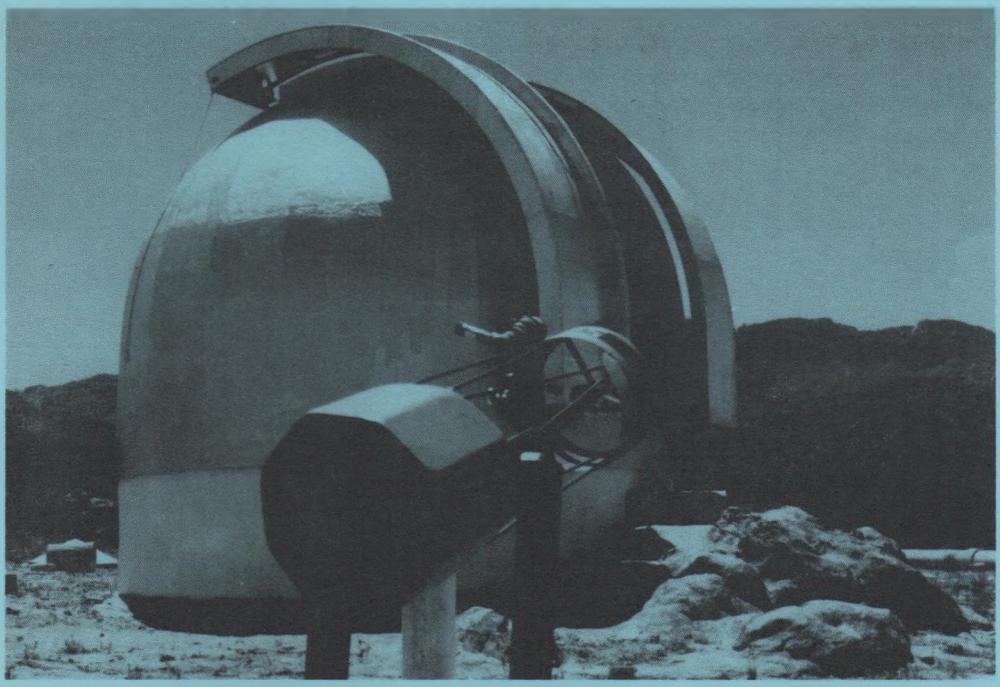
ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1991



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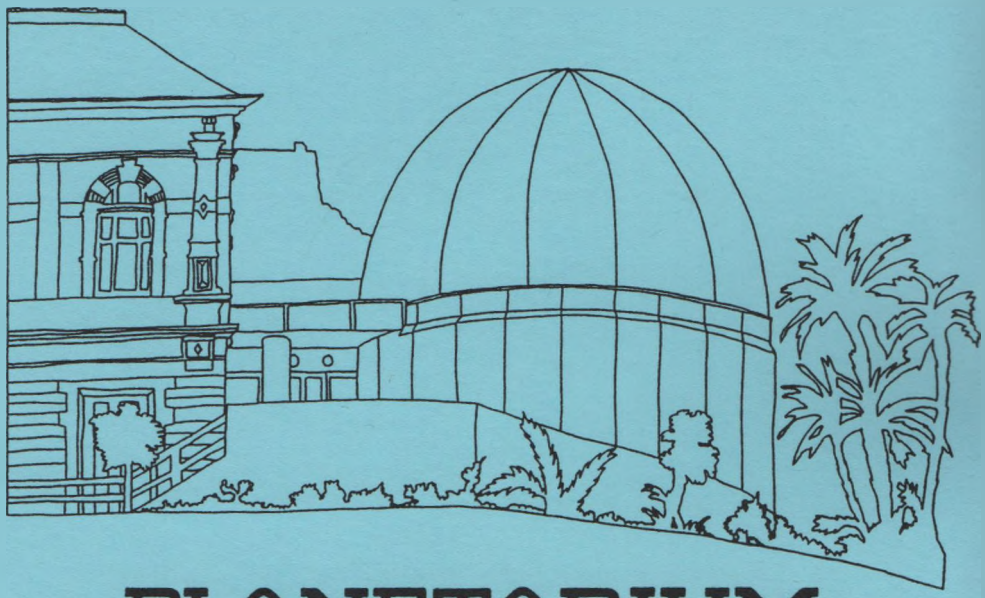

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ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA 1991

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

Front cover
The dome of the Cederberg Observatory. The Cederberg Observatory is 250 km north, by road, of Cape Town. This observatory, founded by Dr. P. Mack, is being operated and further developed by a group of 5 amateur astronomers. In the foreground is a 225 cm amateur made reflector telescope. Photograph courtesy of Mr C. Forder.

CONTENTS

NOTE

All times are SAST unless otherwise stated.Right Ascension and Declination are given for equinox of date 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 The Astronomical Almanac for 1991, the Handbook of the British Astronomical Association, the International Lunar Occultation Centre,Tokyo. The star charts on pages 30, 32, 34 and 36 are from "A Beginner's Guide to the Southern Stars" by J.S. Bondietti, published by the South African Museum. The Minor Planet Occultations were provided by Edwin Goffin, who wishes to thank Dr. Josef de Kerfo, General Manager of Agfa-Gevaert IVV (Mortsel, Belguim) for making the computing facilities available.

Assistance in the compilation of this booklet was received from the Directors of the observing sections of the ASSA and Mrs. P. Kramer.

Further copies of this booklet are available at R5,00 per copy from The Business Manager, Astronomical Society of Southern Africa, P O Box 9, Observatory, 7935. All other correspondence concerning this booklet should be addressed to the Handbook Editor, Astronomical Society of Southern Africa, 10 Bristol Rd., Observatory, 7925.

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 nor its members accept 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.

P.J.Booth
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 in Cape Town also carrys out a limited amount of observing. 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.

Boyden Observatory, situated at Mazelspoort, 25 km from Bloemfontein, is owned by the Dept of Physics and Astronomy of the University of the Orange Free State. 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.

The Nooitgedacht Gammaa Ray Telescope, established in 1985 in the Vredefort area south of Potchefstroom, is operated as a facility of the FRD/PU Cosmic Ray Research unit of the Potchefstroom University, under the leadership of Prof B C Raubenheimer. It consists of twelve parabolic mirrors with a total reflecting area of 21 square metres. The weak blue Cerenkov light emitted by high energy gamma rays in the atmosphere is detected by fast coincidence techniques. Radio pulsars, X-ray binaries, Supernova Remnants and Cataclysmic Variables are some of the objects studied.

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, Cape Town is 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.

Enquiries as to visiting nights at Boyden Observatory, Bloemfontein should be made to the Dept of Physics and Astronomy of the University of the Orange Free State.

The Nooitgedacht Telescope, Potchefstroom. Interested individuals or groups are welcome to contact Prof. B C Raubenheimer to arrange visits.

The Port Elisabeth Peoples Observatory Society. The Observatory, situated on the corner of Westview Drive and MacFarlane Road, is open to the public on the 1st and 3rd Wednesdays of every month and on every Wednesday during December and January. Admission is free. Donations are accepted to help with running costs. Viewing evenings are arranged for groups at other times during the month.
Society meetings are held bi-monthly on the 3rd Monday.
Secretarial address: P. O. Box 7988, Newton Park, Port Elizabeth. 6055.

PLANETARIA

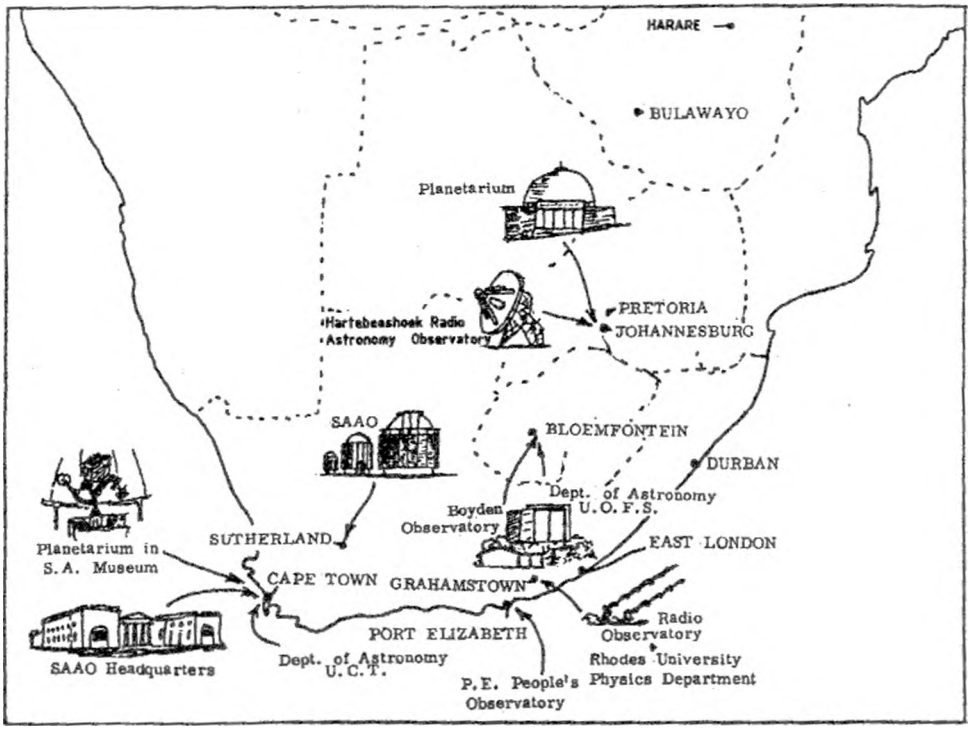
A planetarium is located within the South African Museum in Cape Town. This new planetarium, containing a Minolta Series 4 projector and seating 120, represents one of the most advanced of its kind in the world today.

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

Regular shows are given at both of these planetaria, from which 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 uses the SAAO observing facilities at Sutherland. The Dept of Applied Mathematics, UCT has a group carrying out research in theoretical cosmology lead by Profs G F R Ellis and D R Matravers. The University of OFS has a Dept of Physics and Astronomy, headed by Prof. P E Viljoen, incorporated with the Boyden Observatory. 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. Courses in Gamma Ray Astronomy and General Astrophysics form part of the regular honors and masters courses of the Department of Physics at Potchefstroom.



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 R75.00 and there is an entrance fee of R10.00. A prospectus and application form may be obtained from the Honorary Secretary, Astronomical Society of Southern Africa, c/o S A Astronomical Observatory, P O Box 9, Observatory 7935.

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 receive neither 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. Meetings are held at the SAAO, Observatory Road, Observatory at 20h00. 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, P.O.Box 13018, Mowbray, 7705, or telephone (021) 725897.

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) 8865602.

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, views and current information on astronomical and related topics. Secretarial address: P O Box 5330, Durban, 4000, or telephone (031) 3072093 / 7011104 / 7013178 / (0323) 51647.

NATAL MIDLANDS CENTRE (Pietermaritzburg): Regular monthly meetings on the second Wednesday of each month at 19h45. Information on activitys and membership is available from the Secretary, P O Box 2106, Pietermaritzburg, 3200 or by phoning (0331) 33646.

BLOEMFONTEIN CENTRE: Meetings are held every fourth Friday of the month. For information contact the Secretary, Mrs S Rabe, P O Box 1238, Bloemfontein, 9300 or telephone (051) 224977.

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. More information on a section is given in the appropriate parts of this handbook.

DIARY OF PHENOMENA

	d	h	
Jan	1	17	Venus 1°·2 S. of Saturn
	1	18	Mars stationary
	3	1	Jupiter 2° N. of Moon
	3	5	Earth at perihelion
	3	21	Mercury stationary
	5	5	Neptune in conjunction with Sun
	5	10	Vesta stationary
	7	21	LAST QUARTER
	12	5	Antares 0°·6S. of Moon
	12	13	Moon at apogee
	13	22	Mercury 4° N. of Moon
	14	11	Mercury greatest elong. W.(24°)
	16	2	NEW MOON
	17	20	Venus 3° S. of Moon
	18	10	Saturn in conjunction with Sun
	23	16	FIRST QUARTER
	23	19	Mercury 0°·4 N. of Uranus
	23	23	Pallas stationary
	25	17	Mars 2° S. of Moon
	26	16	Mercury 1°·1 S. of Neptune
	28	11	Moon at perigee
	29	2	Jupiter at opposition
	30	7	Jupiter 1°·8 N. of Moon
	30	8	FULL MOON Penumbral Eclipse
Feb	5	18	Mercury 1°·2 S. of Saturn
	6	16	LAST QUARTER
	8	13	Antares 0°·7 S. of Moon
	9	6	Moon at apogee
	11	6	Uranus 1°·1 N. of Moon
	11	13	Neptune 1°·9 W. of Moon
	12	20	Saturn 0°·5 S. of Moon
	14	20	NEW MOON
	17	4	Venus 6° S. of Moon
	22	1	FIRST QUARTER
	22	10	Mars 8° N. of Aldebaran
	22	15	Mars 1°·6 S. of Moon
	25	3	Moon at perigee
	25	16	Pluto stationary
	26	11	Jupiter 1°·6 N. of Moon
	28	20	FULL MOON
Mar	2	5	Mercury in superior conjunction
	4	1	Ceres stationary
	6	10	Pallas at opposition
	7	21	Antares 0°·8 S. of Moon
	8	13	LAST QUARTER
	9	3	Moon at apogee
	10	17	Uranus 0°·9N. of Moon
	10	23	Neptune 1°·8 N. of Moon
	12	10	Saturn 0°·9 S. of Moon
	16	10	NEW MOON
	17	17	Mercury 5° S. of Moon
	19	2	Venus 5° S. of Moon
	21	5	Equinox
	22	7	Moon at perigee
	22	19	Mars 0°·7 S. of Moon
	23	8	FIRST QUARTER
	25	15	Jupiter 1°·6 N. of Moon
	27	17	Mercury greatest elong. E.(19°)
	28	4	Pallas 0°·9 N. of Moon
	30	9	FULL MOON
	30	16	Jupiter stationary
Apr	4	5	Antares 1°·1 S. of Moon
	4	19	Mercury stationary
	5	23	Moon at apogee
	7	2	Uranus 0°·6 N. of Moon Occn.
	7	8	Neptune 1°·5 N. of Moon
	7	9	LAST QUARTER
	8	23	Saturn 1°·4 S. of Moon
	10	2	Pallas stationary
	14	22	NEW MOON
	14	23	Mercury in inferior conjunction
	17	18	Ceres at opposition
	17	18	Venus 2° S. of Moon
	17	19	Moon at perigee
	18	14	Uranus stationary
	19	1	Neptune stationary
	20	2	Mars 0°·6 N. of Moon
	21	15	FIRST QUARTER
	21	21	Jupiter 1°·9 N. of Moon
	22	6	Venus 7° N. of Aldebaran
	27	8	Mercury stationary
	28	23	FULL MOON
May	3	17	Moon at apogee
	4	10	Uranus 0°·3 N. of Moon
	4	16	Neptune 1°·2 N. of Moon
	6	9	Saturn 1°·8 S. of Moon
	7	3	LAST QUARTER
	10	5	Pluto at opposition
	12	15	Mercury 9° S. of Moon
	12	20	Mercury greatest elong. W.(26°)
	14	7	NEW MOON
	15	19	Moon at perigee
	16	7	Mars 5° S. of Pollux
	17	9	Venus 1°·6 N. of Moon
	17	13	Saturn stationary
	18	12	Mars 2° N. of Moon
	19	9	Jupiter 2° N. of Moon
	20	22	FIRST QUARTER
	23	21	Juno stationary
	28	14	FULL MOON
	31	3	Venus 4° S. of Pollux
	31	5	Moon at apogee
	31	15	Uranus 0°·2 N. of Moon
	31	22	Neptune 1°·1 N. of Moon
Jun	2	16	Saturn 2° S. of Moon
	5	17	LAST QUARTER
	10	12	Ceres stationary
	12	14	NEW MOON
	13	2	Moon at perigee
	14	0	Venus greatest elong. E.(45°)
	14	7	Mars 0°·6 N. of Jupiter
	15	22	Venus 4° N. of Moon
	16	0	Jupiter 3° N. of Moon
	16	2	Mars 4° N. of Moon
	17	7	Mercury in superior conjunction
	18	1	Venus 1°·2 N. of Jupiter
	19	6	FIRST QUARTER
	21	23	Solstice
	23	14	Venus 0°·3 N. of Mars
	27	5	FULL MOON Penumbral Eclipse
	27	9	Moon at apogee
	27	19	Uranus 0°·3 N. of Moon
	28	2	Neptune 1°·1 N. of Moon
	29	20	Saturn 2° S. of Moon
Jul	1	0	Mercury 5° S. of Pollux
	4	9	Uranus at opposition
	5	5	LAST QUARTER
	6	17	Earth at aphelion
	8	2	Neptune at opposition
	9	21	Vesta in conjunction with Sun
	11	10	Venus 1°·0 S. of Regulus
	11	12	Moon at perigee
	11	21	NEW MOON
	13	16	Mercury 3° N. of Moon

CONFIGURATIONS OF SUN, MOON AND PLANETS

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

THE SUN

BASIC DATA:

Diameter: 1 392 000 km (109 times Earth diameter)

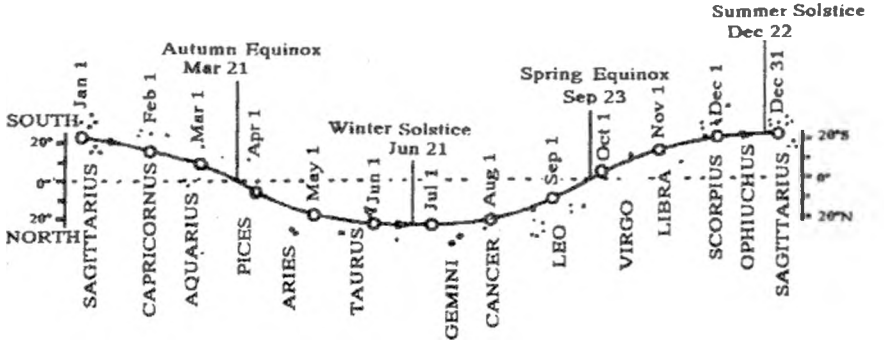
Mass: $1{,}99 \times 10^{30}$ kg (330 000 times Earth mass)

Surface Temperature: Approximately 6 000°C

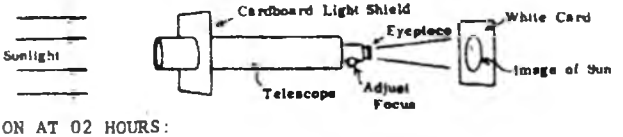
Temperature at centre: Approximately 10 million°C

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 short-lived flares.

The Earth's orbit round the Sun is not quite circular. In 1991 we will be closest to the Sun on January 3 (perihelion - approximate distance 147 million km) and furthest from the Sun on July 6 (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.



THE SUN'S DECLINATION AT 02 HOURS:

Jan	1	23° 4'S	Apr	11	8° 3'N	Jul	20	20° 8'N	Oct	28	12°53'S
	11	21 55 S		21	11 37 N		30	18 41 N	Nov	7	16 4 S
	21	20 4 S	May	1	14 51 N	Aug	9	16 4 N		17	18 48 S
	31	17 35 S		11	17 42 N		19	13 1 N		27	20 60 S
Feb	10	14 35 S		21	20 2 N		29	9 37 N	Dec	7	22 31 S
	20	11 11 S		31	21 49 N	Sep	8	5 58 N		17	23 20 S
Mar	2	7 29 S	Jun	10	22 57 N		18	2 9 N		27	23 21 S
	12	3 36 S		20	23 26 N		28	1 44 S		31	23 9 S
	22	0 21 N		30	23 13 N	Oct	8	5 36 S			
Apr	1	4 16 N	Jul	10	22 20 N		18	9 21 S			

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

	CAPETOWN		DURBAN		BLOEMFONTEIN		JOHANNESBURG		HARARE	
	sunrise	sunset	sunrise	sunset	sunrise	sunset	sunrise	sunset	sunrise	sunset
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
Jan 1	05 38	20 01	04 58	19 01	05 21	19 18	05 18	19 04	05 24	18 35
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

The annular eclipse of January 15 and the total eclipse of July 11 are not visible from Southern Africa.

COMPUTING AND SOLAR SECTIONS

COMPUTING SECTION

This 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 MNASSA. 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) 53 8714
(h) (011) 465 2257.

Mr Hilton has compiled a comprehensive DATA BASE of all interested person's, equipment, available software etc. This report will be available to all interested persons. If you wish to become a subscriber to this DATA BASE list please contact Mr Hilton for the relevant quuestionnaire.

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. 1991, 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 prerequisite! 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 Moon

BASIC DATA

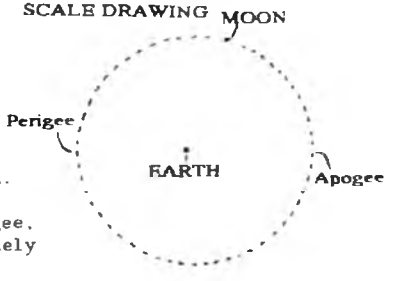
Diameter: 3 480 km (0,27 of Earth)
Mass: $7{,}35 \times 10^{22}$ x kg (1/81 of Earth)
Surface Gravity: 0,16 of Earth
Average distance from Earth: 384 000 km

THE SURFACE OF THE MOON

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

THE MOON'S ORBIT

As a result of its motion around the Earth, the Moon appears to make a complete circuit of the heavens in just under a month. The Moon's orbit around the Earth is slightly elliptical; the Earth is situated at one of the foci of the ellipse. Thus the Earth-Moon distance varies slightly during the course of a revolution. Dates of Apogee, when the moon is furthest from the Earth (approximately 407 000 km) and of Perigee, when the Moon is closest to the Earth (approximately 357 000 km) are given on the next page.



The Moon is best positioned for evening viewing from 3 to 4 days before First Quarter to shortly after Full Moon.

ECLIPSES OF THE MOON

The three penumbral eclipses of the moon will be wholly or partly visible from Southern Africa. The Moon's entry of penumbra will be during morning twilight on January 30 and the middle of the eclipse will be close to sunrise and moonset. All of the eclipse of June 27 will be visible but that of July 26 will be in progress as the moon rises in the evening twilight. The partial eclipse of December 21 will not be visible.

The eclipse data is as follows:

	d	h	m		d	h	m
Moon enters penumbra	Jan 30	5	57.8	Jun 27	3	46.3	
Middle of eclipse		7	58.6		5	14.7	
Moon leaves penumbra		9	59.4		6	43.2	

Contacts of Penumbra with Limb of Moon	Position Angles from the North Point
First	67°.8 to East
Last	25°.6 to West

Penumbral Magnitude of the Eclipse: 0.906

Contacts of Penumbra with Limb of Moon	Position Angles from the North Point
First	20°.2 to East
Last	35°.6 to West

Penumbral Magnitude of the Eclipse: 0.339

Moon enters penumbra	Jul 26	18	47.5
Middle of eclipse		20	07.8
Moon leaves penumbra		21	28.3

Contacts of Penumbra with Limb of Moon	Position Angles from the North Point
First	135°.8 to East
Last	173°.6 to West

Penumbral Magnitude of the Eclipse: 0.280

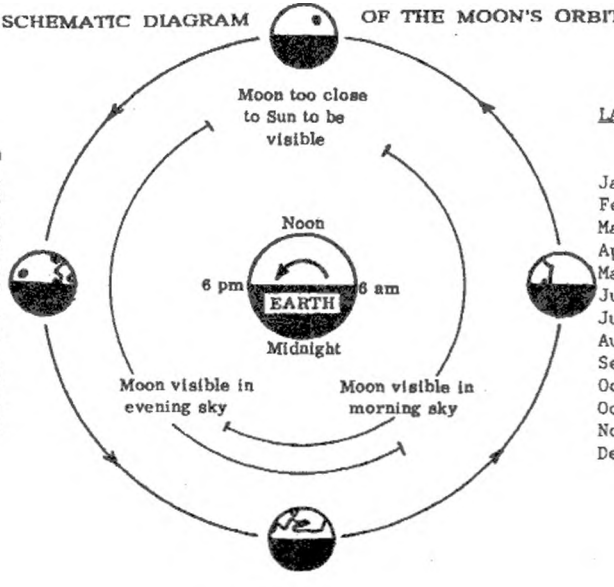
TERMINATOR AND LIBRATION

During the changing phases, the terminator (the boundary between illuminated and dark portions) progresses from left to right in the diagram on page 10. Since the moon does not follow a perfectly circular orbit and its axis is not parallel to the Earth's axis, it is sometimes possible to see a slightly greater proportion of one limb than the opposite one. This effect is known as libration.

PHASES and VISIBILITY

NEW MOON

	d	h	m
Jan	16	01	50
Feb	14	19	32
Mar	16	10	10
Apr	14	21	38
May	14	06	36
Jun	12	14	06
Jul	11	21	06
Aug	10	04	28
Sep	8	13	01
Oct	7	23	39
Nov	6	13	11
Dec	6	05	56



FIRST QUARTER

	d	h	m
Jan	23	16	21
Feb	22	00	58
Mar	23	08	03
Apr	21	14	39
May	20	21	46
Jun	19	06	19
Jul	18	17	11
Aug	17	07	01
Sep	16	00	01
Oct	15	19	33
Nov	14	16	02
Dec	14	11	32

LAST QUARTER

	d	h	m
Jan	7	20	35
Feb	6	15	52
Mar	8	12	32
Apr	7	08	45
May	7	02	46
Jun	5	17	30
Jul	5	04	50
Aug	3	13	25
Sep	1	20	16
Oct	1	02	30
Oct	30	09	10
Nov	28	17	21
Dec	28	03	55

FULL MOON

	d	h	m
Jan	30	08	10
Feb	28	20	25
Mar	30	09	17
Apr	28	22	58
May	28	13	37
Jun	27	04	58
Jul	26	20	24
Aug	25	11	07
Sep	24	00	40
Oct	23	13	08
Nov	22	00	56
Dec	21	12	23

MOON at PERIGEE

	d	h		d	h		d	h
Jan	28	11	Jun	13	2	Oct	27	18
Feb	25	3	Jul	11	12	Nov	24	4
Mar	22	7	Aug	8	20	Dec	22	11
Apr	17	19	Sep	5	21			
May	15	19	Oct	2	20			

MOON at APOGEE

	d	h		d	h		d	h
Jan	12	13	May	31	5	Oct	15	13
Feb	9	6	Jun	27	9	Nov	12	10
Mar	9	3	Jul	24	13	Dec	10	4
Apr	5	23	Aug	20	4			
May	3	17	Sep	17	17			

MAP OF THE MOON'S NEAR SIDE

LIBRATION

Maximum			Minimum			Maximum			Minimum		
Date	Size	P.A.	Date	Size	P.A.	Date	Size	P.A.	Date	Size	P.A.
d	°	°	d	°	°	d	°	°	d	°	°
Jan 7	9.6	335	Jan 15	2.6	44	Jul 5	10.1	109	Jul 11	1.1	245
22	9.1	115	28	1.7	239	17	10.1	335	25	0.7	11
Feb 4	9.1	340	Feb 11	2.4	43	Aug 1	9.5	113	Aug 8	0.9	82
18	8.3	121	25	1.3	236	14	9.8	336	21	0.3	133
Mar 3	8.4	344	Mar 10	2.4	43	29	8.6	118	Sep 4	1.0	49
17	7.9	120	24	1.9	247	Sep 11	9.1	339	18	0.4	243
31	7.9	348	Apr 6	2.4	42	24	8.1	121	Oct 1	0.6	38
Apr 13	8.5	113	20	2.7	240	Oct 8	8.4	343	15	0.6	249
27	8.1	346	May 3	2.2	43	21	8.3	118	28	0.8	226
May 10	9.4	109	17	2.6	227	Nov 4	8.3	345	Nov 11	0.8	235
23	8.9	340	31	1.7	37	18	9.2	114	24	0.9	251
Jun 7	10.1	108	Jun 13	1.8	232	Dec 1	9.1	341	Dec 8	0.9	205
20	9.8	336	27	1.1	50	16	10.0	110	22	0.9	81
						28	10.0	337			

NOTE: Size of libration is given as an angle measured at the centre of the Moon. Position Angle (P.A.) is measured through East on the face of the Moon from the North point of the disk.

1991 TIMES OF MOON RISE AND 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
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	20 52	06 04	21 08	08 23	19 35	07 08	19 38	09 02	19 40	09 47	21 10	10 46
2	21 35	07 19	21 37	09 28	20 04	08 12	20 16	10 02	20 30	10 40	22 07	11 21
3	22 10	08 31	22 06	10 30	20 34	09 14	20 59	11 01	21 24	11 28	23 05	11 52
4	22 42	09 39	22 36	11 31	21 06	10 16	21 46	11 57	22 20	12 10		12 20
5	23 10	10 44	23 09	12 31	21 41	11 17	22 38	12 48	23 18	12 48	00 02	12 48
6	23 38	11 46	23 45	13 31	22 21	12 16	23 33	13 34		13 21	01 01	13 16
7		12 45		14 29	23 05	13 13		14 14	00 16	13 51	02 01	13 45
8	00 07	13 44	00 25	15 24	23 54	14 07	00 30	14 50	01 14	14 20	03 04	14 18
9	00 37	14 43	01 11	16 16		14 56	01 29	15 23	02 13	14 48	04 11	14 55
10	01 10	15 41	02 02	17 03	00 47	15 40	02 28	15 53	03 14	15 17	05 22	15 40
11	01 47	16 38	02 57	17 45	01 44	16 19	03 28	16 22	04 18	15 49	06 34	16 35
12	02 30	17 32	03 56	18 22	02 43	16 53	04 29	16 50	05 24	16 24	07 44	17 38
13	03 17	18 22	04 55	18 55	03 42	17 25	05 32	17 21	06 35	17 06	08 48	18 49
14	04 10	19 07	05 55	19 26	04 43	17 55	06 38	17 54	07 47	17 55	09 43	20 04
15	05 07	19 47	06 56	19 54	05 44	18 23	07 47	18 32	08 59	18 54	10 28	21 16
16	06 05	20 22	07 56	20 22	06 46	18 52	08 58	19 16	10 05	20 01	11 07	22 26
17	07 05	20 54	08 58	20 51	07 50	19 23	10 09	20 08	11 03	21 12	11 40	23 32
18	08 05	21 23	10 01	21 22	08 56	19 57	11 17	21 09	11 52	22 23	12 11	
19	09 04	21 51	11 06	21 56	10 04	20 36	12 18	22 15	12 33	23 32	12 40	00 36
20	10 04	22 18	12 14	22 36	11 13	21 22	13 11	23 24	13 08		13 09	01 37
21	11 05	22 47	13 22	23 23	12 22	22 15	13 55		13 39	00 38	13 40	02 37
22	12 08	23 18	14 30		13 26	23 16	14 33	00 33	14 09	01 42	14 14	03 37
23	13 14	23 54	15 33	00 19	14 24		15 06	01 40	14 37	02 43	14 51	04 36
24	14 22		16 29	01 23	15 13	00 23	15 37	02 45	15 07	03 43	15 33	05 34
25	15 32	00 37	17 17	02 32	15 56	01 32	16 05	03 47	15 38	04 43	16 21	06 29
26	16 41	01 28	17 58	03 43	16 32	02 41	16 34	04 49	16 13	05 43	17 12	07 20
27	17 44	02 29	18 33	04 54	17 04	03 48	17 04	05 49	16 52	06 42	18 07	08 06
28	18 38	03 38	19 05	06 02	17 35	04 53	17 37	06 50	17 36	07 40	19 04	08 47
29	19 25	04 51			18 04	05 56	18 13	07 51	18 25	08 34	20 01	09 22
30	20 04	06 04			18 33	06 58	18 54	08 50	19 17	09 23	20 58	09 54
31	20 38	07 15			19 04	08 00			20 13	10 07		

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

1991 TIMES OF MOON RISE AND SET JOHANNESBURG

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

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

1991 TIMES OF MOON RISE AND 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
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	19 50	05 22	20 15	07 32	18 44	06 16	18 55	08 01	18 59	08 43	20 26	09 45
2	20 35	06 34	20 47	08 34	19 15	07 17	19 34	09 00	19 49	09 35	21 21	10 21
3	21 14	07 44	21 18	09 34	19 48	08 17	20 18	09 57	20 43	10 24	22 17	10 54
4	21 48	08 50	21 51	10 33	20 22	09 16	21 05	10 52	21 38	11 07	23 12	11 25
5	22 19	09 52	22 25	11 31	20 59	10 15	21 57	11 43	22 33	11 47		11 55
6	22 49	10 51	23 03	12 28	21 39	11 13	22 51	12 30	23 29	12 22	00 08	12 25
7	23 20	11 49	23 44	13 25	22 24	12 09	23 47	13 12		12 54	01 06	12 57
8	23 52	12 45		14 19	23 13	13 02		13 50	00 25	13 25	02 07	13 31
9		13 42	00 31	15 11		13 52	00 44	14 25	01 22	13 56	03 11	14 11
10	00 27	14 38	01 22	15 59	00 06	14 37	01 41	14 57	02 20	14 27	04 19	14 58
11	01 06	15 33	02 16	16 42	01 01	15 17	02 38	15 28	03 21	15 01	05 30	15 53
12	01 49	16 27	03 13	17 21	01 58	15 54	03 37	15 59	04 25	15 39	06 39	16 57
13	02 37	17 17	04 10	17 57	02 56	16 28	04 37	16 32	05 33	16 22	07 43	18 07
14	03 29	18 03	05 08	18 29	03 54	17 00	05 40	17 07	06 44	17 14	08 40	19 19
15	04 25	18 45	06 06	19 00	04 53	17 31	06 46	17 47	07 54	18 13	09 28	20 30
16	05 22	19 22	07 04	19 31	05 52	18 02	07 55	18 34	09 00	19 19	10 09	21 37
17	06 19	19 56	08 03	20 02	06 53	18 35	09 05	19 27	10 00	20 29	10 45	22 41
18	07 17	20 28	09 04	20 35	07 57	19 12	10 12	20 28	10 51	21 38	11 18	23 42
19	08 14	20 58	10 07	21 11	09 03	19 53	11 14	21 33	11 34	22 45	11 50	
20	09 11	21 27	11 12	21 53	10 10	20 40	12 08	22 41	12 12	23 49	12 22	00 41
21	10 09	21 59	12 18	22 42	11 17	21 34	12 55	23 48	12 45		12 55	01 39
22	11 10	22 32	13 24	23 38	12 21	22 35	13 35		13 17	00 50	13 30	02 37
23	12 13	23 10	14 27		13 20	23 41	14 11	00 52	13 48	01 48	14 09	03 34
24	13 20	23 55	15 25	00 42	14 11		14 43	01 55	14 20	02 46	14 52	04 30
25	14 28		16 15	01 49	14 55	00 48	15 15	02 55	14 53	03 44	15 40	05 25
26	15 35	00 47	16 58	02 58	15 34	01 55	15 46	03 54	15 30	04 42	16 31	06 16
27	16 39	01 48	17 37	04 07	16 09	02 59	16 18	04 52	16 10	05 39	17 25	07 03
28	17 35	02 56	18 11	05 12	16 42	04 02	16 53	05 50	16 55	06 36	18 20	07 45
29	18 24	04 08			17 14	05 03	17 31	06 49	17 44	07 29	19 16	08 22
30	19 05	05 19			17 45	06 03	18 13	07 47	18 36	08 19	20 11	08 56
31	19 42	06 27			18 19	07 02			19 31	09 04		

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

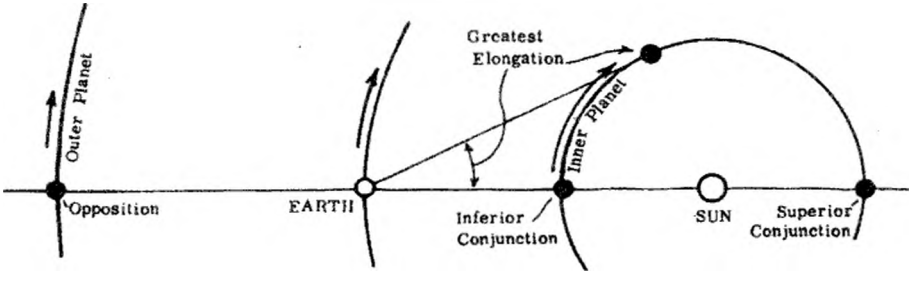
THE PLANETS

BASIC DATA

	Dist from Sun 10^6 km	Period of Revolution years	Mass (Earth = 1)	Equatorial Diameter 10^3 km	Rotation Period	Inclination of Equator to orbit	No. of known satellites
Mercury	58	0.24	0.055	4.98	58.65d	0°	0
Venus	108	0.62	0.815	12.10	243d R	178°	0
Earth	150	1.00	1.000	12.76	23h56m	23°27'	1
Mars	228	1.88	0.107	6.79	24h37m	23°59'	2
Jupiter	778	11.9	318.867	142.80	09h51m	03°04'	16
Saturn	1 426	29.5	95.142	120.00	10h14m	26°44'	17
Uranus	2 868	84.0	14.559	52.00	17.2h	97°52'	15
Neptune	4 494	164.8	17.207	48.40	17.8h	29°34'	8
Pluto	5 896	247.6	0.002	3.00	6.39d	118°?	1

GENERAL

Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Their apparent brightness is measured in magnitudes. A planet of magnitude 1.0, that of the brightest stars, will be 100 times brighter than one of magnitude 6.0, the limit of visibility to the naked eye in the total absence of artificial lighting. Unlike the distant stars, the relative positions of the planets 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 astronony to the various Sun-Earth-Planet configurations are illustrated in the accompanying diagram. Dates of such configurations occuring in 1991 are listed chronologically in the Diary (pages 4 and 5) and are also mentioned in the text below.

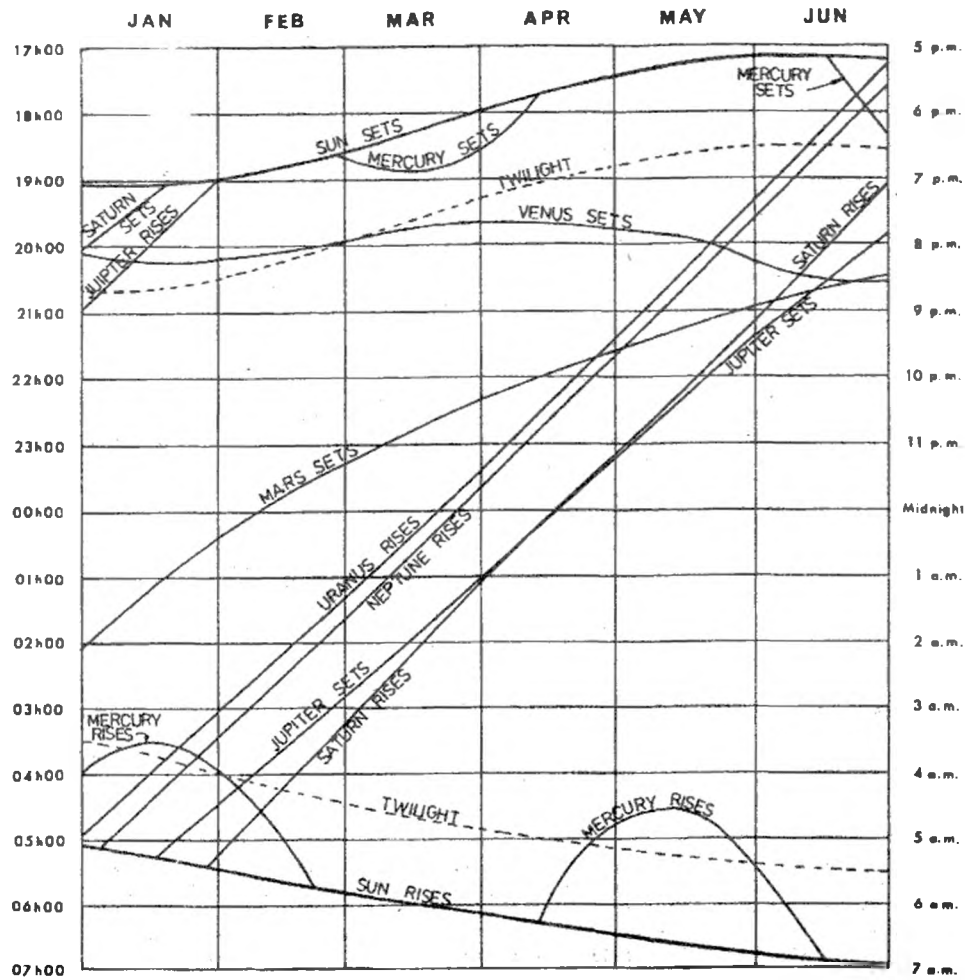


OBSERVING THE PLANETS

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

TIMES OF RISING AND SETTING

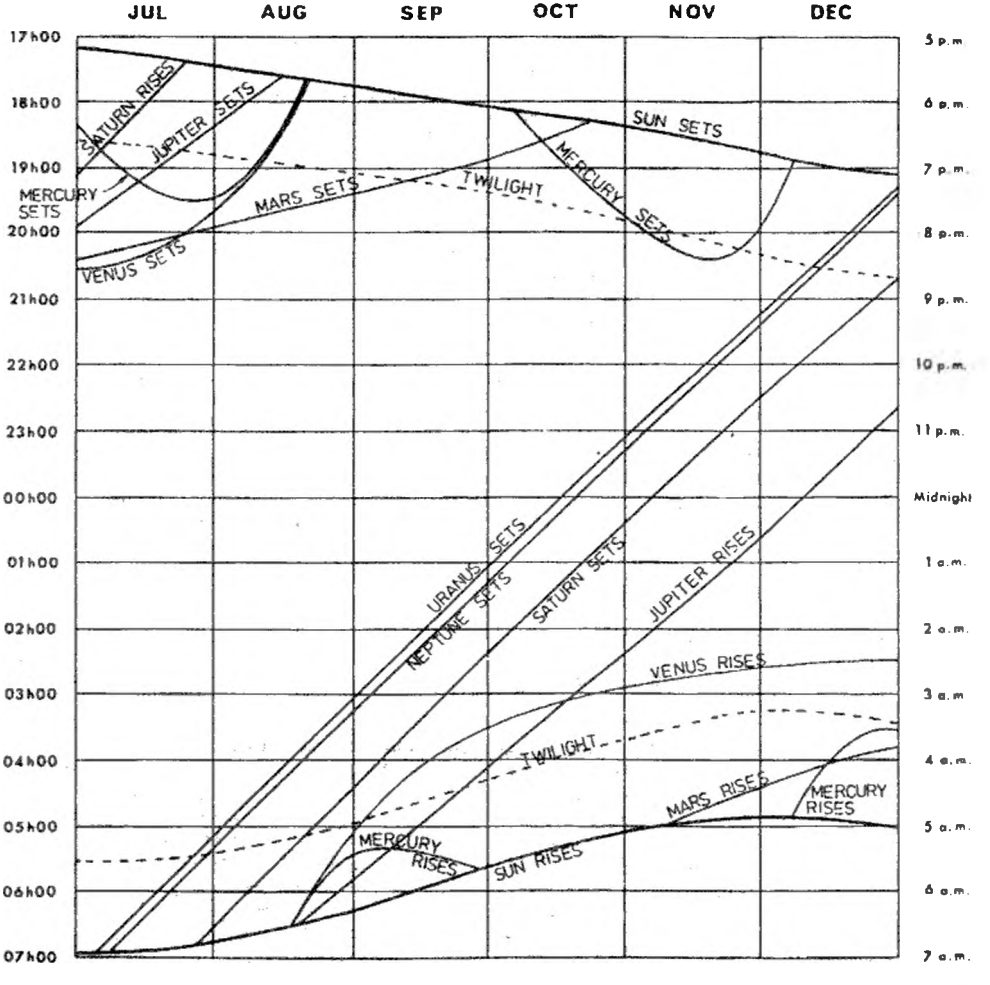
The times of rising and setting given by the diagram are accurate for position 30° East, 30° South and approximately correct for other places in Southern Africa. Strictly speaking, corrections for latitude and longitude should be applied, but the latitude correction is in general sufficiently small to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



CORRECTION FOR PLACES NOT ON THE 30° E MERIDIAN

Approximate longitude corrections from the 30° East meridian are:

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



MERCURY

The planet may be seen low in the east before sunrise between the following approximate dates:

January 1 (at mag.+1.0) to February 18 (at mag.-0.8),
April 23 (at mag.+3.0) to June 10 (at mag.-1.4),
August 30 (at mag.+2.0) to September 23 (at mag.-1.3) and
December 14 (at mag.+1.8) to 31 (at mag.-0.3).

The best conditions for viewing will occur in January and early February when Mercury is in Sagitarius and from the end of April until the end of May when it is in Pices and later in Aries.

Mercury may also be seen low in the west after sunset between the following approximate dates:

March 12 (at mag.-1.4) to April 6 (at mag.+2.2),
June 25 (at mag.-1.3) to August 15 (at mag.+2.9) and
October 18 (at mag.-0.7) to December 3 (at mag.+1.8)

The best conditions for viewing will be from early July until just before mid-August, when Mercury passes through Cancer and into Leo, and again from late October, when Mercury is in Libra, to late November as it moves through Scorpio to Ophiuchus.

	d h	d h	d h	d h
Superior Conjunction		Mar 2 5	Jun 17 7	Oct 3 19
Greatest Elongation East		Mar 27 17 (19°)	Jul 25 4 (27°)	Nov 19 4 (22°)
Stationary		Apr 4 19	Aug 7 6	Nov 28 20
Inferior Conjunction		Apr 14 23	Aug 21 23	Dec 8 17
Stationary	Jan 3 21	Apr 27 8	Aug 30 22	Dec 18 14
Greatest Elongation West	Jan 14 11 (24°)	May 12 20 (26°)	Sep 7 20 (18°)	Dec 27 23 (22°)

VENUS

Venus will be in the evening sky from January (at mag. -3.9) to mid-August (at mag.-4.2). It will reach greatest brilliancy on July 17 at magnitude -4.5. It will be in the morning sky from the end of August (at mag.-4.0) untill the end of the year (at mag.-4.1). It will reach greatest brilliancy on September 29 at magnitude -4.6.

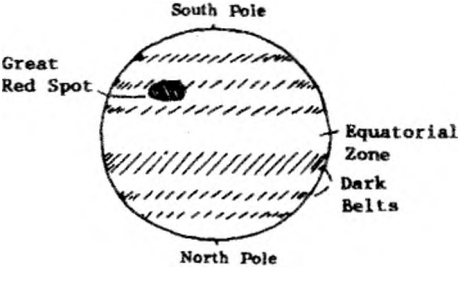
	d h
Greatest Elongation East	Jun 14 0 (45°)
Stationary	Jul 30 6
Inferior Conjunction	Aug 22 22
Stationary	Sep 12 4
Greatest Elongation West	Nov 2 11 (47°)

MARS

Mars, visible for most of the night, begins the year in the constellation of Taurus (at mag.-1.0) passing in early April (at mag. 1.0) to Gemini and in late May (at mag. 1.6) to Cancer having become an evening sky object. It passes into Leo towards the end of June and into Virgo at the end of August (at mag. 1.8) where by the end of September it will be too close to the Sun to be seen. Late December will see its return to the morning sky in Ophiuchus at magnitude 1.4.

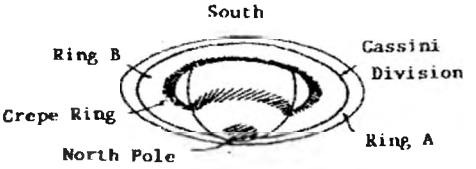
JUPITER

Jupiter begins the year in Cancer (at mag.-2.5) where it is visible for most of the night. It will be an evening sky object by June (at mag.-1.8). It passes to Leo in early July becoming too close to the Sun in early August. Jupiter re-appears in the morning sky at the beginning of September (at mag. -1.7) still in Leo where it remains for the rest of the year. It can be seen for more than half the night by mid-December (at mag. -2.2)



SATURN

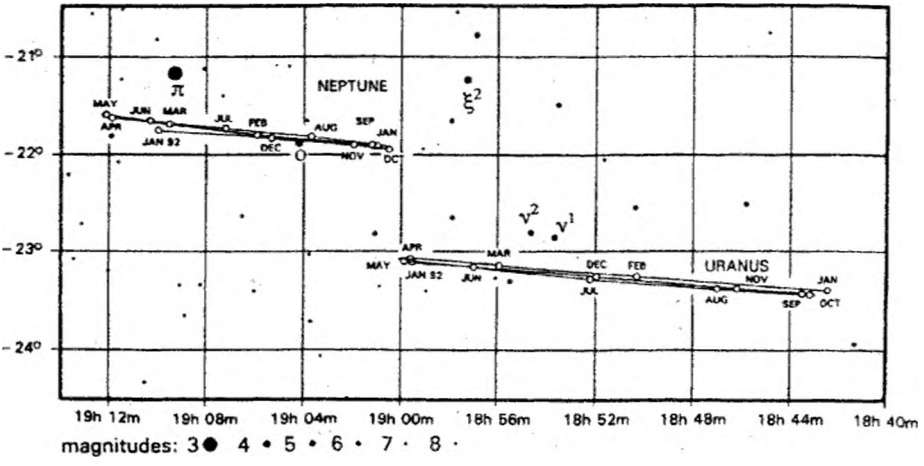
Saturn will be seen in Sagitarius as an the evening sky object on 1 January but will shortly there after not be seen until early February when it will be in the morning sky having passed into Capricornus where it remains for the rest of the year. It will be an all night object by July and an evening sky object from late October. Its magnitude will be +0.6 at the beginning of February increasing to +0.1 in late July and decreasing to +0.7 by the end of the year.



URANUS AND NEPTUNE

Uranus and Neptune are both in Sagitarius all year. Uranus is at magnitude 5.6 at opposition on July 4 and Neptune is at magnitude +7.9. at opposition on July 8. The paths of Uranus and Neptune.

Neptune passes south of omicron SGR on January 20, 26 July and 22 November.



PLUTO

Pluto at magnitude +14 in Serpens is an object for a large telescope.

EVENTS OF INTEREST

Evening Sky:	
1 Jan.	Venus (the brighter object) in conjunction with Saturn.
mid-Mar.	Mercury and Venus visible.
Jun.	Venus, Mars and Jupiter visible.
14 Jun.	Mars and Jupiter (the brighter object) in conjunction.
18 Jun.	Venus and Jupiter in conjunction.
23 Jun.	Venus and Mars in conjunction.
Jul. to early Aug.	Mercury, Venus, Mars and Jupiter visible.
15 Jul.	Jupiter and Mercury in conjunction.
22 Jul.	Venus and Mars in conjunction.
early to mid-Aug.	Mercury, Venus and Mars visible.
7 Aug.	Venus and Mercury in conjunction.
Morning Sky:	
early Feb.	Mercury (the brighter object) and Saturn visible.
5 Feb.	Mercury and Saturn in conjunction.
end Aug. to mid.Sep.	Mercury, Venus and Jupiter visible.
29 Aug.	Mercury and Venus in conjunction.
10 Sep.	Mercury and Jupiter (the brighter object) in conjunction.
Oct.	Venus and Jupiter visible.
17 Oct.	Venus and Jupiter in conjunction.
mid to end Dec.	Mercury, Venus and Mars visible.

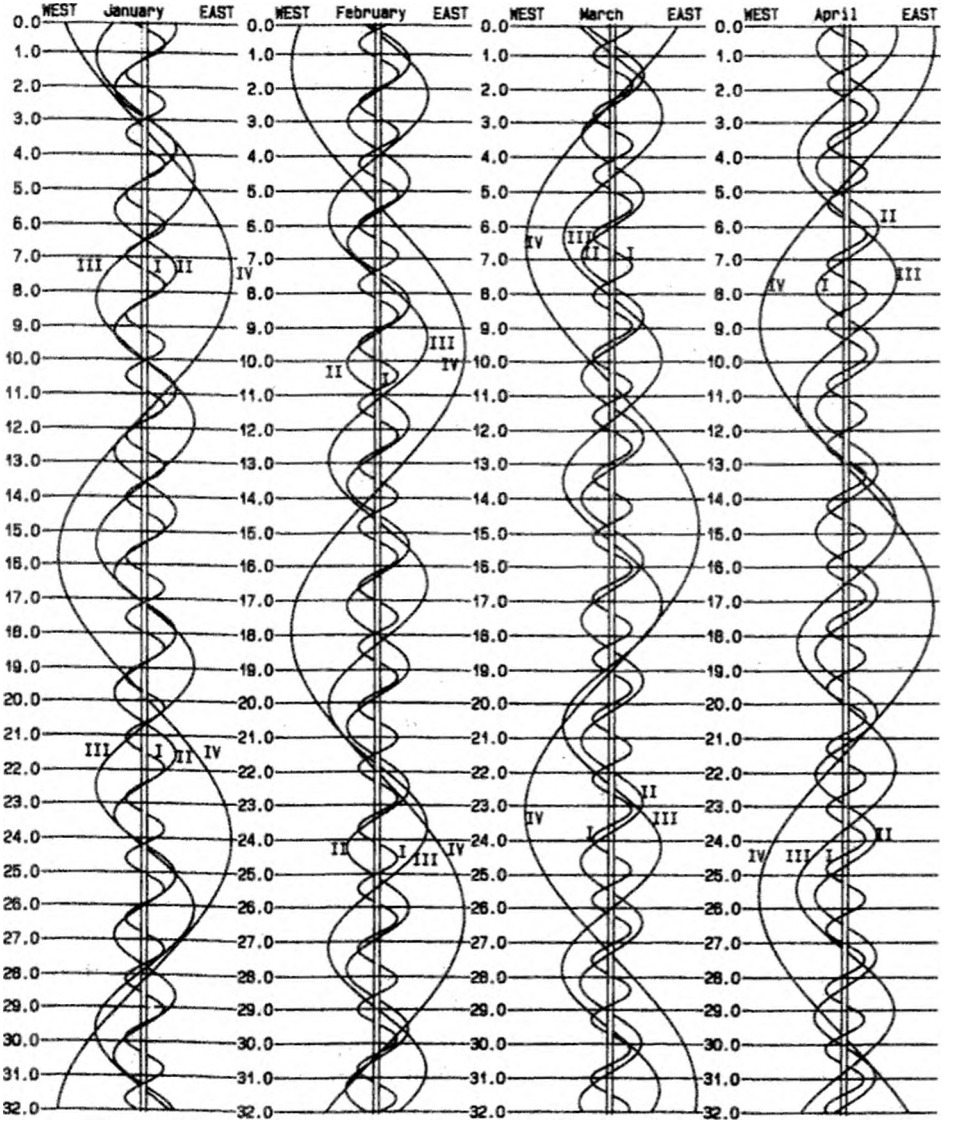
APPARENT PLACES:

	Mercury RA	Mercury DEC	Venus RA	Venus DEC	Mars RA	Mars DEC	Jupiter RA	Jupiter DEC
	h m	° ′	h m	° ′	h m	° ′	h m	° ′
Jan 1	17 35.8	-20 11	19 47.6	-22 27	3 39.7	21 56	8 58.6	17 51
Jan 11	17 47.0	-21 21	20 40.2	-19 53	3 42.0	22 7	8 54.2	18 11
Jan 21	18 33.1	-22 43	21 30.8	-16 22	3 49.0	22 29	8 49.2	18 33
Jan 31	19 32.2	-22 34	22 19.2	-12 7	4 0.1	22 59	8 43.8	18 55
Feb 10	20 36.6	-20 22	23 5.7	-7 19	4 14.3	23 34	8 38.5	19 16
Feb 20	21 43.4	-15 55	23 51.0	-2 12	4 31.2	24 8	8 33.6	19 35
Mar 2	22 51.9	-9 11	0 35.7	3 1	4 50.0	24 39	8 29.5	19 50
Mar 12	0 1.3	1 30	1 20.4	8 8	5 10.6	25 3	8 26.5	20 0
Mar 22	1 4.3	8 21	2 5.7	12 57	5 32.4	25 18	8 24.7	20 6
Apr 1	1 40.2	13 41	2 52.3	17 15	5 55.3	25 22	8 24.2	20 7
Apr 11	1 36.1	13 2	3 40.2	20 52	6 18.8	25 14	8 25.1	20 4
Apr 21	1 13.9	8 17	4 29.5	23 36	6 43.0	24 51	8 27.1	19 56
May 1	1 10.4	5 18	5 19.6	25 19	7 7.4	24 15	8 30.4	19 45
May 11	1 33.1	6 21	6 9.6	25 55	7 32.0	23 24	8 34.7	19 29
May 21	2 15.4	10 22	6 58.4	25 25	7 56.6	22 19	8 39.9	19 9
May 31	3 14.8	16 2	7 44.7	23 55	8 21.1	21 0	8 45.9	18 46
Jun 10	4 33.3	21 43	8 27.4	21 32	8 45.4	19 28	8 52.6	18 19
Jun 20	6 7.3	24 47	9 5.7	18 30	9 9.5	17 44	8 59.8	17 50
Jun 30	7 37.3	23 30	9 38.6	15 4	9 33.3	15 49	9 7.4	17 17
Jul 10	8 49.3	19 10	10 5.0	11 29	9 57.0	13 43	9 15.5	16 42
Jul 20	9 42.2	13 42	10 23.0	8 4	10 20.4	11 29	9 23.7	16 4
Jul 30	10 15.6	8 37	10 29.9	5 15	10 43.7	9 8	9 32.1	15 24
Aug 9	10 24.7	5 38	10 22.9	3 35	11 6.9	6 40	9 40.7	14 43
Aug 19	10 4.6	6 47	10 3.3	3 34	11 30.1	4 7	9 49.2	14 0
Aug 29	9 39.7	11 7	9 39.9	5 5	11 53.5	1 31	9 57.7	13 16
Sep 8	9 56.6	12 45	9 26.0	7 6	12 17.0	-1 8	10 6.0	12 32
Sep 18	10 54.2	8 51	9 27.3	8 37	12 40.8	-3 47	10 14.2	11 48
Sep 28	12 1.7	1 38	9 42.4	9 10	13 5.0	-6 25	10 22.0	11 5
Oct 8	13 5.6	-6 5	10 7.4	8 39	13 29.8	-8 59	10 29.5	10 23
Oct 18	14 6.1	-13 5	10 38.9	7 8	13 55.2	-11 29	10 36.6	9 43
Oct 28	15 5.4	-18 52	11 14.4	4 46	14 21.3	-13 52	10 43.1	9 7
Nov 7	16 4.3	-23 6	11 52.6	1 43	14 48.3	-16 6	10 48.9	8 33
Nov 17	16 59.1	-25 21	12 32.8	-1 51	15 16.2	-18 8	10 54.1	8 4
Nov 27	17 33.3	-25 8	13 14.5	-5 41	15 45.0	-19 56	10 58.4	7 40
Dec 7	17 9.2	-21 58	13 58.0	-9 36	16 14.8	-21 27	11 1.7	7 23
Dec 17	16 27.3	-18 48	14 43.2	-13 21	16 45.4	-22 39	11 3.9	7 11
Dec 27	16 45.7	-20 12	15 30.5	-16 42	17 16.9	-23 29	11 5.1	7 7

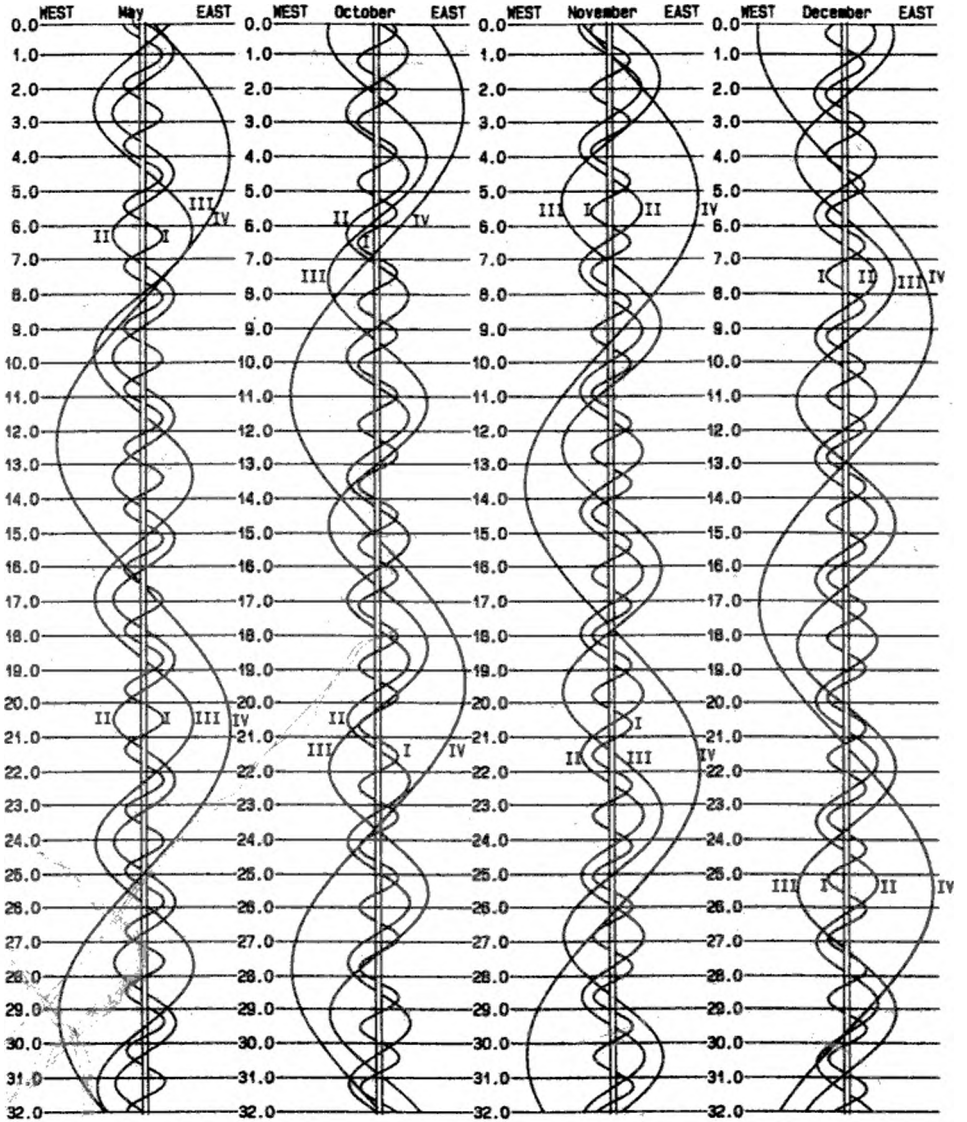
	Saturn RA	Saturn DEC	Uranus RA	Uranus DEC	Neptune RA	Neptune DEC	Pluto RA	Pluto DEC
	h m	° ′	h m	° ′	h m	° ′	h m	° ′
Jan 1	19 50.7	-21 9	18 42.4	-23 24	19 1.0	-21 54	15 24.6	-3 13
Jan 15	19 57.6	-20 51	18 46.1	-23 20	19 3.2	-21 51	15 26.0	-3 13
Feb 1	20 6.1	-20 28	18 50.2	-23 16	19 5.9	-21 47	15 27.2	-3 11
Feb 15	20 12.8	-20 9	18 53.3	-23 12	19 7.8	-21 44	15 27.8	-3 6
Mar 1	20 19.1	-19 50	18 55.9	-23 9	19 9.5	-21 41	15 27.9	-3 0
Mar 15	20 24.7	-19 32	18 58.0	-23 7	19 10.9	-21 39	15 27.6	-2 52
Apr 1	20 30.3	-19 14	18 59.6	-23 5	19 11.9	-21 36	15 26.7	-2 43
Apr 15	20 33.8	-19 3	19 0.2	-23 5	19 12.3	-21 36	15 25.6	-2 35
May 1	20 36.4	-18 56	18 59.9	-23 5	19 12.1	-21 36	15 24.0	-2 27
May 15	20 37.3	-18 54	18 58.9	-23 7	19 11.5	-21 36	15 22.6	-2 21
Jun 1	20 36.6	-18 58	18 57.0	-23 10	19 10.3	-21 38	15 20.8	-2 17
Jun 15	20 34.7	-19 7	18 54.9	-23 13	19 8.9	-21 41	15 19.5	-2 16
Jul 1	20 31.2	-19 22	18 52.2	-23 17	19 7.2	-21 43	15 18.3	-2 18
Jul 15	20 27.4	-19 37	18 49.7	-23 20	19 5.6	-21 46	15 17.6	-2 23
Aug 1	20 22.2	-19 56	18 47.0	-23 23	19 3.7	-21 49	15 17.2	-2 31
Aug 15	20 18.1	-20 10	18 45.1	-23 25	19 2.3	-21 52	15 17.4	-2 40
Sep 1	20 13.8	-20 25	18 43.5	-23 27	19 1.1	-21 54	15 18.1	-2 52
Sep 15	20 11.4	-20 33	18 43.0	-23 27	19 0.6	-21 55	15 19.2	-3 4
Oct 1	20 10.1	-20 38	18 43.2	-23 27	19 0.4	-21 56	15 20.8	-3 18
Oct 15	20 10.4	-20 38	18 44.1	-23 26	19 0.8	-21 56	15 22.5	-3 29
Nov 1	20 12.5	-20 31	18 46.2	-23 23	19 1.9	-21 55	15 24.9	-3 43
Nov 15	20 15.7	-20 21	18 48.6	-23 20	19 3.3	-21 53	15 27.0	-3 52
Dec 1	20 20.7	-20 6	18 52.0	-23 16	19 5.3	-21 51	15 29.4	-4 1
Dec 15	20 26.1	-19 48	18 55.3	-23 12	19 7.3	-21 48	15 31.4	-4 7
Dec 31	20 33.1	-19 24	18 59.3	-23 6	19 9.8	-21 44	15 33.5	-4 11

THE MOONS OF JUPITER

One of the most popular sights for an observer with a small telescope is Jupiter and its moons. Four of the sixteen - 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 on page 22 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 following diagrams which show how their positions along such a straight line change during the 8 months when Jupiter is prominent. For each month, time increases downward; the disc of Jupiter is stretched to make the central column, and horizontal lines representing midnight



(0 am SAST), are shown for every day of the month. The wavy lines show how the moons appear to ossilate from each side of the planet to the other.



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 in the evening and its commencement in the morning when the planet is above the horizon in Southern Africa, are given in the table below.

EXPLANATION OF THE 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 ie.the satellite passes through the shadow of Jupiter; R - Reappearance; Oc - Occultation ie.the satellite is obscured by the disc of Jupiter; I - Ingress; Sh - Shadow Transit ie.the shadow of the satellite transits the disc; E - Egress; Tr - Transit ie.the satellite crosses the disc of Jupiter.

d	h	m		d	h	m		d	h	m		d	h	m	
Jan 01	01	52	II.Sh.I.	Jan 18	20	37	I.Tr.I.	Feb 03	20	55	I.Sh.E.	Feb 22	01	15	III.Ec.R.
	03	12	II.Tr.I.		20	54	II.Tr.I.		22	56	III.Tr.I.		04	07	IV.Oc.R.
	03	38	I.Sh.I.		22	39	I.Sh.E.		23	02	II.Ec.R.	24	02	32	I.Oc.D.
	04	17	I.Tr.I.		22	54	I.Tr.E.		23	32	III.Sh.I.		23	43	I.Tr.I.
	04	46	II.Sh.E.		23	18	II.Sh.E.	04	02	32	III.Tr.E.	25	00	21	I.Sh.I.
02	00	50	I.Ec.D.		23	49	II.Tr.E.		03	08	III.Sh.E.		02	00	I.Tr.E.
	03	48	I.Oc.R.	19	20	09	I.Oc.R.	08	04	36	I.Oc.D.		02	36	II.Oc.D.
	22	07	I.Sh.I.		23	46	IV.Oc.R.	09	01	47	I.Tr.I.		02	38	I.Sh.E.
	22	44	I.Tr.I.	20	20	02	III.Tr.E.		02	04	I.Sh.I.		20	59	I.Oc.D.
	22	44	IV.Ec.D.	24	03	47	I.Sh.I.		03	40	II.Tr.I.		23	57	I.Ec.R.
	23	53	III.Oc.R.		03	55	I.Tr.I.		04	05	I.Tr.E.	26	20	26	I.Tr.E.
03	00	23	I.Sh.E.		04	19	II.Ec.D.		04	14	II.Sh.I.		21	06	I.Sh.E.
	00	44	II.Oc.R.		05	40	III.Ec.D.		04	21	I.Sh.E.		21	24	II.Tr.I.
	01	00	I.Tr.E.	25	01	02	I.Ec.D.		23	02	I.Oc.D.		22	47	II.Sh.I.
	03	29	IV.Ec.R.		03	26	I.Oc.R.	10	01	38	I.Ec.R.	27	00	18	II.Tr.E.
	04	38	IV.Oc.D.		22	16	I.Sh.I.		20	13	I.Tr.I.		01	41	II.Sh.E.
	22	14	I.Oc.R.		22	20	I.Tr.I.		20	32	I.Sh.I.	28	20	02	II.Ec.R.
08	04	28	II.Sh.I.		23	00	II.Sh.I.		22	06	II.Oc.D.		22	41	III.Oc.D.
	05	30	II.Tr.I.		23	10	II.Tr.I.		22	30	I.Tr.E.	Mar 02	19	44	IV.Sh.E.
	05	32	I.Sh.I.	26	00	33	I.Sh.E.		22	49	I.Sh.E.		04	01	29	I.Tr.I.
09	02	45	I.Ec.D.		00	38	I.Tr.E.	11	01	36	II.Ec.R.		02	15	I.Sh.I.
	05	32	I.Oc.R.		01	55	II.Sh.E.		02	12	III.Tr.I.		19	05	III.Sh.E.
	21	42	III.Ec.D.		02	04	II.Tr.E.		03	31	III.Sh.I.		22	45	I.Oc.D.
	23	11	II.Ec.D.		19	30	I.Ec.D.		20	07	I.Ec.R.	05	01	52	I.Ec.R.
10	00	00	I.Sh.I.		21	52	I.Oc.R.	12	19	42	II.Tr.E.		19	56	I.Tr.I.
	00	28	I.Tr.I.	27	19	34	III.Sh.I.		20	27	II.Sh.E.		20	44	I.Sh.I.
	02	17	I.Sh.E.		19	41	III.Tr.I.	13	20	58	IV.Sh.I.		22	12	I.Tr.E.
	02	45	I.Tr.E.		20	31	II.Oc.R.		22	04	IV.Tr.E.		23	01	I.Sh.E.
	02	58	II.Oc.R.		23	09	III.Sh.E.	14	01	43	IV.Sh.E.		23	44	II.Tr.I.
	03	13	III.Oc.R.		23	17	III.Tr.E.		21	16	III.Ec.R.	06	01	24	II.Sh.I.
	21	13	I.Ec.D.	28	02	58	IV.Sh.I.	16	03	32	I.Tr.I.		02	38	II.Tr.E.
	23	58	I.Oc.R.		03	10	IV.Tr.I.		03	58	I.Sh.I.		20	21	I.Ec.R.
11	20	41	II.Sh.E.	31	05	38	I.Tr.I.	17	00	47	I.Oc.D.	07	22	37	II.Ec.R.
	20	45	I.Sh.E.		05	41	I.Sh.I.		03	33	I.Ec.R.	08	02	08	III.Oc.D.
	21	11	I.Tr.E.	Feb 01	02	52	I.Oc.D.		21	58	I.Tr.I.	10	19	04	IV.Oc.R.
	21	33	II.Tr.E.		05	15	I.Ec.R.		22	26	I.Sh.I.		22	53	IV.Ec.D.
16	04	39	I.Ec.D.	02	00	04	I.Tr.I.	18	00	15	I.Tr.E.	11	19	22	III.Tr.E.
17	01	41	III.Ec.D.		00	10	I.Sh.I.		00	20	II.Oc.D.		19	28	III.Sh.I.
	01	45	II.Ec.D.		01	25	II.Tr.I.		00	44	I.Sh.E.		23	04	III.Sh.E.
	01	54	I.Sh.I.		01	37	II.Sh.I.		04	10	II.Ec.R.	12	00	33	I.Oc.D.
	02	11	I.Tr.I.		02	21	I.Tr.E.		19	13	I.Oc.D.		21	43	I.Tr.I.
	04	11	I.Sh.E.		02	27	I.Sh.E.		22	02	I.Ec.R.		22	39	I.Sh.I.
	04	28	I.Tr.E.		04	19	II.Tr.E.	19	19	12	I.Sh.E.	13	00	00	I.Tr.E.
	05	12	II.Oc.R.		04	32	II.Sh.E.		20	09	II.Sh.I.		00	55	I.Sh.E.
	23	07	I.Ec.D.		21	18	I.Oc.D.		21	59	II.Tr.E.		02	07	II.Tr.I.
18	01	43	I.Oc.R.		23	44	I.Ec.R.		23	04	II.Sh.E.		19	00	I.Oc.D.
	20	22	I.Sh.I.	03	19	52	II.Oc.D.	21	19	18	III.Oc.D.		22	16	I.Ec.R.
	20	23	II.Sh.I.		20	47	I.Tr.E.		23	19	IV.Oc.D.	14	19	24	I.Sh.E.

	d	h	m	
Mar	14	20	24	II.Oc.D.
	15	01	12	II.Ec.R.
	16	20	13	II.Sh.E.
	18	19	20	III.Tr.I.
		22	54	III.Tr.E.
		23	26	IV.Tr.I.
		23	27	III.Sh.I.
	19	02	22	I.Oc.D.
		23	32	I.Tr.I.
	20	00	33	I.Sh.I.
		01	48	I.Tr.E.
		20	49	I.Oc.D.
	21	00	11	I.Ec.R.
		19	02	I.Sh.I.
		20	16	I.Tr.E.
		21	19	I Sh.E.
		22	48	II.Oc.D.
	23	19	57	II.Sh.I.
		20	38	II.Tr.E.
		22	50	II.Sh.E.
	25	22	58	III.Tr.I.
	27	01	22	I.Tr.I.
		21	49	IV.Ec.R.
		22	39	I.Oc.D.
	28	19	49	I.Tr.I.
		20	57	I.Sh.I.
		22	06	I.Tr.E.
		23	13	I.Sh.E.
	29	01	13	II.Oc.D.
		20	35	I.Ec.R.
		21	15	III.Ec.R.
	30	20	14	II.Tr.I.
		22	34	II.Sh.I.
		23	06	II.Tr.E.
	31	01	27	II.Sh.E.
Apr	01	19	41	II.Ec.R.
	04	00	31	I.Oc.D.
		20	30	IV.Tr.E.
		21	41	I.Tr.I.
		22	52	I.Sh.I.
		23	57	I.Tr.E.
	05	01	08	I.Sh.E.
		18	59	I.Oc.D.
		20	18	III.Oc.R.
		21	36	III.Ec.D.
		22	30	I.Ec.R.
	06	19	37	I.Sh.E.
		22	44	II.Tr.I.
	08	22	16	II.Ec.R.
	11	23	33	I.Tr.I.
	12	00	47	I.Sh.I.
		20	31	III.Oc.D.
		20	52	I.Oc.D.
		23	01	IV.Oc.D.
	13	00	08	III.Oc.R.
		00	25	I.Ec.R.
		19	15	I.Sh.I.
		20	18	I.Tr.E.
		21	32	I.Sh.E.
	14	18	54	I.Ec.R.

	d	h	m	
Apr	15	19	27	II.Oc.D.
	16	19	02	III.Sh.E.
	17	19	59	II.Sh.E.
	19	22	46	I.Oc.D.
	20	19	55	I.Tr.I.
		21	10	I.Sh.I.
		22	11	I.Tr.E.
		23	27	I.Sh.E.
	21	20	49	I.Ec.R.
		21	04	IV.Sh.I.
	22	22	01	II.Oc.D.
	23	19	26	III.Sh.I.
		23	02	III.Sh.E.
	24	19	43	II.Sh.I.
		20	01	II.Tr.E.
		22	35	II.Sh.E.
	27	21	50	I.Tr.I.
		23	06	I.Sh.I.
	28	19	09	I.Oc.D.
		22	45	I.Ec.R.
	29	18	35	I.Tr.E.
		19	51	I.Sh.E.
		21	38	IV.Oc.R.
	30	21	52	III.Tr.E.
		23	25	III.Sh.I.
May	01	19	46	II.Tr.I.
		22	19	II.Sh.I.
		22	38	II.Tr.E.
	03	19	22	II.Ec.R.
	05	21	05	I.Oc.D.
	06	19	29	I.Sh.I.
		20	31	I.Tr.E.
		21	46	I.Sh.E.
	07	19	08	I.Ec.R.
		22	21	III.Tr.I.
	08	19	52	IV.Sh.E.
		22	25	II.Tr.I.
	10	21	59	II.Ec.R.
	11	21	15	III.Ec.R.
	13	20	11	I.Tr.I.
		21	24	I.Sh.I.
		22	28	I.Tr.E.
	14	21	04	I.Ec.R.
	17	19	15	II.Oc.D.
	18	20	19	III.Oc.R.
		21	35	III.Ec.D.
	19	19	42	II.Sh.E.
	20	22	09	I.Tr.I.
	21	19	29	I.Oc.D.
	22	18	55	I.Tr.E.
		20	05	I.Sh.E.
	24	21	57	II.Oc.D.
		22	16	IV.Tr.I.
	25	20	53	III.Oc.D.
	26	19	26	II.Sh.I.
		20	01	II.Tr.E.
	28	21	28	I.Oc.D.
	29	18	37	I.Tr.I.
		19	00	III.Sh.E.
		19	43	I.Sh.I.

	d	h	m	
May	29	20	54	I.Tr.E.
	30	19	22	I.Ec.R.
Jun	02	19	52	II.Tr.I.
	04	19	07	II.Ec.R.
	05	18	44	III.Tr.E.
		19	24	III.Sh.I.
		20	36	I.Tr.I.
	06	21	17	I.Ec.R.
	07	18	25	I.Sh.E.
	12	19	26	III.Tr.I.
	13	19	56	I.Oc.D.
	14	19	23	I.Tr.E.
		20	20	I.Sh.E.
	18	19	35	II.Oc.D.
	20	19	22	II.Sh.E.
	21	19	05	I.Tr.I.
		19	57	I.Sh.I.
	22	19	35	I.Ec.R.
	27	18	31	IV.Tr.E.
		19	05	II.Sh.I.
		20	23	II.Tr.E.
	29	18	26	I.Oc.D.
	30	18	28	III.Oc.D.
		18	39	I.Sh.E.
Jul	06	18	53	II.Ec.R.
	07	19	55	I.Tr.E.
	11	18	58	III.Sh.E.
Sep	27	04	51	I.Tr.I.
	28	05	46	II.Tr.I.
		05	48	IV.Oc.D.
Oct	09	05	10	III.Ec.D.
	12	05	11	I.Ec.D.
	13	04	47	I.Sh.E.
		05	38	I.Tr.E.
	14	04	33	II.Ec.D.
	20	04	23	I.Sh.I.
		05	20	I.Tr.I.
	21	04	47	I.Oc.R.
	23	03	23	II.Tr.I.
		04	15	II.Sh.E.
	28	03	26	I.Ec.D.
	29	03	02	I.Sh.E.
		04	04	I.Tr.E.
	30	04	00	II.Sh.I.
Nov	01	04	03	II.Oc.R.
	04	05	19	I.Ec.D.
	05	02	39	I.Sh.I.
		03	45	I.Tr.I.
		04	56	I.Sh.E.
	06	03	11	I.Oc.R.
	07	05	08	III.Oc.R.
	12	04	33	I.Sh.I.
	13	05	07	I.Oc.R.
	14	02	27	I.Tr.E.
		04	35	III.Ec.R.
	15	04	13	II.Ec.D.
	17	03	33	II.Tr.E.
	20	03	33	I.Ec.D.
	21	02	07	I.Tr.I.
		03	11	I.Sh.E.

	d	h	m	
Nov	21	04	22	I.Tr.E.
		04	56	III.Ec.D.
	24	03	26	II.Tr.I.
		03	47	II.Sh.E.
	25	03	19	III.Tr.E.
	26	02	43	IV.Tr.I.
	28	02	48	I.Sh.I.
		04	01	I.Tr.I.
		05	04	I.Sh.E.
	29	03	26	I.Oc.R.
Dec	01	03	33	II.Sh.I.
	02	02	23	III.Sh.E.
		03	52	III.Tr.I.
	03	03	58	II.Oc.R.
	04	03	56	IV.Ec.R.
	05	04	41	I.Sh.I.
	06	01	48	I.Ec.D.
	07	01	26	I.Sh.E.
		02	39	I.Tr.E.
	09	02	48	III.Sh.I.
	10	01	15	II.Ec.D.
	12	00	38	II.Tr.E.
	13	00	29	IV.Tr.E.
		01	21	III.Oc.R.
		03	41	I.Ec.D.
	14	01	03	I.Sh.I.
		02	16	I.Tr.I.
		03	19	I.Sh.E.
		04	31	I.Tr.E.
	15	01	40	I.Oc.R.
	17	03	49	II.Ec.D.
	19	00	26	II.Tr.I.
		00	46	II.Sh.E.
		03	10	II.Tr.E.
	20	00	21	III.Ec.R.
		01	43	III.Oc.D.
		05	11	III.Oc.R.
	21	02	56	I.Sh.I.
		04	07	I.Tr.I.
		05	12	I.Sh.E.
		05	24	IV.Oc.D.
	22	00	02	I.Ec.D.
		03	31	I.Oc.R.
	23	00	50	I.Tr.E.
	26	00	33	II.Sh.I.
		02	56	II.Tr.I.
		03	21	II.Sh.E.
	27	00	43	III.Ec.D.
		04	18	III.Ec.R.
	28	00	46	II.Oc.R.
		04	49	I.Sh.I.
	29	01	56	I.Ec.D.
		02	58	IV.Sh.I.
		05	22	I.Oc.R.
		23	17	I.Sh.I.
	30	00	25	I.Tr.I.
		01	33	I.Sh.E.
		02	40	I.Tr.E.
		23	49	I.Oc.R.

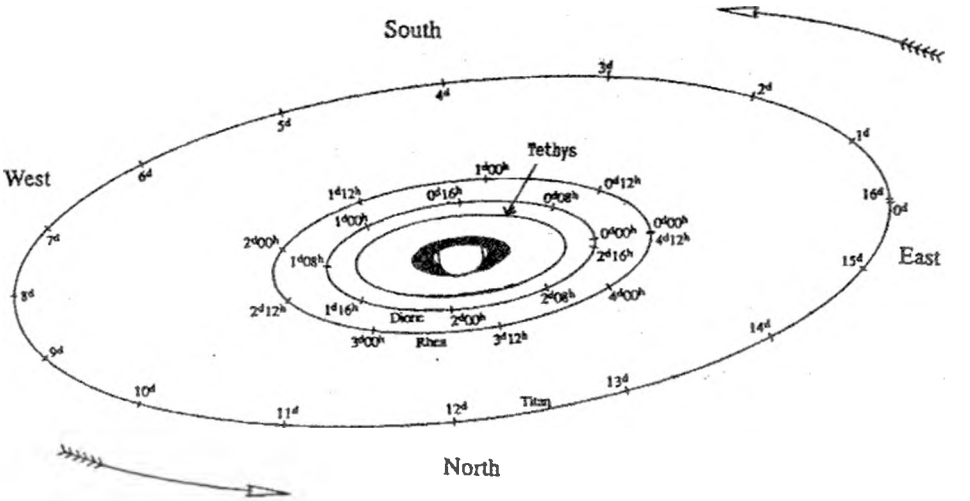
MUTUAL PHENOMENA OF JUPITER'S SATILITES

The table below gives predictions of observable mutual eclipses and occultations of the Galilean Satilites occuring in 1991 conforming to same conditions as stated on page 23 and taking place more than 2.0 Jovian radii from the planet's centre.

Date	Begin	End	Event	J Dist
d	h m	h m		radii
Jan 02	00 45.3	01 01.3	II Ec. III	10.5
Jan 02	03 30.2	03 50.2	II Oc. III	9.3
Jan 05	02 09.5	02 28.1	II Oc. I	5.5
Jan 09	04 52.3	05 14.0	II Ec. III	10.2
Jan 12	03 40.1	04 05.1	II Ec. I	5.4
Jan 12	04 58.1	05 11.4	II Oc. I	5.8
Jan 22	03 32.4	04 01.7	II Oc. I	5.0
Jan 22	20 14.7	20 29.4	II Ec. I	5.9
Jan 22	20 37.2	20 48.2	II Oc. I	5.9
Jan 23	17 20.9	20 13.9	II Oc. III	6.9
Jan 23	21 49.7	22 50.4	II Ec. III	5.2
Jan 29	22 54.5	23 04.5	II Oc. I	5.9
Jan 29	22 56.2	23 08.5	II Ec. I	5.9
Feb 06	01 07.9	01 17.3	II Oc. I	5.9
Feb 06	01 30.3	01 40.6	II Ec. I	5.9
Feb 13	03 19.1	03 27.7	II Oc. I	5.8
Feb 13	03 59.6	04 08.9	II Ec. I	5.7
Feb 20	05 29.4	05 37.4	II Oc. I	5.8
Feb 21	03 05.4	05 27.0	III Oc. IV	8.7
Feb 23	19 38.0	19 46.3	II Ec. I	5.5
Mar 02	20 44.5	20 51.5	II Oc. I	5.7
Mar 02	22 00.8	22 08.8	II Ec. I	5.2
Mar 09	22 54.6	23 00.9	II Oc. I	5.5
Mar 10	00 22.1	00 29.4	II Ec. I	5.0
Mar 17	01 05.7	01 11.1	II Oc. I	5.4
Mar 17	23 49.7	04 14.4	IV Oc. III	9.7
Mar 18	21 37.7	21 47.4	IV Ec. II	6.7
Mar 25	21 38.8	21 45.2	III Ec. II	5.4
Apr 02	00 52.5	01 00.1	III Ec. II	5.9
Apr 03	20 28.3	20 34.3	II Ec. I	4.0
Apr 10	20 51.1	20 54.4	II Oc. I	4.9
Apr 10	22 45.6	22 51.2	II Ec. I	3.8
Apr 13	23 11.1	23 18.4	II Ec. IV	8.8
Apr 21	20 48.3	20 56.3	IV Ec. I	2.1
Apr 29	23 08.8	23 14.1	I Ec. II	2.0
Apr 30	19 37.8	19 43.8	III Ec. I	3.9
May 07	22 25.4	22 32.4	III Ec. I	4.5
May 12	19 06.6	19 08.9	II Oc. I	4.0
May 14	20 30.5	20 37.5	III Ec. II	7.8
May 19	21 25.2	21 27.9	II Oc. I	3.8
May 24	19 02.7	19 08.3	I Ec. II	2.9
May 30	21 19.1	21 24.8	I Ec. II	3.2
Jun 09	19 25.1	19 33.4	II Ec. III	6.5
Jun 11	19 01.4	19 11.7	IV Ec. I	5.3
Jun 19	19 37.7	20 59.7	III Ec. I	4.2
Jun 20	19 55.5	19 59.5	II Oc. I	2.6
Jun 26	19 30.1	19 53.5	III Oc. I	5.5
Jun 27	18 38.6	18 48.6	III Ec. I	4.8
Jul 02	18 31.4	18 36.4	I Oc. II	5.2
Jul 02	19 42.1	19 46.8	I Ec. II	4.5

THE MOONS OF SATURN

Saturn's moons are considerably fainter than the 4 Galilean moons of Jupiter. The diagram shows the orbits of 4 of Saturn's moons. The easiest to find is Titan (magnitude +8.5),according to the diagram and information in the table below.



TITAN

Eastern Elongation			Inferior Conjunction			Western Elongation			Superior Conjunction		
	d	h		d	h		d	h		d	h
Jan	15	00.0		19	01.6		23	06.6		27	05.2
	31	00.7	Feb	4	02.5	Feb	8	07.4	Feb	12	05.8
Feb	16	01.3		20	03.2		24	08.0		28	06.2
Mar	4	01.8	Mar	8	03.7	Mar	12	08.4	Mar	16	06.5
	20	02.0		24	04.0		28	08.6	Apr	1	06.4
Apr	5	01.9	Apr	9	03.9	Apr	13	08.3		17	06.0
	21	01.4		25	03.4		29	07.7	May	3	05.2
May	7	00.6	May	11	02.5	May	15	06.7		19	04.1
	22	23.3		27	01.1		31	05.2	Jun	4	02.5
Jun	7	21.6	Jun	11	23.3	Jun	16	03.3		20	00.5
	23	19.6		27	21.1	Jul	2	01.0	Jul	5	22.3
Jul	9	17.2	Jul	13	18.6		17	22.5		21	19.9
	25	14.8		29	16.0	Aug	2	20.0	Aug	6	17.4
Aug	10	12.2	Aug	14	13.4		18	17.5		22	15.0
	26	09.9		30	11.0	Sep	3	15.2	Sep	7	12.9
Sep	11	07.8	Sep	15	09.0		19	13.2		23	11.1
	27	06.1	Oct	1	07.3	Oct	5	11.7	Oct	9	09.7
Oct	13	04.8		17	06.2		21	10.7		25	08.8
	29	04.0	Nov	2	05.5	Nov	6	10.1	Nov	10	08.3
Nov	14	03.6		18	05.3		22	10.0		26	08.1
	30	03.5	Dec	4	05.4	Dec	8	10.2	Dec	12	08.2
Dec	16	03.8		20	05.9		24	10.6		28	08.6

COMETS AND METEORS

COMETS

A typical comet consists of a solid nucleous surrounded by a very large envelope of gas and dust, called the coma; in some instances, comets might develop a tail. Depending on the length of their periods around the Sun, comets are classed into 2 groups: Short-period comets, with an average of a 7 year period, an orbital inclination of about 13 degrees and small orbital eccentricities, (0.2 to 0.9) and usually travel in a direct motion; Long-period comets have a period greater than 200 years, random orbital inclinations and about 0.9999 eccentricity and random motion.

About a dozen comets are observed each year and of these, 5 or 6 are new discoveries. As a comet approaches or moves away from the Sun its visual appearance changes drastically and it might become bright enough to be observed with modest equipment such as a good pair of binoculars or a telescope with an aperture not less than 75mm; on rare occasions a very bright comet may become visible to the naked-eye.

Interested observers can contribute with valuable information by reporting on their visual appearance such as coma magnitude, apparent diameter and degree of condensation; if the comet sports a tail, its length in degrees and its p.a. (position angle) should also be reported, as well as the type of instrument and magnification used.

Another area much in need of observers, is that of regularly conducting visual searches of possible new comets, namely in the southern celestial hemisphere. Interested members are asked to contact the Director of the Comet and Meteor Section:

Jose Campos, 19 Fiskaal Place, Woodhaven, Durban 4001.

METEORS

Orbiting within the solar system, METEOROIDS often collide with the Earth's atmosphere and as a result, they heat to incandescence by friction with the atmosphere's gaseous molecules and an emission of light takes place due to ionization; while in flight through the atmosphere they are called METEORS and they disintegrate completely. There are two types of meteors: Sporadic ones which may be seen at any time of the night, anywhere in the sky; the shower meteors are associated with known meteor showers that are active during certain times of the year (See the Table on the next page). Bright meteors of visual magnitude equal or greater than that of Venus (-4.0 mag.), are classed as Fireballs and if they explode while in flight, they are termed Bolides. Fireballs of visual magnitude equal or brighter than that of the Full Moon are known to produce debris that when found on the ground are called METEORITES. Interested persons are asked to contact the Director:

Jose Campos, 19 Fiskaal Place, Woodhaven, Durban 4001.

In the event of Fireballs, please phone 031-423684 at any time.

Predicted Limits	Meteor Shower	Radiant (1950) R.A.	Dec	Date at Maximum	Transit of Radiant SAST	Alt	Conditions at Maximum	I.H.R.	Recommended watch at Max. Beginning: SAST	Alt	Ending: SAST	Alt	V km/s
Jan 06-28	Alpha Crucids	12h48	-63	Jan 19	04h56	57	Very good	?	22h30	25	04h00	55	50
Jan 23-Mar 12	Theta Centaurids	14h00	-40	Feb 08	05h05	76	Favourable	?	00h00	31	04h00	70	60
Mar 01-12?	Pyxids(new)	09h00	-35	Mar 06?	22h02	85	Favourable	6?	20h00	63	03h15	26	
Mar 13-18	Corona Australids	16h20	-48	Mar 16	04h43	72	New moon	5	23h15	26	04h30	71	
Mar 21-Apr 08	Delta Pavonids	20h10	-65	Mar 29?	07h43	55	Unfavourable	7	02h00	28	04h00	41	
Apr 16-25	April Lyrids	18h05	+34	Apr 22	04h06	28	Good	15	03h00	26	05h00	26	49
Apr 11-May 12	Alpha Scorpids	16h00	-22	May 03	01h16	82	Favourable	7	21h00	33	04h30	46	
Apr 20-Jul 30	Sco-Sgr System	18h00	-30	Jun 14	00h29	90	Good	10	21h00	45	04h00	44	30
Apr 19-May 28	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	Good	6?	19h00	25	04h10	25	
Jun 08-16	Sagittarids	20h16	-35	Jun 11	02h59	85	Very good	4?	21h45	26	05h10	62	
Jun 08-16	Theta Ophiuchids	17h48	-28	Jun 13	00h23	88	Very good	5?	20h00	34	05h00	30	
Jun 10-21	June Lyrids	18h32	+35	Jun 16	00h53	25	Favourable	5	23h30	22	01h30	24	31
Jun 17-26	Ophiuchids	17h20	-20	Jun 20	23h22	80	Favourable	10	19h00	30	02h00	53	
Jun 26-29	Cetids (new)	02h00	-15	Jun 28	07h35	75	Poor	?	03h00	25	05h20	56	
Jul 10-Aug 05	Capricornids	21h00	-15	Jul 26	00h47	75	Full moon	8	-		-		
Jul 14-Aug 25	North Delta Aquarids	22h36	-05	Aug 12	01h13	65	Good	5	21h00	26	04h30	37	42
Jul 03-Aug 25	Alpha Capricornids	20h36	-10	Jul 30	23h41	70	Poor	8	20h00	33	04h00	29	23
Jul 09-Aug 17	Piscis Australids	22h40	-30	Jul 29	02h03	89	Poor	12	21h30	32	05h00	51	35
Jul 15-Aug 25	South Iota Aquarids	22h20	-15	Aug 05	01h29	75	Favourable	3	22h00	40	04h00	52	34
Aug 11-Sep 20	North Iota Aquarids	21h48	-06	Aug 20	23h51	66	Unfavourable	10	20h00	31	04h00	28	31
Jul 08-Aug 19	South Delta Aquarids	22h12	-17	Jul 29	02h07	77	Unfavourable	20	22h00	33	05h00	47	41
Sep 15-Nov 26	Southern Taurids	03h22	+14	Nov 03	00h31	46	Very good	12	21h30	28	03h00	34	27
Sep 13-Dec 01	Northern Taurids	03h53	+22	Nov 13	00h27	38	Favourable	8	23h30	36	01h00	37	29
Oct 02-Nov 07	Orionids	06h24	+15	Oct 22	04h23	45	Poor	20	02h00	33	03h20	42	66
Nov 14-21	Leonids	10h08	+22	Nov 17	06h21	38	Poor	10	03h00	18	03h30	23	71
Nov 28-Dec 09	December Phoenicids	01h00	-55	Dec 05	20h07	65	Very good	5?	20h30	64	01h00	33	18
Dec 04-16	Geminids	07h28	+33	Dec 14	01h55	28	Favourable	50	23h30	19	03h00	26	35
Dec 05-Jan 07	Velaids	09h56	-51	Dec 29	03h25	69	Favourable	15?	23h00	37	03h30	69	40

The times (SAST) and the altitudes (Alt) given, are for an observer stationed at E 30.5 S 29.5 (Durban), to be used as a guide for meteor observers elsewhere. The times for the recommended watch and the conditions, are based on the radiant altitude and on moonlight and twilight interference during the date of the predicted maximum meteor activity. The Zenithal Hourly Rate (ZHR) is the probable number of meteors expected to be seen by an experienced observer during 1 hour, when the radiant is at the zenith and with seeing conditions corresponding to a naked-eye limiting magnitude of +6.5 mag. near the zenith.

For meaningful visual work, the minimum altitude of the radiant should be 25 degrees above the horizon. Depending on the altitude (Alt) of the radiant at the time of observations, the following table gives the factor (F) by which the hourly observed rate should be multiplied to compute the ZHR:

Alt (deg)	21	27	35	43	52	66	90
F	2.0	1.67	1.43	1.25	1.11	1.0	

The perception coefficient (P-value) varies from observer to observer, hence the absolute necessity of keeping the count per hour (hourly rate) on an individual basis when working in group. A high P-value can mean that a specific observer gets a higher ZHR under the reported seeing conditions than the "average" observer and this can be explained by the fact that the observer may have really seen more meteors/hour or more frequently, that the limiting magnitude at the time of the observation, is not properly estimated. Hence, it is important that the faintest naked-eye star seen near the zenith, be carefully derived from reliable star atlases or catalogues.

The Stars

CONSTELLATIONS

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

In all there are 88 constellations, roughly one half of which would be above the horizon at any one time. Some contain distinctive patterns of bright stars and are relatively easy to find; others are difficult to locate, even with suitable maps. The Southern Cross and Centaurus, Orion and Taurus, Scorpius and Sagittarius, are featured later in this section. Detailed information on other constellations is beyond the scope of this handbook and interested observers are advised to obtain a suitable star atlas.

STAR NAMES

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

STELLAR MAGNITUDES AND STELLAR DISTANCES

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.

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 small telescopes fail to resolve individual stars - instead they appear as fuzzy balls.

NEBULAE

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

THE STAR CHARTS

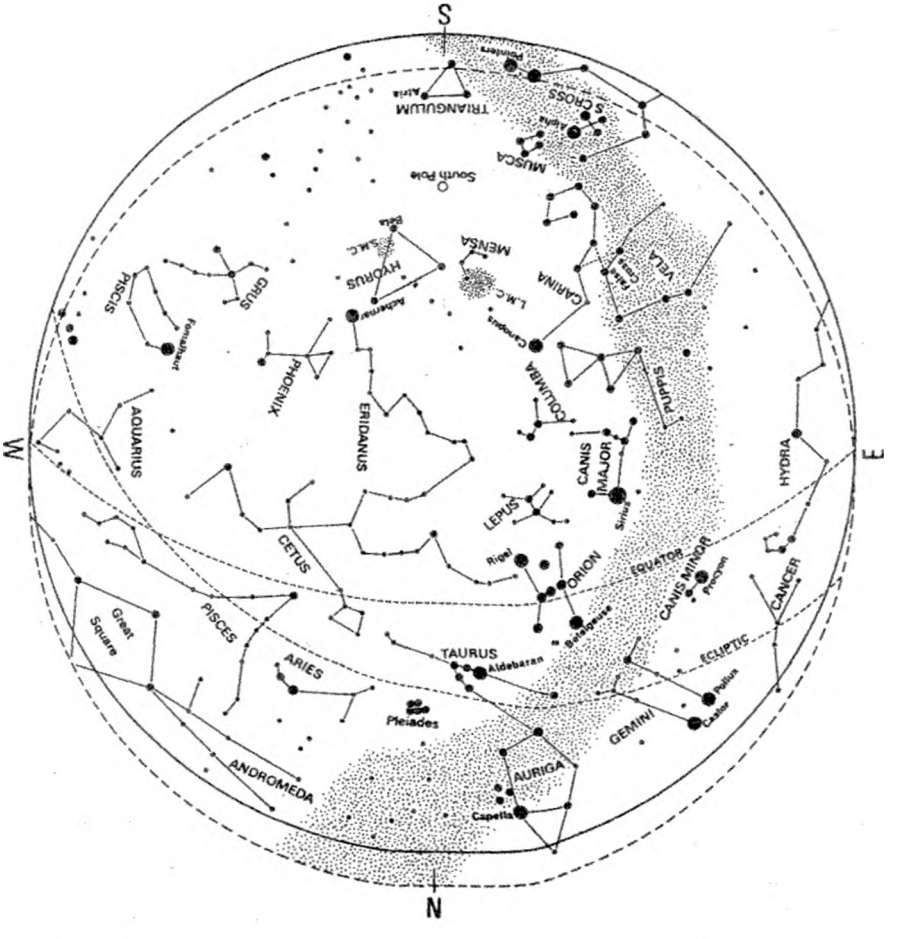
The star charts in this section show the night sky for each of the four seasons of the year. These seasonal charts depict stars down to magnitude 3.5 which is approximately what will be visible to the naked eye in city areas. Charts of 3 of the most interesting regions in the sky (showing stars down to magnitude 4.5) - the Orion region, visible in Summer; the Scorpius region, visible in Winter and the Southern Cross Region, visible all year round - are featured. They are rich in interesting objects visible to the naked eye, or with the aid of binoculars or a small telescope. To use them locate the constellations in the sky from the seasonal chart and rotate the regional chart to match the orientation of the constellations in the sky.

THE SUMMER SKY

The chart below represents the sky in Cape Town on December 1 at midnight, January 1 at 10 pm and February 1 at 8 pm. Corrections for places other than Cape Town are

Bloemfontein and Port Elisabeth	-30 minutes
Johannesburg	-40 minutes
Durban	-50 minutes
Harare	-52 minutes

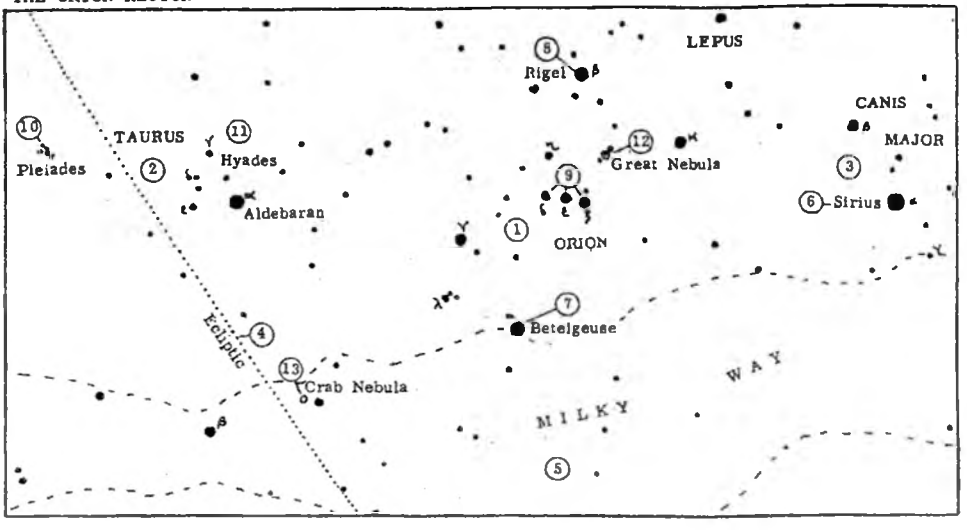
Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.



Courtesy of the

PLANETARIUM SA MUSEUM

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.

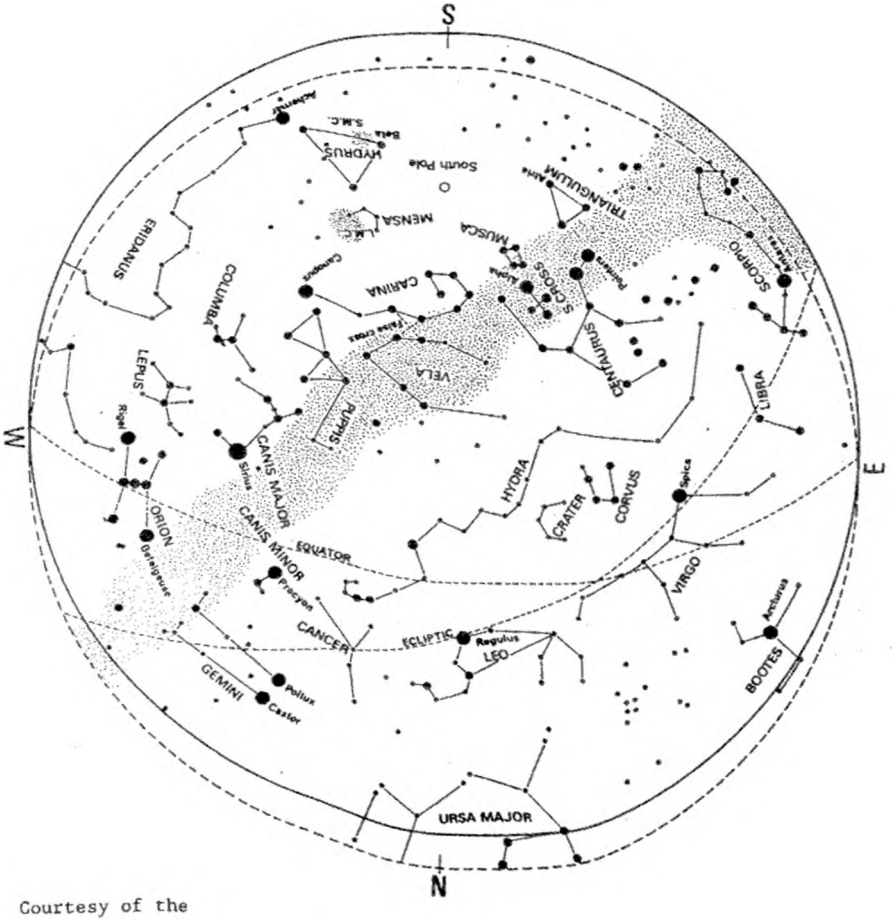
(13) The Crab Nebula, the remnant of a supernova recorded by the Chinese in 1054, requires a moderate sized telescope for observation. In its heart is located the extraodinary pulsar which emits a double flash of light 30 times every second. The current belief is that it is a rapidly rotating neutron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

THE AUTUMN SKY

The chart below represents the sky in Cape Town on March 1 at midnight, April 1 at 10 pm and May 8 pm. Corrections for places other than Cape Town are

Bloemfontein and Port Elisabeth	-30 minutes
Johannesburg	-40 minutes
Durban	-50 minutes
Harare	-52 minutes

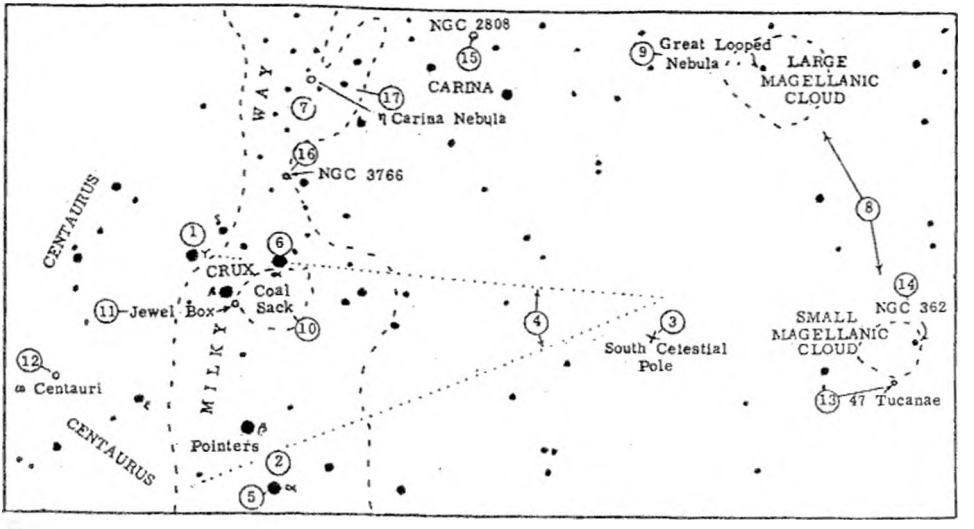
Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.



Courtesy of the

PLANETARIUM  SA MUSEUM

THE SOUTHERN CROSS REGION



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

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

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

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

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

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

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

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

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

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

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

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

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

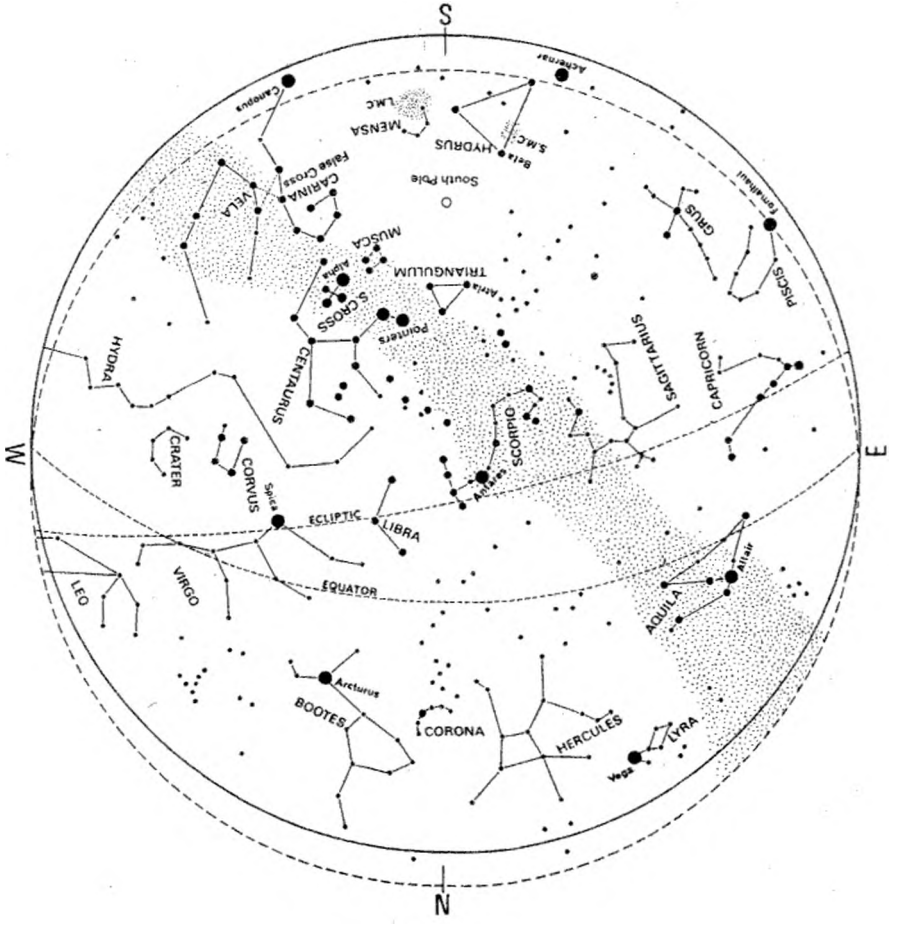
(17) The η Carinae nebula - site of a slow supernova that brightened to magnitude -0,8 in 1843 and is now of magnitude 6,4.

THE WINTER SKY

The chart below represents the sky in Cape Town on June 1 at midnight, July 1 at 10 pm and August 1 at 8 pm. Corrections for places other than Cape Town are

Bloemfontein and Port Elisabeth	-30 minutes
Johannesburg	-40 minutes
Durban	-50 minutes
Harare	-52 minutes

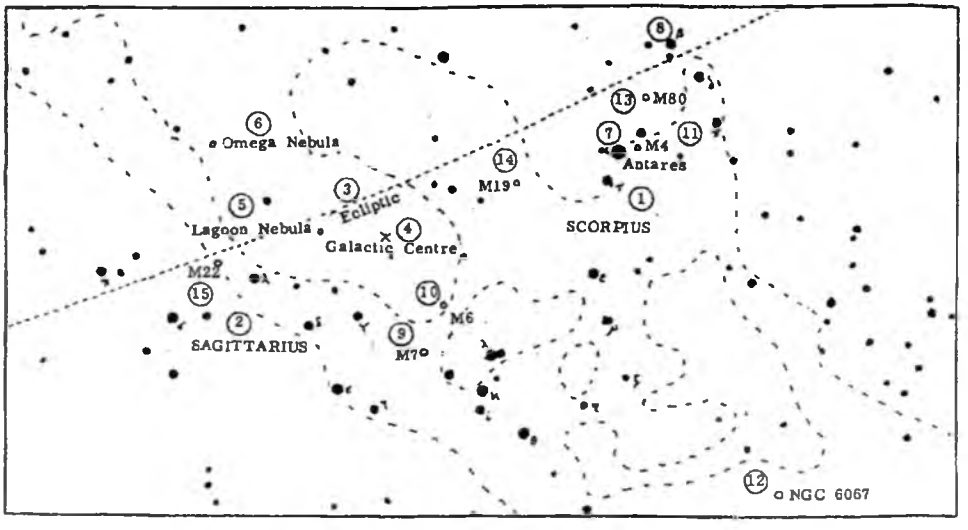
Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.



Courtesy of the

PLANETARIUM SA MUSEUM

THE SCORPIUS REGION



(1) The constellation of Scorpius. The creature is depicted with α in the centre of the body and β and π the claws. The distinctive tail ε — ζ — ℓ 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) ℓ Scorpii can be resolved as a double star (separation 16 sec of arc) with a small telescope. In fact the brighter component is in itself a triple star, and the fainter component a double star!

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

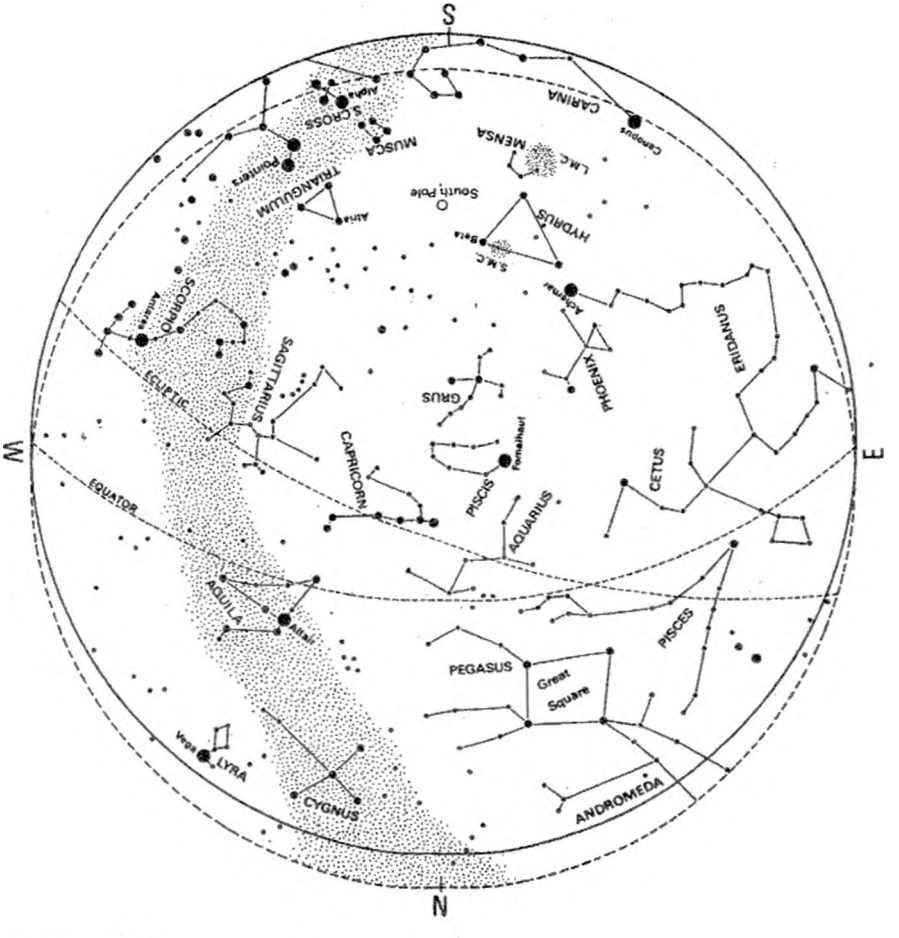
Further from the plane of the Milky Way are some globular clusters: (13) M80 (14) M19 and (15) M22.

THE SPRING SKY

The chart below represents the sky in Cape Town on September 1 at midnight, October 1 at 10 pm and November 1 at 8 pm. Corrections for places other than Cape Town are

Bloemfontein and Port Elisabeth	-30 minutes
Johannesburg	-40 minutes
Durban	-50 minutes
Harare	-52 minutes

Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.



Courtesy of the

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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) 31736.

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 observation 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

These phenomena concern a specialised branch of observational astronony 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. Persons interested in making and reporting occultation observations are urged to contact the Director of the Society's Occultation Section:
Mr. M.D. Overbeek, P.O. Box 212, Edenvale, 1610 Tel: (011) 453 6918

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 E	33°.933 S
Johannesburg	28°.075 E	26°.182 S
Harare	31°.000 E	17°.800 S

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

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

where a and b, in minutes of time, are given in the tables. Alternatively,rough times for intermediate stations can usually be estimated directly 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 ordinary occultations are given in U.T.

EXPLANATIONS OF ABBREVIATIONS USED IN THE 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 UT
a,b	-	parameters in minutes for predicting times other than at standard stations (as explained above in the text)
P.A.	-	The Position Angle on the Moon's limb measured eastward from the north point

UT DATE M D	I.C.	Mag.	Ph	ELG °	CAPE TOWN E 18.5 S 33.9 TIME h m	a. m	b. m	P.A. °	JOHANNESBURG E 28.1 S 26.2 TIME h m	a. m	b. m	P.A. °	HARARE E 31.0 S 17.8 TIME h m	a. m	b. m	P.A. °
Jan 2	1331	5.9	RD	209	20 47.9	-1.2	-3.0	343								
Jan 3	1442	5.0	RD	222									19 44.6	-0.5	-0.9	280
Jan 4	1565m	6.3	RD	236									22 36.9	-2.1	-0.3	262
Jan 10	2108m	6.4	RD	296									1 46.3	-2.0	-0.1	257
Jan 10	2109	6.1	RD	296									2 29.8	-2.7	+0.1	256
Jan 12	2371	4.9	DB	318	2 2.8	-1.9	+1.9	34								
Jan 12	2371	4.9	RD	317	2 21.8	-2.1	-4.9	357								
Jan 19	3340	7.5	DD	43	18 48.0	-0.1	+2.3	28								
Jan 20	3464	7.1	DD	54									17 23.2	-1.0	+1.6	59
Jan 21	42	5.6	DD	67					18 28.1			136	18 27.1	-1.2	+0.2	102
Jan 24	443	7.4	DD	105									17 20.8	-3.0	+0.0	94
Jan 24	448	7.1	DD	105	18 46.6	-2.7	-1.0	129	19 5.4	-2.1	-0.1	111	19 13.7	-2.1	+0.6	88
Jan 25	603	7.5	DD	119	18 56.2	-2.1	+1.0	55	19 30.0	-2.5	+2.4	37				
Feb 1	1611	5.7	RD	214					20 8.8	-1.2	-0.0	247	20 8.0	-1.1	-0.8	274
Feb 6	2183	5.7	RD	274	23 33.7	+0.2	-1.9	309	23 12.1	+0.8	-3.0	344				
Feb 7	2311	6.2	RD	285	23 28.8	+0.9	-2.4	333								
Feb 8	2317	6.6	RD	286	0 26.8	+1.2	-3.5	347								
Feb 9	2458	6.2	RD	298									2 53.2			211
Feb 21	538	5.6	DD	87									17 40.3	-2.0	-1.8	134
Feb 21	555	6.8	DD	88					19 13.8	-0.5	-1.3	141	19 11.7	-1.1	-0.1	109
Feb 21	569	5.4	DD	88	20 5.3	-2.0	+2.9	33								
Feb 24	1058	7.0	DD	127					18 16.6			174	17 57.2	-2.3	-2.1	139
Feb 24	1070	5.2	DD	129					21 25.7	+0.0	-2.0	162	21 16.8	-1.1	-0.8	128
Feb 24	1080	6.9	DD	130	23 14.6	-0.7	+0.4	111								
Mar 5	2134m	6.1	RD	243	23 22.9	-1.1	-1.5	283	23 16.9	-0.7	-2.4	319	22 51.7	+0.7	-4.1	353
Mar 7	2269m	5.4	RD	255	2 20.2	-3.0	+0.7	248	2 44.6	-2.7	-1.2	289	2 34.1	-2.2	-3.4	324
Mar 14	3208	6.5	RD	333									3 2.3	-0.5	+1.1	223
Mar 22	844	5.7	DD	83	17 31.4	-2.5	+1.3	61								
Mar 22	849	6.5	DD	84	18 31.2	-1.5	+0.1	115	18 50.0	-1.7	+1.0	83	19 10.3	-2.8	+3.1	45
Mar 23	1030	3.2	DD	97	19 34.2	-1.5	+0.3	106	19 58.3	-2.2	+1.9	66				
Mar 23	1030	3.2	RB	97	20 46.2	-0.8	+0.3	249								
Mar 24	1167	6.3	DD	110	18 48.5	-2.7	+0.6	77								
Mar 26	1405	7.0	DD	135									16 54.4	-1.4	-2.9	158
Mar 26	1413	6.7	DD	136	19 2.4	-1.5	-1.8	142	19 10.3	-2.4	-0.8	109	19 17.6	-4.1	+0.8	78
Apr 4	2371	4.9	RD	236	4 16.5	-2.6	-2.2	316								
Apr 4	2469	6.3	RD	244	21 7.5	+0.6	-2.2	317								
Apr 5	2622	6.3	RD	256									23 1.6	-1.9	+1.2	232
Apr 6	URANUS	5.7	RD	266	22 45.3			344								
Apr 19	977	6.6	DD	67					18 40.9			169	18 29.7	-0.4	-0.6	129
Apr 20	1118	6.0	DD	79					16 25.7	-1.8	-1.0	131	16 26.1	-2.5	-0.3	105
Apr 20	1128	6.9	DD	81									19 31.9	+1.0	-3.0	173
Apr 21	1275	5.6	DD	95	21 48.2	-0.5	+0.6	105								
Apr 22	1386	6.6	DD	107									20 14.8	-0.1	-2.3	163
May 1	2311	6.2	RD	205	1 40.2	-2.4	-1.1	301	1 47.0			335				
May 3	2714	6.1	RD	236	22 9.6	-0.6	-1.4	276	21 57.7	-0.2	-3.4	318				
May 6	2981m	5.2	RD	259									1 37.8	-2.0	+3.2	207
May 6	2987m	5.0	RD	260	2 31.9	-1.7	+2.6	208	3 8.0	-2.2	+2.1	225	3 29.6	-2.9	+1.3	247
May 6	2989	6.8	DD	260					2 55.5			338				
May 7	3112	6.2	RD	271	3 24.5	-1.9	+1.0	234								
May 10	3482	5.7	RD	305									1 47.1	-0.1	+2.8	190
May 16	900	4.9	DD	35					16 3.5	-1.6	+1.5	70				
May 16	902	6.6	DD	35					16 26.3	-0.9	+0.6	97	16 38.3	-1.5	+1.7	63

UT DATE M D	I.C.	Mag.	Ph	ELG °	CAPE TOWN E 18.5 S 33.9 TIME h m	a. s	b. s	P.A. °	JOHANNESBURG E 28.1 S 26.2 TIME h m	a. s	b. s	P.A. °	HARARE E 31.0 S 17.8 TIME h m	a. s	b. s	P.A. °
May 19	1360	7.5	DD	77	19 53.2	-1.2	+1.4	83								
May 22	1688m	6.3	DD	115	20 0.3	-1.8	-0.5	118	20 26.4	-2.8	+2.6	70				
May 23	1778	7.1	DD	125	17 29.1	-2.4	-0.8	93								
May 23	1788m	6.7	DD	128					22 20.7	-0.9	-2.1	156	22 13.1	-1.2	-0.7	122
May 28	2270	5.4	DD	174	1 42.3	-1.3	+1.3	85								
May 31	2692	5.7	RD	209	3 38.8	-1.2	+1.9	246	4 1.6	-0.8	+1.5	251				
May 31	2694	6.4	RD	209					3 50.9			184				
Jun 1	2822	5.6	RD	218					0 12.7	-1.9	+4.3	203	0 44.5	-2.6	+2.1	232
Jun 1	2838	5.6	RD	220	4 9.2	+0.0	+3.8	196								
Jun 17	1546	7.2	DD	73									18 56.8	-0.0	-2.7	170
Jun 20	1858	6.5	DD	109									18 13.0	-0.8	-4.3	173
Jun 20	1872	7.3	DD	110	20 48.5	-1.6	+0.5	102	21 14.0	-1.2	+2.7	64				
Jun 21	1967	5.7	DD	120					16 16.8	-1.2	-2.6	143	16 4.3	-2.1	-1.5	115
Jun 21	1970m	6.2	DD	120	16 38.7	-4.6	+2.1	55								
Jun 21	1993	6.8	DD	123	23 20.4	-1.0	-1.2	146	23 23.5	-0.6	-0.2	122	23 25.9	-0.3	+0.5	95
Jun 22	2084	6.5	DD	131									17 13.9	+0.5	-5.5	179
Jun 25	2371	4.9	DD	157	0 18.2	-1.8	-0.1	117	0 34.7	-1.2	+0.4	103	0 43.7	-0.7	+1.0	80
Jul 2	3371	6.4	RD	244	21 55.4	-0.7	-4.2	306								
Jul 6	221m	3.7	RD	283									3 24.6			173
Jul 16	1723	7.1	DD	68					19 23.5	-0.5	-1.2	146	19 19.3	-0.5	-0.2	114
Jul 16	1726	6.9	DD	68	19 51.1	-0.7	+3.3	60								
Jul 18	1944m	5.7	DD	92	18 38.4	-1.3	-2.9	159	18 41.8	-1.8	-0.7	121	18 47.3	-2.0	+0.7	89
Jul 19	2066m	6.4	DD	104									21 11.7			183
Jul 20	2183	5.7	DD	115	19 45.1	-2.5	+2.9	59								
Jul 21	2299	6.4	DD	125					16 45.3	-0.9	-4.3	156	16 25.8	-2.1	-1.9	119
Jul 21	2311	6.2	DD	126	18 54.9	-2.9	+1.1	72	19 52.5			22				
Jul 21	2317	6.6	DD	126	20 35.1	-2.3	+1.1	83	21 7.8	-1.5	+2.4	59	21 42.2			19
Jul 21	2328m	6.4	DD	128	23 9.3	+0.0	+3.7	36	23 37.2			12				
Jul 22	2452	6.7	DD	138	21 45.7	G		174	21 41.7	-3.0	-1.8	130	21 43.8	-2.3	+0.1	101
Jul 22	2455	6.8	DD	138	21 52.6	-3.3	-3.4	144	22 6.3	-2.5	-0.8	121	22 11.7	-1.9	+0.4	95
Jul 23	2469	6.3	DD	140	1 51.5	-0.2	+0.7	106								
Jul 31	42	5.6	RD	239	23 4.3	-1.1	-0.4	252	23 15.1	-1.9	-0.5	262	23 13.2	-3.8	-2.5	291
Aug 3	302	6.4	RD	264	0 20.6	-0.4	+0.2	228	0 29.7	-1.0	+0.4	235	0 35.8	-1.7	+0.1	255
Aug 3	320	5.9	RD	267	5 6.1	-3.1	-0.7	296								
Aug 16	2134m	6.1	DD	85	18 5.6	-2.1	+0.6	95	18 34.9	-1.5	+2.3	65				
Aug 17	2257	6.7	DD	96	16 48.1	-2.6	-0.5	98	17 22.0	-2.9	+2.4	62				
Aug 17	2270	5.4	DD	97	20 34.2	-1.3	+1.0	94	20 52.3	-0.6	+1.3	79	21 6.9	+0.1	+2.0	54
Aug 18	2411	6.6	DD	109									21 10.1	-2.4	-2.2	139
Aug 20	2689	6.8	DD	130	20 51.6	-2.8	-0.3	107	21 17.5	-2.3	+0.5	97	21 30.5	-1.6	+1.2	77
Aug 20	2692	5.7	DD	130	21 18.7	-2.4	+0.3	100	21 44.1	-1.9	+0.8	92	21 57.4	-1.2	+1.3	73
Aug 21	2706	5.8	DD	132	0 13.5	-0.3	+1.7	68	0 26.4	+0.1	+1.5	64	0 38.4	+0.5	+1.7	46
Aug 21	2822	5.6	DD	140									18 15.7	-3.6	-1.9	111
Aug 21	2838	5.6	DD	142									22 56.7	-2.9	-1.2	120
Aug 29	266m	5.7	RD	235	22 56.7	-1.1	-0.3	250	23 8.6	-1.8	-0.1	255	23 12.1	-2.8	-0.8	275
Sep 1	537m	3.8	RD	261	0 39.2	+1.2	+3.1	184	0 54.6	+0.2	+2.7	193	1 13.3	-1.2	+1.6	217
Sep 1	536	5.4	RD	261	1 5.0	-0.9	+0.1	234	1 18.6	-1.5	+0.5	238	1 27.1	-2.2	+0.2	255
Sep 1	539	4.4	RD	261	1 26.0	-1.6	-0.6	263	1 40.6	-2.3	-0.4	267	1 43.1	-3.2	-1.1	286
Sep 1	541	4.0	RD	261	1 39.2	-1.1	+0.3	232	1 56.7	-1.8	+0.7	236	2 7.8	-2.5	+0.4	253
Sep 1	542	5.9	RD	261	1 50.6	-1.9	-0.7	269	2 7.4	-2.6	-0.5	273	2 9.2	-3.5	-1.4	293
Sep 1	543	6.5	RD	261	1 55.1	-1.8	-0.5	261	2 12.9	-2.5	-0.2	265	2 17.6	-3.2	-0.8	284
Sep 6	1337	5.6	RD	329					3 39.1	-0.6	+0.2	240				
Sep 11	1967	5.7	DD	42	17 53.9	-1.3	-3.7	171	17 49.3	-0.7	-0.9	138	17 47.7	-0.4	-0.0	108

UT DATE M D	I.C.	Mag.	Ph	ELG °	CAPE TOWN E 18.5 S 33.9 TIME h m	a. m	b. m	P.A. °	JOHANNESBURG E 28.1 S 26.2 TIME h m	a. m	b. m	P.A. °	HARARE E 31.0 S 17.8 TIME h m	a. m	b. m	P.A. °
Sep 11	1970m	6.2	DD	43	18 10.9	+0.1	+4.5	42								
Sep 12	2095	7.2	DD	55	19 59.4	+0.5	+2.7	49								
Sep 15	2483	7.1	DD	88	16 33.9	-2.7	-1.2	111	16 59.0	-2.7	+0.6	87	17 18.0	-2.2	+2.1	59
Sep 15	2499	6.6	DD	89	20 11.8	-0.5	+2.4	53	20 32.6	+0.1	+2.4	44	20 56.0			14
Sep 15	2500m	3.4	DD	89	20 15.9	-0.9	+1.5	78	20 34.0	-0.4	+1.5	70	20 48.3	+0.2	+1.9	50
Sep 15	2500m	3.4	RB	89	21 26.1	-0.3	+1.4	259								
Sep 16	2641	7.4	DD	101	21 41.0	+0.5	+3.4	22	21 59.6	+1.2	+3.6	14				
Sep 17	2769	6.3	DD	110	16 37.6	-2.3	+0.9	61	17 16.5	-2.2	+3.2	36	18 4.3			356
Sep 17	2777	7.0	DD	111									19 22.3	-4.1	-1.7	119
Sep 17	2785	6.8	DD	111	20 43.2	-3.0	-0.8	121	21 4.6	-2.2	-0.3	116	21 11.5	-1.4	+0.5	94
Sep 17	2802	6.4	DD	113	23 58.9	+0.3	+1.9	48								
Sep 18	2908	6.9	DD	122	20 18.1	+1.3	+6.8	354								
Sep 19	3019	5.9	DD	131	16 53.0	-1.6	+1.4	40	17 29.6	-1.3	+4.1	14				
Sep 19	3029	6.9	DD	133	20 29.0	-3.3	-0.3	102	20 59.6	-3.1	+0.2	101	21 12.5	-2.2	+0.9	82
Sep 20	3146	6.5	DD	142	17 31.0	-1.1	+2.7	19	18 12.6			350				
Sep 25	221m	3.7	DD	204	20 11.9	-0.4	+0.3	47								
Sep 25	221m	3.7	RD	204	21 19.5	-1.3	-0.2	250	21 34.4	-2.0	+0.1	253	21 40.3	-3.0	-0.5	272
Sep 26	245	6.1	RD	207	3 3.0	-1.5	+1.8	236								
Sep 30	842	6.3	RD	258	2 45.9	-2.2	-0.4	269	3 6.1	-2.6	-0.5	284				
Oct 1	1015	6.4	RD	271	1 52.5	-1.5	-1.2	280	2 1.2	-2.2	-1.3	291	1 54.4	-2.6	-2.2	314
Oct 1	1023	6.5	RD	271	2 59.2	-2.0	-1.2	292					2 57.5	-2.4	-3.9	338
Oct 11	2305	5.9	DD	47	18 56.4	+0.5	+2.8	41	19 12.1			24				
Oct 11	2314	5.8	DD	47	19 59.1	+0.4	+1.5	68								
Oct 12	2443	5.8	DD	58					19 21.7			164	19 10.6	-0.7	-0.5	121
Oct 12	2443	5.8	RD	58					19 29.2			178				
Oct 15	2859	6.7	DD	90	18 23.5	-6.1	-5.4	137	18 45.9			127	18 49.8	-2.4	+0.2	99
Oct 15	2859	6.7	DR	90	18 48.0	+2.7	+8.5	169								
Oct 18	3216	6.6	DD	123	17 49.2			118	18 13.1	-4.7	-1.7	108	18 21.3	-3.5	+0.4	85
Oct 19	3326	6.4	DD	134									16 26.0	-0.1	+4.5	359
Oct 19	3340	7.5	DD	136	20 55.4	-5.5	-2.5	122	21 28.2			127	21 32.1	-2.7	+0.2	99
Oct 24	440m	4.6	RD	197					18 11.3	+0.4	+1.3	206	18 18.7	-0.2	+0.6	231
Oct 30	1259	5.9	RD	268	2 39.1	-1.8	-1.3	292	2 46.3	-1.9	-1.8	316	2 31.1	-1.5	-3.4	344
Nov 10	2675	7.1	DD	49	19 13.9	+0.5	+2.6	31								
Nov 14	3163	7.3	DD	91									16 42.9	-0.7	+3.7	13
Nov 14	3184	7.1	DD	94	21 47.4	-0.5	+1.5	79								
Nov 14	3185	5.3	DD	94	21 49.8	-0.6	+1.2	92	22 1.9	-0.1	+1.1	83				
Nov 15	3287m	5.9	DD	103					18 4.1	-1.0	+2.9	22	18 34.1	-0.2	+3.9	5
Nov 16	3417	6.8	DD	116	22 1.2	-1.0	+1.9	60	22 23.0	-0.5	+1.9	51	22 41.7	-0.3	+2.3	31
Nov 19	245	6.1	DD	151	18 36.1	-0.4	+1.7	19	18 56.7	-0.7	+2.3	17	19 26.1			352
Nov 20	266m	5.7	DD	154	0 3.8			136	0 12.5	-0.9	+0.4	107	0 20.3	-0.9	+0.9	82
Nov 22	552	3.0	DD	177	0 6.5	-1.9	-0.3	121	0 24.7	-1.7	+0.4	98	0 36.2	-1.9	+1.1	74
Nov 22	552	3.0	RD	184	1 9.1	-1.9	+2.0	227	1 37.4	-1.3	+1.2	256	1 46.6	-0.8	+0.2	283
Nov 25	1205	6.3	RD	235	23 12.1	-1.4	-1.5	292	23 15.1	-1.8	-1.8	307	23 1.7	-1.9	-3.0	332
Nov 26	1336	5.2	RD	248	22 32.0	-0.7	-1.9	308	22 24.3	-1.1	-2.3	324	22 0.6			358
Nov 28	1458	5.9	RD	263					1 45.2			241	1 54.9	-2.8	-0.6	276
Nov 30	1688m	6.3	RD	288	2 13.4	-1.1	-1.4	279	2 12.4	-1.2	-1.9	306	1 57.6	-0.8	-2.5	330
Dec 10	3015	5.3	DD	50	19 4.1	+0.4	+2.9	16	19 21.5			5				
Dec 16	191	7.4	DD	119									20 18.9	-2.3	-0.3	109
Dec 22	1129	5.3	RD	199					19 10.5	-0.2	+0.9	225	19 15.3	-0.8	+0.0	251
Dec 22	1129	5.3	RD	199					19 10.5	-0.2	+0.9	225	19 15.3	-0.8	+0.0	251

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 this data cannot readily be obtained in any other way.

The maps on the following pages have been prepared by the 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 Moon is at a low altitude, the bright limb or sunlight interferes.

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 a small FM radio tuned to a pre-arranged transmission.

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.

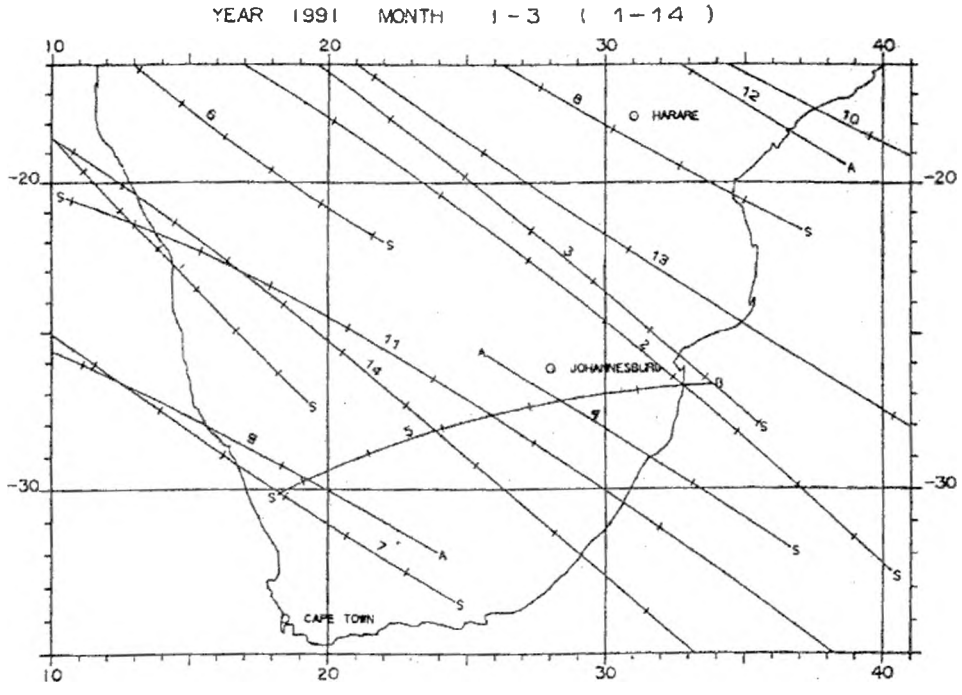
Interested observers - especially those living in the more distant regions - who wish to be informed of favourable grazes occurring in their neighbourhood, are therefore invited to contact the co-ordinator for grazing occultations:

Mr.M.D. Overbeek, P.O. Box 212, Edenvale, 1610. Tel: (011) 453 6918

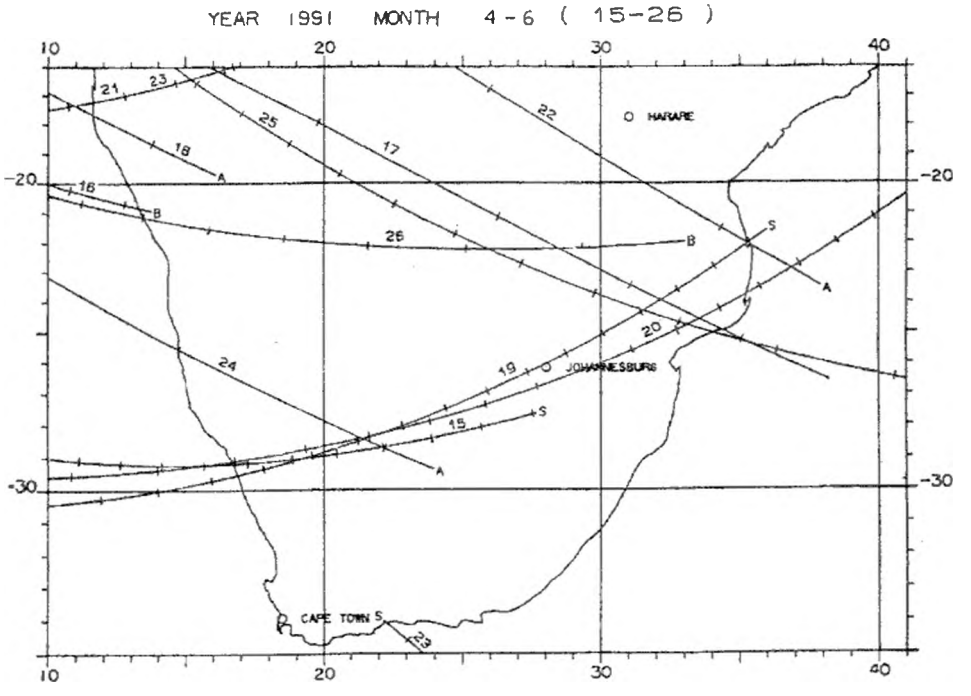
EXPLANATION OF THE COLUMN HEADINGS IN THE TABLES:

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 SAST for the west end of the track.
SUNLIT (%)	: Percentage of the Moon sunlit (a minus sign indicates a waning Moon).
LIMIT	: Whether the track is the north (N) or the south (S) limit 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.

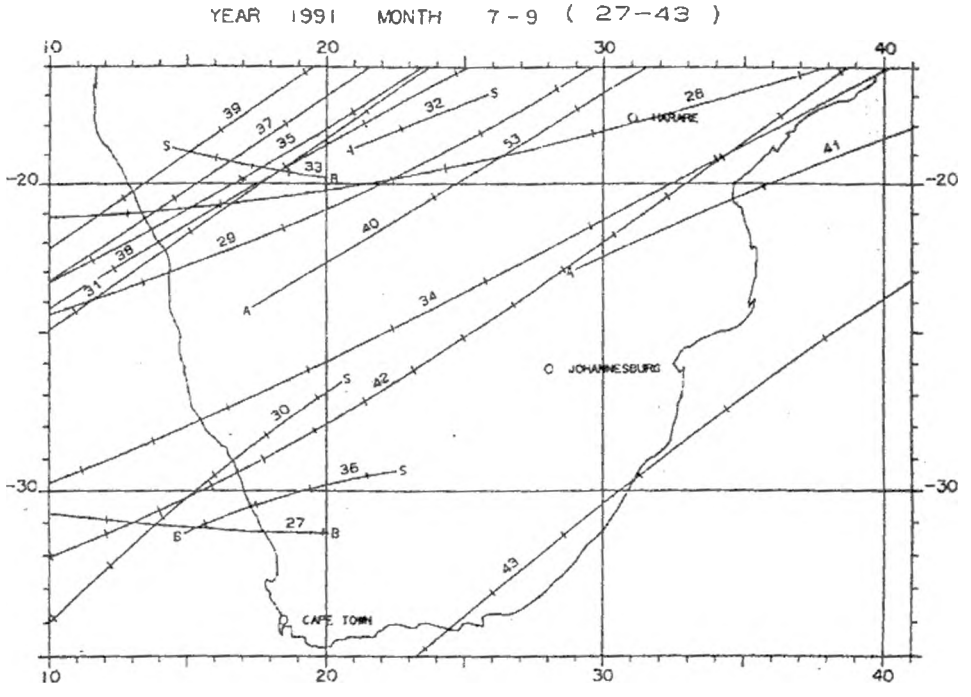
The map gives the graze tracks or the limits of occultations. Along each track on the map tick marks are qiven for the points corresponding to the multiples of five minutes of every hour, while the prediction for the west end of each track is shown in the table. e.g.if the time for the west end of a track is 5h 43m 21s, the tick marks proceeding eastward correspond to 5h 45m 00s, 5h 50m 00s, 5h 55m 00s etc.



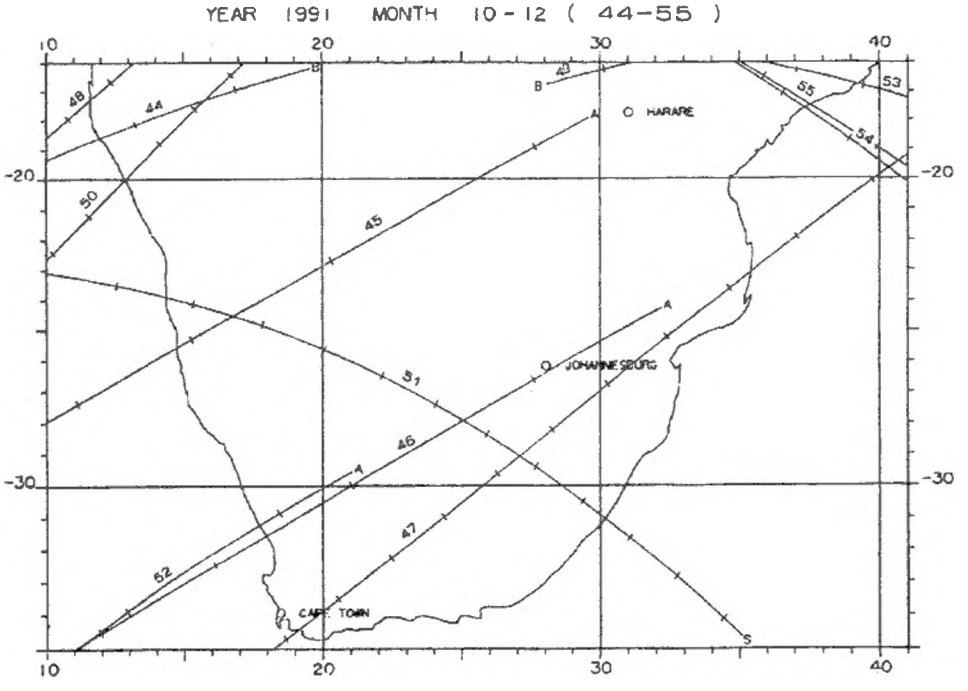
SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(%)	LIMIT		
1	1688m	6.27	1	6	4	55	27.10	-66.47	S	( )	(S)
2	2108m	6.40	1	10	3	11	43.16	-27.95	S	( )	(S)
3	2109	6.11	1	10	3	50	41.34	-27.75	S	( )	(S)
4	2501	7.50	1	13	4	5	31.49	-7.11	S	(A)	(S)
5	42	5.58	1	21	20	17	50.90	30.23	S	(S)	(B)
6	1852	5.96	2	4	5	24	14.25	-73.26	S	( )	(S)
7	2332	6.16	2	8	4	51	51.16	-34.96	S	( )	(S)
8	2458	6.20	2	9	4	32	30.23	-26.34	S	( )	(S)
9	569	5.38	2	21	22	23	56.82	48.31	N	( )	(A)
10	2678	6.23	3	10	1	46	5.85	-34.77	S	( )	( )
11	844	5.70	3	22	19	49	28.19	44.02	N	(S)	( )
12	849	6.47	3	22	21	29	41.16	44.26	N	( )	(A)
13	1030	3.18	3	23	22	14	7.08	56.11	N	( )	( )
14	1167	6.34	3	24	20	52	45.88	67.06	N	( )	( )



SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(%)	LIMIT		
15	2371	4.87	4	4	5	16	12.60	-78.08	N	( )	(S)
16	2501	7.50	4	5	4	17	55.91	-69.76	S	( )	(B)
17	2622	6.27	4	6	0	27	53.40	-61.76	S	( )	( )
18	1275	5.57	4	22	0	12	29.18	53.67	N	( )	(A)
19	2989	6.78	5	6	4	10	35.77	-58.51	N	( )	(S)
20	3109	6.52	5	7	3	48	44.49	-48.86	N	( )	( )
21	3112	6.18	5	7	4	33	18.13	-48.65	N	( )	( )
22	900	4.90	5	16	18	28	51.77	8.60	N	( )	(A)
23	1070	5.21	5	17	17	48	44.89	16.40	N	(S)	( )
24	1360	7.48	5	19	22	10	11.44	38.34	N	( )	(A)
25	1688m	6.27	5	22	22	12	18.13	70.71	N	( )	( )
26	1872	7.34	6	20	23	7	2.13	66.82	N	( )	(B)



SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(%)	LIMIT		
27	1726	6.87	7	16	22	3	15.84	30.74	N	( )	(B)
28	2066m	6.43	7	19	22	50	20.20	61.77	S	( )	( )
29	42	5.58	8	1	0	27	26.64	-75.08	N	( )	( )
30	320	5.92	8	3	6	24	32.23	-52.91	N	( )	(S)
31	780	6.84	8	6	5	48	13.11	-20.62	N	( )	( )
32	1118	6.02	8	8	6	14	18.47	-5.10	N	(A)	(S)
33	2257	6.66	8	17	19	13	41.78	54.97	N	(S)	(B)
34	2411	6.57	8	18	22	52	40.20	65.34	S	( )	( )
35	266m	5.73	8	30	0	18	52.61	-78.51	N	( )	( )
36	288	5.16	8	30	6	17	44.12	-77.05	S	(B)	(S)
37	539	4.37	9	1	2	40	37.66	-57.43	N	( )	( )
38	542	5.85	9	1	3	4	2.14	-57.30	N	( )	( )
39	543	6.46	9	1	3	6	48.51	-57.28	N	( )	( )
40	717	7.48	9	2	2	35	52.08	-46.24	N	(A)	( )
41	1052	6.84	9	4	3	41	10.90	-24.01	N	(A)	( )
42	2777	6.97	9	17	20	44	47.91	67.28	S	( )	( )
43	2785	6.83	9	17	23	9	15.56	67.68	S	( )	( )



SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(%)	LIMIT		
44	1023	6.48	10	1	3	56	12.96	-48.69	N	( )	(B)
45	2442	5.92	10	12	21	8	28.47	22.94	S	( )	(A)
46	2443	5.78	10	12	21	8	43.55	22.96	S	( )	(A)
47	2859	6.73	10	15	20	33	46.62	50.11	S	( )	( )
48	2979	7.09	10	16	22	2	21.91	59.98	S	( )	( )
49	1110m	3.51	10	29	1	31	38.19	-64.30	S	(B)	( )
50	3290	7.31	11	15	20	44	4.95	61.43	S	( )	( )
51	1458	5.93	11	28	2	50	59.65	-56.27	S	( )	(S)
52	2902	5.99	12	9	21	2	51.63	11.15	S	( )	(A)
53	1409	5.12	12	24	23	32	24.54	-82.75	S	( )	( )
54	1872	7.34	12	29	2	21	39.76	-39.48	S	( )	( )
55	2235	6.21	12	32	3	49	5.82	-12.86	S	( )	( )

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 Southern Africa network comprises approximately 35 observers and more observers are badly needed. Very little experience is needed, apart from the ability to locate some of the fainter naked eye stars and familiarity with the user's telescope, which does not have to be a large equatorial. The only other equipment needed is a small FM radio and portable tape recorder.

Observations, especially when made by more than one observer, can be used to refine our knowledge of the size, shape and orbit of a minor planet, to greater accuracy than that obtainable with large Earth-based instruments.

Further information and detailed instructions on finding the occulted stars can be obtained from:

M.D. Overbeek, P O Box 212, Edenvale, 1610. Tel (011) 453-6918.

OCCULTATAONS BY MINOR PLANETS

Date	SAST	MINOR PLANET	Pmag	CAT	STAR	Smag	Mag drop	Duration seconds
d	h m							
JAN 3	21 31	121 HERMIONE	12.3	FAC	176795	11.3	2.1	15.5
JAN 17	23 22	11 PARHTENOPE	10.0	LickV	1712	10.4	0.5	11.9
JAN 18	00 53	532 HERCULINA	9.4	PPM	96101	8.7	1.8	17.9
JAN 25	03 43	203 POMPEJA	14.9	SAO	183986	9.5	5.4	3.5
JAN 1	00 16	43 ARIADNE	11.8	SAO	157542	8.8	3.1	12.4
FEB 5	00 07	201 PENELOPE	12.7	PPM	125971	10.5	3.2	9.7
FEB 12	19 10	886 WASHINGTINIA	13.9	PPM	92304	8.6	6.2	3.4
MAR 7	01 22	514 ARMIDA	13.9	PPM	156222	9.4	5.4	8.4
MAR 9	01 09	199 BYBLIS	13.6	PPM	101332	12.3	2.3	4.2
MAR 11	21 05	15 EUNOMIA	9.6	FAC	356408	10.7	0.7	66.9
MAR 17	04 45	334 CHICAGO	14.1	SAO	162723	7.2	6.9	7.0
MAR 17	21 20	788 HOHENSTEINA	12.2	PPM	178847	9.3	3.8	6.3
MAR 26	02 44	747 WINCHESTER	12.8	PPM	128799	10.4	3.4	13.5
MAR 29	02 51	846 LIPPERTA	16.0	SAO	158344	8.0	8.1	4.1
MAR 1	01 54	96 AEGLE	11.7	SAO	156875	9.2	2.6	10.0
APR 2	23 14	624 HEKTOR	14.5	SAO	181911	8.2	6.4	15.0
APR 15	05 17	177 IRMA	14.8	SAO	184383	7.3	7.6	12.0
APR 18	19 24	121 HERMIONE	13.9	FAC	211278	10.7	4.1	7.8
MAY 27	05 13	674 RACHELE	12.1	SAO	184425	7.3	4.8	6.2
JUN 15	06 11	356 LIGURIA	13.1	SAO	210543	7.9	5.3	11.4
JUN 18	02 42	198 AMPELLA	11.2	AC	15624	10.0	1.5	8.4
JUN 19	19 30	776 BERBERICIA	12.5	SAO	159636	9.2	3.3	13.9
JUN 24	19 39	103 HERA	12.8	PPM	159359	9.1	4.6	8.2
JUN 24	20 53	514 ARMIDA	15.3	PPM	156789	9.8	6.4	3.4
JUN 26	06 06	41 DAPHNE	13.4	AGK3	+06° 0115	8.9	4.5	9.9
JUL 2	03 39	56 MELETE	11.9	PPM	173839	11.1	1.9	14.8
JUL 3	03 08	130 ELEKTRA	11.6	AGK3	-00° 2485	8.4	3.2	11.6
JUL 4	22 34	53 KALYPSO	13.5	SAO	164223	9.1	4.4	12.5
JUL 7	21 16	899 JOKASTE	16.2	SAO	157866	9.3	6.9	5.5
AUG 8	22 41	432 PYTHIA	12.3	SAO	166014	6.2	6.0	6.7
AUG 11	00 05	842 KERSTIN	15.4	PPM	144729	12.4	4.0	3.5
AUG 23	23 38	404 ARSINOE	13.2	SAO	185353	9.0	4.3	10.6
SEP 28	19 49	379 HUENNA	14.5	AC	8235	10.9	3.6	2.8
OCT 1	23 22	920 ROGERIA	15.5	SAO	145812	9.1	6.4	2.5
OCT 16	21 13	91 AEGINA	11.7	PPM	117499	11.1	1.8	10.3
OCT 27	04 09	163 ERIGONE	13.2	LickV	27062	10.6	2.7	3.9
NOV 1	05 02	363 PADUA	12.4	PPM	118793	8.2	5.2	8.7
NOV 12	22 05	1723 KLEMOLA	15.0	SAO	129042	8.4	6.6	8.6
DEC 5	04 47	67 ASIA	13.5	PPM	156397	7.8	6.6	7.7
DEC 19	21 07	56 MELETE	13.0	AC	26247	10.5	2.6	6.4
DEC 30	23 11	287 NEPHTHYS	11.4	PPM	122416	8.0	4.3	5.8

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 this booklet does not permit full explanation, which in any case would appear complicated to the layman.

TIME SIGNALS

CSIR has recently developed a new time service available through the telephone line with an accuracy to within one millisecond. This service replaces the ZUO service which has been discontinued.

Prospective users need have access to a telephone, an IBM-compatible PC with a modem and a "pulse buffer unit" which will be needed to synchronise other timing equipment external to the PC.

Registered users will be supplied with an authorised access code and user manual on a floppy disc. On running the software supplied, the user's computer automatically dials the CSIR time service number and establishes a link with the time service computer. The user's PC is then set to within one electronic "clock tick" of CSIR's national time standard. At the same time a pulse is generated at a pin on the printer port of the user's computer which is accurate to within one millisecond of the national time standard. This pulse can be used to synchronise other timing equipment external to the PC.

Users must pay a registration fee, a monthly fee and a fee for each call made to the system to the CSIR. In addition the user incurs the normal Post Office telephone charges.

Enquiries to: CSIR Time Service, Rm 230, Division of Production Technology, CSIR, P O Box 395, Pretoria, 0001. Tel: (012) 841-2036/841-4623. Telefax: (012) 841-2131.

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 ahead 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	3	24	May 11	11	56	20	Sep 18	11	54	18
11	12	7	47	21	11	56	31	28	11	50	48
21	12	11	13	31	11	57	33	Oct 8	11	47	41
31	12	13	24	Jun 10	11	59	18	18	11	45	16
Feb 10	12	14	14	20	12	1	25	28	11	43	50
20	12	13	48	30	12	3	31	Nov 7	11	43	41
Mar 2	12	12	14	Jul 10	12	5	16	17	11	44	54
12	12	9	53	20	12	6	18	27	11	47	29
22	12	7	2	30	12	6	25	Dec 7	11	51	17
Apr 1	12	4	0	Aug 9	12	5	32	17	11	55	55
11	12	1	9	19	12	3	42	27	12	0	52
21	11	58	47	29	12	1	3	31	12	2	49
May 1	11	57	7	Sep 8	11	57	49				

CORRECTION FOR PLACES NOT ON THE 30° MERIDIAN

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

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

SIDEREAL TIME ON THE 30° MERIDIAN

	At 0 hrs	At 21 hrs		At 0 hrs	At 21 hrs		At 0 hrs	At 21 hrs
	h m	h m		h m	h m		h m	h m
Jan 1	6 40	3 44	May 11	15 13	12 16	Sep 18	23 45	20 49
11	7 20	4 23	21	15 52	12 56	28	0 25	21 28
21	7 59	5 3	31	16 32	13 35	Oct 8	1 4	22 8
31	8 39	5 42	Jun 10	17 11	14 15	18	1 44	22 47
Feb 10	9 18	6 21	20	17 51	14 54	28	2 23	23 26
20	9 57	7 1	30	18 30	15 33	Nov 7	3 2	0 6
Mar 2	10 37	7 40	Jul 10	19 9	16 13	17	3 42	0 45
12	11 16	8 20	20	19 49	16 52	27	4 21	1 25
22	11 56	8 59	30	20 28	17 32	Dec 7	5 1	2 4
Apr 1	12 35	9 39	Aug 9	21 8	18 11	17	5 40	2 44
11	13 15	10 18	19	21 47	18 51	27	6 20	3 23
21	13 54	10 57	29	22 26	19 30	31	6 35	3 39
May 1	14 33	11 37	Sep 8	23 6	20 9			

CORRECTION FOR PLACES NOT ON THE 30° MERIDIAN

Approximate longitude corrections from the 30° East Meridian are provided below. To find the sidereal times at SAST 0 hrs and SAST 21 hrs apply the following corrections to the data in the table.

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

TELESCOPE SETTING

When a telescope equipped with setting circles is aimed on the meridian, its R.A. circle should read the sidereal time. Thus one can calculate the sidereal time and then set the circle, but 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 (1991.5)

Star	R.A. h m	Dec. ° ′	Mag.	Sp.	Star	R.A. h m	Dec. ° ′	Mag.	Sp.
ACHERNAR	1 37.4	-57 16	0.6	B5	PROCYON	7 38.9	5 15	0.5	F5
ALDEBARAN	4 35.4	16 30	1.1	K5	REGULUS	10 7.9	12 1	1.3	B8
RIGEL	5 14.1	-8 13	0.3	B8	SPICA	13 24.8	-11 7	1.2	B2
BETELGEUSE	5 54.7	7 24	0.4	M0	ARCTURUS	14 15.3	19 14	0.2	K0
CANOPUS	6 23.7	-52 41	-0.9	F0	ANTARES	16 28.9	-26 25	1.2	M1
SIRIUS	6 44.8	-16 42	-1.6	A0	ALTAIR	19 50.4	8 51	0.9	A5

JULIAN DATE AT 1400 HOURS - SAST 1991

	JAN. 2448	FEB. 2448	MAR. 2448	APR. 2448	MAY 2448	JUN. 2448	JUL. 2448	AUG. 2448	SEP. 2448	OCT. 2448	NOV. 2448	DEC. 2448
1	258	289	317	348	378	409	439	470	501	531	562	592
2	259	290	318	349	379	410	440	471	502	532	563	593
3	260	291	319	350	380	411	441	472	503	533	564	594
4	261	292	320	351	381	412	442	473	504	534	565	595
5	262	293	321	352	382	413	443	474	505	535	566	596
6	263	294	322	353	383	414	444	475	506	536	567	597
7	264	295	323	354	384	415	445	476	507	537	568	598
8	265	296	324	355	385	416	446	477	508	538	569	599
9	266	297	325	356	386	417	447	478	509	539	570	600
10	267	298	326	357	387	418	448	479	510	540	571	601
11	268	299	327	358	388	419	449	480	511	541	572	602
12	269	300	328	359	389	420	450	481	512	542	573	603
13	270	301	329	360	390	421	451	482	513	543	574	604
14	271	302	330	361	391	422	452	483	514	544	575	605
15	272	303	331	362	392	423	453	484	515	545	576	606
16	273	304	332	363	393	424	454	485	516	546	577	607
17	274	305	333	364	394	425	455	486	517	547	578	608
18	275	306	334	365	395	426	456	487	518	548	579	609
19	276	307	335	366	396	427	457	488	519	549	580	610
20	277	308	336	367	397	428	458	489	520	550	581	611
21	278	309	337	368	398	429	459	490	521	551	582	612
22	279	310	338	369	399	430	460	491	522	552	583	613
23	280	311	339	370	400	431	461	492	523	553	584	614
24	281	312	340	371	401	432	462	493	524	554	585	615
25	282	313	341	372	402	433	463	494	525	555	586	616
26	283	314	342	373	403	434	464	495	526	556	587	617
27	284	315	343	374	404	435	465	496	527	557	588	618
28	285	316	344	375	405	436	466	497	528	558	589	619
29	286		345	376	406	437	467	498	529	559	590	620
30	287		346	377	407	438	468	499	530	560	591	621
31	288		347		408		469	500		561		622

JANUARY

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

FEBRUARY

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

MARCH

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

APRIL

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

MAY

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

JUNE

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

JULY

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

AUGUST

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

SEPTEMBER

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

OCTOBER

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

NOVEMBER

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

DECEMBER

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

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