.3	65	18 53.4	-1.8	+2.2	46
20	1284	6.3	2	247	A				A				21 44.	0.9	-1.5	293
25	1712	3.8	1	293	N				0 35.1	-0.3	+2.9	154	0 17.	.	-1.7	126
25	1712	3.8	2	293	N				1 23.6	-1.1	0.0	246	1 22.9	-1.	-0.8	275
27	1937d	6.1	2	317	N				K				2 07.1	-0.8	+0.2	249
Dec. 4	3270	6.6	1	60	20 15.1	-0.2	+1.0	90	A				A			
8	81	6.6	1	112	20 38.8	-1.9	+0.9	90	21 02.1	-1.3	+1.2	80	21 18.1	-1.0	+1.6	59
9	215	6.7	1	124	20 45.5	-2.1	+0.8	86	21 12.4	-1.7	+1.3	75	21 32.5	-1.4	+1.9	5
26	2128	5.8	2	310	S				S				2 27.2	-0.6	-1.8	310

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

EXPLANATION OF COLUMN HEADINGS IN TABLES

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

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

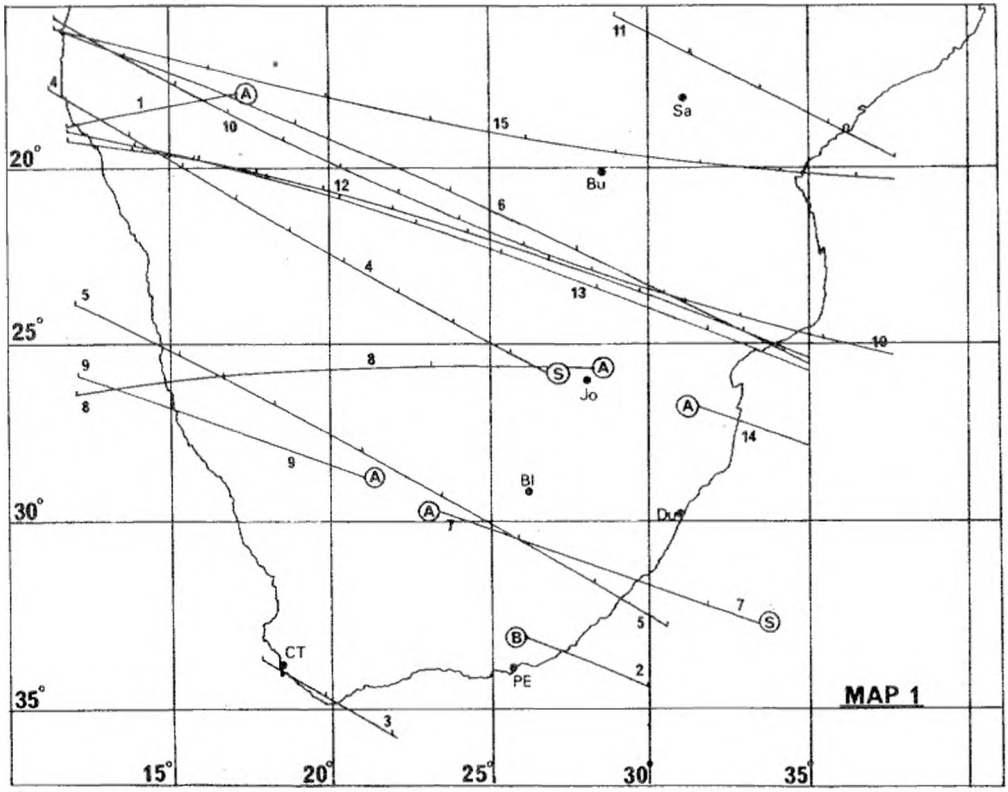
Date

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

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

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

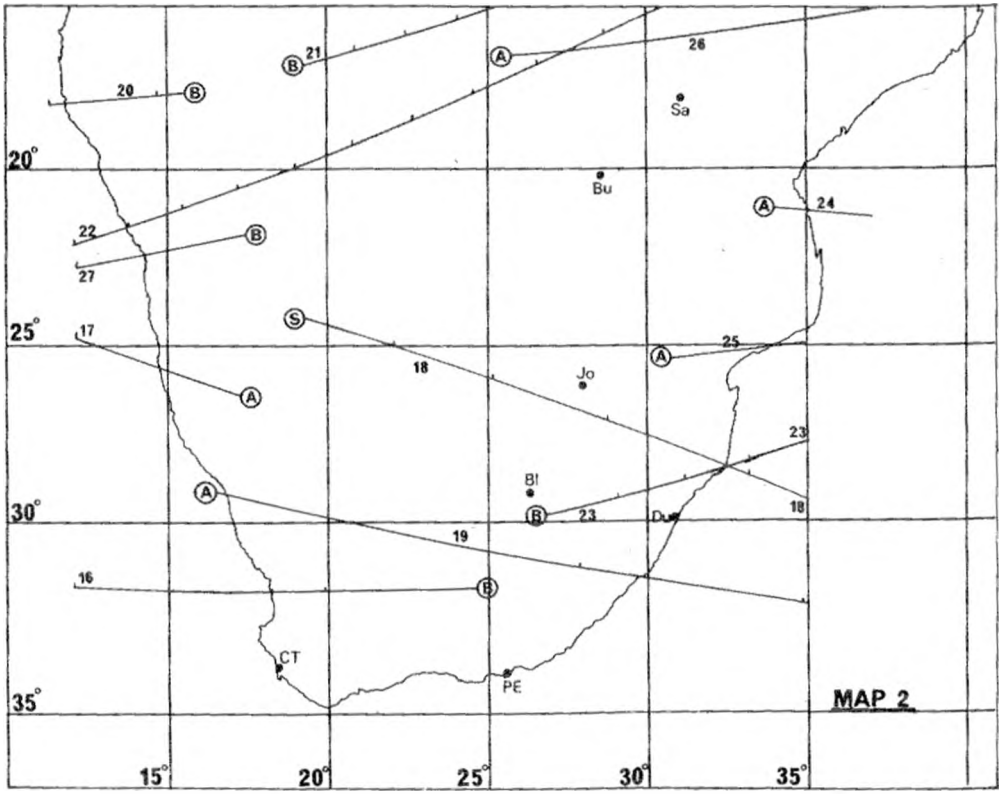
JANUARY TO MARCH



No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit
1*	3344	6.8	JANUARY	19	30	18	N	8	136	6.3	FEBRUARY	18	29	21	S
2*	1855	7.1	JANUARY	22	9	77	S	9*	658	4.2	FEBRUARY	22	6	60	N
3	1996	6.9	JANUARY	2	55	59	S	10	1962	5.2	FEBRUARY	2	1	82	S
4	1997	6.8	JANUARY	2	38	59	S	11	2208	7.4	FEBRUARY	23	57	63	S
5	2110	6.4	FEBRUARY	1	8	48	S	12	862	7.5	MARCH	18	7	51	N
6	2247	5.6	FEBRUARY	0	46	37	S	13	863	6.7	MARCH	18	27	51	N
7	2737	6.8	FEBRUARY	2	41	8	N	14	2789	7.3	MARCH	22	34	44	S
								15	2808	7.4	APRIL	1	42	43	S

Track No.	Zc	
1	3344	is the mean of the two brightest components of the triple star Aitken 16720. The two components are of magnitude 7.3 and 7.8; separation 2.4 in p.a. 278°. The third component, of magnitude 8.0 is at a wide separation.
2	1855	is the brighter component of the double star Aitken 8707. The companion is of magnitude 8.6; separation 5.7 in p.a. 148°.
9	658	is the brightest component of the triple star Aitken 3206. The brighter companion is of magnitude 7.5; separation 1.5 in p.a. 342°. The second companion is of magnitude 8.7 at a wide separation.

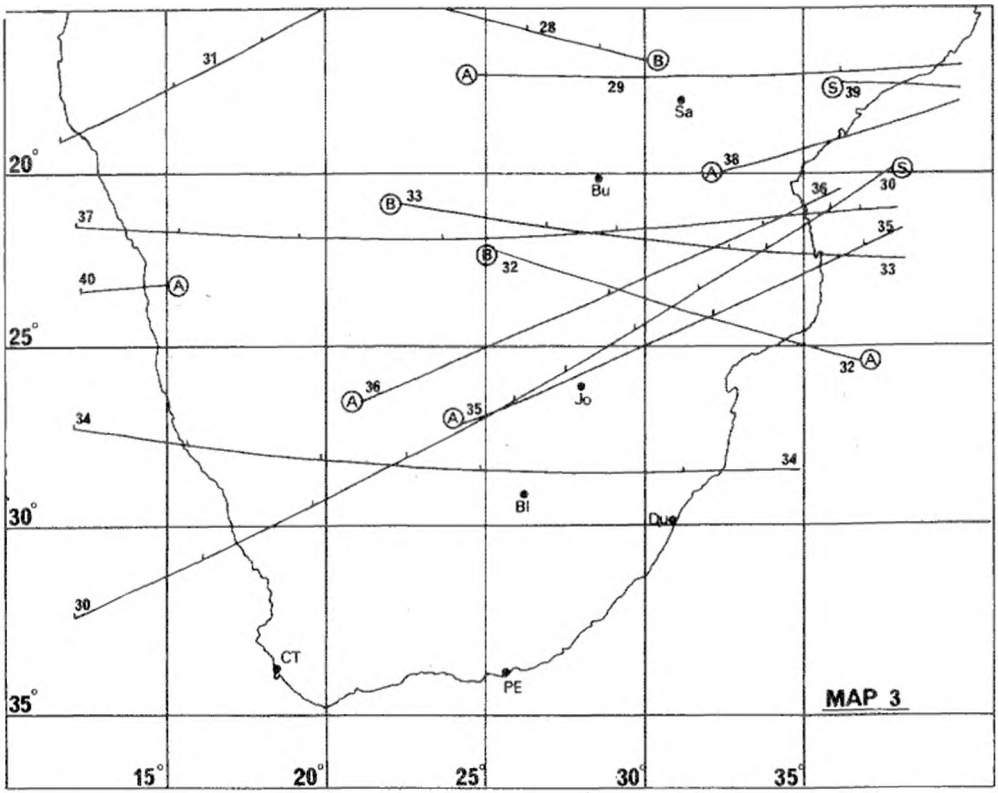
APRIL TO JUNE



No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit
16	3247	7.0	APRIL	4	3 42	12	S	22	2880	5.1	MAY	26	3 7	81	N
17*	684	6.2	APRIL	11	18 35	18	N	23	3163	7.3	MAY	28	1 30	61	N
18	800	7.5	APRIL	12	16 55	25	N	24	3294	6.9	MAY	28	22 17	51	S
19	3051	7.0	APRIL	29	23 32	47	S	25	24	6.9	MAY	31	0 24	29	S
20	3070	6.6	APRIL	30	3 9	45	S	26	26	7.0	MAY	31	0 42	29	S
21*	2876	5.4	MAY	26	2 16	82	N	27	35	6.4	MAY	31	2 22	28	S

Track No.	Zc	
17	684	is the mean of the double star Aitken 3297. The components are of magnitude 7.0 and 7.1; separation 3.0 in p.a. 278°.
21, 42	2876	is the brightest component of the triple star Aitken 12767. The companions are of magnitudes 8.9 and 11.9 and at wide separations.

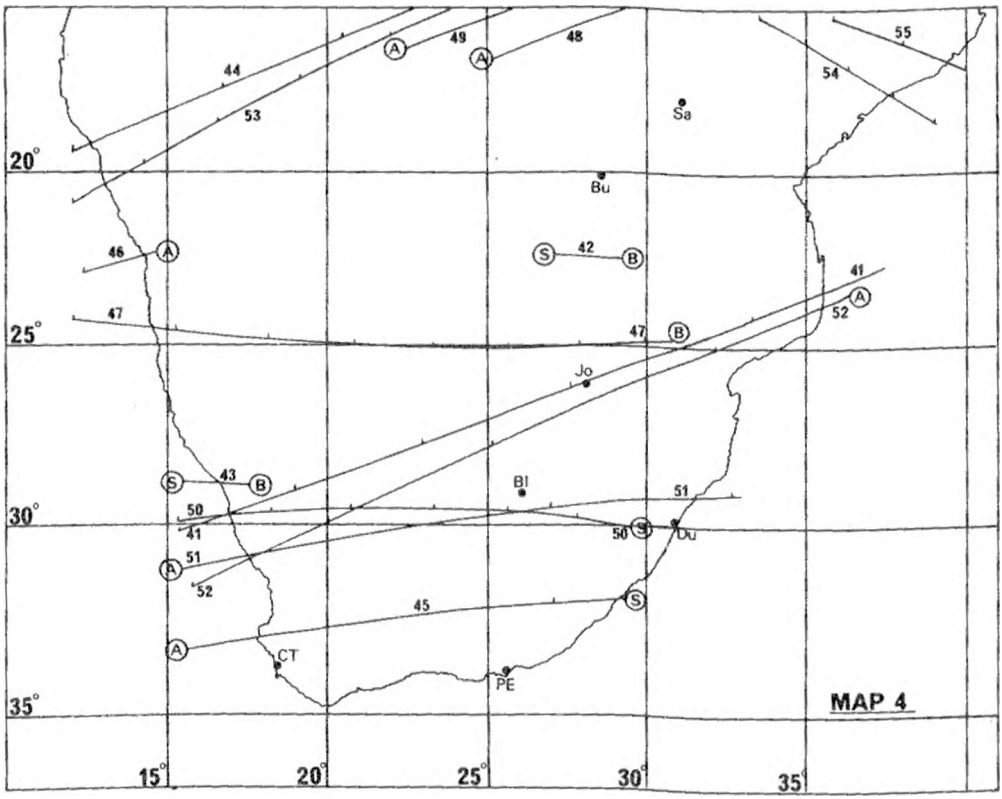
JUNE TO SEPTEMBER



No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit
28	1874	7.5	JUNE	15	20 14	69	N	35	862	7.5	JULY	31	3 1	13	N
29	3385	6.6	JUNE	25	21 45	66	S	36	863	6.7	JULY	31	3 12	13	N
30	257	4.5	JUNE	29	3 2	32	N	37	2033	4.3	AUGUST	10	19 3	37	S
31	384	5.7	JUNE	30	3 51	23	N	38	494	5.2	AUGUST	25	21 6	67	N
32	1409	5.1	JULY	8	17 6	9	S	39	1874	7.5	SEPTEMBER	5	15 51	8	S
33*	1830	6.8	JULY	12	19 21	42	S	40*	1891	4.4	SEPTEMBER	5	18 55	6	S
34*	1951	7.1	JULY	13	20 15	53	S								

Track No.	Zc	
33	1830	is the brighter component of the double star Aitken 8657. The companion is of magnitude 8.3; separation 15"9 in p.a. 349°.
34	1951	is the mean of the two brightest components of the triple star Aitken 8372. The two components are each of magnitude 7.9, separation 2"8 in p.a. 41°. The third component is of magnitude 11.0; separation from the mean of the brightest components is 14"1 in p.a. 328°.
40	1891	is the brightest component of the triple star Aitken 8801. The brighter companion is of magnitude 9.4 separation 7"1 in p.a. 343°. The second companion is of magnitude 10.4 at a wide separation.

SEPTEMBER TO DECEMBER



No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit	No	ZC	Mag.	Date	Beginning UT HR	MIN	Sunlit %	Limit
41*	2555	7.5	SEPTEMBER 10	20	51	56	S	49	985	6.9	OCTOBER 21	22	3	70	N
42*	2876	5.4	SEPTEMBER 12	16	14	77	N	50	1238	6.1	OCTOBER 24	2	21	51	N
43	2880	5.1	SEPTEMBER 12	16	59	77	N	51	1442	5.0	OCTOBER 26	1	21	32	N
44	904	7.1	SEPTEMBER 24	1	0	53	N	52	2806	7.4	NOVEMBER 5	19	18	27	S
45	1486	4.6	SEPTEMBER 29	3	27	10	N	53	3208	6.5	DECEMBER 5	18	47	35	S
46*	2223	4.0	OCTOBER 5	19	35	12	S	54	1678	5.8	DECEMBER 22	1	43	57	S
47*	2969	3.2	OCTOBER 10	14	40	63	N	55*	1772	4.0	DECEMBER 23	0	30	47	S
48	932	4.7	OCTOBER 20	20	40	79	N								

* THE TICKS ARE AT 5 MINUTE INTERVALS.

Track No.	Zc	
41	2555	is the mean of the double star Aitken 10788. The components are of magnitude 7.5 and 11.6; separation 0".9 in p.a. 327°.
46	2223	is the brighter component, itself a close double, of the double star Aitken 9704. The close companion is of magnitude 4.2; separation 0".1 in p.a. 285°. The companion listed by Aitken is magnitude 11.2 at a wide separation.
47	2969	is a spectroscopic binary.
55	1772	is a spectroscopic binary.

TIME SYSTEMS AND TELESCOPE SETTINGS

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 SUO

Radio signals of mean solar time are generated by the Precise Physical Measurements Division of the National Physical Research Laboratory in Pretoria. They are broadcast by the Post Office, the 2.5 and 5 MHz signals from Olifantsfontein, and the 100 MHz signals from Johannesburg.

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 UTI 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 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	$12^h03^m30^s$	May	11	$11^h56^m19^s$	Sep	18	$11^h54^m14^s$
	11	12 07 54		21	11 56 29		28	11 50 45
	21	12 11 18		31	11 57 32	Oct	8	11 47 39
	31	12 13 27	Jun	10	11 59 17		18	11 45 14
Feb	10	12 14 16		20	12 01 24		28	11 43 51
	20	12 13 48		30	12 03 30	Nov	7	11 43 43
Mar	2	12 12 13	Jul	10	12 05 15		17	11 44 56
	12	12 09 51		20	12 06 16		27	11 47 34
	22	12 06 59		30	12 06 22	Dec	7	11 51 23
Apr	1	12 03 57	Aug	9	12 05 30		17	11 56 00
	11	12 01 07		19	12 03 39		27	12 00 58
	21	11 58 44		29	12 00 59		31	12 02 55
May	1	11 57 04	Sep	8	11 57 46			

SIDEREAL TIME ON THE 30° MERIDIAN

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

		At 0 hrs SAST	At 21 hrs SAST			At 0 hrs SAST	At 21 hrs SAST			At 0 hrs SAST	At 21 hrs SAST
Jan	1	6^h41^m	3^h44^m	May	11	15^h13^m	12^h17^m	Sep	18	23^h46^m	20^h49^m
	11	7 20	4 23		21	15 53	12 56		28	2 25	21 29
	21	8 00	5 03		31	16 32	13 36	Oct	8	1 05	22 08
	31	8 39	5 43	Jun	10	17 12	14 15		18	1 44	22 48
Feb	10	9 19	6 22		20	17 51	14 55		28	2 24	23 27
	20	9 58	7 01		30	18 31	15 34	Nov	7	3 03	0 06
Mar	2	10 37	7 41	Jul	10	19 10	16 13		17	3 42	0 46
	12	11 17	8 20		20	19 50	16 53		27	4 22	1 25
	22	11 56	9 00		30	20 29	17 32	Dec	7	5 01	2 05
Apr	1	12 36	9 39	Aug	9	21 09	18 12		17	5 41	2 44
	11	13 15	10 19		19	21 48	18 51		27	6 20	3 24
	21	13 55	10 58		29	22 27	19 31		31	6 36	3 39
May	1	14 34	11 37	Sep	8	23 07	20 10				

CORRECTION FOR PLACES NOT ON THE 30° MERIDIAN

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

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

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

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

TELESCOPE SETTING

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

A LIST OF BRIGHT STARS FOR CHECKING TELESCOPE CIRCLES

Star	R.A.	Dec.	Mag.	Sp.	Star	R.A.	Dec.	Mag.	Sp.
Achernar	$1^h36^m,8$	$-57^\circ21'$	0,6	B5	Procyon	$7^h38^m,1$	$+5^\circ\ 17'$	0,5	F5
Aldebaran	4 34 ,6	+16 28	1,1	K5	Regulus	10 07 ,1	+12 05	1,3	B8
Rigel	5 13 ,4	- 8 14	0,3	B8	Spica	13 24 ,0	-11 02	1,2	B2
Betelgeuse	5 53 ,9	+ 7 24	0,4	M0	Arcturus	14 14 ,6	+19 18	-0,2	K0
Canopus	6 23 ,4	-52 41	-0,9	F0	Antares	16 28 ,0	-26 23	1,2	M1
Sirius	6 44 ,1	-16 41	-1,6	A0	Altair	19 49 ,7	+8 48	0,9	A5

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JULIAN DATE AT 1400 HOURS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	2443	2443	2443	2443	2443	2443	2443	2443	2443	2443	2443	2443
1	510	541	569	600	630	661	691	722	753	783	814	844
2	511	542	570	601	631	662	692	723	754	784	815	845
3	512	543	571	602	632	663	693	724	755	785	816	846
4	513	544	572	603	633	664	694	725	756	786	817	847
5	514	545	573	604	634	665	695	726	757	787	818	848
6	515	546	574	605	635	666	696	727	758	788	819	849
7	516	547	575	606	636	667	697	728	759	789	820	850
8	517	548	576	607	637	668	698	729	760	790	821	851
9	518	549	577	608	638	669	699	730	761	791	822	852
10	519	550	578	609	639	670	700	731	762	792	823	853
11	520	551	579	610	640	671	701	732	763	793	824	854
12	521	552	580	611	641	672	702	733	764	794	825	855
13	522	553	581	612	642	673	703	734	765	795	826	856
14	523	554	582	613	643	674	704	735	766	796	827	857
15	524	555	583	614	644	675	705	736	767	797	828	858
16	525	556	584	615	645	676	706	737	768	798	829	859
17	526	557	585	616	646	677	707	738	769	799	830	860
18	527	558	586	617	647	678	708	739	770	800	831	861
19	528	559	587	618	648	679	709	740	771	801	832	862
20	529	560	588	619	649	680	710	741	772	802	833	863
21	530	561	589	620	650	681	711	742	773	803	834	864
22	531	562	590	621	651	682	712	743	774	804	835	865
23	532	563	591	622	652	683	713	744	775	805	836	866
24	533	564	592	623	653	684	714	745	776	806	837	867
25	534	565	593	624	654	685	715	746	777	807	838	868
26	535	566	594	625	655	686	716	747	778	808	839	869
27	536	567	595	626	656	687	717	748	779	809	840	870
28	537	568	596	627	657	688	718	749	780	810	841	871
29	538		597	628	658	689	719	750	781	811	842	872
30	539		598	629	659	690	720	751	782	812	843	873
31	540		599		660		721	752		813		874

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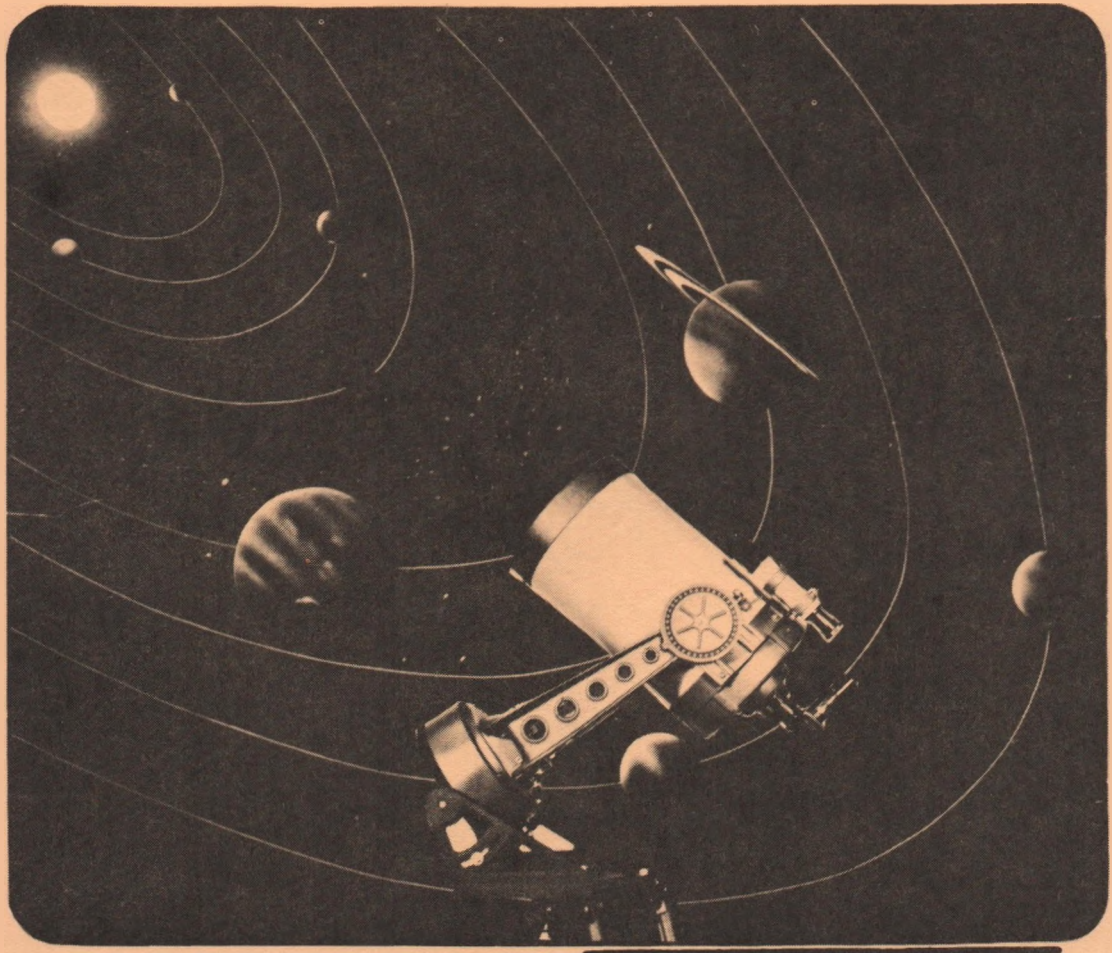

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