ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1989

published by the Astronomical Society of Southern Africa

ISSN 0571—7191

MINOR PLANET OCCULTATIONS

A number of A.S.S.A. members and professional observatories form part of a worldwide network which observes the above events. The observations are very useful to astronomers who study the Solar System.

Often an amateur is located on or near an occultation path, and the observation which he or she can make may be of considerable value. The equipment requirements are modest. A 60mm telescope and means to record the time of multiple events will suffice in some instances. The timing equipment comprises a tape recorder tuned to ZUO, WWV or an ordinary FM station as advised by one of the regional co-ordinators listed below. If a continuous time signal cannot be received reliably, than an assistant can read off time intervals of, say, ten seconds from a quartz watch synchronised with the SABC "six pips" time signal. The commentary of the observer and timekeeper is thus recorded for later analysis.

A list of possible events during 1989 is given below. From time to time instructions will be sent to observers wishing to participate in the programme. These will assist observers to locate and identify the occulted stars.

If you are in touch with one of the A.S.S.A. Centres and would like to participate, then you are invited to contact one of the conveners listed below. If you do not live near a Centre, then please contact M.D. Overbeek, P O Box 212, Edenvale, 1610. Further updated information may also be obtained from him at 011 535447.

CAPE TOWN	P van Blommestein, 4 Belmont Road, Simons Town, 7995.
PIETERMARITZBURG	Mr C S Lake, Budleigh Road, Winterskloof, 3240.
WITWATERSRAND	M D Overbeek, P O Box 212, Edenvale, 1610.
HARARE	J Vincent, 2 Dungarvan Flats, Willson Ave., Borrowdale, Harare.
DURBAN	R K Field, 303 Wakesleigh Road, Bellair, 4094.
PRETORIA	Dr J Smit, Dickinsonrylaan 1183, Waverley, 0186.

OCCULTATIONS BY MINOR PLANETS

DATE	UT	MINOR PLANET	Pmag	DIAM	CAT STAR	Smag	DROP	DUR
Feb 6	02 24	3 Juno	8.7	267	AGK3 +02° 1370	9.0	0.6	23.5
Feb 15	00 25	338 Budrosa	12.7	52	AGK3 +20° 1383	8.6	4.1	4.2
Feb 19	01 00	1143 Odysseus	15.2	77	AGK3 +13° 0909	8.9	6.3	5.2
Feb 25	18 00	18 Melpomene	10.7	164	AGK3 +04° 0240	8.8	2.1	4.2
Feb 25	19 19	69 Hesperia	11.8	108	AGK3 +12° 0528	9.9	2.1	8.3
Mar 11	23 33	530 Turandot	15.3	86	AGK3 +20° 0971	10.1	5.2	11.8
Mar 13	13 28	144 Vibilia	12.7	132	AGK3 +09° 0179	8.5	4.2	2.9
Mar 15	19 27	690 Wratislavia	13.4	175	AGK3 +15° 0592	8.6	4.8	15.3
Mar 17	01 28	790 Pretoria	13.7	178	SAO 185039	10.0	3.7	13.6
Apr 10	19 48	415 Palatia	13.8	87	AGK3 +22° 0981	8.9	4.9	6.1
May 9	00 46	273 Atropos	14.4	52	AGK3 +02° 2689	8.3	6.1	2.8
May 24	18 39	412 Elisabetha	13.1	51	AGK3 +01° 1702	9.2	3.9	4.9
May 29	02 27	171 Ophelia	13.1	80	SAO 139358	7.0	6.1	25.9
Jun 6	19 02	313 Chaldaea	12.7	108	SAO 141914	7.8	4.9	9.2
Jun 16	01 59	346 Hermentaria	11.4	102	SAO 187080	5.8	5.6	8.8
Jun 29	20 41	87 Sylvia	13.1	251	AGK3 -00° 1824	8.3	4.8	24.8
Jun 30	16 57	601 Nerthus	14.1	71	AGK3 +00° 2098	9.0	5.1	6.5
Jul 9	17 18	675 Ludmilla	13.9	81	SAO 157428	8.9	5.1	4.8
Jul 23	02 00	693 Zerbinetta	13.3	81	SAO 211938	10.0	3.3	6.8
Aug 15	00 04	409 Aspasia	11.1	194	AGK3 +00° 2576	8.8	2.4	18.9
Aug 20	20 25	386 Siegena	12.9	203	AGK3 +00° 1998	10.0	3.0	14.5
Sep 2	00 27	24 Themis	12.4	249	AGK3 +03° 0076	7.3	5.1	23.9
Sep 5	20 40	79 Eurynome	10.2	80	AGK3 +01° 2821	9.4	1.2	10.1
Sep 19	21 31	893 Leopoldina	14.2	78	SAO 130468	8.0	6.2	9.2
Sep 23	00 37	246 Asporina	13.8	70	AGK3 +04° 0492	9.1	4.7	7.1
Oct 16	17 54	359 Georgia	13.6	93	SAO 189062	9.6	4.1	5.8
Nov 8	21 12	16 Psyche	11.0	249	SAO 164047	8.8	2.4	12.6
Dec 1	00 05	498 Tokio	14.1	72	AGK3 +21° 0987	9.6	4.5	18.8
Dec 2	03 16	118 Peitho	13.5	52	AGK3 +10° 1463	8.9	4.6	2.2
Dec 13	20 03	369 Aeria	12.2	120	AGK3 +08° 0362	8.5	3.8	12.9
Dec 23	22 22	584 Semiramis	11.6	57	AGK3 +22° 0871	9.8	2.0	5.1

ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA **1989**

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.

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NOTE

All times are SAST unless otherwise stated.

This handbook is produced for the Astronomical Society of Southern Africa. The data it contains has been adapted for Southern Africa from data obtained from Royal Greenwich Observatory, Herstmonceux, from the International Lunar Occultation Centre, Tokyo, the British Astronomical Association and the Hydrographer of the South African Navy.

All correspondence concerning this booklet should be addressed to the Handbook Editor, Astronomical Society of Southern Africa, 8 Glebe Road, Rondebosch, 7700 from whom further copies are available at R4.00 per copy.

Although every care has been taken in the compilation of the Handbook, it is sold and distributed on the explicit understanding that neither the Society or its members accepts any responsibility for errors therein.

Dit spyt ons dat as gevolg van beperkte fondse en produksie fasiliteite dit nie moontlik is om die 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

The South African Astronomical Observatory (SAAO) was established in 1972, as a joint venture between the Council for Scientific and Industrial Research (CSIR) of SA and the Science Research Council of the UK, combining the facilities of the former Royal and Republic Observatories, and is directed by Prof M W Feast. On the closure of the Radcliffe Observatory in 1974, the CSIR acquired the 1.9-m telescope, and moved it to Sutherland in the Karoo, where there are also 1.0-m, 0.75-m and 0.5-m telescopes. The headquarters are in Cape Town, where also a limited amount of observing continues. Research is undertaken in many areas, with considerable effort being put into the study of variable stars, the Galactic Centre, the Magellanic Clouds and sources detected by satellites. These studies involve the use of spectroscopic, photometric and infrared techniques. Besides providing research facilities for its own staff, SAAO observing time is allocated to astronomers from South African universities and elsewhere in the world.

The 0.67-m visual refractor at the former Republic Observatory, Johannesburg is maintained by the CSIR. The 0.25-m Franklin-Adams Camera at the Broederstroom Observatory, Hartbeespoort is maintained by the Dept of National Education.

Boyden Observatory, situated at Mazelspoort, 25 km from Bloemfontein, is owned by the Institute and Dept of Astronomy of the University of the Orange Free State, and directed by Prof A H Jarrett. Observing facilities include a 1.52-m and two 0.41-m telescopes, as well as the 0.25-m Metcalf camera, a 0.33-m refractor and a 0.20-m solar installation. The main research areas include flare stars, short period variable stars, and atomic emissions from nebulae, the Sun and interplanetary space.

The Hartebeesthoek Radio Astronomy Observatory, 30 km NW of Krugersdorp, is a national facility managed by the Foundation for Research development. The Director is Dr G D Nicolson. The 26 m telescope operates at 18, 13, 6, 3.6 and 2.5 cm wavelengths and is used for observations of interstellar and circumstellar molecules, pulsars, x-ray sources as well as quasars and active galaxies. The observatory provides research facilities for astronomers in South African universities as well as its own staff and frequently collaborates in global networks of telescopes using the technique of very long baseline interferometry.

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

Observatories Open to the Public

SAAO headquarters in Observatory are open to visitors on the second saturday of each month at 20h00. It is not necessary to make a booking, unless there are more than ten persons in a party. Day visits are possible to the SAAO observing site near Sutherland, and enquiries should be made to Sutherland prior to the intended visit.

Visiting nights at Boyden Observatory are generally held around the time of first quarter, and numbers are restricted to 20 persons on each occasion. Enquiries should be made to the Observatory.

Planetaria

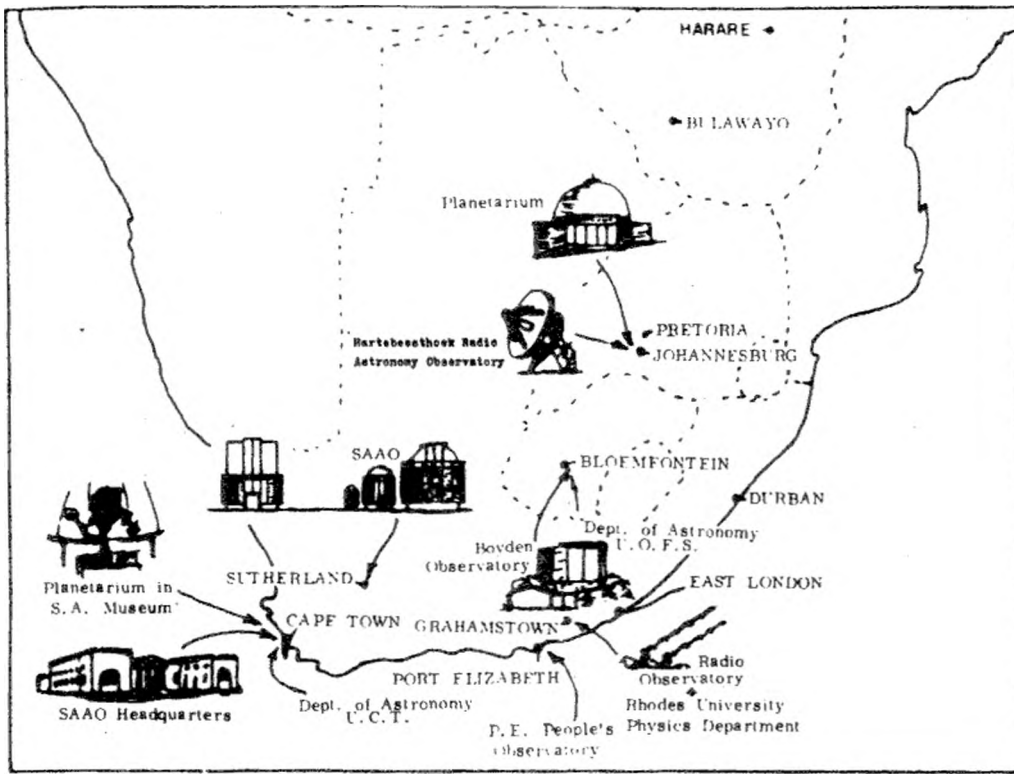
A planetarium is located within the South African Museum in Cape Town. This new planetarium, containing a Minolta Series 4 projector and seating 120, represents one of the most advanced of its kind in the world today.

A planetarium is situated in the grounds of the University of the Witwatersrand in Johannesburg (entrance in Yale Road, alongside M1). It is equipped with a Zeiss projector and seats over 400 persons.

Regular shows are given at both of these planetaria, from whom details may be obtained.

Universities

Several universities undertake research in astronomy and offer teaching courses. The chair of astronomy at UCT is occupied by Brian Warner, whose department use the SAAO observing facilities at Sutherland. Prof G F R Ellis of the Dept of Applied Mathematics, UCT heads a group carrying out research in theoretical cosmology. The University of OFS has an Institute (created in 1981) and a Dept of Astronomy. Both are incorporated with the Boyden Observatory, and headed by Prof A H Jarrett. The Dept of Physics and Electronics at Rhodes University, under Prof E E Baart, specialises in radio astronomy, and has its own observatory outside Grahamstown. The Dept of Mathematics, Applied Mathematics and Astronomy at UNISA offers a number of courses in astronomy and astrophysics. Prof W F Wargau is the head of Astronomy at UNISA.



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 the popular monthly magazine 'Sky and Telescope' published in the USA, which provides information on professional and amateur activities, together with news of space research and other related subjects. The Society's annual subscription is R60.00 and there is an entrance fee of R10.00. A prospectus and application form may be obtained from the Honorary Secretary, Astronomical Society of S A, c/o S A 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, Durban, Johannesburg, Bloemfontein, Pietermaritzburg, Pretoria and Harare. Visitors are very welcome at meetings and may, if they wish, join a Centre without becoming a full member of the Society. Centre members do not receive society publications, nor "Sky and Telescope".

CAPE CENTRE (Cape Town): Formal meetings are held on the second Wednesday of the month (except in January and December) when professional and prominent local amateur astronomers present lectures on the latest topics in Astronomy. Informal meetings are held on most other Wednesdays except during January and December. At these informal meetings discussion groups and observing sessions are held. Two or three out-of-town weekend observing sessions are held annually in areas where dark skies are available. The Centre publishes a quarterly journal, the "Cape Observer" which gives information on meetings, current activities and objects to observe. Further information may be obtained from the secretary Mrs R Scoble, 1 Lanyon Road, Rondebosch, 7700, telephone (021) 6853666. Meetings are held at the S A A O, Observatory Road, Observatory at 20h00.

TRANSVAAL CENTRE (Johannesburg): General meetings are held on the second Wednesday of each month, excluding December, in the Sir Herbert Baker building in the grounds of the former Republic Observatory, 18A Gill Street, Observatory, Johannesburg at 20h00. The meetings consist of lectures, films or observing evenings. There are two small observatories on the site. One contains the Jacobs telescope, a 30cm F8 Newtonian and in the Papadopoulos Dome is housed a combined instrument comprising a 18cm F16 refractor, a 15cm refractor and a 30cm F16 Cassegrain reflector. Informal observing evenings are held every Friday night. The Centre publishes a monthly newsletter "Canopus", which carries information on meetings and the Centre's activities. Secretarial address: P O Box 93145, Yeoville 2143, telephone (011) 9461998

NATAL CENTRE (Durban): Regular monthly meetings are held at 19h45 on the second Wednesday of each month at Marist Brothers School, South Ridge Road, Durban. The Centre publishes a monthly magazine "Ndaba" which contains news and views and current information on astronomical and related topics. Secretarial address P O Box 5330, Durban, 4000, telephone 031-(W) 842321 (H) 255979/823316/844751.

NATAL MIDLANDS CENTRE (Pietermaritzburg): Regular monthly meetings on the second Wednesday of each month (except January) at the PMB Music College, Havelock Road at 19h45. Information meetings and membership is available from the secretary Mr J Watson, P O Box 2106, Pietermaritzburg, 3200 or by phoning 0331-33710 or 33646.

BLOEMFONTEIN CENTRE: Meetings are held every fourth Friday of the month. For information contact Miss L E Stone, 17 La Quellerie, Pres. Paul Kruger Avenue, Bloemfontein 9301.

PRETORIA CENTRE: Meetings are held on the fourth Wednesday of each month (except December) at 19h00 at the Christian Brothers' College, Silverton Road, where the Centre's observatory containing a 30cm reflecting telescope is situated. For further information contact the secretary Mr N Young at 201 Kritzinger St., Meyers Park, Pretoria, 0184 telephone 012-833765.

HARARE CENTRE: The Centre holds a meeting on the last Wednesday of each month (except December). These are usually held at 17h30 at the Queen Victoria Museum and consist of lectures, films or general discussions. Informal observing sessions are also held at the homes of members. Secretarial address P O Box UA 428, Union Avenue, Harare, Zimbabwe.

OBSERVING SECTIONS OF THE SOCIETY:

These sections exist to co-ordinate 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.

Computing Section	see page 16
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Minor Planet Occultations	see inside front cover.

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h		
Jan.	2	00	Earth at perihelion	
	4	05	Juno stationary	
	5	03	Antares 0°.5 N. of Moon	Occn.
	6	06	Venus 5° N. of Moon	
	7	21	NEW MOON	
	9	04	Mercury greatest elong.E.(19°)	
	9	07	Mercury 1°.7 N. of Moon	
	11	01	Moon at perigee	
	12	19	Venus 0°.5 N. of Uranus	
	14	16	FIRST QUARTER	
	15	00	Mars 4° S. of Moon	
	15	17	Mercury stationary	
	16	18	Venus 0°.6 S. of Saturn	
	17	02	Jupiter 6° S. of Moon	
	19	06	Venus 0°.9 S. of Neptune	
	20	16	Jupiter stationary	
	22	00	FULL MOON	
	24	06	Regulus 0°.03 S. of Moon	Occn.
	25	02	Mercury in inferior conjunction	
	27	02	Moon at apogee	
	30	04	LAST QUARTER	
Feb.	1	05	Mercury 4° N. of Venus	
	1	13	Antares 0°.7 N. of Moon	Occn.
	3	08	Uranus 4° N. of Moon	
	3	17	Saturn 5° N. of Moon	
	3	20	Neptune 5° N. of Moon	
	4	20	Mercury 6° N. of Moon	
	5	16	Mercury stationary	
	6	10	NEW MOON	
	8	00	Moon at perigee	
	12	09	Mars 4° S. of Moon	
	13	01	FIRST QUARTER	
	13	09	Jupiter 6° S. of Moon	
	18	18	Mercury greatest elong.W.(26°)	
	20	13	Regulus 0°.02 S. of Moon	Occn.
	20	14	Pluto stationary	
	20	18	FULL MOON	Eclipse
	21	04	Juno at opposition	
	23	16	Moon at apogee	
	26	00	Pallas in conjunction with Sun	
	28	21	Antares 0°.7 N. of Moon	Occn.
	28	22	LAST QUARTER	
Mar.	2	19	Uranus 4° N. of Moon	
	3	04	Saturn 0°.2 S. of Neptune	
	3	08	Neptune 5° N. of Moon	
	3	08	Saturn 5° N. of Moon	
	6	06	Mercury 0°.8 S. of Moon	Occn.
	7	20	NEW MOON	Eclipse
	8	10	Moon at perigee	
	12	10	Mars 2° N. of Jupiter	
	12	21	Jupiter 6° S. of Moon	
	12	21	Mars 4° S. of Moon	
	14	12	FIRST QUARTER	
	19	19	Regulus 0°.01 S. of Moon	Occn.
	20	17	Equinox	
	22	12	FULL MOON	
	22	20	Moon at apogee	
	28	04	Antares 0°.6 N. of Moon	Occn.
	28	20	Mars 7° N. of Aldebaran	
	30	04	Uranus 4° N. of Moon	
	30	12	LAST QUARTER	
	30	16	Neptune 5° N. of Moon	
	30	18	Saturn 5° N. of Moon	
Apr.	4	16	Mercury in superior conjunction	
	5	01	Venus in superior conjunction	
	5	04	Juno stationary	
	5	22	Moon at perigee	
	6	06	NEW MOON	
	9	11	Uranus stationary	
	9	14	Jupiter 6° S. of Moon	
	10	11	Mars 4° S. of Moon	
	13	01	FIRST QUARTER	
	14	00	Neptune stationary	
	16	01	Regulus 0°.1 N. of Moon	Occn.
	18	23	Moon at apogee	
	21	05	FULL MOON	
	23	02	Saturn stationary	
	24	09	Antares 0°.5 N. of Moon	Occn.
	26	10	Uranus 4° N. of Moon	
	26	22	Neptune 5° N. of Moon	
	27	01	Saturn 5° N. of Moon	
	28	08	Ceres in conjunction with Sun	
	28	23	LAST QUARTER	
May	1	05	Mercury greatest elong.E.(21°)	
	4	07	Moon at perigee	
	4	09	Pluto at opposition	
	4	19	Jupiter 5° N. of Aldebaran	
	5	14	NEW MOON	
	7	00	Mercury 3° S. of Moon	
	7	09	Jupiter 5° S. of Moon	
	9	03	Mars 3° S. of Moon	
	12	16	FIRST QUARTER	
	13	01	Mercury stationary	
	13	05	Juno 0°.4 S. of Moon	Occn.
	13	08	Regulus 0°.4 N. of Moon	Occn.
	14	19	Vesta stationary	
	16	09	Mercury 0°.6 N. of Venus	
	16	11	Moon at apogee	
	19	21	Venus 6° N. of Aldebaran	
	20	20	FULL MOON	
	21	15	Antares 0°.4 N. of Moon	Occn.
	23	06	Venus 0°.8 N. of Jupiter	
	23	14	Uranus 4° N. of Moon	
	24	00	Mercury in inferior conjunction	
	24	03	Neptune 5° N. of Moon	
	24	06	Saturn 4° N. of Moon	
	28	08	LAST QUARTER	
	30	08	Pallas 0°.7 S. of Moon	Occn.
June	1	07	Moon at perigee	
	3	22	NEW MOON	
	5	03	Venus 3° S. of Moon	
	5	04	Mercury stationary	
	6	20	Mars 1°.6 S. of Moon	
	7	02	Mars 5° S. of Pollux	
	9	11	Jupiter in conjunction with Sun	
	9	16	Regulus 0°.7 N. of Moon	Occn.
	11	09	FIRST QUARTER	
	13	04	Moon at apogee	
	17	23	Antares 0°.4 N. of Moon	Occn.
	18	14	Mercury greatest elong.W.(23°)	
	19	09	FULL MOON	
	19	19	Uranus 4° N. of Moon	
	20	09	Neptune 5° N. of Moon	
	20	09	Saturn 4° N. of Moon	
	21	12	Solstice	
	23	15	Mercury 3° N. of Aldebaran	
	24	11	Venus 5° S. of Pollux	
	24	18	Saturn 0°.3 S. of Neptune	
	25	00	Uranus at opposition	
	26	06	Vesta at opposition	
	26	11	LAST QUARTER	
	28	06	Moon at perigee	
July	1	23	Mercury 6° S. of Moon	
	2	01	Jupiter 5° S. of Moon	
	2	15	Saturn at opposition	
	2	19	Mercury 0°.6 S. of Jupiter	
	3	01	Neptune at opposition	

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h		
July	3	07	NEW MOON	
	4	14	Earth at aphelion	
	5	06	Venus 0°.1 S. of Moon	Occn.
	5	14	Mars 0°.09 S. of Moon	
	7	01	Regulus 0°.9 N. of Moon	Occn.
	10	23	Moon at apogee	
	11	02	FIRST QUARTER	
	12	14	Venus 0°.5 N. of Mars	
	15	07	Antares 0°.5 N. of Moon	Occn.
	17	01	Uranus 4° N. of Moon	
	17	14	Saturn 4° N. of Moon	
	17	16	Neptune 5° N. of Moon	
	18	10	Mercury in superior conjunction	
	18	20	FULL MOON	
	23	09	Moon at perigee	
	23	13	Venus 1°.2 N. of Regulus	
	25	16	LAST QUARTER	
	28	13	Pluto stationary	
	29	18	Jupiter 5° S. of Moon	
Aug.	1	18	NEW MOON	
	2	18	Mars 0°.7 N. of Regulus	
	3	04	Mercury 1°.6 N. of Moon	
	3	09	Regulus 0°.9 N. of Moon	Occn.
	3	10	Mars 1°.6 N. of Moon	
	4	15	Venus 3° N. of Moon	
	4	18	Mercury 0°.8 N. of Regulus	
	6	00	Mercury 0°.01 N. of Mars	
	7	17	Moon at apogee	
	7	21	Vesta stationary	
	9	19	FIRST QUARTER	
	11	16	Antares 0°.6 N. of Moon	Occn.
	13	09	Uranus 4° N. of Moon	
	13	20	Saturn 4° N. of Moon	
	14	00	Neptune 5° N. of Moon	
	17	05	FULL MOON	Eclipse
	18	05	Pallas stationary	
	19	14	Moon at perigee	
	23	21	LAST QUARTER	
	26	09	Jupiter 4° S. of Moon	
	29	12	Mercury greatest elong.E.(27°)	
	31	08	NEW MOON	Eclipse
Sept.	2	18	Mercury 0°.6 N. of Moon	Occn.
	3	23	Venus 5° N. of Moon	
	4	10	Moon at apogee	
	6	15	Venus 1°.9 N. of Spica	
	8	00	Antares 0°.6 N. of Moon	Occn.
	8	12	FIRST QUARTER	
	9	18	Uranus 4° N. of Moon	
	10	03	Uranus stationary	
	10	04	Saturn 4° N. of Moon	
	10	09	Neptune 5° N. of Moon	
	11	07	Saturn stationary	
	11	16	Mercury stationary	
	15	14	FULL MOON	
	16	17	Moon at perigee	
	21	07	Neptune Stationary	
	22	04	LAST QUARTER	
	22	21	Jupiter 4° S. of Moon	
	23	03	Equinox	
	25	00	Mercury in inferior conjunction	
	26	23	Regulus 1°.0 N. of Moon	Occn.
	29	21	Mars in conjunction with Sun	
	30	00	NEW MOON	
	30	15	Pallas at opposition	
Oct.	1	22	Moon at apogee	
	3	08	Mercury stationary	
	4	03	Venus 3° N. of Moon	
	5	07	Antares 0°.4 N. of Moon	Occn.
Oct.	7	02	Uranus 4° N. of Moon	
	7	13	Saturn 4° N. of Moon	
	7	17	Neptune 5° N. of Moon	
	7	18	Vesta 0°.5 N. of Moon	Occn.
	8	03	FIRST QUARTER	
	9	15	Juno in conjunction with Sun	
	10	14	Mercury greatest elong.W.(18°)	
	14	23	FULL MOON	
	15	03	Moon at perigee	
	17	03	Venus 1°.8 N. of Antares	
	20	07	Jupiter 4° S. of Moon	
	21	15	LAST QUARTER	
	24	04	Regulus 1°.1 N. of Moon	Occn.
	26	01	Mercury 4° N. of Spica	
	29	00	Moon at apogee	
	29	03	Jupiter stationary	
	29	17	NEW MOON	
Nov.	1	13	Antares 0°.2 N. of Moon	Occn.
	3	00	Venus 0°.7 N. of Moon	Occn.
	3	02	Ceres stationary	
	3	10	Uranus 4° N. of Moon	
	3	23	Saturn 4° N. of Moon	
	4	00	Neptune 4° N. of Moon	
	4	22	Vesta 1°.0 S. of Moon	Occn.
	6	16	FIRST QUARTER	
	7	15	Pluto in conjunction with Sun	
	8	04	Venus 3° S. of Uranus	
	8	19	Venus greatest elong.E.(47°)	
	10	21	Mercury in superior conjunction	
	12	15	Moon at perigee	
	12	23	Saturn 0°.5 S. of Neptune	
	13	08	FULL MOON	
	15	17	Venus 4° S. of Neptune	
	15	21	Venus 4° S. of Saturn	
	16	16	Jupiter 3° S. of Moon	
	20	07	LAST QUARTER	
	24	01	Pallas stationary	
	25	06	Moon at apogee	
	26	21	Mars 6° N. of Moon	
	28	12	NEW MOON	
	30	18	Uranus 3° N. of Moon	
Dec.	1	07	Neptune 4° N. of Moon	
	1	09	Saturn 3° N. of Moon	
	2	10	Venus 0°.8 S. of Moon	Occn.
	6	03	FIRST QUARTER	
	10	15	Mercury 2° S. of Uranus	
	11	01	Moon at perigee	
	12	18	FULL MOON	
	13	22	Jupiter 3° S. of Moon	
	14	11	Venus greatest brilliancy	
	15	06	Mercury 3° S. of Neptune	
	17	00	Mercury 2° S. of Saturn	
	20	02	LAST QUARTER	
	20	09	Ceres at opposition	
	21	23	Solstice	
	22	21	Moon at apogee	
	23	10	Mercury greatest elong.E.(20°)	
	25	19	Mars 5° N. of Moon	
	26	02	Antares 0°.2 N. of Moon	Occn.
	27	08	Uranus in conjunction with Sun	
	27	16	Jupiter at opposition	
	28	01	Venus stationary	
	28	05	NEW MOON	
	29	17	Mercury 1°.7 N. of Moon	
	30	12	Venus 2° N. of Moon	
	30	18	Mercury stationary	
	31	01	Mars 5° N. of Antares	

THE SUN

TIMES OF SUNRISE AND SUNSET FOR THE MAIN CITIES OF SOUTHERN AFRICA

		CAPE TOWN		DURBAN		BLOEMFONTEIN		JOHANNESBURG		HARARE	
		sunrise	sunset	sunrise	sunset	sunrise	sunset	sunrise	sunset	sunrise	sunset
Jan	1	05h38m	20h01m	04h58m	19h01m	05h21m	19h18m	05h18m	19h04m	05h24m	18h35m
	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 54	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 04	18 29	05 57	18 15
	21	06 49	18 58	05 59	18 06	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 06	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 06	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 06	17 27	06 55	17 24	06 26	17 29
Jul	1	07 53	17 48	06 53	17 07	07 10	17 30	06 57	17 27	06 27	17 32
	11	07 51	17 52	06 51	17 11	07 06	17 34	06 55	17 30	06 27	17 35
	21	07 47	17 58	06 48	17 16	07 05	17 39	06 53	17 35	06 26	17 40
Aug	1	07 39	18 06	06 42	17 22	07 00	17 45	06 48	17 41	06 23	17 42
	11	07 30	18 13	06 34	17 29	06 53	17 51	06 41	17 46	06 18	17 46
	21	07 19	18 20	06 24	17 35	06 42	17 55	06 32	17 50	06 11	17 48
Sep	1	07 06	18 27	06 12	17 40	06 31	18 01	06 21	17 54	06 04	17 49
	11	06 52	18 34	06 00	17 46	06 19	18 06	06 11	17 59	05 55	17 51
	21	06 38	18 41	05 48	17 51	06 07	18 10	05 59	18 03	05 46	17 52
Oct	1	06 25	18 48	05 37	17 57	05 57	18 16	05 50	18 08	05 39	17 54
	11	06 12	18 55	05 25	18 03	05 45	18 22	05 39	18 12	05 30	17 57
	21	05 58	19 04	05 12	18 09	05 33	18 27	05 27	18 17	05 23	17 59
Nov	1	05 46	19 13	05 02	18 17	05 24	18 35	05 19	18 24	05 16	18 03
	11	05 38	19 23	04 55	18 26	05 17	18 44	05 13	18 32	05 14	18 08
	21	05 31	19 33	04 49	18 34	05 12	18 52	05 06	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

ECLIPSES OF THE SUN

A partial eclipse of the Sun on March 7 will not be seen from Southern Africa. That on August 31 begins at 05.34 and ends at 09.28. At maximum eclipse at 07h30 0.63 of the Sun's diameter will be obscured but from Southern Africa it will be seen as only a very small eclipse.

Basic Data

Diameter: 1 392 000 km (1 09 times Earth diameter)

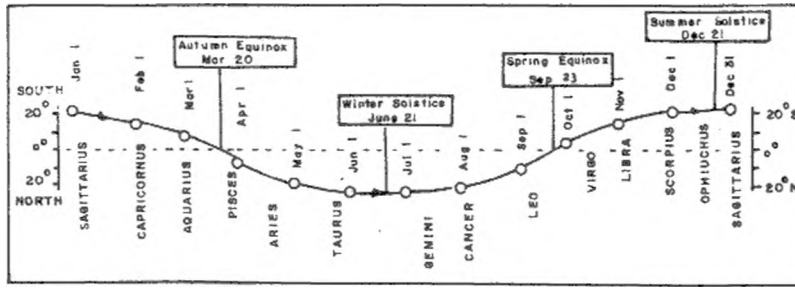
Mass: 1,99 x 10^{30}kg (330 000 times Earth Mass)

Surface Temperature: Approximately 6 000°C

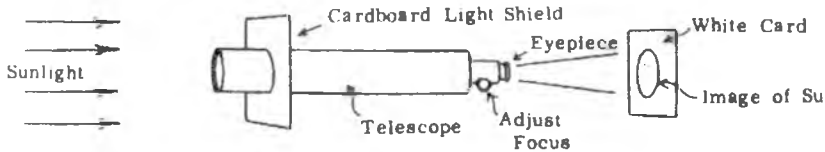
Temperature at centre: Approximately 10 million°C

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 round the Sun is not quite circular. In 1987 we will be closest to the Sun on January 5 (perihelion - approximate distance 147 million km) and furthest from the Sun on July 4 (aphelion - approximately 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 disc 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 disc - if monitored over a period of a week or so, the rotation of the Sun should be apparent.



SUN'S DECLINATION AT 02 HOURS

Jan 1	23 01 S	Apr 1	4 27 N	Jul 10	22 16 N	Oct 8	5 47 S
11	21 51 S	11	8 14 N	20	20 43 N	18	9 32 S
21	19 57 S	21	11 47 N	30	18 34 N	28	13 02 S
31	17 27 S	May 1	15 00 N	Aug 9	15 55 N	Nov 7	16 12 S
Feb10	14 26 S	11	17 49 N	19	12 51 N	17	18 56 S
20	11 00 S	21	20 08 N	29	9 27 N	27	21 05 S
Mar 2	7 18 S	31	21 53 N	Sep 8	5 42 N	Dec 7	22 35 S
12	3 25 S	Jun10	23 00 N	18	1 58 N	17	23 26 S
22	0 32 N	21	23 27 N	28	1 56 S	22	23 27 S
		30	23 11 N			31	23 07 S

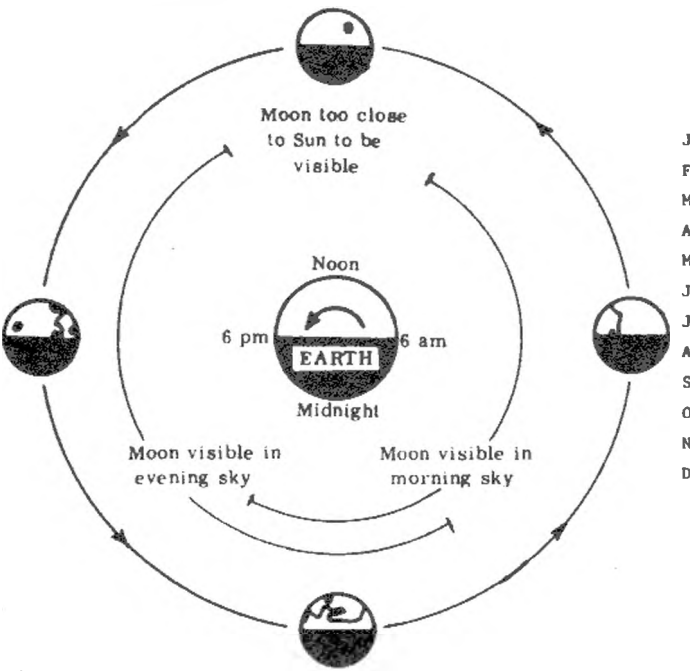
The Moon

PHASES AND VISIBILITY

NEW MOON

	d	h	m		d	h	m		d	h	m
Jan	7	21	22	May	5	13	46	Aug	31	07	44
Feb	6	09	37	Jun	3	21	53	Sep	29	23	47
Mar	7	20	19	Jul	3	06	59	Oct	29	17	27
Apr	6	05	53	Aug	1	18	06	Nov	28	11	41
								Dec	28	05	20

SCHEMATIC DIAGRAM OF MOON'S ORBIT



FIRST QUARTER

	d	h	m
Jan	14	15	58
Feb	13	01	15
Mar	14	12	11
Apr	13	01	13
May	12	16	19
Jun	11	08	59
Jul	11	02	19
Aug	09	19	28
Sep	08	11	49
Oct	08	02	52
Nov	06	16	11
Dec	06	03	26

THIRD QUARTER

	d	h	m
Jan	30	04	02
Feb	28	22	08
Mar	30	12	21
Apr	28	22	46
May	28	06	41
Jun	26	11	09
Jul	25	15	31
Aug	23	20	40
Sep	22	04	10
Oct	21	15	19
Nov	20	06	44
Dec	20	01	54

FULL MOON

	d	h	m		d	h	m		d	h	m
Jan	21	23	33	May	20	20	16	Sep	15	13	51
Feb	20	17	32	Jun	19	08	57	Oct	14	22	32
Mar	22	11	58	Jul	18	19	42	Nov	13	07	51
Apr	21	05	13	Aug	17	05	07	Dec	12	18	30

LUNAR PHENOMENA, 1989

MOON AT PERIGEE

	d	h		d	h		d	h
Jan	11	01	May	4	07	Aug	19	14
Feb	8	00	Jun	1	07	Sep	16	17
Mar	8	10	Jun	28	06	Oct	15	03
Apr	5	22	Jul	23	09	Nov	12	15
						Dec	11	01

MOON AT APOGEE

	d	h		d	h		d	h
Jan	27	02	May	16	11	Sep	4	10
Feb	23	16	Jun	13	04	Oct	1	22
Mar	22	20	Jul	10	23	Oct	29	00
Apr	18	23	Aug	7	17	Nov	25	06
						Dec	22	21

LUNAR ECLIPSES

The total eclipse of the Moon on February 20 will not be seen from Southern Africa except for the last phase which may be seen in the Eastern parts of the continent. The eclipse begins at 15.45 and ends at 19.27. Totality ends at 18.15 just when the Moon rises at Durban.

The total eclipse of the Moon on August 15 begins at 03.21, totality starts at 04.20 ending at 05.56 and the eclipse ends at 06.55 while the Moon sets at Cape Town at 06.15.

MAP OF THE MOON'S NEAR SIDE

LIBRATIONS

Jan 5, Feb 2 Mar 2
Mar 31, Apr 28, May 25
Jun 20, Jul 17, Aug 14
Sep 9, Oct 9, Nov 7
Dec 4, Dec 31

Jan 19, Feb 15, Mar 19
Apr 12, May 10, Jun 7
Jul 4, Jul 31, Aug 27
Sep 21, Oct 21, Nov 18
Dec 16

Jan 18, Feb 14, Mar 13
Apr 9, May 7, Jun 3
Jun 30, Jul 27, Aug 23
Sep 20, Oct 17, Nov 13
Dec 11

Jan 5, Feb 1, Feb 28
Mar 28, Apr 24, May 21
Jun 17, Jul 14, Aug 10
Sep 7, Oct 4, Oct 31
Nov 27, Dec 24

1 9 8 9

TIMES OF MOON RISE AND MOON SET - JOHANNESBURG

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	00h08m	13h13m	00h31m	14h48m	-	13h33m	00h57m	14h51m	01h56m	14h43m	03h59m	15h13m
2	00 39	14 07	01 22	15 48	00h05m	14 32	02 03	15 32	03 00	15 18	05 08	16 01
3	01 14	15 04	02 21	16 46	01 05	15 26	03 08	16 11	04 04	15 56	06 17	16 55
4	01 56	16 04	03 25	17 40	02 09	16 15	04 13	16 48	05 10	16 37	07 23	17 55
5	02 43	17 06	04 33	18 28	03 17	16 59	05 19	17 25	06 19	17 23	08 25	18 59
6	03 38	18 06	05 41	19 11	04 24	17 41	06 26	18 05	07 28	18 15	09 21	20 03
7	04 40	19 03	06 48	19 50	05 31	18 20	07 35	18 49	08 38	19 13	10 05	21 04
8	05 47	19 53	07 53	20 27	06 37	18 57	08 44	19 37	09 43	20 15	10 44	22 01
9	06 55	20 37	08 59	21 03	07 43	19 35	09 53	20 30	10 41	21 17	11 18	22 55
10	08 01	21 18	10 03	21 40	08 50	20 15	10 58	21 29	11 30	22 19	11 49	23 47
11	09 07	21 55	11 07	22 21	09 57	20 59	11 58	22 30	12 11	23 17	12 18	-
12	10 08	22 29	12 12	23 05	11 05	21 48	12 51	23 31	12 47	-	12 46	00 37
13	11 10	23 05	13 17	23 54	12 11	22 42	13 36	-	13 20	00 13	13 16	01 27
14	12 12	23 43	14 19	-	13 12	23 40	14 14	00 29	13 49	01 03	13 45	02 18
15	14 15	-	15 17	00 47	14 07	-	14 47	01 25	14 17	01 53	14 20	03 11
16	15 19	00 22	16 11	01 45	14 56	00 39	15 18	02 18	14 45	02 44	15 00	04 06
17	15 23	01 07	16 57	02 45	15 38	01 38	15 47	03 09	15 15	03 34	15 49	05 03
18	16 25	01 57	17 37	03 43	16 13	02 35	16 15	03 59	15 46	04 26	16 36	06 02
19	17 22	02 52	18 12	04 41	16 46	03 30	16 44	04 48	16 23	05 20	17 33	07 00
20	18 12	03 52	18 44	05 35	17 15	04 22	17 14	05 40	17 03	06 16	18 34	07 53
21	18 58	04 52	19 13	06 27	17 44	05 13	17 47	06 32	17 50	07 14	19 37	08 42
22	19 37	05 51	19 40	07 17	18 12	06 03	18 24	07 26	18 44	08 11	20 41	09 27
23	20 11	06 46	20 09	08 07	18 41	06 53	19 06	08 23	19 41	09 06	21 42	10 06
24	20 42	07 41	20 38	08 57	19 11	07 44	19 54	09 20	20 42	09 58	22 43	10 43
25	21 11	08 33	21 10	09 49	19 46	08 37	20 47	10 17	21 45	10 46	23 44	11 18
26	21 39	09 23	21 45	10 42	20 42	09 31	21 46	11 11	22 47	11 27	-	11 52
27	22 07	10 13	22 25	11 38	21 07	10 28	22 48	12 01	23 48	12 06	00 45	12 28
28	22 37	11 04	23 21	12 35	21 57	11 25	23 51	12 47	-	12 42	01 48	13 08
29	23 10	11 57			22 52	12 22	-	13 28	00 49	13 17	02 54	13 53
30	23 48	12 51			23 53	13 16	00 53	13 56	01 50	13 52	04 02	14 44
31	-	13 49				14 07			02 53	14 30		

TIMES OF MOON RISE AND MOON SET - JOHANNESBURG

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	05h08m	15h41m	06h34m	17h36m	06h48m	19h04m	06h19m	19h32m	06h49m	21h05m	07h24m	21h33m
2	06 11	16 42	07 13	18 34	07 17	19 55	06 51	20 25	07 38	21 58	08 23	22 17
3	07 07	17 46	07 47	19 28	07 46	20 46	07 26	21 19	08 32	22 48	09 22	22 56
4	07 57	18 49	08 18	20 20	08 17	21 37	08 06	22 15	09 29	23 35	10 22	23 33
5	08 39	19 48	08 47	21 11	08 50	22 32	08 51	23 10	10 28	-	11 20	-
6	09 15	20 44	09 15	22 06	09 27	23 26	09 42	-	11 28	00 17	12 18	00 07
7	09 48	21 38	09 50	22 53	10 08	-	10 37	00 03	12 29	00 57	13 20	00 42
8	10 18	22 29	10 16	23 46	10 56	00 23	11 36	00 53	13 29	01 33	14 23	01 18
9	10 47	23 19	10 51	-	11 50	01 18	12 28	01 40	14 31	02 09	15 27	01 56
10	11 15	-	11 30	00 41	12 49	02 12	13 40	02 22	15 35	02 45	16 39	02 40
11	11 46	00 09	12 15	01 37	13 51	03 02	14 43	03 01	16 42	03 23	17 49	03 31
12	12 18	01 02	13 06	02 34	14 56	03 47	15 48	03 38	17 52	04 06	18 58	04 29
13	13 00	01 56	14 03	03 31	16 00	04 30	16 52	04 16	19 04	04 54	20 00	05 33
14	13 37	02 52	15 06	04 24	17 05	05 09	17 59	04 53	20 15	05 49	20 54	06 39
15	14 25	03 50	16 11	05 13	18 10	05 47	19 08	05 33	21 20	06 51	21 40	07 46
16	15 20	04 48	17 16	05 58	19 15	06 24	20 19	06 20	22 18	07 56	22 19	08 48
17	16 21	05 43	18 21	06 38	20 23	07 02	21 30	07 11	23 06	09 01	22 53	09 47
18	17 25	06 36	19 25	07 16	21 31	07 44	22 37	08 08	23 48	10 04	23 25	10 42
19	18 29	07 23	20 24	07 53	22 40	08 31	23 36	09 09	-	11 03	23 53	11 35
20	19 33	08 05	21 33	08 29	23 47	09 22	-	10 13	00 23	11 58	-	12 26
21	20 36	08 43	22 38	09 08	-	10 19	00 28	11 15	00 55	12 51	00 24	13 16
22	21 38	09 19	23 45	09 49	00 49	11 20	01 12	12 15	01 25	13 42	00 59	14 08
23	22 39	09 55	-	10 36	01 44	12 22	01 50	13 11	01 53	14 32	01 24	15 02
24	23 42	10 30	00 51	11 28	02 31	13 22	02 23	14 03	02 23	15 23	02 00	15 56
25	-	11 08	01 55	12 25	03 12	14 20	02 53	14 56	02 54	16 15	02 43	16 51
26	00 46	11 50	02 54	13 26	03 49	15 15	03 23	15 46	03 28	17 09	03 29	17 47
27	01 52	12 38	03 47	14 28	04 21	16 08	03 51	16 36	04 00	18 04	04 20	18 40
28	02 58	13 32	04 32	15 27	04 51	16 59	04 21	17 27	04 47	19 00	05 16	19 30
29	04 01	14 31	05 12	16 25	05 20	17 49	04 52	18 20	05 35	19 54	06 16	20 16
30	05 03	15 33	05 47	17 20	05 49	18 41	05 27	19 14	06 27	20 46	07 16	20 57
31	05 52	16 36	06 18	19 13			06 06	20 10			08 16	21 34

1989

TIMES OF MOON RISE AND MOON SET CAPE TOWN

FOR PORT ELIZABETH SUBTRACT 28 MINUTES

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	00h39m	14h05m	00h46m	15h56m	-	14h42m	01h16m	15h50m	02h29m	15h26m	04h54m	15h35m
2	01 05	15 04	01 34	16 57	00h16m	15 40	02 26	16 26	03 38	15 56	06 08	16 18
3	01 36	16 06	02 32	17 54	01 17	16 31	03 37	16 58	04 49	16 28	07 22	17 09
4	02 12	17 10	03 38	18 44	02 25	17 17	04 49	17 29	06 02	17 03	08 31	18 08
5	02 57	18 14	04 50	19 27	03 37	17 56	06 01	18 00	07 17	17 43	09 32	19 13
6	03 50	19 14	06 04	20 04	04 50	18 31	07 15	18 34	08 32	18 30	10 23	20 19
7	04 53	20 08	07 18	20 37	06 03	19 03	08 29	19 11	09 45	19 25	11 05	21 25
8	06 03	20 54	08 30	21 08	07 16	19 34	09 45	19 54	10 51	20 27	11 40	22 27
9	07 15	21 34	09 41	21 38	08 29	20 06	10 59	20 44	11 47	21 32	12 09	23 26
10	08 28	22 08	10 51	22 09	09 42	20 40	12 07	21 41	12 33	22 37	12 35	-
11	09 38	22 38	12 02	22 43	10 56	21 19	13 06	22 43	13 10	23 40	12 59	00 23
12	10 47	23 08	13 12	23 23	12 08	22 03	13 56	23 46	13 42	-	13 23	01 18
13	11 55	23 37	14 21	-	13 17	22 54	14 37	-	14 09	00 40	13 47	02 14
14	13 03	-	15 27	00 08	14 20	23 52	15 11	00 49	14 33	01 37	14 13	03 10
15	14 11	00 08	16 26	01 00	15 14	-	15 40	01 50	14 57	02 32	14 43	04 07
16	15 20	00 43	17 17	01 58	16 00	00 53	16 06	02 48	15 20	03 27	15 18	05 07
17	16 28	01 23	18 00	02 59	16 37	01 55	16 30	03 44	15 45	04 22	15 59	06 08
18	17 32	02 11	18 35	04 02	17 09	02 56	16 53	04 39	16 12	05 19	16 48	07 09
19	18 30	03 05	19 06	05 03	17 37	03 56	17 17	05 34	16 44	06 17	17 45	08 07
20	19 19	04 05	19 33	06 02	18 02	04 53	17 42	06 29	17 20	07 18	18 49	09 00
21	20 00	05 08	19 57	07 00	18 25	05 49	18 10	07 27	18 04	08 19	19 56	09 45
22	20 34	06 11	20 20	07 55	18 48	06 44	18 43	08 26	18 55	09 19	21 04	10 25
23	21 04	07 12	20 44	08 50	19 12	07 39	19 21	09 26	19 54	10 14	22 12	10 59
24	21 30	08 11	21 08	09 46	19 38	08 35	20 07	10 26	20 58	11 04	23 19	11 30
25	21 54	09 08	21 35	10 42	20 07	09 33	21 00	11 25	22 05	11 47	-	11 59
26	22 17	10 03	22 05	11 40	20 41	10 32	22 00	12 18	23 12	12 24	00 25	12 28
27	22 40	10 58	22 41	12 40	21 21	11 33	23 05	13 06	-	12 57	01 32	12 59
28	23 05	11 54	23 24	13 42	22 09	12 33	-	13 47	00 19	13 27	02 42	13 33
29	23 34	12 51			23 05	13 30	00 12	14 23	01 26	13 56	03 53	14 12
30	-	13 51			-	14 23	01 21	14 56	02 33	14 26	05 04	14 58
31	00 07	14 53			00 08	15 09			03 43	14 58		

1989

TIMES OF MOON RISE AND MOON SET CAPE TOWN

FOR PORT ELIZABETH SUBTRACT 28 MINUTES

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	06h14m	15h53m	07h34m	17h58m	07h30m	19h45m	06h47m	20h26m	07h04m	22h11m	07h38m	22h37m
2	07 18	16 55	08 08	19 00	07 54	20 40	07 15	21 23	07 51	23 05	08 40	23 17
3	08 13	18 01	08 36	20 00	08 18	21 36	07 46	22 22	08 44	23 55	09 44	23 51
4	08 59	19 08	09 02	20 58	08 44	22 33	08 22	23 20	09 43	-	10 48	-
5	09 36	20 12	09 27	21 53	09 12	23 31	09 04	-	10 46	00 38	11 53	00 22
6	10 08	21 13	09 50	22 49	09 45	-	09 54	00 17	11 51	01 16	12 56	00 52
7	10 36	22 12	10 15	23 45	10 23	00 30	10 50	01 10	12 57	01 50	14 04	01 20
8	11 01	23 08	10 42	-	11 09	01 29	11 52	01 58	14 03	02 21	15 13	01 50
9	11 24	-	11 12	00 43	12 02	02 26	12 58	02 41	15 11	02 51	16 25	02 24
10	11 48	00 04	11 47	01 42	13 02	03 19	14 05	03 19	16 21	03 21	17 40	03 02
11	12 14	00 59	12 29	02 42	14 08	04 06	15 14	03 53	17 35	03 54	18 54	03 47
12	12 42	01 56	13 18	03 41	15 17	04 48	16 24	04 24	18 51	04 30	20 04	04 42
13	13 14	02 55	14 16	04 38	16 28	05 24	17 35	04 55	20 08	05 13	21 06	05 45
14	13 52	03 55	15 21	05 30	17 39	05 58	18 49	05 27	21 21	06 04	21 57	06 54
15	14 38	04 56	16 30	06 15	18 50	06 29	20 04	06 01	22 27	07 03	22 38	08 04
16	15 32	05 55	17 41	06 55	20 02	07 00	21 21	06 41	23 22	08 09	23 12	09 12
17	16 34	06 51	18 52	07 30	21 16	07 33	22 36	07 27	-	09 17	23 41	10 16
18	17 41	07 40	20 02	08 02	22 30	08 08	23 44	08 21	00 07	10 25	-	11 16
19	18 51	08 22	21 12	08 32	23 44	08 49	-	09 22	00 44	11 29	00 08	12 14
20	20 01	08 59	22 22	09 03	-	09 37	00 43	10 27	01 14	12 29	00 32	13 10
21	21 09	09 32	23 34	09 35	00 54	10 32	01 31	11 33	01 41	13 27	00 57	14 05
22	22 17	10 02	-	10 11	01 56	11 32	02 11	12 37	02 06	14 23	01 23	15 02
23	23 25	10 32	00 46	10 53	02 49	12 37	02 44	13 38	02 30	15 18	01 51	15 59
24	-	11 01	01 56	11 42	03 34	13 41	03 13	14 37	02 55	16 13	02 22	16 58
25	00 34	11 34	03 02	12 37	04 11	14 44	03 39	15 33	03 21	17 10	02 59	17 57
26	01 44	12 11	04 01	13 39	04 42	15 44	04 03	16 28	03 50	18 08	03 42	18 54
27	02 54	12 54	04 51	14 43	05 09	16 42	04 27	17 24	04 23	19 07	04 33	19 47
28	04 04	13 45	05 33	15 48	05 34	17 38	04 51	18 20	05 02	20 05	05 30	20 35
29	05 08	14 43	06 09	16 50	05 58	18 34	05 18	19 17	05 48	21 01	06 32	21 16
30	06 05	15 47	06 39	17 50	06 22	19 29	05 48	20 15	06 40	21 52	07 37	21 53
31	06 54	16 53	07 05	18 48			06 23	21 14			08 42	22 25

1989

TIMES OF MOON RISE AND MOON SET DURBAN

FOR BLOEMFONTEIN ADD 19 MINUTES

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	-	13^h07^m	00^h06^m	14^h50^m	23^h37^m	13^h37^m	00^h33^m	14^h49^m	01^h40^m	14^h33^m	03^h54^m	14^h51^m
2	00^h21^m	14 04	00 55	15 51	-	14 34	01 41	15 28	02 46	15 06	05 06	15 36
3	00 53	15 03	01 53	16 49	00 37	15 27	02 50	16 03	03 54	15 40	06 17	16 29
4	01 31	16 05	02 58	17 40	01 43	16 15	03 58	16 37	05 03	16 18	07 25	17 28
5	02 17	17 08	04 08	18 26	02 53	16 57	05 07	17 11	06 16	17 00	08 27	18 33
6	03 11	18 08	05 19	19 06	04 04	17 35	06 18	17 48	07 29	17 49	09 20	19 38
7	04 13	19 04	06 30	19 42	05 14	18 10	07 29	18 27	08 40	18 45	10 04	20 41
8	05 21	19 52	07 39	20 16	06 24	18 44	08 42	19 13	09 45	19 47	10 41	21 41
9	06 32	20 35	08 47	20 49	07 34	19 19	09 54	20 04	10 42	20 51	11 13	22 38
10	07 41	21 11	09 54	21 23	08 44	19 56	11 01	21 02	11 30	21 54	11 41	23 33
11	08 49	21 45	11 02	22 00	09 54	20 37	12 01	22 03	12 10	22 55	12 07	-
12	09 55	22 17	12 10	22 41	11 04	21 23	12 53	23 05	12 44	23 53	12 33	00 26
13	11 00	22 49	13 17	23 28	12 12	22 15	13 36	-	13 13	-	13 00	01 18
14	12 05	23 23	14 21	-	13 14	23 12	14 12	00 06	13 40	00 48	13 28	02 12
15	13 11	-	15 20	00 21	14 09	-	14 43	01 04	14 06	01 41	14 00	03 07
16	14 17	00 00	16 12	01 18	14 56	00 13	15 11	02 00	14 32	02 33	14 36	04 05
17	15 24	00 42	16 57	02 19	15 36	01 13	15 38	02 54	14 59	03 26	15 19	05 04
18	16 27	01 31	17 35	03 19	16 11	02 13	16 03	03 47	15 28	04 20	16 09	06 04
19	17 25	02 26	18 08	04 19	16 41	03 10	16 29	04 39	16 01	05 17	17 06	07 02
20	18 15	03 25	18 37	05 16	17 08	04 05	16 56	05 32	16 40	06 15	18 08	07 55
21	18 58	04 27	19 04	06 11	17 34	04 59	17 27	06 27	17 25	07 14	19 13	08 43
22	19 35	05 28	19 30	07 04	17 59	05 51	18 01	07 24	18 16	08 13	20 19	09 25
23	20 07	06 27	19 55	07 57	18 25	06 44	18 41	08 23	19 14	09 09	21 24	10 02
24	20 35	07 24	20 22	08 49	18 53	07 38	19 27	09 22	20 17	10 00	22 28	10 35
25	21 01	08 18	20 50	09 44	19 24	08 33	20 21	10 19	21 21	10 45	23 32	11 07
26	21 27	09 11	21 23	10 39	20 00	09 30	21 20	11 13	22 26	11 25	-	11 39
27	21 52	10 04	22 01	11 37	20 42	10 29	22 23	12 02	23 30	12 00	00 36	12 12
28	22 20	10 57	22 45	12 37	21 30	11 28	23 28	12 46	-	12 33	01 43	12 48
29	22 50	11 52			22 26	12 25	-	13 25	00 35	13 05	02 51	13 30
30	23 25	12 49			23 27	13 18	00 34	14 00	01 39	13 37	04 00	14 18
31	-	13 49			-	14 06			02 46	14 12		

1989

TIMES OF MOON RISE AND MOON SET DURBAN

FOR BLOEMFONTEIN ADD 19 MINUTES

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	05h09m	15h14m	06h33m	17h14m	06h38m	18h52m	06h01m	19h27m	06h24m	21h06m	06h58m	21h34m
2	06 13	16 15	07 09	18 14	07 04	19 45	06 31	20 22	07 11	22 00	07 58	22 16
3	07 09	17 20	07 41	19 11	07 30	20 39	07 04	21 19	08 05	22 50	09 00	22 53
4	07 56	18 25	08 09	20 06	07 58	21 34	07 42	22 16	09 03	23 35	10 02	23 26
5	08 37	19 27	08 35	21 00	08 29	22 30	08 25	23 12	10 04	–	11 04	23 58
6	09 11	20 26	09 02	21 53	09 03	23 27	09 15	–	11 06	00 16	12 04	–
7	09 41	21 22	09 28	22 47	09 43	–	10 10	00 05	12 10	00 52	13 09	00 30
8	10 08	22 16	09 57	23 42	10 29	00 24	11 11	00 55	13 13	01 26	14 15	01 02
9	10 34	23 09	10 29	–	11 23	01 21	12 14	01 39	14 18	01 59	15 25	01 38
10	11 00	–	11 06	00 39	12 22	02 14	13 20	02 19	15 25	02 32	16 37	02 18
11	11 28	00 03	11 49	01 38	13 26	03 03	14 26	02 56	16 36	03 07	17 49	03 06
12	11 58	00 57	12 39	02 36	14 33	03 47	15 32	03 30	17 49	03 46	18 59	04 02
13	12 32	01 53	13 37	03 33	15 41	04 26	16 41	04 04	19 03	04 31	20 01	05 05
14	13 12	02 52	14 40	04 25	16 49	05 02	17 51	04 38	20 16	05 23	20 54	06 13
15	13 59	03 51	15 47	05 13	17 57	05 36	19 04	05 16	21 22	06 23	21 38	07 21
16	14 53	04 50	16 55	05 55	19 06	06 10	20 18	05 58	22 18	07 29	22 15	08 27
17	15 54	05 46	18 03	06 33	20 17	06 46	21 31	06 46	23 05	08 36	22 46	09 28
18	16 59	06 36	19 11	07 08	21 28	07 24	22 38	07 41	23 44	09 41	23 15	10 26
19	18 07	07 21	20 18	07 41	22 40	08 07	23 38	08 42	–	10 43	23 42	11 22
20	19 14	08 01	21 25	08 14	23 48	08 57	–	09 46	00 18	11 41	–	12 15
21	20 20	08 36	22 34	08 49	–	09 52	00 28	10 51	00 47	12 36	00 09	13 09
22	21 25	09 09	23 43	09 28	00 51	10 53	01 11	11 53	01 14	13 30	00 36	14 03
23	22 30	09 42	–	10 12	01 45	11 56	01 46	12 52	01 41	14 23	01 06	14 58
24	23 35	10 14	00 51	11 02	02 32	12 58	02 17	13 48	02 07	15 16	01 40	15 55
25	–	10 49	01 57	11 58	03 11	13 59	02 45	14 42	02 36	16 11	02 18	16 52
26	00 43	11 28	02 56	12 59	03 44	14 57	03 11	15 35	03 07	17 07	03 03	17 49
27	01 51	12 13	03 48	14 02	04 14	15 52	03 38	16 28	03 42	18 04	03 54	18 42
28	02 59	13 05	04 32	15 04	04 41	16 46	04 05	17 22	04 22	19 01	04 50	19 31
29	04 03	14 04	05 09	16 05	05 08	17 40	04 34	18 17	05 08	19 56	05 51	20 15
30	05 01	15 07	05 42	17 03	05 34	18 33	05 06	19 13	06 01	20 48	06 53	20 54
31	05 51	16 11	06 11	17 58			05 42	20 10			07 56	21 28

COMPUTING SECTION

This newly formed section invites all those interested in Astronomical Computing in any form to share their expertise and any Software they may have with other members in the Society.

The objectives of The Computing section were outlined in M.N.A.S.S.A. Vol 46 Nos. 5 & 6 June 1987 page 66. Please refer to this write up for detailed information.

Persons interested in the activities of the Computing Section are urged to contact the Director of the Societies Computing Section Mr Tony Hilton, P O Box 68846, Bryanston, 2021. Phone (w) 011-4032422.

Mr Hilton is in the process of compiling a comprehensive DATA BASE of all interested person's, equipment, available software etc. This report will be available to all interested persons in the first quarter of 1988. If you wish to become a subscriber to this DATA BASE list please contact Mr Hilton for the relevant questionnair.

Furthermore, if you are embarking on any Computer Projects, Mr Hilton would like to hear from you, and would make himself or any other competent individuals available to supply expert advice or additional information where necessary.

SOLAR SECTION

The work undertaken by this section covers a broad range of techniques to observe activity on the sun's disk. Members of the section note their observations on appropriate forms, which are then forwarded to various organisations in the United States of America, the United Kingdom, the Federal Republic of Germany and South Africa. The results we provide are further reduced by these organisations and incorporated with the information provided by other world-wide groups of Solar Observers, such as ours. The data produced is then fed to over 450 scientific institutions all over the world, where it is used by a very wide range of scientific disciplines.

Observational techniques employed include the visual observation of the sun's disk (using suitable filters or by projecting the image onto an appropriate screen) to determine sun spots and active areas, the monitoring of solar flares by very low frequency radio waves and monitoring changes in the earth's magnetic field caused by solar activity. Other activities such as photographing and the drawing of visible solar features are also undertaken.

A weekly update of solar activity is broadcast country wide on Sunday mornings at 10h00 and again on Monday evenings at 20h30 by the Amateur Radio League, enabling amateur astronomers and amateur radio enthusiasts alike to keep abreast of the latest developments as well as with all other interesting solar information. Short lectures are also given at this time.

Towards the end of 1986, the Sun entered the new 11 year Solar cycle and this cycle is characterised by a steady climb over approximately 4½ years, followed by a slower decline to minimum lasting approximately 6½ years. 1988, will therefore experience a marked increase in Solar activity and provide the observer with much to look at.

A word of caution - NEVER observe the sun directly without adequate filtration as permanent eye damage can occur, and do not use the screw-in filters provided with some commercial telescopes, as they are inclined to shatter!

Large instruments are not a pre-requisite! Any telescope from 50mm, reflector or refractor can be used and provides an ideal opportunity for owners of small instruments to contribute immediately to Science. If one has no filter, then the only safe method is to project the image on to a white card. Image quality will be enhanced if the card is kept in the shade, or enclosed in a screen. Details of suitable filters are best sought from experienced solar observers or from the Director of the Solar Section.

Persons interested in observing the sun, or requiring information are invited to contact The Director of the Solar Section, Jim Knight, at Mars Street, Atlasville, Boksburg, 1459 or at 011-9731380.

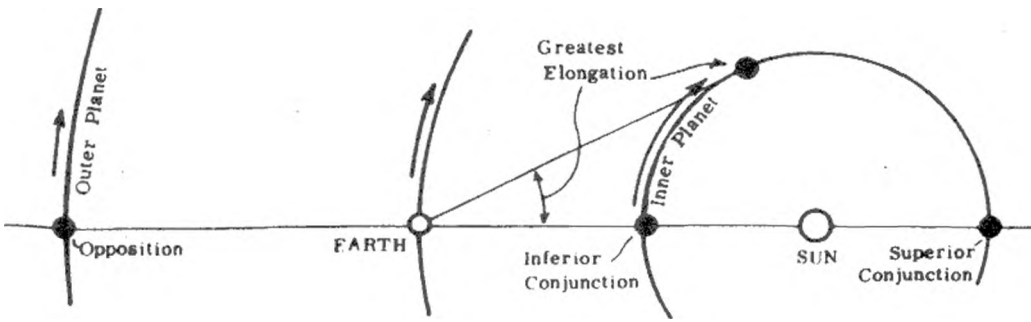
THE PLANETS

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^h56^m	23°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	1 426	29,5	95,2	120,8	10 14	26 44
Uranus	2 868	84,0	14,6	47,1	10 49	27 53
Neptune	4 494	164,8	17,3	44,6	14 ?	98 48
Pluto	5 896	247,6	0,9?	?	6d?	?

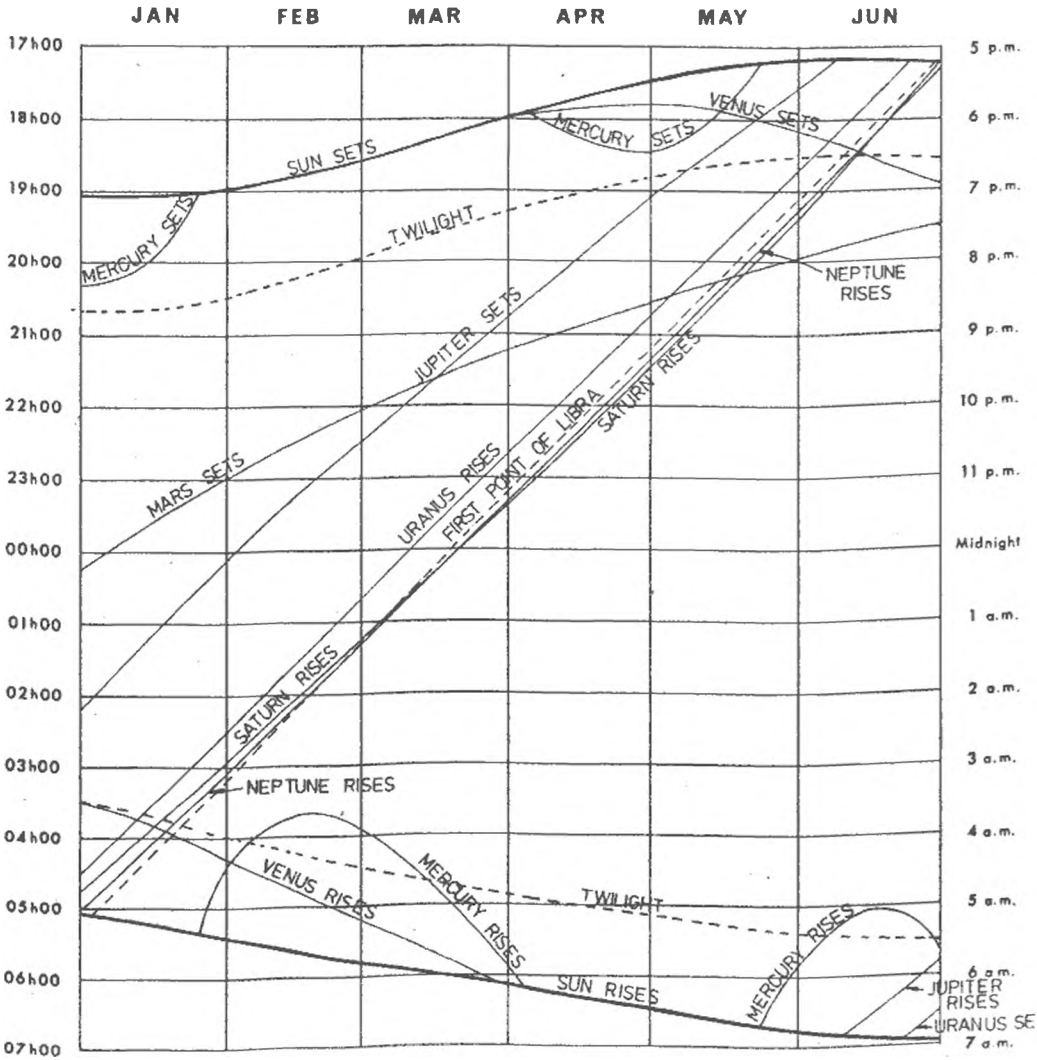
GENERAL

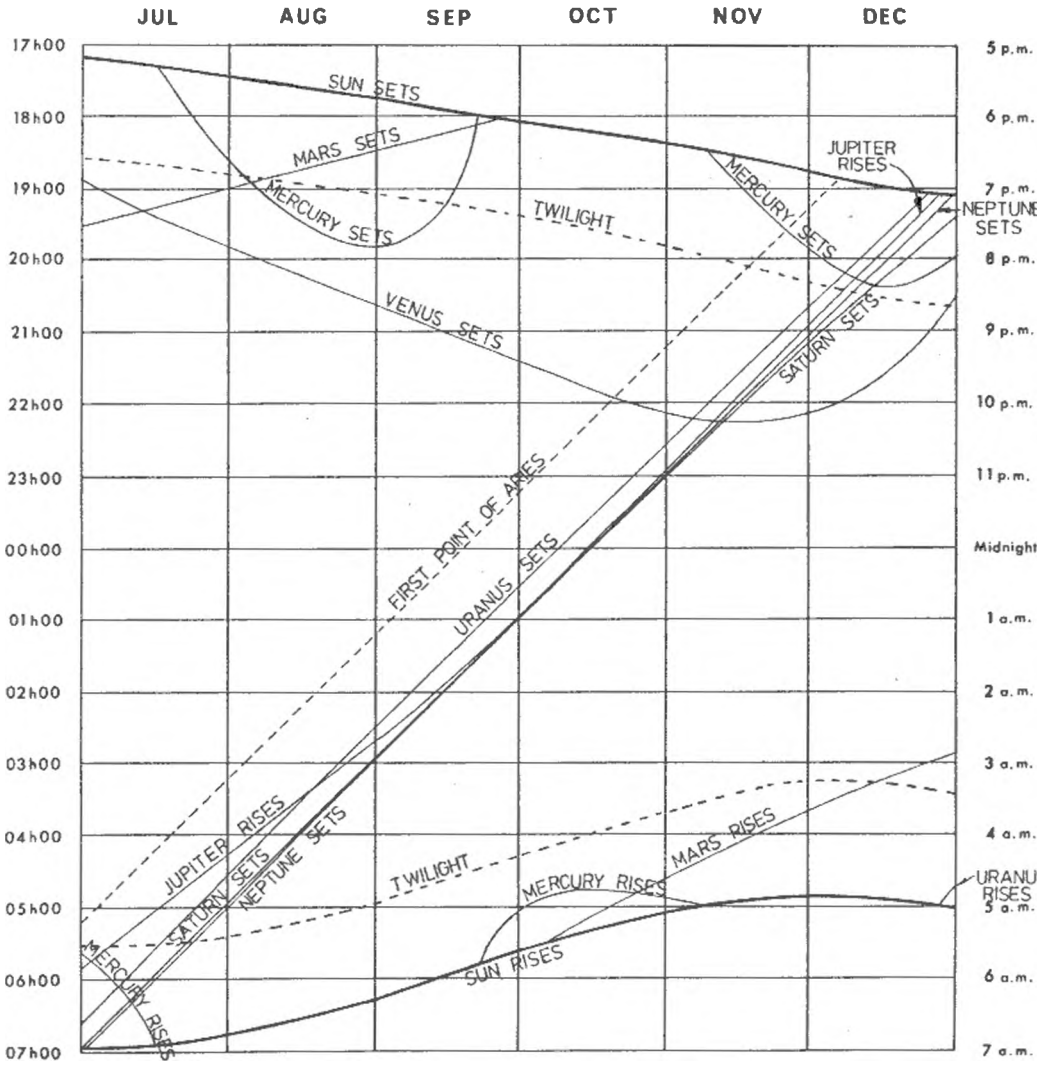
Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Unlike the distant stars, their relative positions do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the 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 1989 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.




JUL
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06h00
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5 p.m.
6 p.m.
7 p.m.
8 p.m.
9 p.m.
10 p.m.
11 p.m.
Midnight
1 a.m.
2 a.m.
3 a.m.
4 a.m.
5 a.m.
6 a.m.
7 a.m.
SUN SETS
MARS SETS
MERCURY SETS
TWILIGHT
VENUS SETS
JUPITER RISES
MERCURY SETS
NEPTUNE SETS
SATURN SETS
FIRST POINT OF ARIES
URANUS SETS
JUPITER RISES
SATURN SETS
NEPTUNE SETS
TWILIGHT
MERCURY RISES
MARS RISES
URANUS RISES
SUN RISES
MERCURY RISES

THE PLANETS

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 of 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

Mercury is visible in the evening sky from the beginning of the year until the third week in January, from mid April to mid May, from the end of July to mid September and from the end of November to the end of the year. It will be seen in the morning sky in February and for the first three weeks in March, from June 3 to July 8 and for most of October. It will be brightest on January 1, mag −0.7, April 4 -2.0, July 18 -2.1, November 10 -1.3. It will best be seen from Southern Africa from mid August to early September.

	d	h		d	h		d	h		d	h
Superior Conjunction			Apr	4	16	Jul	18	10	Nov	10	21
Greatest Elongation East	Jan 9	04(19°)	May	1	05(21°)	Aug	29	12(27°)	Dec	23	10(20°)
Stationary	Jan 15	17	May	13	01	Sep	11	16	Dec	30	18
Inferior Conjunction	Jan 25	02	May	24	00	Sep	25	00			
Stationary	Feb 5	16	Jun	5	04	Oct	3	08			
Greatest Elongation West	Feb 18	18(26°)	Jun	18	14(23°)	Oct	10	14(18°)			

Venus

Venus will be seen in the morning sky until late February at mag -3.9 and in the evening sky from mid May for the rest of the year. It will brighten slightly to a maximum of -4.7 in mid December.

Mars

Mars sets about midnight at the beginning of the year and slowly moves towards the evening twilight which it reaches about mid-August. It will be seen again about mid-November in the morning sky. It will be at mag −0.2 at the beginning of the year and will fade to +1.8 by July when it will start to brighten again but only to +1.5 at the end of the year.

Jupiter

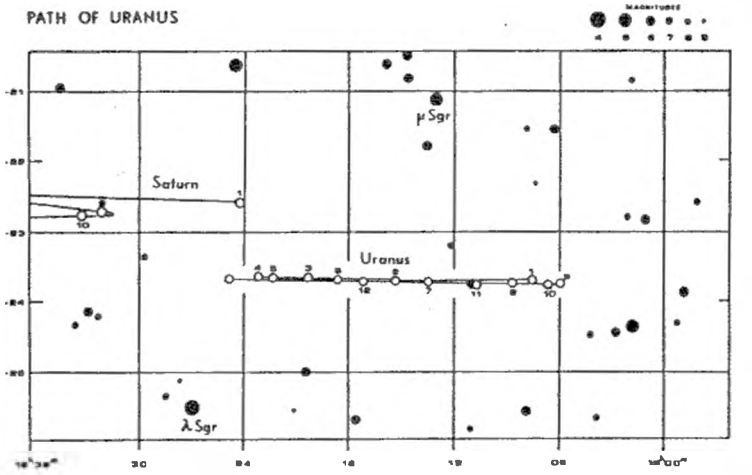
Jupiter sets at 2 am at the beginning of the year and moves steadily towards the evening twilight being lost there about mid-May. It re-appears in the morning twilight in late June after which it is a morning sky object. Its brightness varies from mag -2.7 in January to -1.9 at the end of June and then brightens to -2.7 at the end of the year.

Saturn

Saturn will be seen from the third week in January in the morning twilight and it will rise earlier each day until it disappears into the evening twilight in the middle of December. Saturn varies from mag +0.6 when first seen to 0.0 in July and fades again to +0.5 at the end of the year.

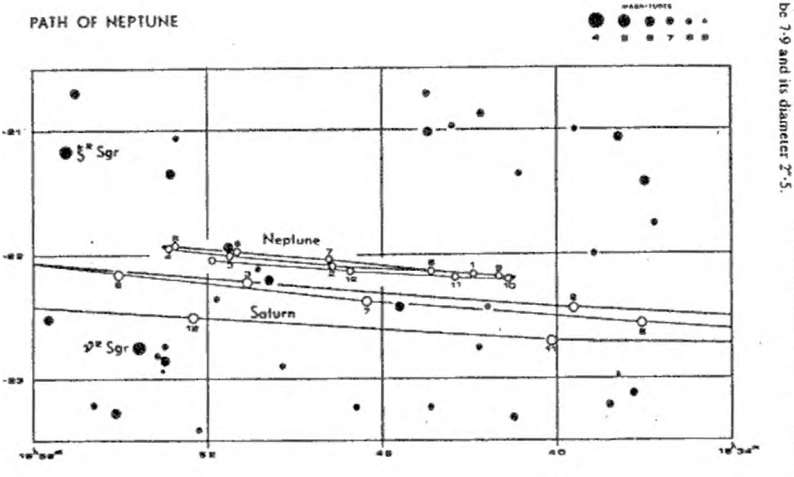
URANUS

Uranus is in Sagittarius. At opposition on June 24 its magnitude will be 5.6 and its apparent diameter 3".9.



NEPTUNE

Neptune is in Sagittarius; it is at opposition on July 2, when its magnitude will be 7.9 and its diameter 2".5.



Uranus and Neptune

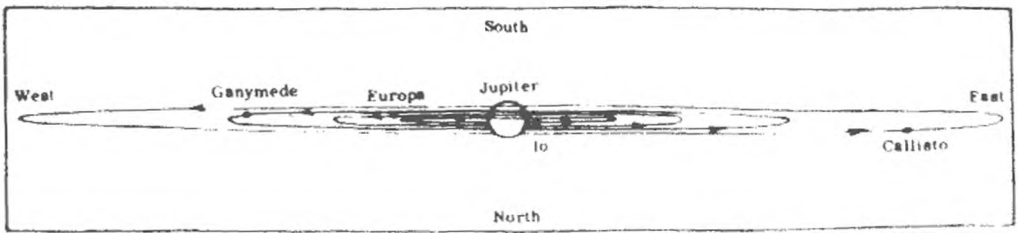
Uranus and Neptune will be close to Saturn all year. The RA and DEC of the three planets are tabulated at roughly 15 day intervals below so that Saturn can be used as a marker for the fainter planets. Uranus and Neptune at 5.6 and 7.9 require optical aid.

		Saturn RA h m	Saturn Dec	Uranus RA h m	Uranus Dec	Neptune RA h m	Neptune Dec
Feb	1	18 39	-22°26'	18 15	-23°37'	18 48	-22°05'
	15	18 43	-22°20'	18 18	-23°36'	18 50	-22°03'
Mar	1	18 51	-22°15'	18 20	-23°36'	18 51	-22°00'
	15	18 55	-22°09'	18 22	-23°35'	18 52	-21°58'
Apr	1	18 59	-22°05'	18 23	-23°35'	18 53	-21°57'
	15	19 00	-22°03'	18 23	-23°35'	18 53	-21°57'
May	1	19 00	-22°03'	18 22	-23°36'	18 53	-21°57'
	15	18 59	-22°06'	18 21	-23°37'	18 52	-21°58'
Jun	1	18 55	-22°11'	18 19	-23°38'	18 51	-21°59'
	15	18 51	-22°16'	18 16	-23°39'	18 50	-22°01'
Jul	1	18 46	-22°23'	18 14	-23°41'	18 48	-22°03'
	15	18 42	-22°29'	18 11	-23°41'	18 46	-22°05'
Aug	1	18 37	-22°36'	18 09	-23°42'	18 44	-22°07'
	15	18 34	-22°40'	18 07	-23°42'	18 43	-22°09'
Sep	1	18 32	-22°44'	18 06	-23°42'	18 42	-22°11'
	15	18 32	-22°46	18 06	-23°42'	18 42	-22°12'
Oct	1	18 33	-22°47'	18 07	-23°42'	18 42	-22°12'
	15	18 36	-22°46'	18 08	-23°42'	18 42	-22°12'
Nov	1	18 40	-22°44'	18 11	-23°41'	18 42	-22°12'
	15	18 46	-22°40'	18 13	-23°40'	18 45	-22°10'

THE MOONS OF JUPITER AND SATURN

MOONS OF JUPITER

One of the most popular sights for an observer with a small telescope is Jupiter and its Moons. Four of the fifteen - Io, Europa, Ganymede and Callisto - are generally clearly visible - they would just be visible to the naked eye were it not for the glare from the mother planet. As the diagram below indicates, the system is seen almost edge-on so



the moons always lie close to a straight line extending from the planet s equator. As they orbit, so they appear to oscillate from one side to the other, alternately passing in front and behind the planet. This motion is represented in the diagrams on page 26 which cover the period when Jupiter is clearly visible in the evening sky. The horizontal lines show their relative configurations at 2am each day.

When the moons pass in front and behind the planet, transits, occultations and eclipses occur. Details of such phenomena occurring between the end of astronomical twilight and just after midnight (and when the planet is above the horizon in Southern Africa) are given in the table below.

Explanation of Table

- Date and predicted times are given; these are for mid-phenomean and are not instantaneous.
- The moon concerned are I - Io, II - Europa, III - Ganymede and IV - Callisto.
- Phenomena - the abbreviations used are: D - Disappearance; Ec - Eclipse: the satellite passes through the shadow of Jupiter; R - Reappearance; Oc - Occultation: the satellite is obscured by the disc of Jupiter; I - Ingress; Sh - Shadow Transit: the shadow of the satellite transits the disc; E - Egress; Tr - Transit: the satellite crosses the disc of Jupiter.

d	h	m		d	h	m		d	h	m		d	h	m	
Jan 01	01	03	I.Oc.D.	Jan 16	19	31	II.Sh.E.	Feb 02	19	46	I.Sh.I.	Feb 24	21	32	I.Oc.D.
	20	45	III.Ec.R.		23	08	I.Oc.D.		20	38	I.Tr.E.		21	51	II.Sh.E.
	22	10	I.Tr.I.	17	20	16	I.Tr.I.		21	37	III.Tr.E.	25	20	02	I.Sh.I.
	23	05	I.Sh.I.		21	25	I.Sh.I.		21	56	I.Sh.E.		20	54	I.Tr.E.
02	00	20	I.Tr.E.		22	26	I.Tr.E.	06	22	26	II.Tr.I.		22	12	I.Sh.E.
	01	15	I.Sh.E.		23	35	I.Sh.E.	08	19	19	II.Ec.D.	26	19	31	I.Ec.R.
	19	30	I.Oc.D.	18	20	56	I.Ec.R.		21	41	II.Ec.R.	27	21	18	III.Oc.D.
	22	37	I.Ec.R.	21	22	17	II.Oc.D.		23	13	I.Oc.D.	Mar 03	19	34	II.Tr.I.
03	19	44	I.Sh.E.	22	00	37	II.Oc.R.	09	20	23	I.Tr.I.		21	55	II.Tr.E.
05	23	19	II.Tr.I.		00	44	II.Ec.D.		21	42	I.Sh.I.		22	07	II.Sh.I.
06	01	18	II.Sh.I.	23	19	42	II.Tr.E.		22	33	I.Tr.E.	04	20	41	I.Tr.I.
	01	36	II.Tr.E.		19	49	II.Sh.I.		23	14	III.Tr.I.		21	58	I.Sh.I.
07	21	49	II.Ec.R.		22	08	II.Sh.E.		23	51	I.Sh.E.	05	21	26	I.Ec.R.
08	20	30	III.Oc.R.	24	00	59	I.Oc.D.	10	21	11	I.Ec.R.	10	20	41	III.Sh.I.
	22	32	III.Ec.D.		22	08	I.Tr.I.	13	20	56	III.Ec.R.		22	15	II.Tr.I.
	23	59	I.Tr.I.		23	21	I.Sh.I.	15	19	14	II.Oc.D.	12	19	04	II.Oc.R.
09	00	47	III.Ec.R.	25	00	17	I.Tr.E.		21	36	II.Oc.R.		19	12	II.Ec.D.
	01	01	I.Sh.I.		19	27	I.Oc.D.		21	57	II.Ec.D.		19	56	I.Oc.D.
	21	18	I.Oc.D.		22	52	I.Ec.R.	16	22	18	I.Tr.I.		21	36	II.Ec.R.
10	00	32	I.Ec.R.	26	20	00	I.Sh.E.	17	19	15	II.Sh.E.	13	19	20	I.Tr.E.
	19	30	I.Sh.I.		20	33	III.Sh.I.		19	36	I.Oc.D.		20	33	I.Sh.E.
	20	35	I.Tr.E.		22	48	III.Sh.E.		23	06	I.Ec.R.	17	19	48	III.Tr.I.
	21	40	I.Sh.E.	29	00	47	II.Oc.D.	18	20	16	I.Sh.E.	19	19	25	II.Oc.D.
13	01	43	II.Tr.I.	30	19	54	II.Tr.I.	20	19	37	III.Oc.R.	20	19	08	I.Tr.I.
14	19	49	II.Oc.D.		22	12	II.Tr.E.		22	38	III.Ec.D.		20	19	I.Sh.I.
15	00	27	II.Ec.R.		22	25	II.Sh.I.	22	21	53	II.Oc.D.		21	19	I.Tr.E.
	21	55	III.Oc.D.	Feb 01	00	00	I.Tr.I	24	19	15	II.Tr.E.	21	18	57	II.Sh.E.
16	00	09	III.Oc.R.		21	19	I.Oc.D.		19	31	II.Sh.I.		19	45	I.Ec.R.

	d	h	m	
Mar	27	21	08	I.Tr.I.
	28	18	44	III.Ec.D.
		19	11	II.Sh.I.
		19	24	II.Tr.E.
		21	07	III.Ec.R.
	29	18	54	I.Sh.E.
Apr	04	19	47	II.Tr.I.
		20	24	I.Oc.D.
	05	18	39	I.Sh.I.
		19	50	I.Tr.E.
		20	50	I.Sh.E.
	06	18	52	II.Ec.R.
	12	19	40	I.Tr.I.
	13	19	59	I.Ec.R.
	15	19	12	III.Sh.E.
	20	18	55	I.Oc.D.
		20	04	II.Oc.D.
	21	19	10	I.Sh.E.
	22	17	37	III.Tr.I.
		18	38	II.Sh.E.
	28	18	55	I.Sh.I.
	29	17	30	II.Tr.I.
		18	50	II.Sh.I.
Aug	01	04	48	III.Sh.I.
	03	05	50	I.Ec.D.
	04	05	23	I.Sh.E.
		06	16	I.Tr.E.
	11	05	06	I.Sh.I.
		06	03	I.Tr.I.
	12	05	25	I.Oc.R.
		05	29	III.Oc.R.
	16	04	47	II.Ec.D.
	18	03	39	II.Tr.E.
	19	04	07	I.Ec.D.
		05	25	III.Ec.R.
	20	03	40	I.Sh.E.
		04	43	I.Tr.E.
	25	03	49	II.Tr.I.
		04	06	II.Sh.E.
	26	06	01	I.Ec.D.
	27	03	22	I.Sh.I.
		04	29	I.Tr.I.
		05	33	I.Sh.E.
	28	03	52	I.Oc.R.
	30	04	14	III.Tr.E.
Sep	01	04	11	II.Sh.I.
	03	04	11	II.Oc.R.
		05	15	I.Sh.I.
	04	05	50	I.Oc.R.
	05	03	07	I.Tr.E.
	06	03	27	III.Sh.E.
		05	38	III.Tr.I.
	11	04	17	I.Ec.D.
	12	02	52	I.Tr.I.
		03	49	I.Sh.E.
		05	04	I.Tr.E.
	13	02	16	I.Oc.R.
		04	42	III.Sh.I.
	17	02	45	III.Oc.R.
		04	20	II.Ec.D.
	19	03	31	I.Sh.I.
		03	55	II.Tr.E.
		04	47	I.Tr.I.

	d	h	m	
Sep	19	05	42	I.Sh.E.
		20	04	12	I.Oc.R.
		24	03	57	III.Oc.D.
		26	03	51	II.Sh.E.
			03	57	II.Tr.I.
			05	24	I.Sh.I.
		27	02	33	I.Ec.D.
		28	01	24	II.Oc.R.
			02	04	I.Sh.E.
			03	22	I.Tr.E.
Oct	01	02	37	III.Ec.D.
			05	26	III.Ec.R.
		03	03	54	II.Sh.I.
		04	04	27	I.Ec.D.
		05	01	18	II.Ec.R.
			01	20	II.Oc.D.
			01	46	I.Sh.I.
			03	03	I.Tr.I.
			03	57	I.Sh.E.
			03	58	II.Oc.R.
			05	15	I.Tr.E.
		06	02	30	I.Oc.R.
		08	04	49	IV.Oc.D.
			05	36	IV.Oc.R.
		12	01	18	II.Ec.D.
			01	50	III.Tr.I.
			03	39	I.Sh.I.
			04	44	III.Tr.E.
			04	56	I.Tr.I.
		13	00	49	I.Ec.D.
			04	23	I.Oc.R.
		14	01	03	II.Tr.E.
			01	36	I.Tr.E.
		19	00	35	III.Sh.I.
			03	24	III.Sh.E.
			03	51	II.Ec.D.
			05	32	I.Sh.I.
		20	02	43	I.Ec.D.
		21	00	01	I.Sh.I.
			00	56	II.Tr.I.
			00	59	II.Sh.E.
			01	14	I.Tr.I.
			02	12	I.Sh.E.
			03	27	I.Tr.E.
			03	35	II.Tr.E.
		22	00	42	I.Oc.R.
		26	04	34	III.Sh.I.
		27	04	37	I.Ec.D.
		28	01	00	II.Sh.I.
			01	54	I.Sh.I.
			03	04	I.Tr.I.
			03	26	II.Tr.I.
			03	36	II.Sh.E.
			04	06	I.Sh.E.
			05	17	I.Tr.E.
		29	02	33	I.Oc.R.
			23	44	I.Tr.E.
		30	00	39	II.Oc.R.
			02	17	III.Oc.R.
Nov	04	03	37	II.Sh.I.
			03	47	I.Sh.I.
			04	53	I.Tr.I.
		05	01	00	I.Ec.D.

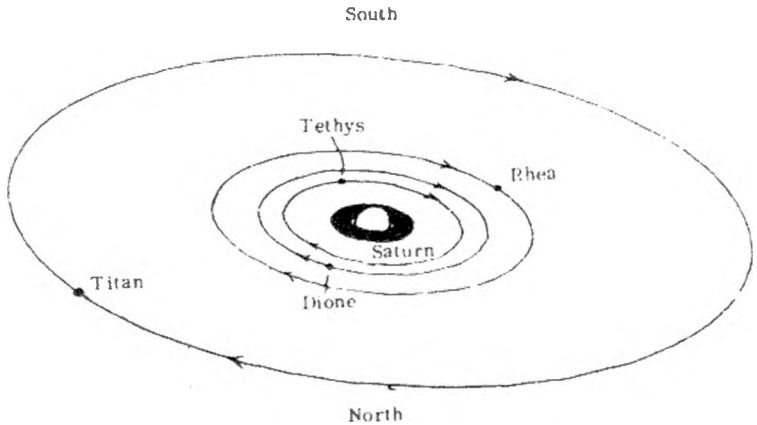
	d	h	m	
Nov	05	04	22	I.Oc.R.
		23	20	I.Tr.I.
	06	00	27	I.Sh.E.
		01	25	III.Ec.R.
		01	33	I.Tr.E.
		02	58	III.Oc.D.
		03	03	II.Oc.R.
	12	02	54	I.Ec.D.
	13	00	09	I.Sh.I.
		00	49	II.Ec.D.
		01	07	I.Tr.I.
		02	21	I.Sh.E.
		02	31	III.Ec.D.
		03	20	I.Tr.E.
	14	00	37	I.Oc.R.
	15	00	08	II.Tr.E.
	16	23	09	III.Tr.E.
	18	23	28	IV.Tr.I.
	19	00	51	IV.Tr.E.
	20	02	02	I.Sh.I.
		02	53	I.Tr.I.
		03	22	II.Ec.D.
		04	15	I.Sh.E.
		05	06	I.Tr.E.
		23	17	I.Ec.D.
	21	02	23	I.Oc.R.
		22	08	II.Sh.I.
		22	43	I.Sh.E.
		23	33	I.Tr.E.
		23	50	II.Tr.I.
	22	00	46	II.Sh.E.
		02	30	II.Tr.E.
	23	23	21	III.Sh.E.
		23	40	III.Tr.I.
	24	02	36	III.Tr.E.
	26	22	38	IV.Ec.D.
		23	13	IV.Ec.R.
	27	03	55	I.Sh.I.
		04	39	I.Tr.I.
		05	16	IV.Oc.D.
	28	01	11	I.Ec.D.
		04	09	I.Oc.R.
		22	24	I.Sh.I.
		23	05	I.Tr.I.
	29	00	37	I.Sh.E.
		00	45	II.Sh.I.
		01	18	I.Tr.E.
		02	09	II.Tr.I.
		03	23	II.Sh.E.
		04	49	II.Tr.E.
		22	35	I.Oc.R.
	30	23	09	II.Oc.R.
Dec	01	00	26	III.Sh.I.
		03	03	III.Tr.I.
		03	21	III.Sh.E.
	05	03	05	I.Ec.D.
	06	00	17	I.Sh.I.
		00	49	I.Tr.I.
		02	30	I.Sh.E.
		03	03	I.Tr.E.
		03	21	II.Sh.I.
		04	27	II.Tr.I.
		21	34	I.Ec.D.

	d	h	m	
Dec	07	00	20	I.Oc.R.
		20	59	I.Sh.E.
		21	29	I.Tr.E.
		21	47	II.Ec.D.
	08	01	24	II.Oc.R.
		04	25	III.Sh.I.
	11	23	04	III.Oc.R.
	13	02	11	I.Sh.I.
		02	33	I.Tr.I.
		04	24	I.Sh.E.
		04	47	I.Tr.E.
		21	09	IV.Oc.R.
		23	28	I.Ec.D.
	14	02	04	I.Oc.R.
		20	39	I.Sh.I.
		20	59	I.Tr.I.
		22	53	I.Sh.E.
		23	12	I.Tr.E.
	15	00	21	II.Ec.D.
		03	37	II.Oc.R.
		20	30	I.Oc.R.
	16	21	56	II.Sh.E.
		22	30	II.Tr.E.
	18	22	27	III.Ec.D.
	19	02	21	III.Oc.R.
	20	04	05	I.Sh.I.
		04	16	I.Tr.I.
	21	01	23	I.Ec.D.
		03	48	I.Oc.R.
		22	33	I.Sh.I.
		22	42	I.Tr.I.
	22	00	47	I.Sh.E.
		00	56	I.Tr.E.
		02	55	II.Ec.D.
		03	09	IV.Sh.I.
		04	31	IV.Tr.I.
		04	37	IV.Sh.E.
		19	51	I.Ec.D.
		22	14	I.Oc.R.
	23	21	53	II.Sh.I.
		22	05	II.Tr.I.
	24	00	33	II.Sh.E.
		00	44	II.Tr.E.
	26	02	27	III.Ec.D.
	28	03	17	I.Oc.D.
	29	00	25	I.Tr.I.
		00	27	I.Sh.I.
		02	39	I.Tr.E.
		02	41	I.Sh.E.
		05	25	II.Oc.D.
		05	25	II.Oc.D.
		19	21	III.Sh.E.
		21	43	I.Oc.D.
	30	00	01	I.Ec.R.
		21	05	I.Tr.E.
		21	10	I.Sh.E.
	31	00	19	II.Tr.I.
		00	30	II.Sh.I.
		02	59	II.Tr.E.
		03	10	II.Sh.E.
		03	10	II.Sh.E.

THE MOONS OF JUPITER AND SATURN

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.

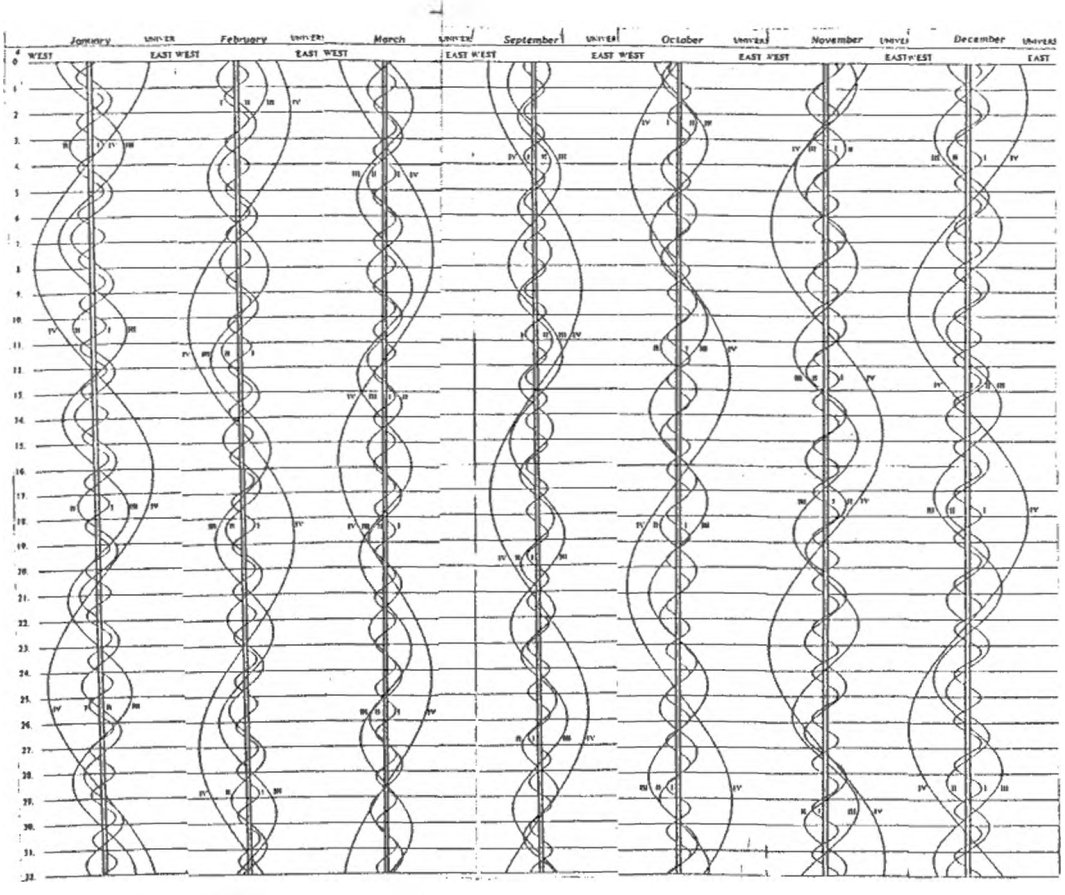


TITAN 1989

Eastern Elongation		Inferior Conjunction		Western Elongation		Superior Conjunction	
SAST		SAST		SAST		SAST	
				Jan 2	17.7	Jan 6	18.2
Jan 10	13.5	Jan 14	13.3	18	18.6	22	19.0
26	14.2	30	14.1	Feb 3	19.4	Feb 7	19.5
Feb 11	14.7	Feb 15	14.8	19	19.9	23	19.9
27	15.0	Mar 3	15.1	Mar 7	20.1	Mar 11	19.9
Mar 15	14.9	19	15.0	23	19.9	27	19.5
31	14.4	Apr 4	14.4	Apr 8	19.3	Apr 12	18.6
Apr 16	13.5	20	13.4	24	18.1	28	17.4
May 2	12.1	May 6	11.9	May 10	16.5	May 14	15.6
18	08.3	22	09.9	26	14.4	30	13.5
Jun 3	08.2	Jun 7	07.6	Jun 11	12.0	Jun 15	11.1
19	03.6	23	05.0	27	09.3	Jul 1	08.6
Jul 5	03.0	Jul 9	02.3	Jul 13	06.6	17	06.0
21	00.5	24	23.6	29	04.0	Aug 2	03.5
Aug 5	22.1	Aug 9	21.2	Aug 14	01.7	18	01.4
21	20.1	25	19.2	29	23.8	Sep 2	23.7
Sep 6	18.4	Sep 10	17.7	Sep 14	22.4	18	22.4
22	17.3	26	16.6	30	21.5	Oct 4	21.6
Oct 8	16.6	Oct 12	16.1	Oct 16	21.1	20	21.2
24	16.3	28	16.0	Nov 1	21.1	Nov 5	21.2
Nov 9	16.4	Nov 13	16.3	17	21.5	21	21.5
25	16.8	29	16.9	Dec 3	22.2	Dec 7	22.1

The Moons of Jupiter and Saturn 1987

CHANGING CONFIGURATIONS OF JUPITER'S MOONS



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

COMETS AND METEORS

COMETS

About a dozen comets are observed each year. Of these, five or six are new discoveries while the others have been observed during their previous returns around our Sun.
Comets are divided into two groups, depending on the length of their periods around the Sun: Short-period comets, which on the average have a 7 year period, an orbital inclination of about 13 degrees, small orbital eccentricities (between 0.2 and 0.9) and usually travel in a direction motion.
Long-period comets, i.e. those of a period greater than 200 years, have random orbital inclinations, about 0.9999 eccentricity and random motion.
A typical comet consists of a very small solid nucleous surrounded by a large envelope of gas and dust called the coma and in some instances they might develop two kinds of tail, dust and gas tails. As a comet approaches or moves away from the Sun its visual appearance changes drastically. Observers with modest equipment such as a good pair of binoculars (for bright comets) or a refractor with an objective not less than 7,5cm can contribute with valuable information, by reporting on their visual appearance. Another area in need of observers, is that of regularly and systemetrically conducting visual searches for new comets, namely in the southern celestial hemisphere: this activity is also well within the scope of the equipment mentioned. Occasionally, very bright comets are discovered with the naked eye.
Interested members are asked to contact the Director of the Comet & Meteor Section, Mr. Jose' Campos, 19 Fiskaal Place, Woodhaven, Durban, 4001.

PREDICTED PERIHELION PASSAGES OF COMETS, 1989

Periodic comet	Perihelion date	Revolution period years	Perihelion distance au
Tempel 1	Jan. 4	5·5	1·50
d'Arrest	Feb. 4	6·4	1·29
Schwassmann-Wachmann 1	Feb.–Mar	15	5·4
du Toit	Mar.–Apr.	15	1·3
Churyumov-Gerasimenko	June 18	6·6	1·30
Pons-Winnecke	Aug 19	6·4	1·26
Gunn	Sept 24	6·8	2·47
Loves	Oct. 10	9·1	1·68
Gehrels 2	Nov 2	7·9	2·35
Clark	Nov 28	5·5	1·56

METEORS

Orbiting in the interplanetary space, METEOROIDS (usually about the size of a grain of sand), sometimes collide with the Earth's atmosphere and due to the direction of the Earth's motion around the Sun, these collisions are generally seen in greater numbers after local midnight, than in the early evening.
As the meteoroid enters the upper Earth's atmosphere, its rapid motion will heat it to incandescence by friction with the atmosphere's gaseous molecules, causing them to be ionized resulting in an emission of light; this is then called a METEOR (popularly known as a "shooting star") and they are disintergrated completely, long before they reach the ground. There are two types of meteors, the sporadic ones and the showers; the direction in the sky where the shower appears to come from, is called the Radiant. Some showers are known to be caused by the debris of a comet; when our planet intersects a comet's orbit, such a shower may take place.
A table of predicted meteor showers is given on the next page.
Occasionally an extremely bright meteor, i.e. those of visual magnitude greater than Venus (-4.0 mag.), is seen travelling across the sky and it may break up or even explode during its flight; such a very bright meteor is called a fireball and sometimes it may produce debris that reach the ground becoming then known as METEORITES and their masses can range from a few grams, up to several tons.
Interested persons are urged to contact the Director of Comet and Meteor Section, Mr. J. Campos, 19 Friskaal Place, Woodhaven, Durban 4001. In the event of bright fireballs, please phone 031-423684 at any time.

Comets and Meteors

Predicted Limits	Meteor Shower	Radiant (1950) R.A.	Dec	Date at Maximum	Transit of Radiant SAST	Alt	Conditions at Maximum	Z.H.R.	Recommended watch at Max. Beginning: SAST	Alt.	Ending: SAST	Alt.
Feb 06-15	Theta Centaurids	14h20	-44	Feb 08	05h05	76	Favourable	?	01h00	40	04h00	70
Mar 01-12?	Pyxids (new)	09h00	-35	Mar 06?	22h02	85	Very good	6?	20h30	70	03h15	26
Mar 13-18	Corona Australids	16h20	-48	Mar 16	04h43	72	Unfavourable	5	01h00	44	04h30	71
Mar 21-Apr 08	Delta Pavonids	20h10	-65	Mar 29?	07h43	55	Unfavourable	7	02h00	28	04h00	41
Apr 19-24	April Lyrids	18h08	+33	Apr 22	04h06	28	Unfavourable	15	03h00	26	05h00	26
Apr 11-May 12	Alpha Scorpids	16h00	-22	May 03	01h16	82	Very good	7	21h00	33	04h30	46
Apr 20-Jul 30	Sco-Sgr System	18h00	-30	Jun 14	00h29	90	Unfavourable	?	21h00	45	04h00	44
Apr 21-May 12	Eta Aquarids	22h24	-01	May 03	07h23	60	Good	30	04h00	31	05h00	43
May 25-Jun 20	Chi Scorpids	16h28	-13	Jun 05	23h30	73	Very good	6?	19h00	25	04h10	25
Jun 08-16	Sagittarids	20h16	-35	Jun 11	02h59	85	Favourable	4?	21h45	26	05h10	62
Jun 08-16	Theta Ophiuchids	17h48	-28	Jun 13	00h23	88	Unfavourable	5?	20h00	34	05h00	30
Jun 10-21	June Lyrids	18h22	+35	Jun 16	00h53	25	Unfavourable	8	23h30	22	01h30	24
Jun 17-26	Ophiuchids	17h20	-20	Jun 20	23h22	80	Unfavourable	10	19h00	30	02h00	53
Jun 26-29	Cetids (new)	02h00	-15	Jun 28	07h35	75	Favourable	?	03h00	25	05h20	56
Jul 10-Aug 05	Capricornids	21h00	-15	Jul 26	00h47	75	Favourable	8	20h30	30	05h15	25
Jul 14-Aug 25	North Delta Aquarids	22h36	-05	Aug 12	01h13	65	Unfavourable	10	21h00	26	04h30	37
Jul 15-Aug 10	Alpha Capricornids	20h36	-10	Jul 30	23h41	70	Favourable	10	20h00	33	04h00	29
Jul 15-Aug 20	Piscis Australids	22h40	-30	Jul 31	02h03	89	Favourable	12	21h30	32	05h00	51
Jul 15-Aug 25	South Iota Aquarids	22h13	-15	Aug 05	01h29	75	Favourable	12	22h00	40	04h00	52
Jul 15-Sep 20	North Iota Aquarids	21h48	-06	Aug 20	23h51	66	Unfavourable	10	20h00	31	04h00	28
Jul 21-Aug 29	South Delta Aquarids	22h12	-17	Jul 29	02h07	77	Favourable	40	22h00	33	05h00	47
Sep 15-Nov 26	Southern Taurids	03h22	+14	Nov 03	00h31	46	Poor	5	21h30	28	03h00	34
Sep 19-Dec 01	Northern Taurids	03h53	+22	Nov 13	00h27	38	Unfavourable	10	23h30	36	01h00	37
Oct 02-Nov 07	Orionids	06h24	+15	Oct 21	04h23	45	Favourable	20	02h00	33	03h20	42
Nov 14-20	Leonids	10h08	+22	Nov 17	06h21	38	Unfavourable	10	03h00	18	03h30	23
Dec 03-05	December Phoenicids	01h00	-55	Dec 05	20h07	65	Poor	5	20h30	64	01h00	33
Dec 04-16	Geminids	07h28	+32	Dec 14	01h55	28	Unfavourable	50	23h30	19	03h00	26
Dec 05-Jan 07	Velaids	09h56	-51	Dec 29	03h25	69	Very good	15?	00h30	51	03h30	69

NOTE: The times (SAST) and the altitudes (Alt in degrees) given, are for an observer stationed at E 30.5 S 29.5 (Durban). The Zenith Hourly Rate (ZHR) is the no. of meteors seen by an experienced observer during 1 hour, with a naked-eye limiting magnitude of +6.5 and the radiant in the zenith.

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 patters, 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, roughtly 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 a(Alpha), the next B(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 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 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 smll telescopes fail to resolve individual stars - instead they appear as fuzzy balls.

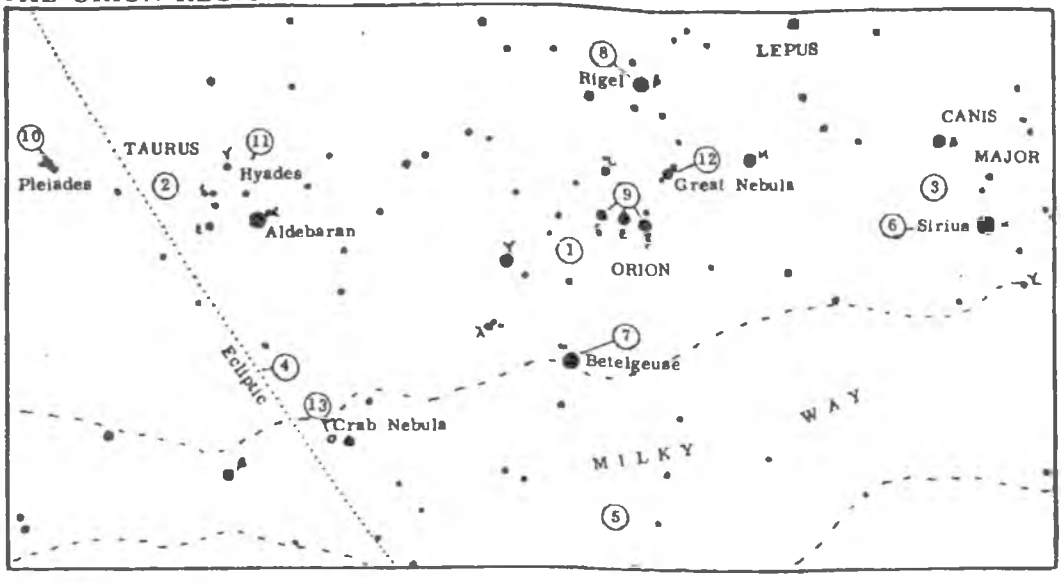
NEBULAE

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.

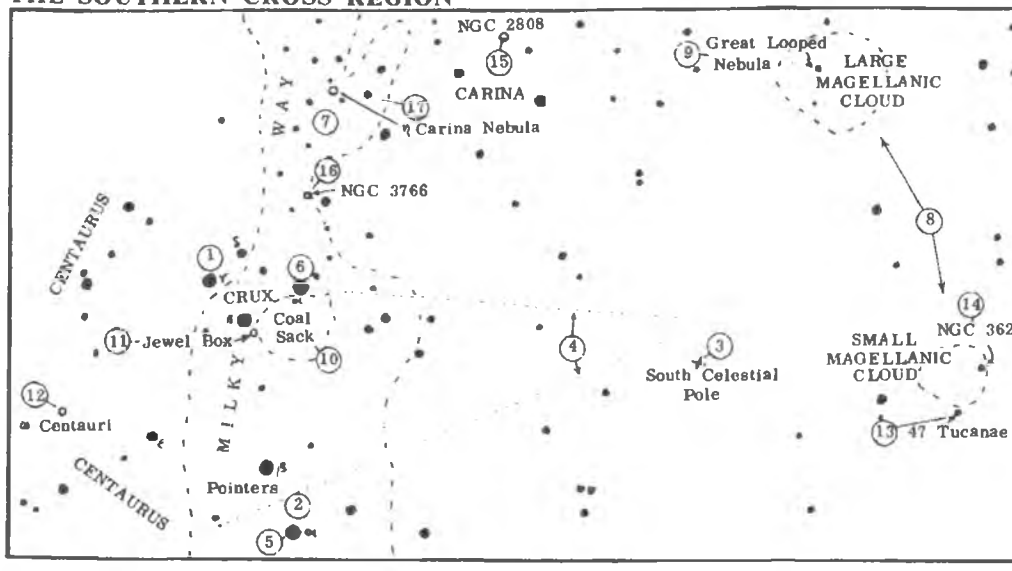
(10) The Pleiades or Seven Sisters form the best known nearby star cluster. Six or seven stars are visible to the naked eye, binoculars or a small telescope show more.

(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).

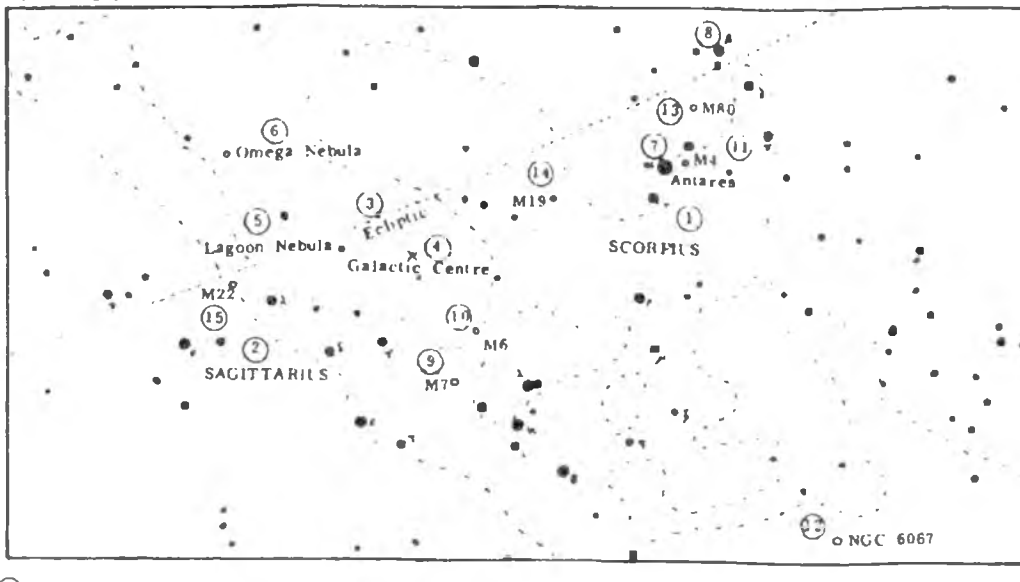
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).

(12) ω Centauri and (13) 47 Tucanae are perhaps the best known globular clusters. Binoculars will show thei 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 σ in the centre of the body and β and π the claws. The distinctive tail ε – ζ – η 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) ν Scorpii can be resolved as a double star (separation 18 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.

VARIABLE STAR OBSERVING

The latest (1985) edition of the "General Catalogue of Variable Stars" lists more than 28 000 stars. Professional observatories cannot possibly monitor all of these, and this makes the observation of variable stars a field in which amateurs can make a real contribution to astronomical knowledge.

Of these 28 000 stars at least 2 000 are suitable for visual monitoring in the southern hemisphere. However, the number of active observers in this part of the world remains woefully small, and less than 400 variables are at present being observed from Southern Africa.

The Variable Star Section of the A.S.S.A. exists for the purpose of encouraging observers and of acting as a medium 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 the Variable Star Observers (AAVSO) and the Variable Star Section of the Royal Astronomical Society of New Zealand. These bodies combine the South African light estimates with those from other parts of the world. The resulting "light curves" and tables are made available to a large number of professional observatories where astronomers are interested in investigating certain of the stars more fully.

In recent years amateur observers have played an invaluable part by alerting the operators of orbiting satellite observatories whenever outburst occurred of certain eruptive variables.

Visual estimates of magnitude are made by comparing the variable with two or more comparison stars, respectively brighter and fainter than the unknown variable. Suitable comparison stars are shown on special charts, which have been prepared for each variable, mainly by the two variable star organisations mentioned above. The use of these charts is essential for accurate, standardized observations and intending new observers are therefore advised to obtain the necessary data by contacting the Director of the Variable Star Section, Mr. J. Hers, P.O. Box 48, Sedgefield, 6573, Telephone (04455) 736. They will then be sent charts of a few easy objects and data on stars which may be observed with the equipment at their disposal.

Prospective observers should, when writing, give brief details of their equipment. Larger, more powerful telescopes will naturally greatly increase the number of stars which may be measured, but many variables are bright enough to be observed through most of their cycles with quite modest equipment, e.g. binoculars. Some stars, such as 071044 L2 Puppis, are so bright that they may be observed without optical aid whatever.

Variable stars are designated in two ways. The first of these, the Harvard designation, consists of six figures which give the position for 1900; the first four figures give hours and minutes of R.A., the last two give the declination in degrees, underlined for southern declinations. The second name consists of one or two letters (or letter V plus a number) and the name of constellation.

Variables can be divided into three main classes: pulsating, eruptive and eclipsing binary stars.

Most suitable for beginners are the long period variables (or Mira variables, named after the typical representative Mira = o Ceti) which belongs to the class of pulsating stars. They are giant stars which vary through a range of brightness of 2.5 to 5 magnitudes or more, and which have well defined periodicities, ranging from 80 to 1000 days. In most cases one observations per observer every 10 days will suffice.

Typical examples include:

			Approximate magnitude range
021403	o	Ceti(Mira)	2.0-10.1
092962	R	Carinae	3.9-10.0
100661	S	Carinae	4.5-9.9

Among the eruptive variables, two groups are of special importance:

U Geminorum type. These are dwarf novae which have long periods of apparent quiescence at minimum, with sudden rises to maximum. A typical representative in the southern hemisphere is 040971 VW Hydri.

R. Coronae Borealis type. These are high luminosity variables with slow, non-periodic drops in brightness. A typical representative is 191033 RY Sagittarii.

Eclipsing Binary Stars have orbital planes which lie close to the line of sight of the observer. The two components periodically eclipse each other, thus causing variations in the apparent brightness of the system. Periods are generally short, of the order of hours, so that observational programmes need very careful planning. Monitoring these interesting stars is therefore for experienced observers only.

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.

ORDINARY OCCULTATIONS

This Section and that following concern a specialised branch of observational astronomy in which both professional and amateur participate. The tables of predictions must necessarily occupy a number of pages as this handbook is the sole published source for Southern Africa.

An occultation occurs when the disk of the Moon moves in front of a star. Timings of occultations, to a precision of one-tenth of a second if possible are very valuable for studies of the Moon's shape and motion. Since only very modest equipment is required, amateurs can make important contributions in this field.

Predictions of occultations of all stars brighter than magnitude 7,5 supplied by Hydrographic Dept, Tokyo are given below. The main set of tables give predictions for three stations, namely,

	Longitude	Latitude
Cape Town	- 18°.475	- 33°.933
Johannesburg	- 28°.075	- 26°.182
Harare	- 31°.100	- 17°.700

This does not restrict its use to observers to those centres. The approximate time of an occultation at a place $\Delta\lambda$ degrees west and $\Delta\phi$ degrees north of one of the standard stations given above may be found from:

$$\text{Approximate time} = \text{predicted time} + a.\Delta\lambda + b.\Delta\phi$$

where a and b, in minutes of time, are given in the tables. Alternatively, rough times for intermediate stations can usually be estimated direct from the tables.

Occulted stars have been identified by their Z.C. numbers, that is their numbers in the "Catalogue of 3539 Zodiacal Stars for the Equinox 1950.0" by James Robertson (U S Naval Observatory, 1939).

Note: That the times of these occultations are given in U.T.

Explanations of Abbreviations used in Tables

Z.C. - the number of the star in the Zodiacal Catalogue. An "m" following the number indicates the star is not single.

Mag. - the visual magnitude
Ph - the Phase: D = Disappearance, R = Reappearance
h.m. - the time of the occultation in U T
a,b - parameters in minutes for predicting times other than at standard stations (explained above in text)
P.A. - The Position Angle on the Moon's limb measured eastward from the north point

LUNAR OCCULTATIONS

DATE						CAPE TOWN				JOHANNESBURG				HARARE			
						E 18.5	S 33.9			E 28.1	S 26.2			E 31.0	S 17.8		
M	D	S.C.	Mag.	Ph	ELG	TIME	a.	b.	P.A.	TIME	a.	b.	P.A.	TIME	a.	b.	P.A.
					°	h m	s	s	°	h m	s	s	°	h m	s	s	°
Jan	1	1888	6.2	RD	279	00 50.8	-0.2	-2.2	322	00 31.9	+0.2	-3.1	352				
Jan	11	3380	6.2	DD	53	19 23.3			123								
Jan	16	490	5.7	DD	118					18 13.5	-2.3	+1.0	61	18 32.4	-2.4	+1.9	45
Jan	17	673	6.6	DD	132									22 16.2	-0.1	-1.9	144
Jan	18	801	6.4	DD	142					17 44.1	-1.9	-0.0	71	17 53.6	-2.0	+1.0	54
Jan	18	810	1.8	DD	143									20 18.5			163
Jan	18	810	1.8	RB	144									20 51.5			203
Jan	18	824	6.2	DD	144	21 50.4	-2.6	+1.6	51								
Jan	20	1008	5.1	DD	158	00 55.2	-0.3	-0.4	139	01 1.1	-0.7	+0.6	99	01 12.6	-1.4	+1.7	64
Jan	24	1487	1.3	DB	206	05 23.1	+0.4	-2.1	172								
Jan	25	1660	6.2	RD	225	22 27.8	-0.6	-2.8	344								
Jan	25	1663	5.2	RD	225	23 11.2	-0.0	-3.4	2								
Jan	28	1853	4.9	RD	248									02 7.3	-4.5	+0.2	266
Feb	4	2804	5.9	RD	330	02 42.9	+0.2	-1.1	278	02 26.0	+0.8	-2.6	320				
Feb	11	329	7.1	DD	75	19 14.1			4								
Feb	16	1088	5.6	DD	138					22 2.6	-0.7	-1.0	141	22 0.9	-1.5	-0.2	112
Feb	16	1093	6.4	DD	138	22 19.6	-2.8	+1.8	66								
Feb	28	2263	4.8	RD	262									02 21.9	-4.0	+1.1	251
Feb	28	2268	4.8	RD	262	03 30.3	-1.4	-3.1	327								
Feb	28	2287	3.0	DB	264					06 45.3	-2.4	-2.4	145	06 41.5	-2.0	-0.4	113
Feb	28	2287	3.0	RD	264					07 35.4	-0.2	+3.5	223	07 55.0	-0.5	+1.3	253
Mar	1	2405	6.4	RD	272					00 44.4	-1.7	-0.4	258	00 41.1	-1.1	-1.3	289
Mar	2	2545	6.4	RD	284	01 0.8	-0.2	-1.6	290	00 43.6	+0.6	-3.2	332				
Mar	3	2721	3.3	RD	297	02 0.9	-0.3	-1.7	289	01 38.9			342				
Mar	10	267	7.3	DD	42					16 58.1			351				
Mar	14	897	6.4	DD	95	20 23.2	-1.3	+1.0	92								
Mar	15	1056	7.0	DD	108					21 27.2	+0.0	-0.9	144	21 24.3	-0.6	-0.1	112
Mar	17	1308	4.7	DD	130	21 7.7	-3.4	+1.6	72								
Mar	17	1315	6.9	DD	132	23 39.5	+0.0	-0.9	151								
Mar	20	1600	5.1	DD	163	21 27.0	-2.7	-0.7	103								
Mar	23	1884	5.3	RD	197	22 28.2	-2.0	-1.5	293	22 28.0	-1.2	-2.7	332	22 0.7	+0.6	-4.4	5
Mar	26	2108	6.4	RD	221	03 23.0	-2.2	+0.9	271								
Mar	26	2109	6.1	RD	221	04 7.7	-1.8	+1.8	257								
Mar	29	2505	5.4	RD	253					00 18.0	-2.2	-0.0	254	00 18.2	-1.8	-1.2	286
Apr	2	3115	6.3	RD	303	01 38.8			191	01 54.7	-0.8	+0.3	236	01 56.1	-0.8	-0.6	268
Apr	2	3126	4.3	RD	305	04 6.9	-1.3	-0.4	256								
Apr	10	810	1.8	DD	62					16 5.4			161	15 54.8	-1.9	-1.0	125
Apr	10	810	1.8	RB	62					16 41.0			211	17 8.9	-2.1	+1.3	250
Apr	11	996	6.9	DD	75					17 4.4	-1.9	-0.1	112	17 12.6	-2.5	+0.7	85
Apr	11	1008	5.1	DD	76	19 29.0	-0.8	+0.4	114	19 44.5	-1.2	+1.4	75				
Apr	12	1131	7.2	DD	87					16 35.0	-2.6	-0.4	107	16 43.8	-3.4	+0.6	82
Apr	14	1383	6.6	DD	112	21 42.4	-1.3	+0.7	100								
Apr	25	2470	6.1	RD	225	02 53.4	-2.4	+0.3	273	03 16.1	-2.6	-0.6	294	03 5.7			335
Apr	29	3069	6.2	RD	273	01 23.8	-1.3	+2.0	204	01 47.2	-1.7	+0.7	237	01 54.5	-2.2	-0.4	267
Apr	30	3206	5.2	RD	285	01 28.3	-0.8	+1.8	201	01 45.8	-1.2	+0.6	234	01 51.2	-1.6	-0.3	263
May	3	68	5.7	RD	326									02 44.6	-0.9	-2.1	293
May	13	1531	5.9	DD	102					15 48.4	-1.1	-2.7	160				
May	13	1547	3.9	DD	104	19 51.9			56								
May	13	1547	3.9	RD	104	20 12.4			26								
May	13	1550	5.8	DD	105	21 35.1	-1.0	+0.4	111	21 57.4			60				

					CAPE TOWN				JOHANNESBURG				HARARE			
					E 18.5	S 33.9			E 28.1	S 26.2			E 31.0	S 17.8		
DATE	I.C.	Mag.	Ph	ELG	TIME	a.	b.	P.A.	TIME	a.	b.	P.A.	TIME	a.	b.	P.A.
M D				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
May 16	1815	4.8	DD	136									19 50.2	-0.1	-4.4	181
May 22	2554	4.4	RD	205	21 58.9	-2.3	+0.7	238								
May 22	2554	4.4	RD	206					22 19.5	-2.4	-0.9	278	22 11.7	-2.1	-2.8	312
May 23	2721	3.3	RD	217					21 50.4	-2.3	+1.2	230	22 0.0	-2.1	-0.3	266
May 24	2740	6.3	RD	220	01 56.4	-1.9	+2.1	231	02 29.3	-1.9	+1.6	244	02 45.2	-2.3	+0.7	266
May 24	2750	2.1	DB	220	02 31.2	-1.9	+1.7	60	03 2.5	-1.3	+2.3	50	03 27.1	-0.3	+3.1	27
May 24	2750	2.1	RD	220	03 53.2	-1.7	+1.2	262	04 16.3	-1.4	+1.0	267	04 25.0	-1.8	-0.1	287
May 27	3173	5.3	RD	257	03 49.3	-2.8	-0.3	273								
May 27	3173	5.3	DD	257									04 0.0			333
Jun 8	1395	6.3	DD	61	16 20.8	-1.6	-0.6	126	16 41.6	-2.8	+1.3	82				
Jun 9	1487	1.3	DD	71	13 8.1	-1.0	-2.8	165	13 1.8	-1.7	-2.1	137	12 52.1	-2.4	-1.5	116
Jun 9	1487	1.3	RB	71	14 13.4	-2.9	-0.5	265	14 31.7	-2.3	-1.3	300	14 23.0	-1.8	-2.3	325
Jun 13	1885	7.4	DD	118					20 3.8	-1.0	-3.4	167	19 48.8	-2.0	-1.6	132
Jun 15	2108	6.4	DD	141	22 16.3	-1.9	-0.7	123	22 34.6	-1.7	+0.7	94	22 51.6	-1.1	+2.5	60
Jun 15	2109	6.1	DD	141	23 7.6	-1.7	-1.2	138	23 18.2	-1.3	+0.0	112	23 25.7	-0.9	+1.0	84
Jun 17	2366	1.2	DD	162	19 36.4	-3.2	+1.5	55								
Jun 17	2366	1.2	RB	162	20 29.2	-0.9	-4.7	340								
Jun 21	2961	6.0	RD	211					18 38.2	-0.3	-0.4	255	18 32.0	+0.1	-1.2	288
Jun 24	3380	6.2	RD	251									21 34.6	-0.4	-0.0	253
Jun 28	266	5.7	DD	294	04 34.3			327								
Jun 28	266	5.7	RD	294	04 39.5			319								
Jul 8	1652	5.5	DD	65					17 40.1	-0.4	-2.4	165	17 28.7	-1.2	-1.1	131
Jul 12	2066	6.4	DD	110									21 4.6	-1.5	-1.5	138
Jul 14	2298	5.1	DD	131	16 31.4	-0.4	-3.0	149	16 24.2	-1.7	-1.4	108	16 25.4	-3.1	+0.4	75
Jul 14	2312	5.6	DD	132	20 9.7			176	20 2.2	-2.6	-1.7	127	20 4.1	-2.9	+0.1	96
Jul 16	2470	6.1	DD	146	00 16.3			151	00 24.0	-1.8	-1.1	135	00 24.3	-0.9	+0.0	108
Jul 17	2650	4.7	DD	160	03 3.4	-0.2	+0.9	98	03 10.0	+0.1	+0.7	94				
Jul 17	2750	2.1	DD	166	15 28.4	+1.1	-2.7	145	15 9.3	+0.2	-1.1	103	15 4.2	-0.2	-0.1	73
Jul 17	2750	2.1	RB	166	16 0.6	-0.9	+0.9	216	16 6.8	-0.5	-0.6	260	16 0.3	-0.1	-1.3	291
Jul 20	3079	4.2	RD	197	00 46.4			297	01 14.0			297				
Jul 22	3362	5.9	RD	224	02 7.2	+0.0	+3.3	180	02 32.1	+0.4	+3.7	175	02 59.8	-0.3	+3.0	191
Jul 25	221	3.7	RD	264	02 58.4			304	03 26.2			297				
Jul 27	490	5.7	RD	290	02 26.9	-1.6	-1.6	283	02 34.1	-2.4	-1.5	287				
Aug 6	1809	6.9	DD	58	19 38.0			186								
Aug 10	2268	4.8	DD	104	23 5.2	-0.2	+1.0	94								
Aug 10	2273	5.9	DD	104	23 34.9	+0.3	+1.5	73								
Aug 11	2366	1.2	DD	110	11 56.5	+0.1	-1.2	97	11 54.0	-0.9	+0.1	61				
Aug 11	2366	1.2	RB	110	12 54.6	-0.0	-1.7	299	12 35.1	+0.7	-3.0	338				
Aug 11	2405	6.4	DD	114	21 15.5			158	21 22.0	-2.1	-1.2	133	21 23.1	-1.4	+0.0	105
Aug 12	2545	6.4	DD	126	21 37.4	-2.2	-0.4	117	21 56.3	-1.7	+0.2	106	22 5.1	-1.1	+0.8	84
Aug 13	2554	4.4	DD	127									00 12.4	-0.9	-0.9	130
Aug 14	2861	5.7	DD	149	17 53.2	-1.2	-3.1	126	17 56.0	-2.1	-0.7	90	18 4.7	-2.5	+1.2	59
Aug 14	2864	4.7	DD	149					18 48.5			155	18 26.2	-2.8	-1.1	102
Aug 21	302	6.4	RD	246					22 13.1	-1.7	-2.0	289				
Aug 25	771	6.1	RD	286									00 58.0	+0.6	+2.2	202
Aug 25	810	1.8	DB	291	09 18.1	-1.0	+0.7	104	09 37.1	-1.3	+1.6	68				
Sep 5	2084	6.5	DD	60					16 47.6	-1.8	+1.9	75				
Sep 8	2470	6.1	DD	93					16 26.8	-2.9	+1.1	73	16 57.3	-2.4	+4.8	35
Sep 8	2474	6.6	DD	94	17 8.2	-2.5	-0.7	106	17 34.7	-2.5	+1.0	81	17 56.3	-1.9	+2.6	52
Sep 9	2634	7.4	DD	106	18 49.8	-2.5	+0.0	98	19 16.0	-2.1	+0.9	85	19 32.1	-1.4	+1.6	63

					CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
DATE M D	I.C.	Mag.	Ph	ELG °	TIME h m	a. m	b. m	P.A. °	TIME h m	a. m	b. m	P.A. °	TIME h m	a. m	b. m	P.A. °
Sep 9	2650	4.7	DD	107	21 20.0	-0.4	+2.4	47	21 39.5	+0.1	+2.3	42	21 59.5	+1.1	+3.1	18
Sep 10	2804	5.9	DD	119									20 7.7			131
Sep 10	2809	4.9	DD	119	20 53.1	-1.3	+1.9	59	21 17.7	-0.8	+1.9	55	21 36.2	-0.2	+2.2	38
Sep 12	2964	6.6	DD	133	00 32.6	+0.1	+1.9	42	00 44.7	+0.4	+1.8	39				
Sep 12	3086	6.0	DD	144	19 26.5	-2.2	+0.2	78	19 53.3	-2.3	+1.0	69	20 11.5	-1.9	+1.8	51
Sep 18	266	5.7	RD	217	01 5.3	-1.7	+1.0	233	01 32.4	-1.9	+1.5	233	01 49.7	-2.2	+1.2	248
Sep 21	731	5.9	RD	257					00 44.2			185	01 7.1	-1.2	+1.9	214
Oct 4	2298	5.1	DD	53	17 58.7	-1.7	-0.9	135	18 8.5	-1.0	-0.1	119	18 12.5	-0.5	+0.5	95
Oct 5	2449	7.5	DD	65	20 47.9	+0.1	+1.2	82								
Oct 6	2575	6.8	DD	76	18 24.5	-0.6	+3.3	37	18 51.8	+0.4	+3.5	26				
Oct 9	3026	7.3	DD	112	19 32.6	-2.2	+0.8	83	20 0.0	-1.9	+1.0	83	20 14.9	-1.4	+1.3	68
Oct 11	3186	6.7	DD	127	00 12.1	-0.3	+1.4	77								
Oct 17	490	5.7	RD	212	01 30.5	-2.0	+1.0	243	01 58.1	-2.0	+1.0	255	02 10.0	-1.9	+0.3	275
Nov 1	2366	1.2	DD	30	09 1.3	-0.6	-2.1	125	09 1.0	-1.9	-0.7	87	09 17.1			41
Nov 1	2366	1.2	RB	31	10 17.6	-1.9	-1.0	274	10 21.3	-1.6	-2.6	313	09 47.2			2
Nov 1	2404	6.9	DD	34	18 11.5	-0.8	+0.0	125								
Nov 1	2409	6.9	DD	35	18 59.2	+0.0	+1.0	93								
Nov 2	2537	7.4	DD	46	18 42.8			17								
Nov 4	2834	5.0	DD	67									16 21.2	-0.7	+3.3	26
Nov 4	2835	7.1	DD	67									16 46.4			360
Nov 4	2857	6.7	DD	70	21 1.8			140								
Nov 7	3238	7.0	DD	105					18 7.3	-2.1	+1.3	66	18 26.2	-1.7	+1.8	53
Nov 15	909	6.1	RD	216									19 47.6	+0.4	+1.5	214
Nov 17	1221	6.2	RD	243									21 35.0	-0.4	+0.4	242
Nov 30	2657	6.7	DD	27	18 40.6			15								
Dec 6	3477	6.7	DD	100	20 20.5	-1.6	+1.2	88	20 42.3	-1.1	+1.2	83	20 55.3	-0.7	+1.3	66
Dec 7	51	7.2	DD	113	19 43.6	-2.3	+0.8	89	20 10.9	-1.9	+0.9	88	20 25.0	-1.6	+1.2	72
Dec 9	329	7.1	DD	139					18 35.1	-0.8	+2.1	18	19 1.0			357
Dec 9	337	5.7	DD	141	20 28.3	-2.2	+0.6	79	20 55.3	-2.1	+1.0	75	21 11.8	-2.0	+1.5	58
Dec 14	1155	6.3	RD	209					20 19.7	-0.8	-0.1	246	20 20.3	-1.3	-0.5	267
Dec 14	1157	6.0	RD	209					20 34.7			211	20 47.5	-1.3	+0.5	242
Dec 14	1170	3.7	RD	211	23 36.6	-1.9	-1.4	311	23 40.4	-1.6	-2.5	337				
Dec 15	1295	6.5	RD	223	22 50.2	-1.6	+0.3	234	23 10.0	-2.5	-0.3	260	23 12.5	-2.6	-0.9	283
Dec 17	1415	6.2	RD	237					02 7.4	-4.0	+0.9	257	02 16.6	-2.7	-0.8	290

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, 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 Hydrographic Dept, Tokyo to show the tracks of stars brighter than 7.5 magnitude which will graze the limb of the Moon when it is at a favourable elongation from the Sun and at least 10° above the observer's horizon (2° in the case of bright stars). Each track starts in the West at some arbitrary time given in the key and ends beyond 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 (at whole minutes), 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. Such predictions, which include graphical representations of the probable profile of the Moon, are computed annually for a number of centres in Southern Africa. By plotting the predicted graze track on a reliable survey map (e.g. 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 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 observation at all.

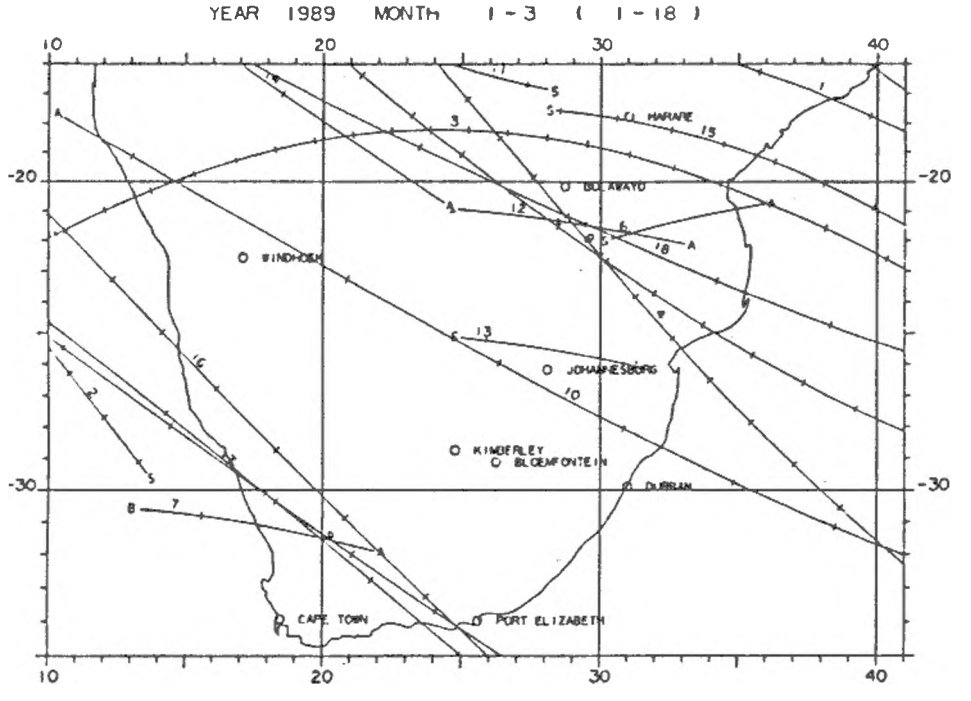
Interested observers - especially those living in the more distant regions - who wish to be informed of favourable grazes occurring in their neighbourhood, are therefore invited to contact the co-ordinator for grazing occultations M.D. Overbeek, P.O. Box 212, Edenvale, 1610. Tel: (011) 535 447.

EXPLANATION OF COLUMN HEADINGS IN TABLES:

SEQ	Sequential number in the year. The same number is attached to the corresponding track on the map.
NZC NO	Zodiacal Catalogue number of the star.
MAG	Magnitude of the star.
MON, DAY, H, M, S	Month, day, hour, minute and second in UT for the west end of the track.
SUNLIT (%)	Percent of the Moon sunlit (a minus sign indicates a waning Moon).
Limit	Whether the track is the north (N) or the south (S) limits of the occultation.
	(A) denotes that the Moon is at a low altitude.
	(B) denotes that the star is occultated at bright limb.
	(S) denotes that the daylight interferes.

The map gives the graze tracks or the limits of occultations. Along each track on the map, tick marks are given for the points corresponding to the multiples of five minutes of every hour, while the prediction for the west end of each track is shown on the computer list, e.g. if the time for the west end of a track is 5h 43m 17s, the tick marks proceeding eastward correspond to 5h 45m 00s, 5h 50m 00s, 5h 55m 00s etc.

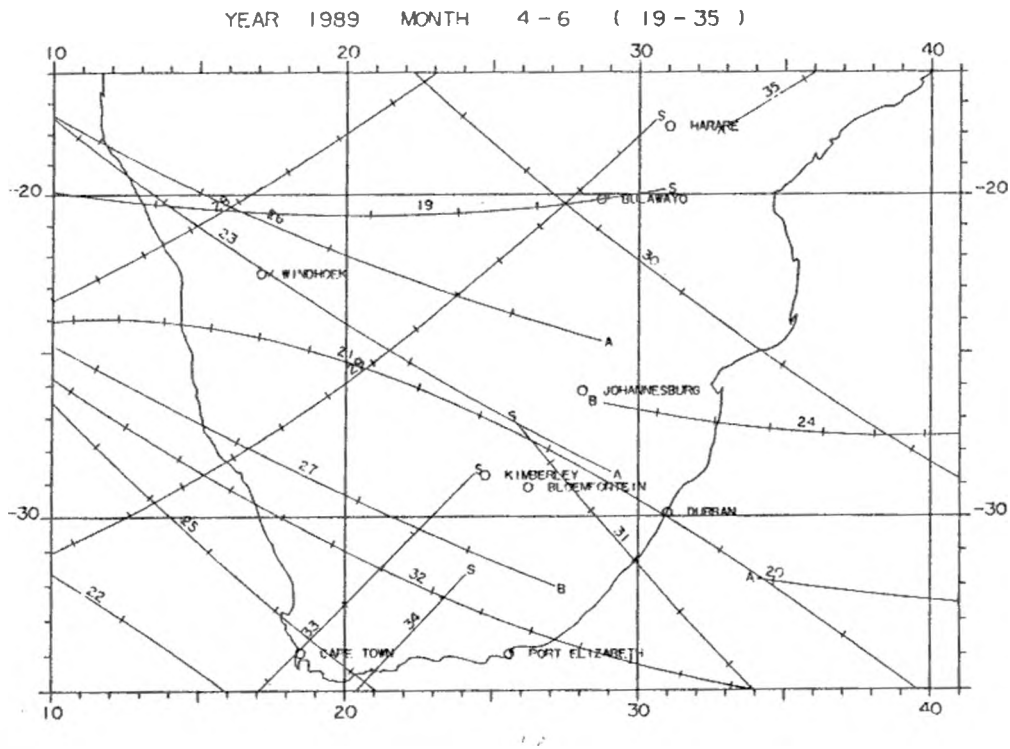
GRAZING OCCULTATIONS



S A S T

SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT (%)	LIMIT		
1	1779	6.68	1	0	00	24	9.33	-51.91	S	( )	( )
2	1792	7.14	1	0	5	26	47.69	-50.38	S	( )	(S)
3	810	1.78	1	18	21	24	11.99	90.11	S	( )	( )
4	1853	4.91	1	28	3	20	28.73	-68.64	S	( )	( )
5	2312	5.64	2	1	2	19	46.39	-30.63	S	( )	( )
6	3460	7.10	2	8	19	4	19.32	7.85	S	(S)	(A)
7	329	7.10	2	11	21	27	48.77	36.79	N	(B)	(A)
8	2263	4.77	2	28	3	28	42.28	-57.22	S	( )	( )
9	2405	6.38	3	1	2	5	39.57	-47.58	S	( )	( )
10	2723	6.70	3	3	3	28	57.81	-26.81	S	(A)	( )
11	2899	7.45	3	4	5	41	18.58	-16.97	S	( )	(S)
12	266	5.73	3	10	19	2	28.64	12.36	N	(S)	(A)
13	267	7.32	3	10	19	4	20.15	12.40	N	(S)	(A)
14	897	6.42	3	14	23	3	36.25	54.09	N	( )	(A)
15	1169	5.40	3	16	18	29	35.83	72.75	N	(S)	( )
16	1308	4.73	3	17	23	8	0.32	82.11	N	( )	( )
17	2505	5.43	3	29	1	29	20.77	-64.06	S	( )	( )
18	2824	7.40	3	31	2	6	31.93	-43.07	S	( )	( )

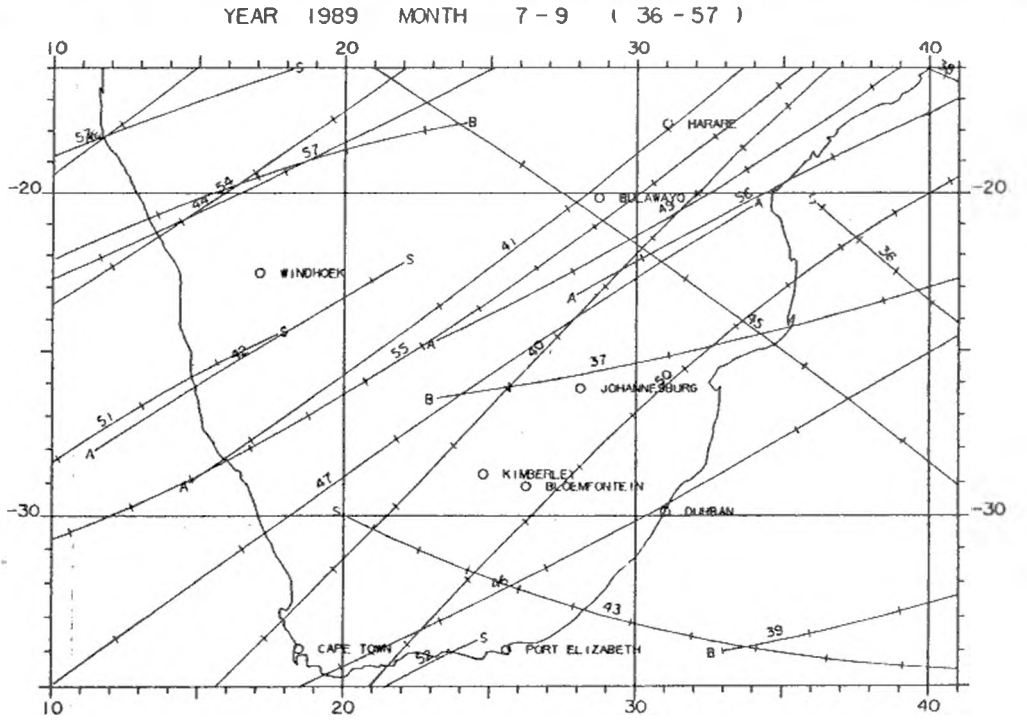
GRAZING OCCULTATIONS



S A S T

SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT (%)	LIMIT		
19	3126	4.30	4	2	5	21	15.82	-21.20	N	( )	(S)
20	3255	7.36	4	3	3	29	46.04	-13.06	N	(A)	( )
21	810	1.78	4	10	17	32	37.00	26.40	S	( )	( )
22	824	6.24	4	10	19	31	39.55	26.89	N	( )	( )
23	1383	6.60	4	14	23	58	21.71	68.27	N	( )	(A)
24	2781	7.42	4	27	2	15	9.65	-68.86	N	(B)	( )
25	1547	3.85	5	13	21	40	30.12	61.33	N	( )	( )
26	1550	5.78	5	13	23	52	20.55	61.87	N	( )	(A)
27	2721	3.30	5	23	23	3	37.07	-89.62	S	( )	(B)
28	2750	2.14	5	24	5	9	57.60	-88.58	N	( )	( )
29	3173	5.28	5	27	5	3	1.79	-61.16	N	( )	(S)
30	1395	6.27	6	8	18	50	45.82	25.27	N	( )	( )
31	1589	6.05	6	10	17	55	30.09	43.82	N	(S)	( )
32	2366	1.22	6	17	21	33	17.03	97.66	N	( )	( )
33	266	5.73	6	28	6	34	24.15	-29.25	N	( )	(S)
34	267	7.32	6	28	6	48	41.47	-29.21	N	( )	(S)
35	529	6.15	6	30	4	18	28.03	-11.63	N	(A)	( )

GRAZING OCCULTATIONS

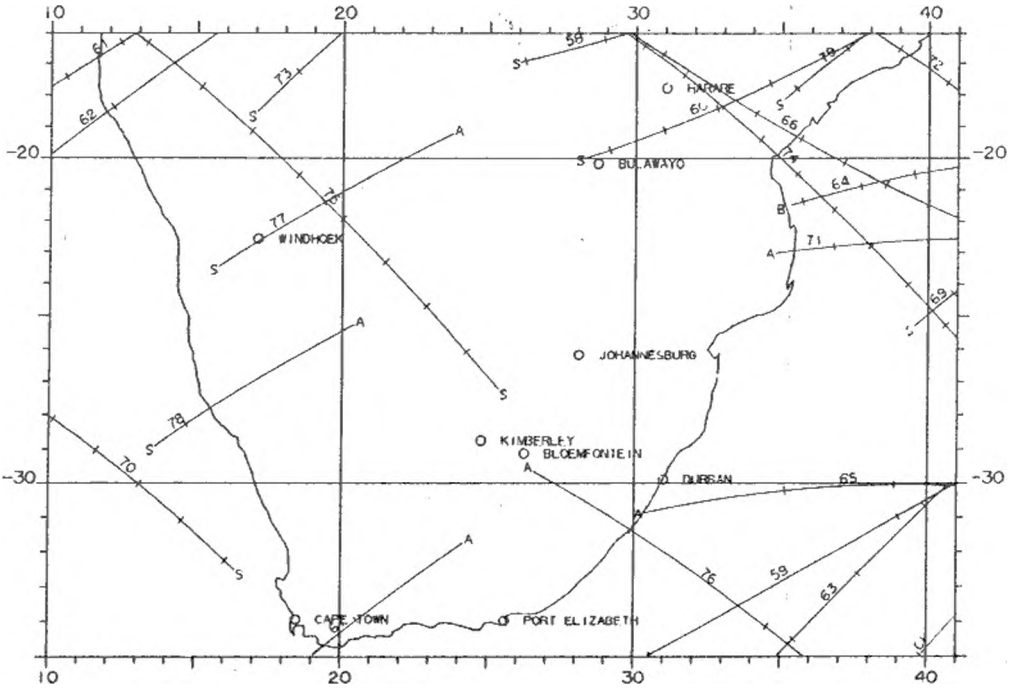


S A S T

SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT (%)	LIMIT		
36	2051	5.74	7	12	17	34	14.27	65.52	N	(S)	( )
37	2066	6.43	7	12	27	27	18.10	66.89	S	(B)	( )
38	2298	5.10	7	14	19	22	27.95	82.98	N	( )	( )
39	2312	5.64	7	14	22	49	40.53	83.62	S	(B)	( )
40	221	3.72	7	25	4	41	46.69	-54.67	N	( )	( )
41	490	5.66	7	27	3	58	52.30	-32.25	N	(A)	( )
42	1008	5.05	7	30	6	50	25.54	-6.53	N	(A)	(S)
43	2011	6.53	8	8	18	36	35.39	39.91	N	(S)	( )
44	2263	4.77	8	11	0	28	23.63	60.86	S	( )	( )
45	2366	1.22	8	11	14	2	9.29	67.74	N	( )	( )
46	2405	6.38	8	11	23	27	45.46	70.10	S	( )	( )
47	2554	4.40	8	13	2	7	5.26	79.84	S	( )	(A)
48	2721	3.30	8	14	1	40	13.50	87.51	S	( )	( )
49	302	6.42	8	21	23	52	14.14	-70.08	N	(A)	( )
50	320	5.92	8	22	4	7	1.03	-68.62	N	( )	( )
51	788	6.89	8	25	6	29	37.96	-34.16	N	( )	(S)
52	1105	6.51	8	27	6	18	14.12	-15.86	N	( )	(S)
53	1239	6.44	8	28	6	29	17.78	-8.82	N	( )	(S)
54	2643	6.70	9	9	22	55	29.11	64.05	S	( )	( )
55	2804	5.86	9	10	21	28	28.10	73.58	S	( )	( )
56	1056	6.97	9	23	2	38	52.30	-39.29	N	(A)	( )
57	1067	7.19	9	23	4	55	37.34	-38.43	N	( )	(B)

GRAZING OCCULTATIONS

YEAR 1989 MONTH 10 - 12 (58 - 79)



S A S T

SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT (%)	LIMIT		
58	2287	3.00	10	4	18	9	45.48	18.86	S	(S)	( )
59	2298	5.10	10	4	20	29	54.97	19.39	S	( )	( )
60	2721	3.30	10	7	18	2	47.22	46.19	S	(S)	( )
61	2735	7.22	10	7	20	43	30.93	47.02	S	( )	( )
62	2750	2.14	10	7	23	32	5.10	47.83	S	( )	( )
63	3026	7.33	10	9	22	23	39.54	68.30	S	( )	( )
64	1013	6.89	10	20	2	13	41.45	-65.90	S	(B)	( )
65	1387	6.79	10	23	2	45	22.31	-34.64	S	(A)	( )
66	2366	1.22	11	1	11	26	44.23	7.15	N	( )	( )
67	2857	6.67	11	4	23	8	41.59	31.97	S	( )	(A)
68	3238	7.00	11	7	20	44	53.01	62.55	S	( )	( )
69	3362	5.87	11	8	18	6	29.24	72.46	S	(S)	( )
70	1362	7.35	11	19	4	54	22.78	-60.68	S	( )	(S)
71	1449	6.70	11	20	0	43	29.65	-51.90	S	(A)	( )
72	1652	5.52	11	22	3	32	38.16	-31.73	S	( )	( )
73	3071	6.54	12	3	19	40	59.37	25.59	S	(S)	( )
74	1516	6.96	12	18	2	17	47.38	-68.73	S	( )	( )
75	1809	6.90	12	21	4	13	54.94	-39.07	S	( )	(S)
76	2011	6.53	12	23	2	17	25.19	-22.51	S	(A)	( )
77	3038	6.70	12	30	20	11	34.29	6.82	S	(S)	(A)
78	3041	6.37	12	30	20	33	56.25	6.93	S	(S)	(A)
79	3420	7.14	12	33	18	43	37.66	30.54	S	(S)	( )

TIME SYSTEMS

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

TIME SIGNALS FROM RADIO STATION ZUO

Radio signals of mean solar time are generated by the Time Frequency Project in the Electromagnetic Metrology Programme of the Division for Production Technology of the CSIR 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

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 (formerly known as Greenwich Mean Time) at the next minute. (A special coding indicating UT1 minus UTC is also indicated in the first 15 seconds of the minute by slightly lengthened second pulses).

SOUTH AFRICAN STANDARD TIME

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

TIME OF SUN'S TRANSIT OVER 30° MERIDIAN

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

		h	m	s			h	m	s			h	m	s
Jan	1	12	03	36	May	11	11	56	20	Sep	18	11	54	08
	11	12	07	58		21	11	56	31		28	11	50	38
	21	12	11	21		31	11	57	36					
	31	12	13	28						Oct	8	11	47	34
					Jun	10	11	59	22		18	11	45	10
Feb	10	12	14	16		20	12	01	29		28	11	43	48
	20	12	13	45		30	12	03	35					
										Nov	7	11	43	42
Mar	2	12	12	09	Jul	10	12	05	19		17	11	44	58
	12	12	09	46		20	12	06	18		27	11	47	40
	22	12	06	53		30	12	06	23					
										Dec	7	11	51	28
Apr	1	12	03	52	Aug	9	12	05	29		17	11	56	06
	11	12	01	03		19	12	03	36		27	12	01	04
	21	11	58	42		29	12	00	52		31	12	03	00
May	1	11	57	03	Sep	8	11	57	40					

SIDEREAL TIME ON THE 30° MERIDIAN

		At 0 hrs SAST h	m	At 21 hrs SAST h	m			At 0 hrs SAST h	m	At 21 hrs SAST h	m			At 0 hrs SAST h	m	At 21 hrs SAST h	m
Jan	1	6	42	3	46	May	11	15	15	12	18	Sep	18	23	48	20	51
	11	7	22	4	25		21	15	54	12	58		28	0	27	21	30
	21	8	01	5	04		31	16	34	13	37	Oct	8	1	06	22	11
	31	8	41	5	44	Jun	10	17	13	14	17		18	1	46	22	49
Feb	10	9	20	6	23		20	17	53	14	56		28	2	25	23	28
	20	10	00	7	03		30	18	32	15	35	Nov	7	3	05	0	08
Mar	2	10	39	7	42	Jul	10	19	12	16	15		17	3	44	0	47
	12	11	19	8	22		20	19	51	16	54		27	4	24	1	27
	22	11	58	9	01		30	20	30	17	34	Dec	7	5	03	2	06
Apr	1	12	37	9	40	Aug	9	21	10	18	13		17	5	42	2	46
	11	13	17	10	20		19	21	49	18	52		27	6	22	3	25
	21	13	56	10	59		29	22	29	19	32		31	6	37	3	41
May	1	14	36	11	39	Sep	8	23	08	20	11						

CORRECTION FOR PLACES NOT ON THE 30° MERIDIAN

Approximate longitude corrections from the 30° East Meridian are provided below. To find time of Sun's transit over local meridian, apply the longitude corrections to the data in the table on page 43.

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	$+\ 8^m$	Harare	$-\ 4^m$
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 it 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	$1^h37^m,3$	-57°17'	0,6	B5	Procyon	$7^h38^m,8$	5°15'	0,5	F5
Aldebaran	4 35,3	+16 29	1,1	K5	Regulus	10 07,8	+12 01	1,3	B8
Rigel	5 14,0	- 8 13	0,3	B8	Spica	13 24,6	-11 06	1,2	B2
Betelgeuse	5 54,6	+ 7 24	0,4	M0	Arcturus	14 15,2	+19 14	0,2	K0
Canopus	6 23,7	-52 41	-0,9	F0	Antares	16 28,7	-26 25	1,2	M1
Sirius	6 44,7	-16 42	-1,6	A0	Altair	19 50,3	+ 8 50	0,9	A5

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	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
	2447	2447	2447	2447	2447	2447	2447	2447	2447	2447	2447	2447
1	528	559	587	618	648	679	709	740	771	801	832	862
2	529	560	588	619	649	680	710	741	772	802	833	863
3	530	561	589	620	650	681	711	742	773	803	834	864
4	531	562	590	621	651	682	712	743	774	804	835	865
5	532	563	591	622	652	683	713	744	775	805	836	866
6	533	564	592	623	653	684	714	745	776	806	837	867
7	534	565	593	624	654	685	715	746	777	807	838	868
8	535	566	594	625	655	686	716	747	778	808	839	869
9	536	567	595	626	656	687	717	748	779	809	840	870
10	537	568	596	627	657	688	718	749	780	810	841	871
11	538	569	597	628	658	689	719	750	781	811	842	872
12	539	570	598	629	659	690	720	751	782	812	843	873
13	540	571	599	630	660	691	721	752	783	813	844	874
14	541	572	600	631	661	692	722	753	784	814	845	875
15	542	573	601	632	662	693	723	754	785	815	846	876
16	543	574	602	633	663	694	724	755	786	816	847	877
17	544	575	603	634	664	695	725	756	787	817	848	878
18	545	576	604	635	665	696	726	757	788	818	849	879
19	546	577	605	636	666	697	727	758	789	819	850	880
20	547	578	606	637	667	698	728	759	790	820	851	881
21	548	579	607	638	668	699	729	760	791	821	852	882
22	549	580	608	639	669	700	730	761	792	822	853	883
23	550	581	609	640	670	701	731	762	793	823	854	884
24	551	582	610	641	671	702	732	763	794	824	855	885
25	552	583	611	642	672	703	733	764	795	825	856	886
26	553	584	612	643	673	704	734	765	796	826	857	887
27	554	585	613	644	674	705	735	766	797	827	858	888
28	555	586	614	645	675	706	736	767	798	828	859	889
29	556		615	646	676	707	737	768	799	829	860	890
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31	558		617		678		739	770		831		892

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