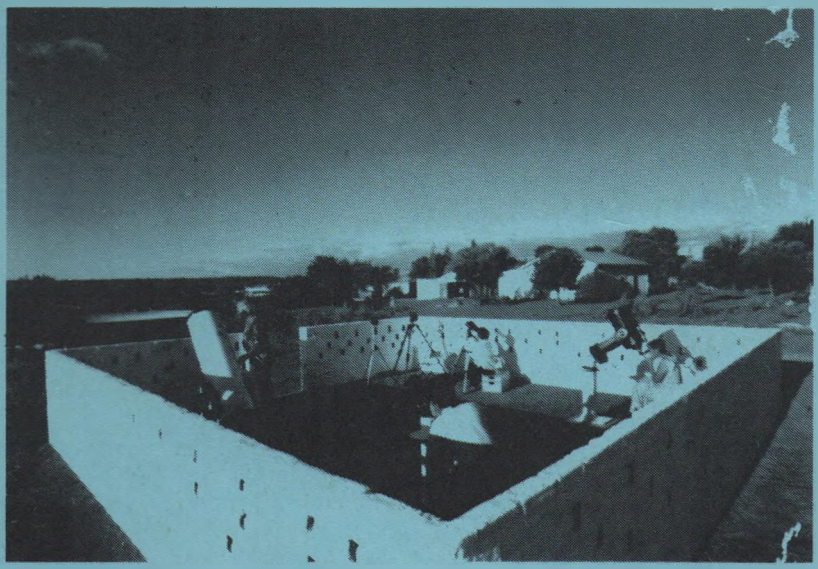
ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

1999



Astronomical Society of Southern Africa

ASSA

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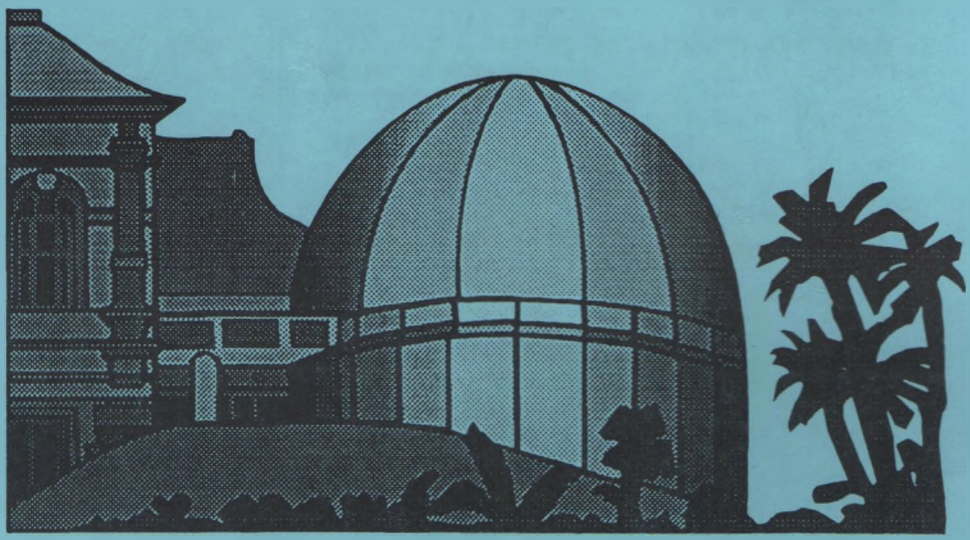

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ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA 1999

The 53rd year of publication

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 Spreeufontein Observatory
Photograp: A Jansen

ISSN 0571-7191

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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 1999, the Handbook of the British Astronomical Association for 1999 and the International Lunar Occultation Centre, Tokyo. The star charts on pages 36, 38, 40 and 42 are from "A Beginner's Guide to the Southern Stars" by J.S. Bondietti, published by the South African Museum. The star charts on pages 37, 39 and 41 were adapted from charts output by Skymap 2.29 for Windows. 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. The Editor is indebted to the South African Astronomical Observatory for supplying the visibility criteria data of The Horizon Chart for the Visibility of the Lunar Cresent at Sunset. Acsistance in the compilation of this booklet was received from the Directors of the sections of the ASSA and B Wagener.

Further copies of this booklet are available at R20.00 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.

The ASSA regrets that due to the restriction of funds it is not possible to print this handbook in any of the other official languages of South Africa.

P.J.Booth
Editor

ASTRONOMY IN SOUTHERN AFRICA

Southern Africa, enjoying the rich southern skies and a suitable climate, has a number of professional observatories engaged in research while many individuals have become enthusiastic amateur astronomers. Thus South Africa, Namibia and Zimbabwe have numerous private observatories, built and operated by 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), directed by Dr. R. Stobie is part of the Foundation for Research and Developement. It has headquarters in Cape Town and an observing station at Sutherland in the Karoo, where there are 1.9-m, 1.0-m, 0.75-m and 0.5-m telescopes. The headquarters in Cape Town also carries 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 telescope, which is gradually being upgraded as funds become available, as well as a 0.41-m telescope, a 0.33-m refractor and a 0.20-m solar installation. THE FRIENDS OF BOYDEN is an organisation, founded to foster a wider public appreciation of the historical, cultural and scientific value of Boyden, to promote public interest in the affairs of the Observatory and to raise funds for the restoration and preservation of the installation. The Friends organise a number of activities such as popular lectures on astronomy and viewing sessions at Boyden. Membership of the Friends is open to all interested persons. Contact: Mrs M. Schoch (tel 051-311 061), Mr M. Hoffman (tel 051-401 2924, email nwfsmjh@med.uovs.ac.za), P Meintjies (tel 051-401 2191) or Schoch (tel 051-4366342). Secretarial address: PO Box 13004, Brandhof, 9324.

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 GAMMA 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.

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.

BOYDEN OBSERVATORY, BLOEMFONTEIN. Enquiries as to visits should be made to the Dept. of Physics of the University of the Orange Free State. Tel. 051-401 2324 (Mr. M. Hoffman).

THE HARTEBEESTHOEK RADIO ASTRONOMY OBSERVATORY has visiting days for the public

once a month on a Sunday at 15:00. It is essential to book, phone 012-326 0742 between 9:00 and 12:00 during the week for more details.

THE NOOITGEDACHT TELESCOPE, POTCHEFSTROOM. Interested individuals or groups are welcome to contact Prof. B C Raubenheimer to arrange visits.

The PORT ELIZABETH 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.

THE CEDERBERG OBSERVATORY. This observatory, situated 250 km by road north of Cape Town, is operated by 6 amateur astronomers. It has excellent dark skys and public open nights are held twice monthly at Last Quarter and New Moon. Enquiries to Mr. Chris Forder Tel 021-9134200.

THE SPREEUFONTEIN OBSERVATORY is an astronomical guest house on a farm in the Great Karoo 75km SSW of Beaufort West, 30km from the N1 National road. Vacilities include a 10" Meade LX200 and 16" Meade Dobsonian Starfinder. Contact Mr A. Jansen, Markstraat 3, Prins Albert, 6930, Tel/Fax 023-5411 871, email agjansen@ilink.nis.za, http://www.nis.za/~agjansen/spreeu.htm

THE ALOE RIDGE HOTEL OBSERVATORY is part of the hotel and game Reserve Complex some 40 km northwest of Johannesburg. Vacilities include a 16" LX200 telescope, 1616XT CCD Camera and Autoguider. Telescope time is available for a fee to interested users. Contact Mr A. Richter, PO Box 3040, Honeydew, 2040, Tel 011-9572070, Fax 011-9572017 or Website aloe@matie.co.za.

PLANETARIA

A planetarium is located within the South African Museum in Cape Town, containing a Minolta Series 4 projector and seating 120.

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.

EDUCATIONAL INSTITUTIONS

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, headed by Prof.G L P Bernings, incorporated with the Boyden Observatory. The Dept. of Physics and Electronics at Rhodes University, 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. Courses in Gamma Ray Astronomy and General Astrophysics form part of the regular honors and masters courses of the Dept. of Physics at Potchefstroom. The Dept. of Computational and Applied Mathematics, University of Witwatersrand, offers an Introductory first year course in Astronomy and a postgraduate course in Cosmology/ Astrophysics. Unique research facilities are available, such as Photomicrographic Tubes, the Schmidt Surveys (in blue and red) and SUN work stations. Contact Prof D.L. Block.

ASTRONOMICAL SOCIETIES

THE ASTRONOMICAL SOCIETY OF BULAWAYO, ZIMBABWE. The society holds meetings on the second Monday of every month at the City Club, 95 Josiah Tongara St. Visitors are welcome. The Society also publishes monthly newsletters. Secretarial address: c/o Mr E. Bloomhill, P O Box 2365, Bulawayo.

THE LADYSMITH ASTRONOMICAL SOCIETY, NATAL. The society holds a viewing evening for the public on the third Tuesday of every month weather permitting. Members receive the monthly journal Z Octantis. For further information contact Mr W. Venter 0361-310770.

THE ASTRONOMICAL WORK GROUP, NAMIBIA. The society, situated in Windhoek, is active in the fields of astrophotography, solar and occultation observing. It has an observing site, housing a .36m telescope, at the Brakwater Agricultural Centre outside Windhoek. Exibitions and public viewing sessions are organised. For further information contact Mrs. S. Enke, P O Box 5198, Windhoek.

THE PORT ELIZABETH PEOPLES OBSERVATORY SOCIETY. Society meetings are held bi-monthly on the 3rd Monday. Secretarial address: P O Box 7988, Newton Park, Port Elizabeth, 6055.

THE RHODES ASTRONOMY AND HAM RADIO SOCIETY, RHODES UNIVERSITY, GRAHAMSTOWN. The society meets twice monthly in Physics Department during the university terms. Meetings consist of talks, discussions, slide shows and videos. Frequent observing sessions including public evenings are held. The society is active in fields of astrophotography, variable star and comet observing. It also has an astronomy education program for schools. Although this is largely a student society membership is open to all interested persons as well as bodies such as school clubs. Secretarial address: c/o The Physics Department, Rhodes University, Grahamstown. 6140. For information about meetings contact 0461-22023 ext 450 o/h or 0461-26063 a/h.

THE ASTRONOMICAL SOCIETY OF SOUTHERN AFRICA. This society 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). The society's has an entrance fee of R40.00 and an annual subscription of R80.00. Members may also subscribe at a reduced rate to 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. This additional amount for "Sky and Telescope's" yearly subscription is subject to the Rand Dollar exchange rate, details of which are regularly published in MNASSA. A prospectus and application form may be obtained from the Honorary Secretary, Astronomical Society of Southern Africa, P O Box 9, Observatory 7935, or telephone 021-7612112 (Mrs. A. Joubert).

AUTONOMOUS LOCAL CENTRES OF THE ASSA hold regular meetings in Cape Town, Durban, Johannesburg, Bloemfontein, Pietermaritzburg, Pretoria, Harare and Sedgefield. 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". Centres publish newsletters and journals carrying information on meetings, centre activities and topics of interest.

BLOEMFONTEIN CENTRE: Meetings are usually held every second Friday of the month at Boyden Observatory, Mazelspoort. Phoning for confirmation beforehand is essential. The Centre publishes a monthly newsletter 'Clear Skys'. Secretarial address: PO Box 13004, Brandhof, 9324 or telephone 051-4012924(o/h) or 051-4471921(a/h).

CAPE CENTRE (Cape Town): Formal meetings, involving lectures on the latest astronomical topics are held on the second Wednesday of the month (except in January and December). Informal meetings are held on other Wednesdays except during January and December. Meetings are held at the SAAO, Observatory Road, Observatory at 20h00. The centre publishes a monthly newsletter, the "Cape Observer". Secretarial address: P.O.Box 13018, Mowbray, 7705, or tel. 021-6856214.

GARDEN ROUTE CENTRE. This Centre covers the coastal area between Mossel Bay and Plettenberg Bay, holding regular monthly meetings at 16h00 on the first Saturday of the month except December at "Laurel and Hardy", Main St., Sedgefield. Secretarial address: 9a Ironside St., George, 6530 or tel. 044-874 5902.

HARARE CENTRE: The centre holds a meeting on the last Wednesday of each month (except December). These are usually held at 17h30 at the Harry Robinson Study Centre Prince Edward School, consist of lectures, films or general discussions. Informal observing sessions are also held at the homes of members. Secretarial address: 3 Delano Place, Mt Pleasant, Harare, Zimbabwe.

JOHANNESBURG CENTRE: General meetings, consisting of lectures, films or observing evenings 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. There are two small observatories on the site, one houses the 30cm F8 Newtonian Jacobs telescope, and the Papadopoulos Dome houses 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 newsletter "Canopus". Secretarial address: P O Box 93145, Yeoville 2143. Tel. 011-7163199/7163038

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". Secretarial address: P O Box 201554, Durban North, 4016, or telephone 031-84 7136 / 21 5829 / 44 6089

NATAL MIDLANDS CENTRE (Pietermaritzburg): Regular monthly meetings on the second Wednesday of each month starting at 19h45. The centre publishes a monthly newsletter, "Stardust". Secretarial address: P O Box 2106, Pietermaritzburg, 3200 tel 0331-433646.

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. Secretarial address: P O Box 11151, Queenswood, 0121, tel: 012-333 9991.

SECTIONS OF THE ASSA

These sections exist to co-ordinate the activities of special interest groups within the society. Several of these sections co-ordinate constructive observing programmes and more information on an observing section is given in the appropriate part of this handbook.

THE 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 Computing Section: Mr Tony Hilton, P O Box 68846, Bryanston, 2021. Phone (w) (011) 53 8714 or (h) (011) 465 2257.
Mr Hilton has compiled a comprehensive DATA BASE of all interested person's, equipment, available software etc. If you wish to become a subscriber to this DATA BASE list please contact Mr Hilton for the relevant questionnaire.

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.

THE HISTORICAL SECTION. This section was formed for the purpose of establishing a stronger historical record than hitherto available relating to astronomy in Southern Africa and in particular, to the ASSA and its members. Amongst the activities are

- maintaining an archive of photographic and other material of historical interest;
- undertaking research into specific topics and publishing articles, obituaries etc;
- following up specific enquiries.

All members (and families of deceased members) are invited to donate material to the archive and to participate in the other activities of the Section.
For further information, contact the Director :
Chris de Coning, 15 Wilkinson St., Gardens, 8001. Tel 021-234538

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

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

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

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h	
Jul	14	11	Mercury 3° S. of Moon
	14	21	Venus greatest brilliancy
	15	23	Regulus 1°·1 S. of Moon
	16	1	Venus 3° S. of Moon
	20	11	FIRST QUARTER
	21	0	Mars 7° S. of Moon
	23	8	Moon at apogee
	24	7	Ceres in conjunction with Sun
	25	7	Juno stationary
	26	12	Neptune at opposition
	26	18	Mercury in inferior conjunction
	27	22	Venus stationary
	28	10	Neptune 0°·6 S. of Moon
	28	13	FULL MOON
	29	9	Uranus 0°·5 S. of Moon
Aug	4	4	Jupiter 4° N. of Moon
	4	19	LAST QUARTER
	5	2	Saturn 3° N. of Moon
	5	18	Mercury stationary
	6	18	Aldebaran 0°·8 S. of Moon
	7	21	Uranus at opposition
	8	2	Moon at perigee
	10	5	Mercury 1°·2 S. of Moon
	10	18	Venus 8° S. of Regulus
	11	13	NEW MOON
	14	16	Mercury greatest elong. W. (19°)
	18	14	Mars 7° S. of Moon
	19	4	FIRST QUARTER
	20	1	Moon at apogee
	20	14	Venus in inferior conjunction
	21	9	Pluto stationary
	24	16	Neptune 0°·7 S. of Moon
	25	14	Jupiter stationary
	25	15	Uranus 0°·6 S. of Moon
	26	14	Mercury 10° N. of Venus
	27	2	FULL MOON
	30	18	Saturn stationary
	31	11	Jupiter 4° N. of Moon
Sep	1	8	Saturn 3° N. of Moon
	2	20	Moon at perigee
	3	0	Aldebaran 0°·8 S. of Moon
	3	0	LAST QUARTER
	7	18	Venus 8° S. of Moon
	8	17	Mercury in superior conjunction
	8	17	Regulus 1°·1 S. of Moon
	9	22	Venus stationary
	10	0	NEW MOON
	11	14	Vesta 0°·9 N. of Moon
	16	12	Mars 7° S. of Moon
	16	21	Moon at apogee
	17	9	Mars 3° N. of Antares
	17	22	FIRST QUARTER
	21	0	Neptune 0°·7 S. of Moon
	21	22	Uranus 0°·6 S. of Moon
	23	14	Equinox
	25	13	FULL MOON
	26	17	Venus greatest brilliancy
	27	15	Jupiter 4° N. of Moon
	28	14	Saturn 3° N. of Moon
	28	19	Moon at perigee
	30	6	Aldebaran 1°·0 S. of Moon
	30	18	Mercury 1°·7 N. of Spica
Oct	2	6	LAST QUARTER
	5	19	Venus 5° S. of Moon
	6	0	Regulus 1°·2 S. of Moon
	9	0	Venus 3° S. of Regulus
	9	14	NEW MOON
	11	5	Mercury 7° S. of Moon
	14	0	Neptune stationary
	14	16	Moon at apogee
	15	15	Mars 5° S. of Moon
	17	17	FIRST QUARTER
	18	9	Neptune 0°·5 S. of Moon
	19	7	Uranus 0°·4 S. of Moon
	22	5	Vesta in conjunction with Sun
	23	13	Uranus stationary
	23	21	Jupiter at opposition
	24	19	Jupiter 4° N. of Moon
	24	23	FULL MOON
	25	0	Mercury greatest elong. E. (24°)
	25	20	Saturn 2° N. of Moon
	26	15	Moon at perigee
	27	14	Aldebaran 1°·2 S. of Moon
	31	2	Venus greatest elong. W. (46°)
	31	14	LAST QUARTER
Nov	4	1	Venus 3° S. of Moon
	5	10	Mercury stationary
	6	16	Saturn at opposition
	8	6	NEW MOON
	11	8	Moon at apogee
	13	18	Mars 3° S.of Moon
	14	17	Neptune 0°·2 S. of Moon
	15	15	Uranus 0°·1 S. of Moon Occn.
	16	0	Mercury in inferior conjunction, transit over Sun
	16	11	FIRST QUARTER
	21	0	Jupiter 4° N. of Moon
	22	3	Saturn 3° N. of Moon
	23	9	FULL MOON
	24	0	Aldebaran 1°·3 S. of Moon
	24	0	Moon at perigee
	25	3	Mercury stationary
	28	16	Mars 1°·7 S. of Neptune
	29	6	Venus 4° N. of Spica
	30	1	LAST QUARTER
Dec	3	2	Pluto in conjunction with Sun
	3	3	Mercury greatest elong. W. (20°)
	3	23	Venus 3° S. of Moon
	6	1	Vesta 0°·4 S. of Moon
	6	3	Mercury 3° S. of Moon
	8	1	NEW MOON
	8	13	Moon at apogee
	10	9	Pallas stationary
	12	0	Neptune 0°·07 N. of Moon
	12	21	Mars 0°·6 S. of Moon
	12	23	Uranus 0°·2 N. of Moon
	14	7	Mars 0°·7 S. of Uranus
	16	3	FIRST QUARTER
	17	10	Mercury 5° N. of Antares
	18	8	Jupiter 4° N. of Moon
	19	11	Saturn 3° N. of Moon
	21	7	Jupiter stationary
	21	11	Aldebaran 1°·3 S. of Moon
	22	10	Solstice
	22	13	Moon at perigee
	22	20	FULL MOON
	28	22	Juno in conjunction with Sun
	29	16	LAST QUARTER

THE SUN

BASIC DATA:

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

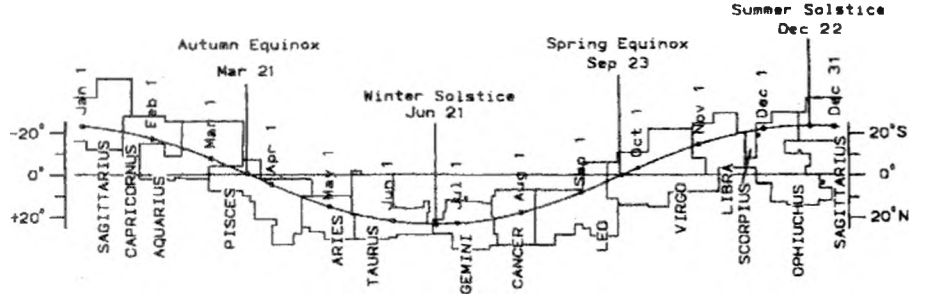
Mass: $1{,}99 \times 10^{30}$kg (330 000 times Earth mass)

Surface Temperature: Approximately 6 000°C

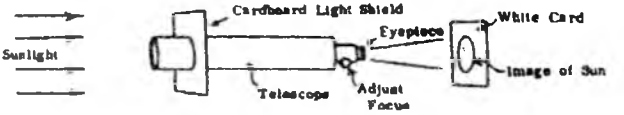
Temperature at centre: Approximately 10 million°C

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 1999 we will be closest to the Sun on January 3 (perihelion - approximate distance 147 million km) and furthest from the Sun on July 7 (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° 3'	Apr 11	8° 4'	Jul 20	20°47'	Oct 28	-12°53'
11	-21 54	21	11 38	30	18 40	Nov 7	-16 5
21	-20 3	May 1	14 52	Aug 9	16 3	17	-18 49
31	-17 34	11	17 42	19	12 59	27	-21 0
Feb 10	-14 34	21	20 3	29	9 36	Dec 7	-22 32
20	-11 9	31	21 49	Sep 8	5 57	17	-23 20
Mar 2	-7 28	Jun 10	22 57	18	2 8	27	-23 21
12	-3 35	20	23 26	28	-1 46		
22	0 22	30	23 12	Oct 8	-5 38		
Apr 1	4 17	Jul 10	22 19	18	-9 22		

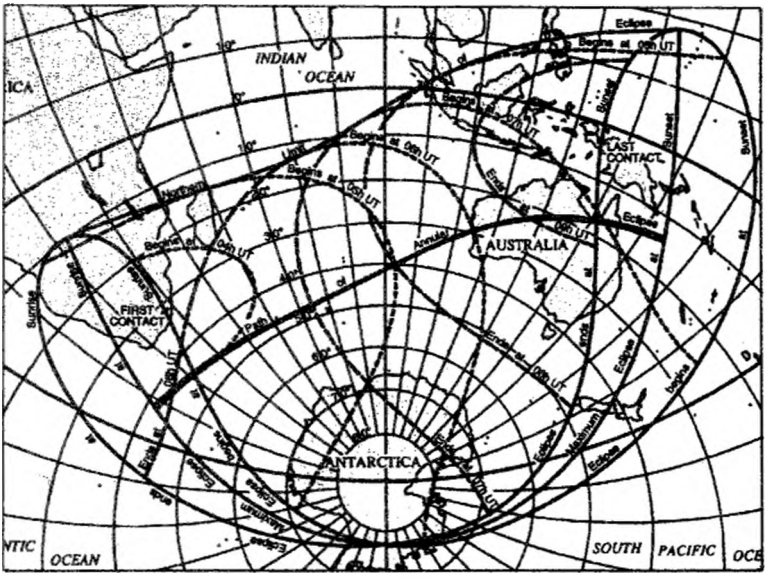
TIMES OF SUNRISE AND SUNSET FOR THE MAIN CITIES OF SOUTHERN AFRICA

	CAPETOWN		DURBAN		BLOEMFONTEIN		JOHANNESBURG		HARARE		WINDHOEK	
	sunrise	sunset	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	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	06 11	19 40
11	05 46	20 02	05 06	19 02	05 29	19 18	05 25	19 05	05 29	18 37	06 17	19 42
21	05 55	19 59	05 14	19 00	05 37	19 17	05 33	19 04	05 37	18 38	06 24	19 42
Feb 1	06 07	19 52	05 24	18 55	05 46	19 13	05 42	19 00	05 42	18 36	06 32	19 38
11	06 17	19 44	05 32	18 48	05 54	19 06	05 49	18 55	05 47	18 32	06 38	19 33
21	06 26	19 33	05 41	18 39	06 02	18 57	05 54	18 47	05 52	18 27	06 44	19 26
Mar 1	06 33	19 23	05 46	18 30	06 08	18 48	06 00	18 39	05 55	18 21	06 48	19 20
11	06 41	19 11	05 53	18 19	06 13	18 38	06 04	18 29	05 57	18 15	06 52	19 11
21	06 49	18 58	05 59	18 06	06 18	18 27	06 11	18 19	06 00	18 06	06 56	19 02
Apr 1	06 58	18 41	06 06	17 53	06 25	18 13	06 17	18 06	06 02	17 57	07 00	18 51
11	07 04	18 30	06 11	17 43	06 30	18 03	06 21	17 56	06 04	17 50	07 03	18 42
21	07 13	18 17	06 17	17 31	06 35	17 52	06 25	17 47	06 07	17 43	07 07	18 34
May 1	07 20	18 06	06 24	17 22	06 42	17 44	06 31	17 38	06 10	17 37	07 11	18 26
11	07 28	17 57	06 31	17 14	06 49	17 36	06 37	17 31	06 13	17 32	07 15	18 21
21	07 34	17 50	06 36	17 06	06 54	17 30	06 41	17 26	06 16	17 29	07 20	18 17
Jun 1	07 43	17 45	06 43	17 04	07 01	17 27	06 47	17 23	06 20	17 28	07 24	18 14
11	07 48	17 44	06 48	17 03	07 05	17 26	06 52	17 22	06 23	17 27	07 28	18 14
21	07 51	17 44	06 51	17 04	07 06	17 27	06 55	17 24	06 26	17 29	07 31	18 16
Jul 1	07 53	17 48	06 53	17 07	07 10	17 30	06 57	17 27	06 27	17 32	07 32	18 19
11	07 51	17 52	06 51	17 11	07 06	17 34	06 55	17 30	06 27	17 35	07 32	18 22
21	07 47	17 58	06 48	17 16	07 05	17 39	06 53	17 35	06 26	17 40	07 30	18 26
Aug 1	07 39	18 06	06 42	17 22	07 00	17 45	06 48	17 41	06 23	17 42	07 25	18 31
11	07 30	18 13	06 34	17 29	06 53	17 51	06 41	17 46	06 18	17 46	07 19	18 35
21	07 19	18 20	06 24	17 35	06 42	17 55	06 32	17 50	06 11	17 48	07 12	18 38
Sep 1	07 06	18 27	06 12	17 40	06 31	18 01	06 21	17 54	06 04	17 49	07 02	18 42
11	06 52	18 34	06 00	17 46	06 19	18 06	06 11	17 59	05 55	17 51	06 52	18 44
21	06 38	18 41	05 48	17 51	06 07	18 10	05 59	18 03	05 46	17 52	06 42	18 47
Oct 1	06 25	18 48	05 37	17 57	05 57	18 16	05 50	18 08	05 39	17 54	06 33	18 51
11	06 12	18 55	05 25	18 03	05 45	18 22	05 39	18 12	05 30	17 57	06 23	18 54
21	05 58	19 04	05 12	18 09	05 33	18 27	05 27	18 17	05 23	17 59	06 15	18 58
Nov 1	05 46	19 13	05 02	18 17	05 24	18 35	05 19	18 24	05 16	18 03	06 07	19 04
11	05 38	19 23	04 55	18 26	05 17	18 44	05 13	18 32	05 14	18 08	06 02	19 10
21	05 31	19 33	04 49	18 34	05 12	18 52	05 06	18 39	05 11	18 13	05 59	19 17
Dec 1	05 29	19 43	04 48	18 42	05 11	19 00	05 07	18 46	05 12	18 19	05 58	19 23
11	05 28	19 50	04 48	18 50	05 11	19 07	05 08	18 53	05 14	18 25	06 00	19 30
21	05 32	19 57	04 52	18 57	05 15	19 14	05 12	19 00	05 18	18 31	06 04	19 36

ECLIPSES OF THE SUN

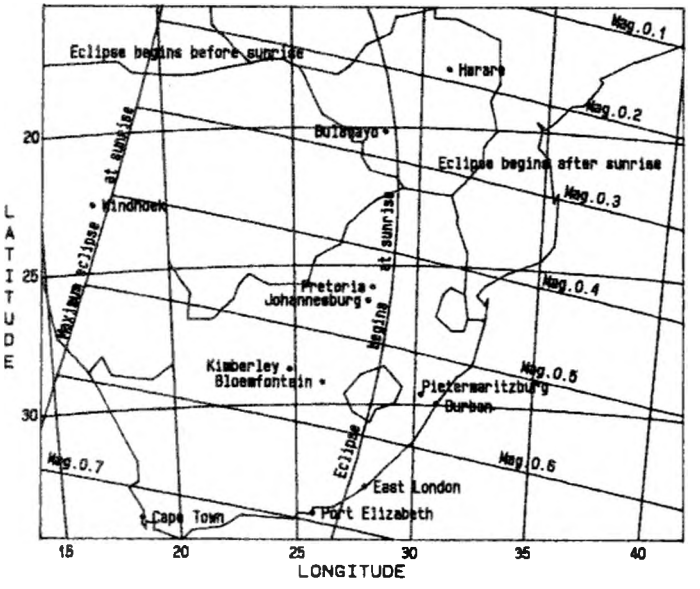
Partial phases of the annular eclipse of 16 February will be visible from Southern Africa. The total eclipse of the 11 August will not be visible.

THE ANNULAR SOLAR ECLIPSE 16 FEBRUARY 1999



Copied from the Astronomical Almanac for 1999

PARTIAL PHASES OVER SOUTHERN AFRICA



PREDICTIONS

	ECLIPSE BEGINS		MAXIMUM ECLIPSE				ECLIPSE ENDS	
	TIME	ALTITUDE	TIME	ALTITUDE	MAGNITUDE	OBSCURATION	TIME	ALTITUDE
Bloemfontein	05:52	-01° 54'	06:47	+09° 41'	0.552	0.447	07:47	+22° 48'
Bulawayo	05:59	-00° 23'	06:42	+09° 26'	0.270	0.161	07:29	+20° 17'
Cape Town	05:54	-06° 28'	06:49	+04° 38'	0.729	0.655	07:51	+17° 13'
Durban	05:52	+02° 21'	06:49	+14° 23'	0.548	0.442	07:52	+28° 00'
East London	05:52	+00° 33'	06:50	+12° 28'	0.652	0.563	07:54	+25° 56'
Harare	06:05	+02° 36'	06:42	+11° 20'	0.186	0.093	07:23	+20° 51'
Johannesburg	05:53	-00° 49'	06:45	+10° 34'	0.456	0.341	07:43	+23° 23'
Kimberley	05:52	-03° 08'	06:46	+08° 19'	0.546	0.439	07:45	+21° 16'
Pietermaritzburg	05:52	+01° 43'	06:48	+13° 40'	0.543	0.436	07:51	+27° 11'
Port Elisabeth	05:52	-00° 56'	06:50	+10° 46'	0.691	0.609	07:54	+24° 02'
Pretoria	05:54	-00° 43'	06:45	+10° 34'	0.440	0.324	07:42	+23° 18'
Windhoek	05:56	-10° 49'	06:42	-00° 34'	0.414	0.297	07:32	+10° 49'

NOTE: Magnitude is the proportion of the Sun's diameter covered by the Moon's disk at maximum eclipse.
Obscuration is the proportion of the Sun's disk covered by that of the Moon at maximum eclipse.
A negative altitude means that the Sun is below the horizon at the time of the event.

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 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, 17 Mars Street, Atlasville, Boksburg, 1459 or tel. 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, Perigee ±357 000km, Apogee ±407 000km

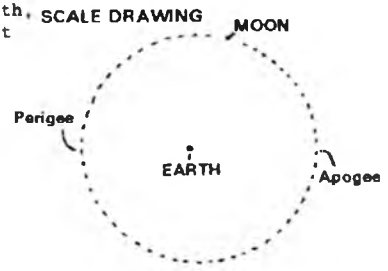
THE SURFACE OF THE MOON

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 mare 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 and of Perigee, when the Moon is closest to the Earth are given on the next page.



ECLIPSES OF THE MOON

The eclipse data is as follows:

Penumbral Eclipse	d	h	m
Moon enters penumbra	Jan 31	16	04.5
Middle of eclipse	31	18	17.5
Moon leaves penumbra	31	20	30.3

Contacts of Penumbra with Limb of Moon	Position Angles from the North Point
First	60.2 to East
Last	39.4 to West

Penumbral magnitude of the eclipse: 1.028

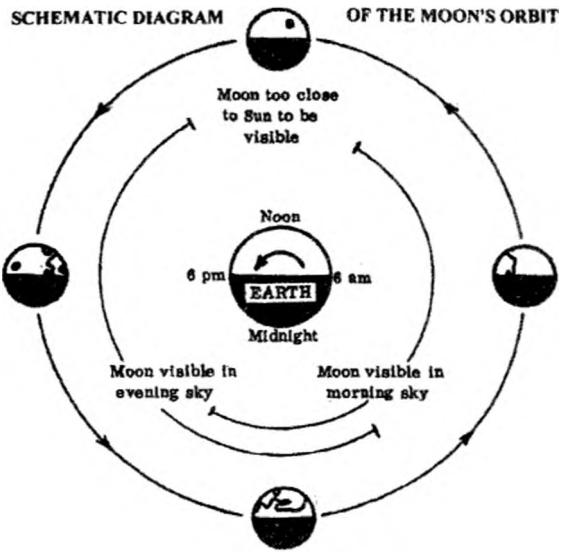
The partial eclipse of July 28 does not take place over Southern Africa.

PHASES and VISIBILITY

NEW MOON

	d	h	m
Jan	17	17	47
Feb	16	08	40
Mar	17	20	49
Apr	16	06	22
May	15	14	05
Jun	13	21	03
Jul	13	04	24
Aug	11	13	08
Sep	10	0	03
Oct	09	13	35
Nov	08	05	54
Dec	08	0	32

SCHEMATIC DIAGRAM OF THE MOON'S ORBIT



FIRST QUARTER

	d	h	m
Jan	24	21	16
Feb	23	04	43
Mar	24	12	18
Apr	22	21	02
May	22	07	34
Jun	20	20	12
Jul	20	11	00
Aug	19	03	47
Sep	17	22	06
Oct	17	17	00
Nov	16	11	03
Dec	16	02	50

LAST QUARTER

	d	h	m
Jan	09	16	32
Feb	08	13	59
Mar	10	10	41
Apr	09	04	51
May	08	19	28
Jun	07	06	20
Jul	06	13	57
Aug	04	19	27
Sep	03	00	18
Oct	02	06	03
	31	14	04
Nov	30	01	19
Dec	29	16	05

FULL MOON

	d	h	m
Jan	02	04	50
	31	18	07
Mar	02	08	59
Apr	01	0	49
Apr	30	16	55
May	30	08	40
Jun	28	23	37
Jul	28	13	25
Aug	27	01	48
Sep	25	13	51
Oct	24	23	03
Nov	23	09	04

MOON at PERIGEE

d	h	d	h	d	h
Jan 26	23	Jun 13	3	Oct 26	15
Feb 20	17	Jul 11	8	Nov 24	0
Mar 20	2	Aug 8	2	Dec 22	13
Apr 17	7	Sep 2	20		
May 15	17	28	19		

MOON at APOGEE

d	h	d	h	d	h
Jan 11	14	May 29	10	Oct 14	16
Feb 8	11	Jun 25	18	Nov 11	8
Mar 8	7	Jul 23	8	Dec 8	13
Apr 5	0	Aug 20	1		
May 2	8	Sep 16	21		

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 the next page. 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.

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 2	6.1	317	Jul 6	8.3	19	Jul 12	4.5	322
Jan 13	6.8	177	Jan 20	4.8	61	Jul 19	8.1	247	Jul 27	4.3	109
Jan 25	6.8	349	Jan 31	5.0	299	Aug 3	7.6	10	Aug 9	3.8	316
Feb 10	7.0	167	Feb 17	4.9	42	Aug 16	7.9	239	Aug 24	4.4	109
Feb 22	6.9	335	Mar 1	4.8	286	Aug 31	7.1	1	Sep 6	3.9	307
Mar 11	7.1	139	Mar 17	5.8	22	Sep 12	7.6	234	Sep 19	4.7	124
Mar 23	7.2	323	Mar 29	5.4	273	Sep 26	6.9	6	Oct 3	4.9	302
Apr 11	7.5	70	Apr 16	6.5	353	Oct 10	7.5	235	Oct 16	4.6	134
Apr 21	7.3	309	Apr 27	6.5	256	Oct 22	7.8	26	Oct 29	5.5	317
Apr 30	6.6	217	May 4	6.3	151	Nov 5	7.9	245	Nov 12	4.2	135
May 11	8.2	41	May 16	6.3	333	Nov 19	9.1	29	Nov 25	4.8	325
May 22	7.6	275	Jun 1	5.5	133	Dec 2	8.9	254	Dec 10	3.5	131
Jun 8	8.5	29	Jun 14	5.4	327	Dec 17	9.8	27	Dec 23	3.6	327
Jun 21	8.1	257	Jun 29	4.8	119	Dec 29	9.6	253			

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.

1999 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	19 22		20 31	06 43	19 05	05 31	19 19	07 12	18 59	07 49	19 44	09 16
2	20 20	05 55	21 09	07 44	19 41	06 30	19 51	08 07	19 36	08 43	20 34	10 05
3	21 12	06 57	21 44	08 44	20 15	07 28	20 24	09 01	20 16	09 36	21 28	10 52
4	21 57	07 59	22 17	09 41	20 47	08 25	20 59	09 55	20 59	10 28	22 24	11 35
5	22 37	09 01	22 49	10 37	21 19	09 21	21 37	10 48	21 47	11 19	23 22	12 15
6	23 13	10 01	23 21	11 31	21 52	10 15	22 19	11 41	22 39	12 07		12 53
7	23 47	10 58	23 53	12 25	22 25	11 09	23 04	12 33	23 34	12 52	00 23	13 30
8		11 54		13 19	23 02	12 03	23 53	13 23		13 35	01 25	14 06
9	00 18	12 48	00 28	14 12	23 41	12 56		14 11	00 32	14 15	02 29	14 43
10	00 50	13 42	01 06	15 06		13 49	00 47	14 56	01 32	14 54	03 35	15 22
11	01 22	14 36	01 47	15 59	00 24	14 40	01 45	15 39	02 35	15 31	04 43	16 04
12	01 55	15 29	02 33	16 51	01 12	15 30	02 45	16 19	03 40	16 09	05 53	16 51
13	02 31	16 23	03 24	17 41	02 04	16 18	03 49	16 59	04 47	16 48	07 04	17 44
14	03 10	17 17	04 19	18 28	03 01	17 03	04 54	17 38	05 56	17 30	08 12	18 43
15	03 54	18 10	05 18	19 13	04 02	17 46	06 02	18 17	07 07	18 16	09 15	19 46
16	04 42	19 01	06 20	19 54	05 05	18 27	07 11	18 58	08 19	19 07	10 11	20 50
17	05 35	19 50	07 24	20 34	06 10	19 07	08 22	19 42	09 28	20 03	11 00	21 55
18	06 32	20 35	08 29	21 12	07 17	19 46	09 32	20 30	10 33	21 03	11 43	22 57
19	07 32	21 18	09 34	21 50	08 25	20 25	10 41	21 22	11 31	22 05	12 21	23 57
20	08 34	21 58	10 40	22 29	09 33	21 07	11 46	22 18	12 22	23 07	12 55	
21	09 36	22 36	11 46	23 10	10 41	21 51	12 45	23 17	13 06		13 27	00 54
22	10 40	23 13	12 52	23 54	11 49	22 39	13 38		13 45	00 09	13 58	01 50
23	11 43	23 50	13 57		12 53	23 30	14 25	00 17	14 21	01 08	14 30	02 44
24	12 48		14 59	00 42	13 54		15 06	01 17	14 53	02 05	15 02	03 38
25	13 53	00 29	15 58	01 34	14 50	00 26	15 43	02 16	15 24	03 01	15 36	04 32
26	14 59	01 10	16 53	02 31	15 40	01 24	16 17	03 14	15 55	03 56	16 14	05 26
27	16 04	01 56	17 42	03 30	16 25	02 23	16 50	04 11	16 27	04 50	16 55	06 19
28	17 07	02 46	18 26	04 30	17 05	03 23	17 21	05 06	17 00	05 44	17 40	07 12
29	18 06	03 41			17 41	04 22	17 52	06 01	17 36	06 38	18 30	08 02
30	19 00	04 40			18 15	05 20	18 25	06 55	18 15	07 32	19 23	08 50
31	19 48	05 41			18 47	06 16			18 57	08 24		

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

1999 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	18 20		19 33	05 57	18 08	04 43	18 28	06 18	18 13	06 51	19 00	08 15
2	19 19	05 11	20 13	06 56	18 46	05 41	19 02	07 12	18 51	07 44	19 50	09 04
3	20 12	06 12	20 50	07 54	19 22	06 38	19 37	08 04	19 31	08 36	20 43	09 51
4	20 59	07 13	21 24	08 50	19 56	07 33	20 13	08 57	20 16	09 27	21 38	10 35
5	21 40	08 14	21 58	09 44	20 29	08 27	20 52	09 49	21 03	10 18	22 35	11 17
6	22 18	09 12	22 31	10 37	21 03	09 19	21 34	10 41	21 54	11 06	23 34	11 56
7	22 53	10 08	23 06	11 29	21 39	10 12	22 20	11 32	22 49	11 52		12 35
8	23 27	11 02	23 42	12 21	22 16	11 04	23 10	12 22	23 45	12 36	00 34	13 13
9	24 00	11 55		13 13	22 56	11 56		13 10		13 18	01 35	13 52
10		12 47	00 20	14 06	23 40	12 48	00 03	13 56	00 44	13 58	02 39	14 33
11	00 33	13 39	01 03	14 58		13 39	00 59	14 40	01 45	14 37	03 46	15 17
12	01 08	14 31	01 49	15 50	00 28	14 29	01 58	15 23	02 47	15 17	04 54	16 06
13	01 45	15 23	02 39	16 40	01 20	15 18	03 00	16 04	03 52	15 58	06 03	17 00
14	02 26	16 16	03 34	17 28	02 16	16 04	04 03	16 45	05 00	16 42	07 10	17 59
15	03 10	17 09	04 32	18 14	03 15	16 49	05 09	17 26	06 09	17 30	08 13	19 02
16	03 58	18 00	05 33	18 57	04 17	17 31	06 16	18 09	07 18	18 22	09 10	20 05
17	04 51	18 49	06 35	19 39	05 20	18 13	07 24	18 55	08 26	19 19	10 01	21 08
18	05 47	19 36	07 38	20 19	06 25	18 54	08 32	19 44	09 31	20 19	10 45	22 09
19	06 46	20 20	08 41	20 59	07 30	19 35	09 40	20 37	10 29	21 20	11 25	23 07
20	07 46	21 02	09 45	21 40	08 37	20 19	10 44	21 34	11 21	22 22	12 01	
21	08 47	21 41	10 49	22 23	09 43	21 05	11 44	22 32	12 07	23 22	12 35	00 03
22	09 48	22 20	11 53	23 08	10 48	21 54	12 37	23 32	12 48		13 08	00 56
23	10 50	23 00	12 56	23 57	11 52	22 46	13 25		13 25	00 19	13 41	01 49
24	11 52	23 40	13 58		12 53	23 42	14 08	00 31	14 00	01 15	14 15	02 42
25	12 55		14 57	00 50	13 49		14 47	01 29	14 33	02 09	14 51	03 34
26	13 59	00 23	15 52	01 46	14 40	00 39	15 23	02 25	15 06	03 02	15 29	04 27
27	15 03	01 10	16 42	02 45	15 26	01 38	15 57	03 20	15 39	03 54	16 11	05 19
28	16 05	02 01	17 27	03 44	16 07	02 36	16 30	04 13	16 13	04 47	16 57	06 11
29	17 04	02 56			16 45	03 34	17 03	05 06	16 50	05 39	17 46	07 01
30	17 59	03 55			17 21	04 30	17 37	05 59	17 30	06 32	18 38	07 49
31	18 48	04 56			17 55	05 25			18 13	07 24		

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

1999 TIMES OF MOON RISE AND SET HARARE

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

1999 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	18 26		19 41	06 15	18 17	05 01	18 42	06 31	18 30	07 00	19 20	08 20
2	19 25	05 31	20 22	07 13	18 56	05 57	19 17	07 22	19 09	07 51	20 10	09 09
3	20 18	06 32	21 01	08 09	19 33	06 52	19 53	08 14	19 51	08 42	21 02	09 57
4	21 06	07 32	21 37	09 04	20 09	07 46	20 31	09 05	20 35	09 33	21 57	10 42
5	21 49	08 31	22 12	09 56	20 44	08 38	21 11	09 56	21 23	10 23	22 52	11 24
6	22 28	09 28	22 46	10 48	21 19	09 30	21 54	10 47	22 14	11 12	23 50	12 05
7	23 05	10 23	23 22	11 39	21 56	10 21	22 40	11 38	23 08	11 58		12 45
8	23 40	11 15	23 59	12 30	22 34	11 12	23 29	12 27		12 43	00 48	13 25
9		12 07		13 21	23 15	12 03		13 16	00 03	13 26	01 48	14 06
10	00 14	12 57	00 39	14 12	24 00	12 54	00 22	14 03	01 01	14 07	02 50	14 48
11	00 49	13 48	01 22	15 04		13 45	01 18	14 48	02 00	14 48	03 55	15 34
12	01 25	14 39	02 09	15 55	00 48	14 35	02 16	15 31	03 01	15 30	05 02	16 25
13	02 03	15 30	02 59	16 46	01 40	15 24	03 16	16 14	04 04	16 13	06 09	17 20
14	02 44	16 23	03 54	17 35	02 35	16 11	04 18	16 57	05 10	16 58	07 16	18 19
15	03 29	17 15	04 51	18 22	03 33	16 57	05 21	17 40	06 17	17 48	08 19	19 22
16	04 18	18 06	05 50	19 06	04 34	17 41	06 27	18 25	07 25	18 41	09 16	20 25
17	05 11	18 56	06 51	19 49	05 35	18 24	07 33	19 12	08 32	19 39	10 08	21 26
18	06 06	19 43	07 52	20 31	06 38	19 07	08 40	20 03	09 36	20 39	10 53	22 26
19	07 04	20 28	08 54	21 13	07 42	19 50	09 46	20 57	10 35	21 40	11 34	23 22
20	08 03	21 11	09 56	21 55	08 47	20 35	10 50	21 54	11 28	22 41	12 12	
21	09 02	21 52	10 58	22 40	09 51	21 22	11 49	22 52	12 15	23 39	12 47	00 16
22	10 02	22 33	12 01	23 26	10 56	22 12	12 43	23 51	12 57		13 22	01 09
23	11 02	23 14	13 03		11 58	23 06	13 32		13 35	00 36	13 56	02 00
24	12 03	23 56	14 04	00 16	12 58		14 16	00 49	14 11	01 30	14 31	02 51
25	13 04		15 03	01 10	13 54	00 02	14 56	01 46	14 46	02 22	15 08	03 42
26	14 07	00 41	15 58	02 06	14 46	00 59	15 34	02 41	15 20	03 14	15 48	04 34
27	15 10	01 29	16 48	03 04	15 33	01 57	16 09	03 34	15 54	04 05	16 31	05 25
28	16 11	02 21	17 35	04 03	16 16	02 54	16 43	04 26	16 30	04 56	17 17	06 16
29	17 10	03 16			16 55	03 50	17 18	05 18	17 08	05 47	18 06	07 06
30	18 05	04 15			17 32	04 45	17 53	06 09	17 49	06 38	18 58	07 55
31	18 55	05 15			18 08	05 38			18 33	07 30		

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

1999 TIMES OF MOON RISE AND SET WINDHOEK

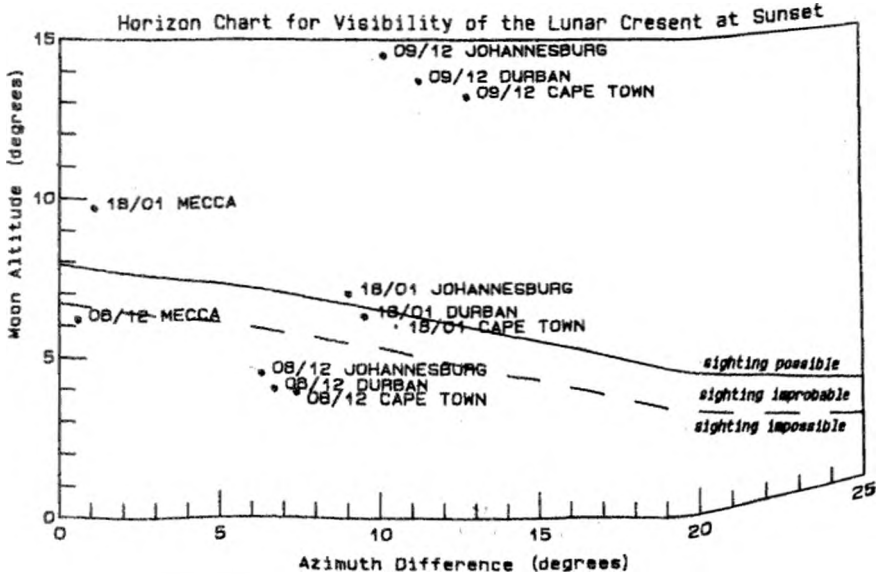
	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	19 06		20 22	07 05	18 59	05 51	19 29	07 16	19 19	07 42	20 12	08 59
2	20 04	06 23	21 05	08 03	19 39	06 46	20 05	08 06	19 59	08 32	21 02	09 48
3	20 58	07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

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

PREDICTIONS FOR YOUNG CRESCENT VISIBILITY FOR RAMADAAN AND SHAWWALL

The tabulation below is for the difference in altitude and azimuth between the Sun and the Moon at sunset for the period after New Moon on each occasion when the Moon is above the horizon. Positions of the Moon at altitudes less than 15° and differences of azimuth less than 25° in the table, are plotted on the accompanying chart.

OCCASION	DATE	CAPE TOWN		JOHANNESBURG		DURBAN		MECCA	
	d m	Alt°	DAzm°	Alt°	DAzm°	Alt°	DAzm°	Alt°	DAzm°
SHAWWALL	18 01	6.0	10.5	7.0	9.0	6.3	9.5	9.7	1.1
RAMADAAN	08 12	3.9	7.4	4.5	6.3	4.0	6.7	6.2	0.6
	09 12	13.2	12.7	14.5	10.1	13.7	11.2	15 2	6.5



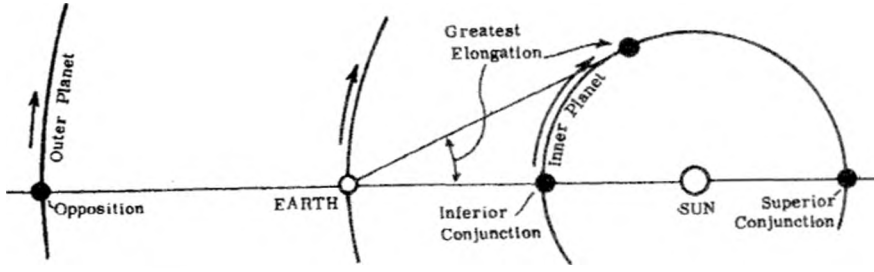
THE PLANETS

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'	18
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 astronomy to the various Sun-Earth-Planet configurations are illustrated in the accompanying diagram. Dates of such configurations occuring during the year are listed chronologically in the DIARY OF PHENOMENA 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.

MERCURY

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

January 1 (at mag.-0.4) to January 21 (at mag.-0.7),
March 27 (at mag.+2.7) to May 18 (at mag.-1.3),
August 4 (at mag.+2.5) to August 31 (at mag.-1.4) and
November 22 (at mag.+1.5) to December 30 (at mag.-0.6)

The best conditions for viewing will occur from early April until early May when Mercury will be found in Pisces

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

February 16 (at mag.-1.3) to March 12 (at mag.+1.8),
June 2 (at mag.-1.5) to July 18 (at mag.+2.8), and
September 20 (at mag.-0.8) to November 10 (at mag.+1.8)

The best conditions for viewing will be in the second half of October, when Mercury will be found in Libra.

	d h	d h	d h
Superior Conjunction	Feb 4 7	May 25 20	Sep 8 17
Greatest Elongation East	Mar 3 15 (18°)	Jun 29 1 (26°)	Oct 25 0 (24°)
Stationary	Mar 10 0	Jul 12 5	Nov 5 10
Inferior Conjunction	Mar 19 21	Jul 26 18	Nov 16 0
Stationary	Apr 1 8	Aug 5 18	Nov 25 3
Greatest Elongation West	Apr 16 18 (28°)	Aug 14 16 (19°)	Dec 3 3 (20°)

The transit of the Sun's disk on November 15/16 (23:15 - 24:07) will not be visible from Southern Africa.

VENUS

Venus will be in the evening sky from the beginning of the year (at mag.-3.9) reaching greatest brilliancy (at mag.-4.5) on July 14. It remains in the evening sky until the middle of August (at mag.-4.1).

It will be a morning sky object from the last week of August (at mag. -4.2), until the end of the year (at mag. -4.1).

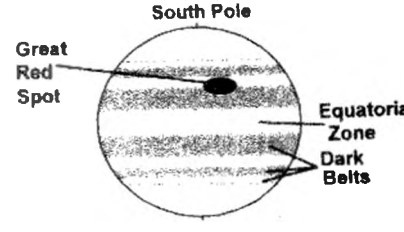
	d h
Greatest Elongation East	Jun 11 14 (45°)
Stationary	Jul 27 22
Inferior Conjunction	Aug 20 14
Stationary	Sep 9 22
Greatest Elongation West	Oct 31 2 (46°)

MARS

Mars, visible (at mag.+1.0) from midnight, begins the year in the constellation of Virgo, passing to Libra in the middle of February (at mag.+0 2), and back into Virgo in the middle of April (at mag.-1.5). It will be visible all night at opposition on April 24 (at mag.-1.7). It passes back into Libra in the last week of July (at mag. 0.0), into Scorpius at the begining of September (at mag.+0.4), into Ophiuchus in mid September, into Sagittarius in mid October (at mag.+0.6) and into Capricornus in late November (at mag.+0.9).

JUPITER

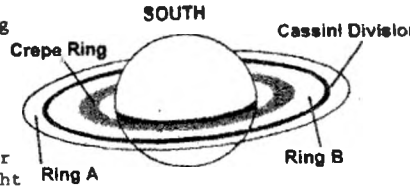
Jupiter (at mag.-2.3) begins the year in the evening sky, in Aquarius, passing mid January into Pisces and into Cetus in mid March (at mag.-2.1) where after a few days it will be too close to the Sun to be seen. It re-appears in the morning sky in mid April in Pisces (at mag.-2.0) and passes into Aries at the beginning of July (at mag.-2.3), where by the end of the



month it will be visible for more than half the night. The planet passes, in mid October, back into Pisces (at mag.-2.9), where it remains for the rest of the year. It will be visible all night at opposition on October 23.

SATURN

Saturn, found in Pisces, will be in the evening sky from January (at mag.+0.4). It passes through Cetus into Aries at the end of March where by the second week of April it becomes too close to the Sun to be seen. It will reappear in the morning sky in mid May (at mag.+0.4) still in Aries where it remains for the rest of the year. It will be visible all night at opposition (at mag.-0.1) on November 23.

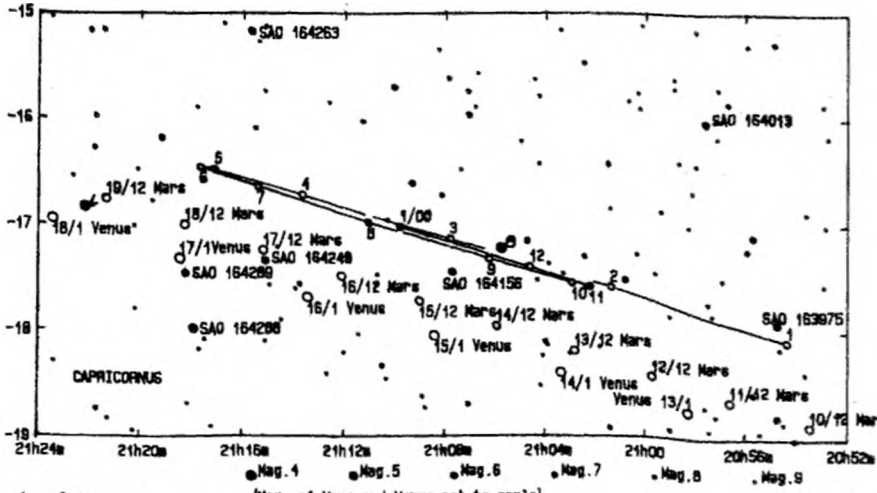


URANUS AND NEPTUNE

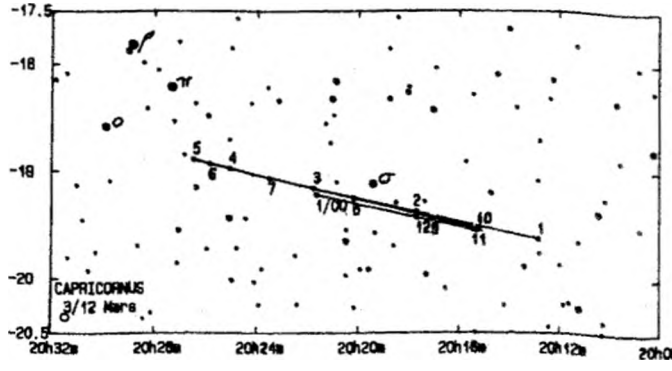
Uranus, visible with optical aid, found throughout the year in Capricornus, will set during the evening twilight until the middle of January. It will reappear in the morning sky in late February. At opposition on August 7, it will be at magnitude 5.7.

Neptune, visible with optical aid, will set during the evening twilight for the first half of January. The planet will be found in the morning sky also in Capricornus, from mid February. At opposition on July 26, it will be at magnitude +7.8.

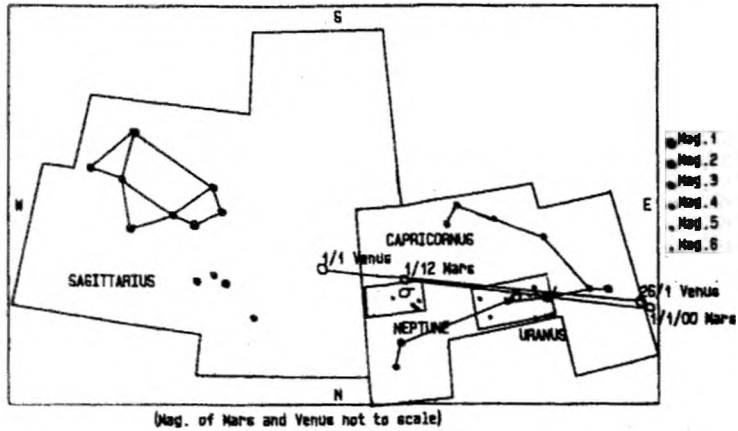
The Path of Uranus.



The Path of Neptune.



Sky Chart for the Paths of Uranus and Neptune



(Mag. of Mars and Venus not to scale)

PLUTO

Pluto at magnitude +14 in Ophiuchus is visible only in a telescope of at least 25cm aperture.

EVENTS OF INTEREST

Evening Sky:

1 Jan	- 15 Feb	Jupiter, Saturn and Venus visible.
16 Feb	- 12 Mar	Jupiter, Mercury, Saturn and Venus visible.
23 Feb		Jupiter and Venus in conjunction.
13 Mar	- 18 Mar	Jupiter, Saturn and Venus visible.
19 Mar	- 10 Apr	Saturn and Venus visible.
20 Mar		Saturn and Venus in conjunction.
24 Apr	- 1 Jun	Mars and Venus visible.
2 Jun	- 18 Jul	Mars, Mercury and Venus visible.
19 Jul	- 16 Aug	Mars and Venus visible.
20 Sep	- 22 Oct	Mars and Mercury visible.
23 Oct	- 5 Nov	Jupiter, Mars and Mercury visible.
6 Nov	- 10 Nov	Jupiter, Mars, Mercury and Saturn visible.
11 Nov	- 31 Dec	Jupiter, Mars and Saturn visible.

Morning Sky:

1 Jan	- 21 Jan	Mars and Mercury visible.
27 Mar	- 14 Apr	Mars and Mercury visible.
15 Apr	- 23 Apr	Jupiter, Mars and Mercury visible.
24 Apr	- 15 May	Jupiter and Mercury visible.
1 May		Jupiter and Mercury in conjunction.
13 May		Mercury and Saturn in conjunction, the planets rising about an hour before the sun.
16 May	- 18 May	Jupiter, Mercury and Saturn visible.
19 May	- 3 Aug	Jupiter and Saturn visible.
4 Aug	- 24 Aug	Jupiter, Mercury and Saturn visible.
25 Aug	- 31 Aug	Jupiter, Mercury, Saturn and Venus visible.
26 Aug		Mercury and Venus in conjunction.
1 Sep	- 23 Oct	Jupiter, Saturn and Venus visible.
24 Oct	- 6 Nov	Saturn and Venus visible.
22 Nov	- 30 Dec	Mercury and Venus visible.

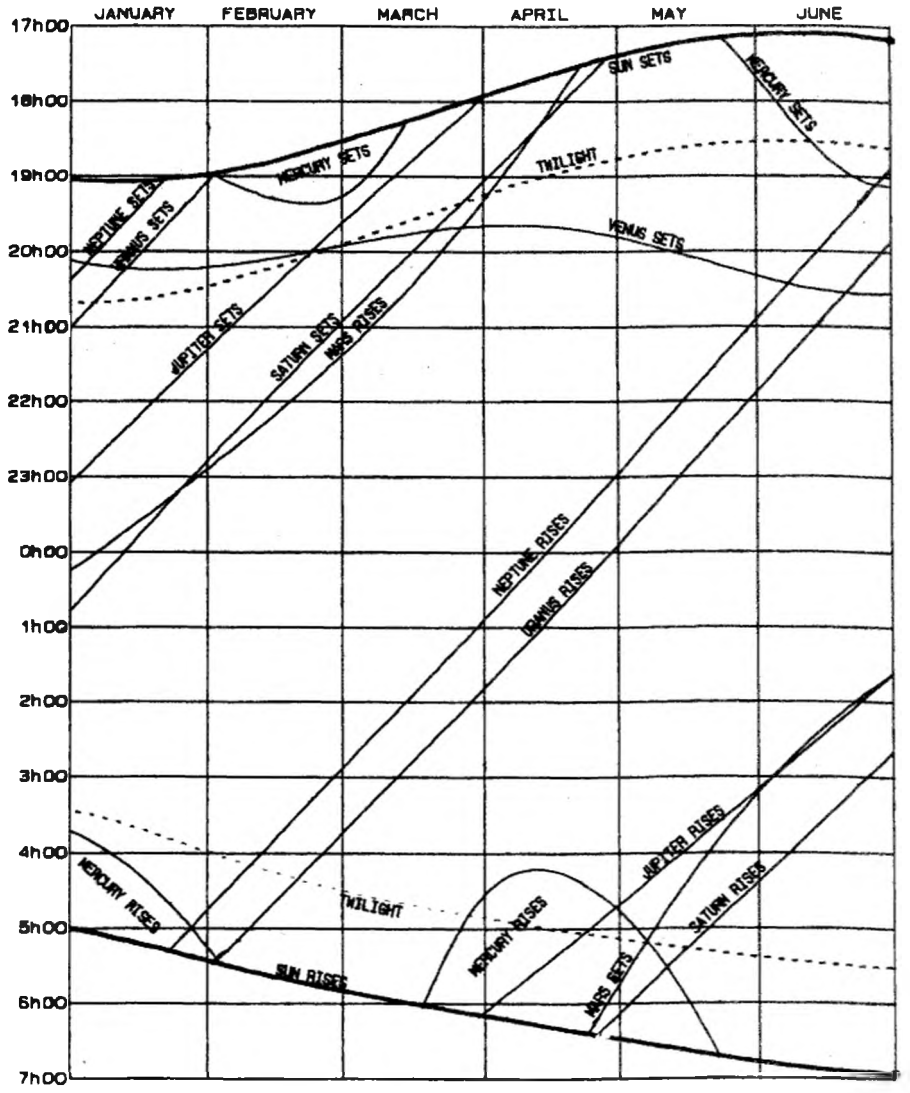
APPARENT PLACES:

	Mercury		Venus		Mars		Jupiter	
	RA	DEC	RA	DEC	RA	DEC	RA	DEC
	h m	° '	h m	° '	h m	° '	h m	° '
Jan 1	17 22.2	-22 33	19 50.4	-22 21	13 10.7	-5 27	23 32.4	-4 20
Jan 11	18 25.5	-23 57	20 42.9	-19 44	13 28.8	-7 11	23 38.1	-3 41
Jan 21	19 33.1	-23 19	21 33.3	-16 10	13 45.8	-8 46	23 44.6	-2 57
Jan 31	20 42.6	-20 20	22 21.6	-11 52	14 1.4	-10 9	23 51.7	-2 9
Feb 10	21 52.5	-14 54	23 8.1	-7 3	14 15.3	-11 19	23 59.4	-1 18
Feb 20	23 0.1	-7 15	23 53.3	-1 56	14 27.0	-12 15	0 7.4	-0 25
Mar 2	23 54.0	0 47	0 37.9	3 17	14 35.7	-12 56	0 15.8	0 31
Mar 12	0 8.9	4 36	1 22.6	8 23	14 40.8	-13 21	0 24.5	1 27
Mar 22	23 43.1	1 29	2 7.9	13 11	14 41.4	-13 27	0 33.3	2 24
Apr 1	23 25.8	-3 1	2 54.5	17 28	14 37.1	-13 15	0 42.2	3 22
Apr 11	23 40.3	-3 47	3 42.4	21 3	14 27.9	-12 44	0 51.1	4 18
Apr 21	0 16.7	-1 3	4 31.7	23 44	14 14.7	-11 57	1 0.0	5 13
May 1	1 6.8	4 9	5 21.7	25 24	13 59.9	-11 4	1 8.7	6 7
May 11	2 8.9	10 59	6 11.4	25 57	13 46.2	-10 16	1 17.3	6 58
May 21	3 25.9	18 20	6 59.9	25 25	13 36.0	-9 46	1 25.6	7 47
May 31	4 56.7	23 55	7 45.7	23 53	13 30.7	-9 41	1 33.5	8 32
Jun 10	6 24.9	25 22	8 27.8	21 30	13 30.6	-10 3	1 41.0	9 14
Jun 20	7 35.1	23 17	9 5.3	18 30	13 35.2	-10 48	1 48.0	9 52
Jun 30	8 22.5	19 31	9 37.2	15 6	13 44.0	-11 54	1 54.3	10 25
Jul 10	8 43.9	15 51	10 2.0	11 36	13 56.3	-13 15	1 59.9	10 54
Jul 20	8 35.3	14 6	10 17.8	8 20	14 11.7	-14 46	2 4.7	11 17
Jul 30	8 8.5	15 16	10 21.7	5 45	14 29.8	-16 24	2 8.4	11 34
Aug 9	8 2.4	17 43	10 11.4	4 24	14 50.2	-18 4	2 11.0	11 46
Aug 19	8 40.6	18 18	9 49.6	4 41	15 12.7	-19 41	2 12.5	11 51
Aug 29	9 50.8	14 41	9 27.2	6 18	15 37.2	-21 13	2 12.7	11 49
Sep 8	11 4.9	7 44	9 16.4	8 10	16 3.5	-22 35	2 11.6	11 41
Sep 18	12 10.9	-0 9	9 21.1	9 26	16 31.4	-23 43	2 9.3	11 27
Sep 28	13 10.0	-7 38	9 38.8	9 44	17 0.8	-24 34	2 5.8	11 8
Oct 8	14 5.1	-14 10	10 5.6	9 1	17 31.4	-25 5	2 1.5	10 43
Oct 18	14 56.8	-19 21	10 38.2	7 21	18 3.0	-25 12	1 56.5	10 16
Oct 28	15 39.9	-22 36	11 14.6	4 52	18 35.2	-24 54	1 51.4	9 49
Nov 7	15 55.4	-22 41	11 53.3	1 42	19 7.6	-24 11	1 46.4	9 22
Nov 17	15 17.6	-17 34	12 33.8	-1 56	19 40.1	-23 2	1 42.0	8 59
Nov 27	14 56.8	-14 11	13 15.9	-5 49	20 12.3	-21 28	1 38.4	8 41
Dec 7	15 31.2	-16 59	13 59.6	-9 45	20 44.1	-19 32	1 36.0	8 30
Dec 17	16 27.2	-20 55	14 45.1	-13 31	21 15.2	-17 15	1 34.8	8 26
Dec 27	17 31.2	-23 41	15 32.6	-16 52	21 45.6	-14 42	1 34.9	8 30

	Saturn			Uranus			Neptune			Pluto		
	RA		DEC	RA		DEC	RA		DEC	RA		DEC
	h	m	° '	h	m	° '	h	m	° '	h	m	° '
Jan 1	1	43.1	7 57	20	54.4	-18 5	20	12.8	-19 38	16	36.7	-10 33
Jan 11	1	43.5	8 2	20	56.5	-17 56	20	14.4	-19 33	16	38.0	-10 35
Jan 21	1	44.6	8 12	20	58.8	-17 47	20	15.9	-19 28	16	39.2	-10 36
Jan 31	1	46.4	8 25	21	1.2	-17 37	20	17.5	-19 23	16	40.2	-10 35
Feb 10	1	48.8	8 41	21	3.5	-17 27	20	19.0	-19 19	16	41.1	-10 34
Feb 20	1	51.8	9 0	21	5.8	-17 17	20	20.5	-19 13	16	41.7	-10 33
Mar 2	1	55.2	9 22	21	8.0	-17 8	20	21.9	-19 9	16	42.1	-10 30
Mar 12	1	59.1	9 45	21	10.1	-16 59	20	23.1	-19 5	16	42.3	-10 28
Mar 22	2	3.3	10 9	21	12.0	-16 51	20	24.2	-19 1	16	42.3	-10 25
Apr 1	2	7.9	10 35	21	13.7	-16 44	20	25.1	-18 58	16	42.0	-10 21
Apr 11	2	12.6	11 0	21	15.1	-16 38	20	25.8	-18 56	16	41.5	-10 18
Apr 21	2	17.4	11 26	21	16.3	-16 33	20	26.2	-18 54	16	40.9	-10 14
May 1	2	22.3	11 51	21	17.1	-16 29	20	26.5	-18 53	16	40.1	-10 11
May 11	2	27.3	12 16	21	17.6	-16 27	20	26.5	-18 53	16	39.1	-10 8
May 21	2	32.1	12 39	21	17.8	-16 27	20	26.3	-18 54	16	38.1	-10 6
May 31	2	36.8	13 1	21	17.7	-16 28	20	25.9	-18 55	16	37.1	-10 4
Jun 10	2	41.3	13 21	21	17.3	-16 30	20	25.3	-18 58	16	36.0	-10 3
Jun 20	2	45.6	13 39	21	16.5	-16 34	20	24.5	-19 0	16	34.9	-10 3
Jun 30	2	49.4	13 55	21	15.5	-16 39	20	23.6	-19 3	16	34.0	-10 3
Jul 10	2	52.9	14 9	21	14.3	-16 44	20	22.6	-19 7	16	33.1	-10 5
Jul 20	2	55.9	14 20	21	12.9	-16 51	20	21.5	-19 11	16	32.4	-10 7
Jul 30	2	58.3	14 28	21	11.4	-16 58	20	20.4	-19 15	16	31.8	-10 10
Aug 9	3	0.1	14 34	21	9.8	-17 5	20	19.3	-19 18	16	31.5	-10 13
Aug 19	3	1.3	14 36	21	8.2	-17 12	20	18.2	-19 22	16	31.3	-10 17
Aug 29	3	1.7	14 36	21	6.7	-17 18	20	17.3	-19 25	16	31.4	-10 22
Sep 8	3	1.5	14 32	21	5.3	-17 24	20	16.5	-19 28	16	31.6	-10 28
Sep 18	3	0.6	14 26	21	4.1	-17 29	20	15.8	-19 30	16	32.1	-10 33
Sep 28	2	59.0	14 18	21	3.2	-17 33	20	15.4	-19 32	16	32.8	-10 39
Oct 8	2	56.8	14 7	21	2.5	-17 35	20	15.1	-19 33	16	33.7	-10 45
Oct 18	2	54.2	13 54	21	2.2	-17 37	20	15.1	-19 33	16	34.8	-10 51
Oct 28	2	51.2	13 41	21	2.2	-17 36	20	15.3	-19 33	16	36.0	-10 57
Nov 7	2	48.1	13 27	21	2.5	-17 35	20	15.7	-19 32	16	37.4	-11 3
Nov 17	2	44.9	13 13	21	3.2	-17 32	20	16.4	-19 30	16	38.8	-11 8
Nov 27	2	41.9	13 1	21	4.2	-17 27	20	17.3	-19 27	16	40.3	-11 13
Dec 7	2	39.3	12 50	21	5.4	-17 21	20	18.3	-19 24	16	41.9	-11 17
Dec 17	2	37.2	12 43	21	7.0	-17 14	20	19.6	-19 20	16	43.4	-11 20
Dec 27	2	35.6	12 38	21	8.8	-17 6	20	20.9	-19 15	16	44.9	-11 23

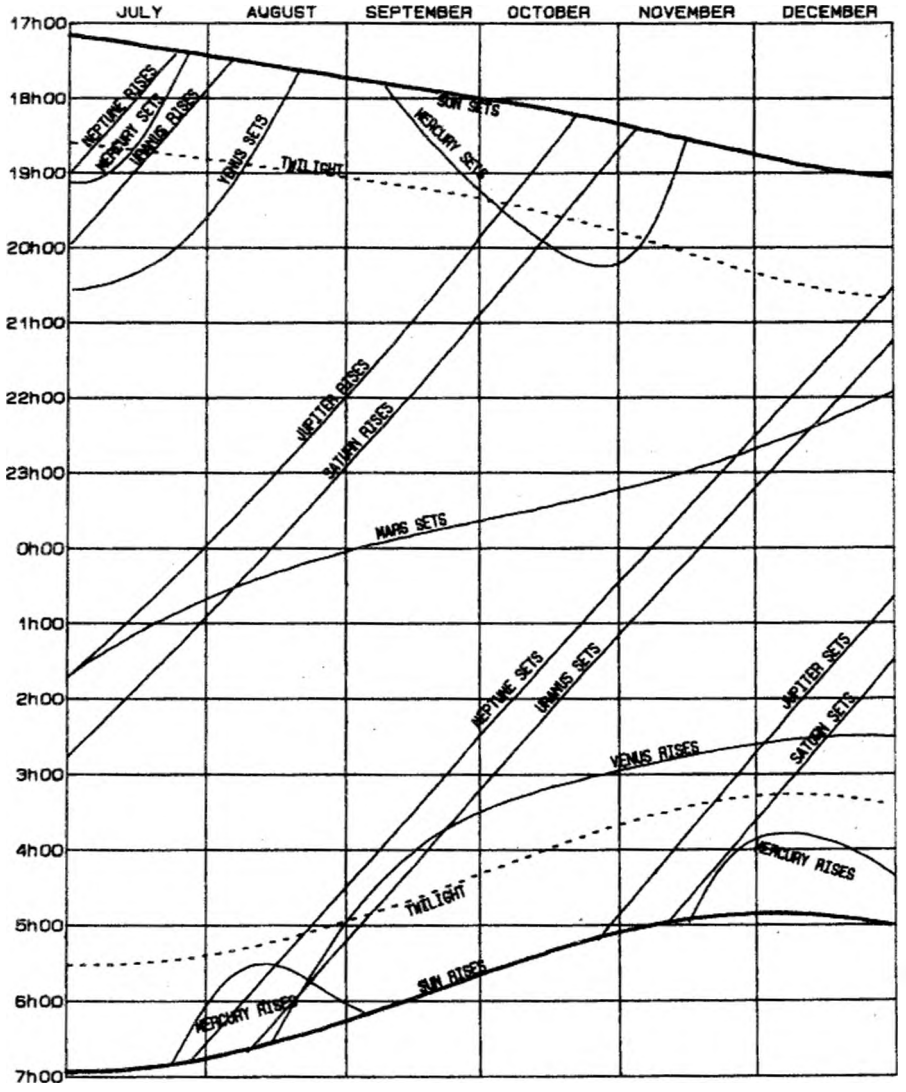
TIMES OF RISING AND SETTING

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.



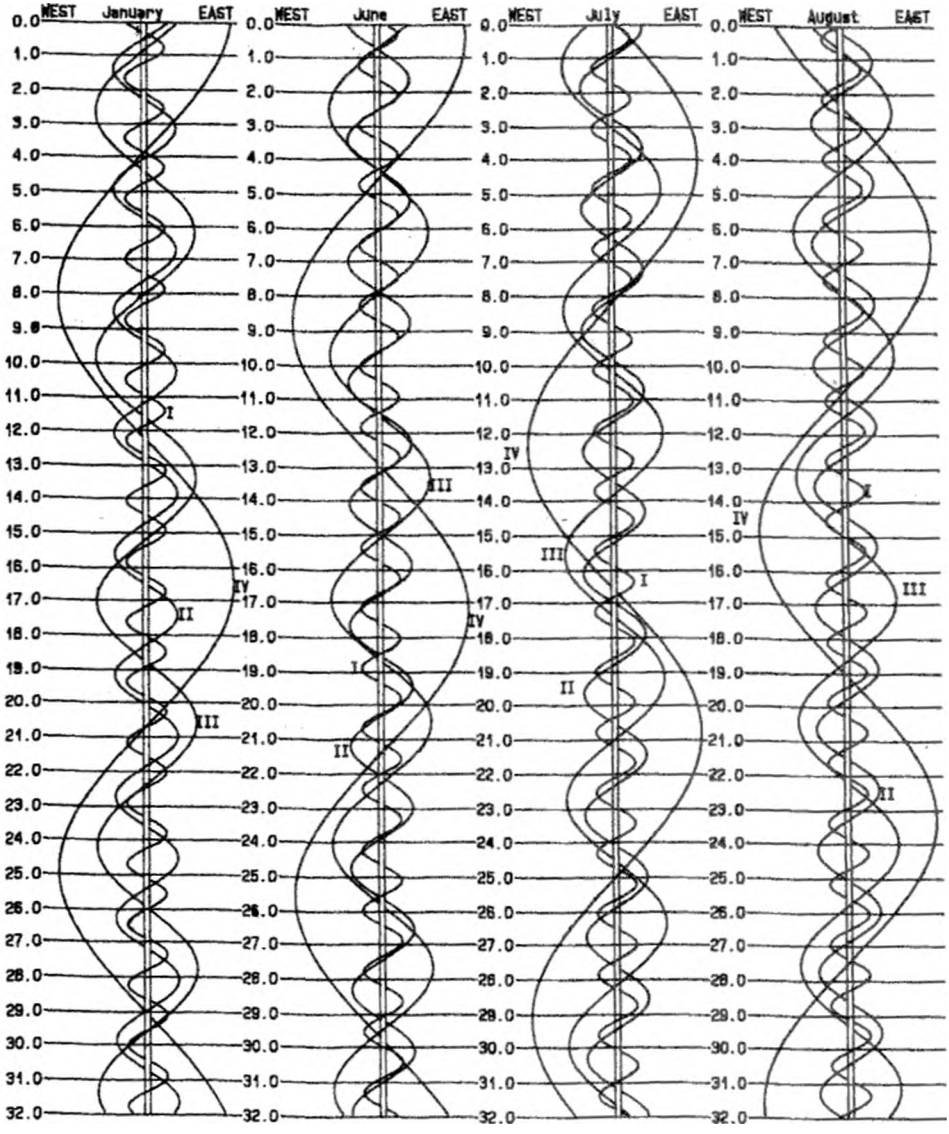
CORRECTION FOR PLACES NOT ON THE 30° E MERIDIAN
Approximate longitude corrections from the 30° East meridian are:

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

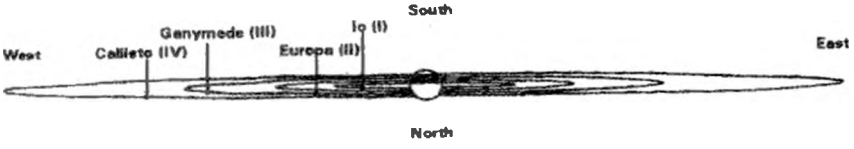


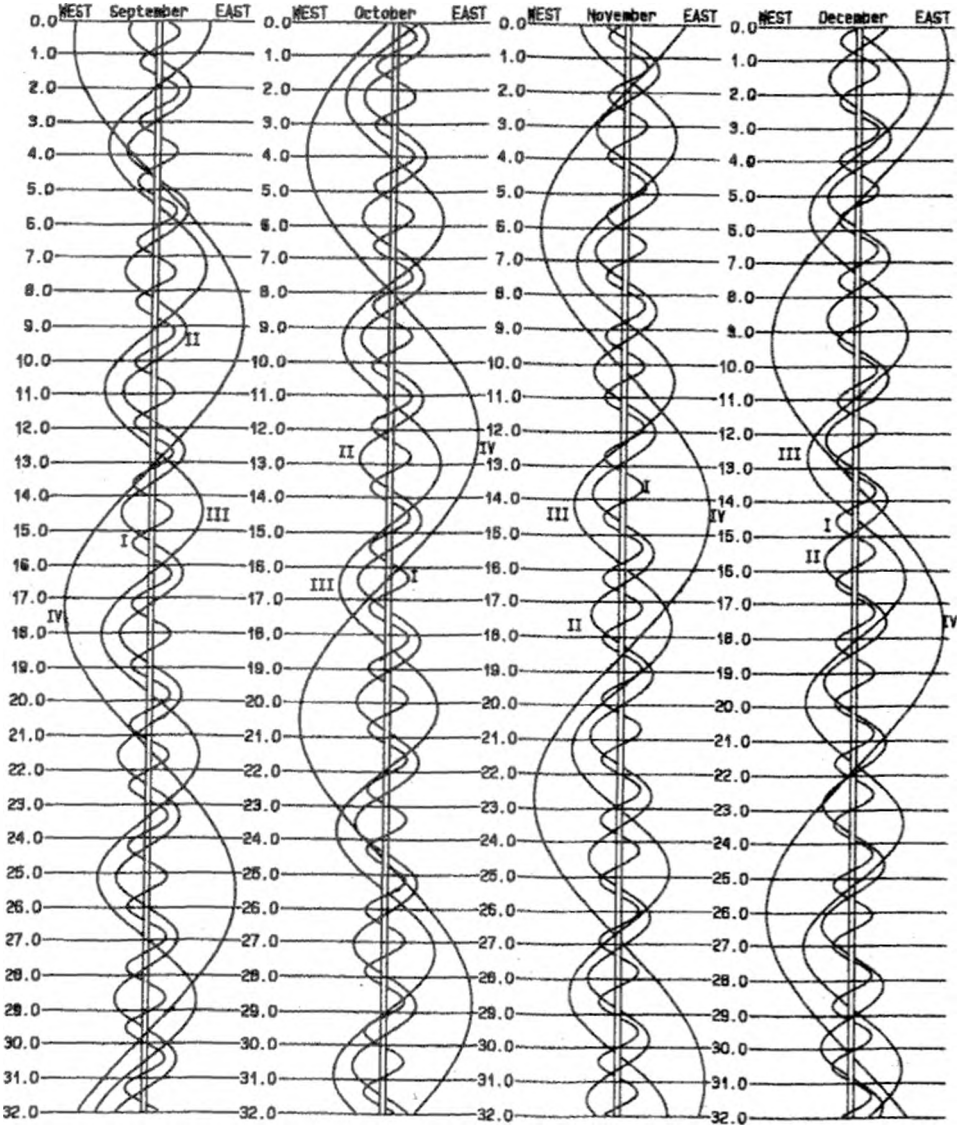
THE MOONS OF JUPITER

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 the next page 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 disk of Jupiter is stretched to make the central column, and horizontal lines representing midnight (0am 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.

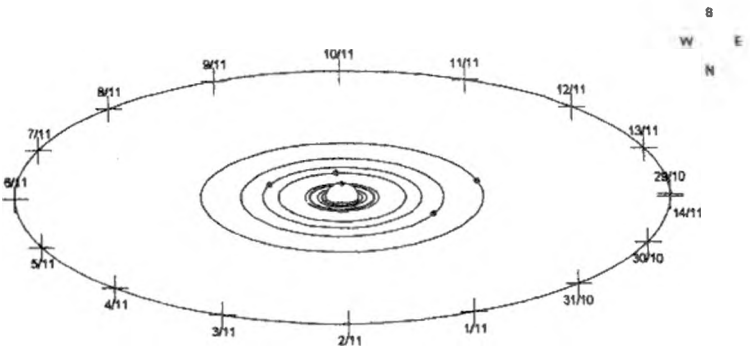
- Date and predicted times are given; these are for mid-phenomean and are not instantaneous.
- The moon concerned are I - Io, II - Europa, III - Ganymede and IV - Callisto.
- Phenomena - the abbreviations used are D - Disappearance; Ec - Eclipse ie.the satellite passes through the shadow of Jupiter; 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	02	21	10	I.Tr.I.	Jun	13	03	18	I.Tr.E.	Jul	24	01	57	II.Oc.R.	Aug	21	03	54	I.Tr.E.
		22	27	I.Sh.I.			04	46	II.Tr.E.			05	04	III.Ec.D.			23	32	III.Ec.R.
	03	19	44	IV.Tr.E.		19	04	40	I.Ec.D.		27	05	53	I.Sh.I.		22	01	16	I.Oc.R.
		21	50	I.Ec.R.		20	03	06	I.Tr.I.		28	01	05	III.Tr.I.			02	38	III.Oc.D.
		22	23	II.Tr.I.			04	05	I.Sh.E.			03	02	III.Tr.E.			04	23	III.Oc.R.
	05	22	34	II.Ec.R.			05	-1	II.Tr.I.			03	09	I.Ec.D.		23	02	07	II.Sh.I.
	07	21	17	III.Tr.I.			05	06	II.Sh.E.		29	01	44	I.Tr.I.			04	38	II.Sh.E.
	10	20	19	I.Oc.D.			05	16	I.Tr.E.			02	30	I.Sh.E.			04	42	II.Tr.I.
	11	19	54	I.Tr.E.		22	04	12	III.Tr.I.			03	51	I.Tr.E.		25	01	16	II.Oc.R.
		21	04	I.Sh.E.		27	03	49	I.Sh.I.			04	57	II.Sh.I.		27	05	14	I.Ec.D.
	12	20	05	II.Oc.D.			05	04	I.Tr.I.		30	01	12	I.Oc.R.		28	02	24	I.Sh.I.
	14	19	26	II.Sh.E.			05	10	II.Sh.I.		31	01	48	II.Ec.R.			03	36	I.Tr.I.
	18	19	40	I.Tr.I.			06	-1	I.Sh.E.			02	03	II.Oc.D.			04	34	I.Sh.E.
		20	14	III.Ec.D.		28	04	32	I.Oc.R.			04	32	II.Oc.R.			05	44	I.Tr.E.
		20	48	I.Sh.I.		29	03	10	III.Sh.I.	Aug	04	01	39	III.Sh.E.			23	43	I.Ec.D.
		21	54	I.Tr.E.			04	44	II.Oc.R.			05	03	I.Ec.D.		29	01	10	III.Ec.D.
	19	20	10	I.Ec.R.			05	40	III.Sh.E.			05	05	III.Tr.I.			03	05	I.Oc.R.
	21	19	26	II.Sh.I.	Jul	04	05	43	I.Sh.I.		05	02	15	I.Sh.I.			03	33	III.Ec.R.
		19	55	II.Tr.E.		05	02	57	I.Ec.D.			03	37	I.Tr.I.			23	02	I.Sh.E.
	25	19	55	III.Oc.D.			06	29	I.Oc.R.			04	24	I.Sh.E.		30	00	11	I.Tr.E.
		21	40	I.Tr.I.		06	02	14	II.Ec.D.			05	44	I.Tr.E.			04	43	II.Sh.I.
	28	20	00	II.Tr.I.			02	21	I.Sh.E.		06	03	05	I.Oc.R.		31	22	52	II.Ec.D.
	30	19	47	II.Ec.R.			03	38	I.Tr.E.		07	00	12	I.Tr.E.	Sep	01	03	41	II.Oc.R.
Feb	02	20	50	I.Oc.D.			04	47	II.Ec.R.			01	50	II.Ec.D.		02	22	46	II.Tr.E.
	03	20	26	I.Tr.E.			04	54	II.Oc.D.			04	22	II.Ec.R.		04	04	18	I.Sh.I.
	11	20	25	I.Ec.R.		08	02	20	II.Tr.E.			04	36	II.Oc.D.			05	25	I.Tr.I.
May	11	06	10	I.Ec.D.		10	02	43	III.Oc.D.		09	02	08	II.Tr.E.		05	01	37	I.Ec.D.
	17	05	40	III.Sh.E.			04	52	III.Oc.R.		11	03	16	III.Sh.I.			04	53	I.Oc.R.
		06	10	III.Tr.I.		12	04	52	I.Ec.D.			05	38	III.Sh.E.			05	11	III.Ec.D.
	19	05	17	II.Sh.E.		13	02	05	I.Sh.I.		12	04	08	I.Sh.I.			22	46	I.Sh.I.
		05	22	I.Sh.I.			03	26	I.Tr.I.			05	29	I.Tr.I.			23	52	I.Tr.I.
		06	10	I.Tr.I.			04	15	I.Sh.E.			06	18	I.Sh.E.		06	00	56	I.Sh.E.
	20	05	35	I.Oc.R.			04	49	II.Ec.D.		13	01	26	I.Ec.D.			02	-1	I.Tr.E.
	26	05	19	II.Sh.I.			05	34	I.Tr.E.			04	57	I.Oc.R.			23	20	I.Oc.R.
	27	04	28	I.Ec.D.		14	02	54	I.Oc.R.			23	56	I.Tr.I.		08	01	28	II.Ec.D.
	28	03	55	I.Sh.E.		15	02	16	II.Sh.E.		14	00	46	I.Sh.E.			06	03	II.Oc.R.
		04	29	II.Oc.R.			02	31	II.Tr.I.			02	04	I.Tr.E.			23	51	III.Tr.I.
		04	50	I.Tr.E.			05	01	II.Tr.E.			04	25	II.Ec.D.		09	01	28	III.Tr.E.
Jun	03	06	22	I.Ec.D.		17	03	32	III.Ec.R.		15	00	39	III.Oc.R.			22	44	II.Tr.I.
	04	03	39	I.Sh.I.		20	04	-1	I.Sh.I.			23	30	II.Sh.I.			23	09	II.Sh.E.
		04	39	I.Tr.I.			05	21	I.Tr.I.		16	02	02	II.Sh.E.		10	01	09	II.Tr.E.
		05	08	III.Oc.D.			06	08	I.Sh.E.			02	12	II.Tr.I.		12	03	32	I.Ec.D.
		05	49	I.Sh.E.		21	01	15	I.Ec.D.			04	39	II.Tr.E.		13	00	40	I.Sh.I.
	05	04	06	I.Oc.R.			04	50	I.Oc.R.		19	06	02	I.Sh.I.			01	39	I.Tr.I.
	11	04	56	III.Ec.D.		22	01	58	I.Tr.E.		20	03	20	I.Ec.D.			02	50	I.Sh.E.
		05	14	II.Ec.D.			02	20	II.Sh.I.		21	00	30	I.Sh.I.			03	46	I.Tr.E.
		05	33	I.Sh.I.			04	53	II.Sh.E.			01	47	I.Tr.I.			22	00	I.Ec.D.
	12	06	05	I.Oc.R.			05	11	II.Tr.I.			02	40	I.Sh.E.		14	01	07	I.Oc.R.

	d	h	m			d	h	m			d	h	m			d	h	m	
Sep	14	22	13	I.Tr.E.	Oct	11	01	18	III.Ec.D.	Nov	02	04	09	II.Tr.I.	Nov	28	23	42	I.Oc.D.
	15	04	03	II.Ec.D.			04	37	III.Oc.R.		03	21	47	II.Oc.D.		29	02	44	I.Ec.R.
		23	20	III.Sh.I.			20	21	II.Sh.I.		04	00	53	II.Ec.R.			20	51	I.Tr.I.
	16	01	38	III.Sh.E.			21	02	II.Tr.I.		05	02	22	III.Tr.I.			21	44	I.Sh.I.
		03	21	III.Tr.I.			22	52	II.Sh.E.			02	41	I.Tr.I.			23	00	I.Tr.E.
		04	57	III.Tr.E.			23	27	II.Tr.E.			03	00	I.Tr.I.			23	54	I.Sh.E.
		23	14	II.Sh.I.		13	02	46	I.Sh.I.			03	31	III.Tr.I.		30	01	55	III.Oc.D.
	17	01	04	II.Tr.I.			03	04	I.Tr.I.			04	12	III.Tr.E.			21	12	I.Ec.R.
		01	46	II.Sh.E.			04	56	I.Sh.E.			19	15	II.Tr.E.	Dec	03	19	40	III.Sh.I.
		03	29	II.Tr.E.			05	12	I.Tr.E.			19	58	II.Sh.E.			21	47	III.Sh.E.
	18	21	34	II.Oc.R.		14	00	07	I.Ec.D.		06	00	00	I.Oc.D.		04	01	58	II.Tr.I.
	19	05	26	I.Ec.D.			02	32	I.Oc.R.			02	30	I.Ec.R.		05	20	11	II.Oc.D.
	20	02	34	I.Sh.I.			21	15	I.Sh.I.			21	07	I.Tr.I.		06	00	45	II.Ec.R.
		03	25	I.Tr.I.			21	30	I.Tr.I.			21	28	I.Tr.I.			01	29	I.Oc.D.
		04	44	I.Sh.E.			23	25	I.Sh.E.			23	16	I.Tr.E.			22	39	I.Tr.I.
		05	32	I.Tr.E.			23	38	I.Tr.E.			23	39	I.Sh.E.			23	39	I.Sh.I.
		23	55	I.Ec.D.		15	20	57	I.Oc.R.		07	21	-1	I.Ec.R.		07	00	48	I.Tr.E.
	21	02	53	I.Oc.R.		17	03	47	II.Ec.D.		08	19	37	III.Ec.R.			01	49	I.Sh.E.
		21	03	I.Sh.I.		18	05	20	III.Ec.D.		11	00	02	II.Oc.D.			19	40	II.Sh.E.
		21	51	I.Tr.I.			22	57	II.Sh.I.			03	31	II.Ec.R.			19	56	I.Oc.D.
		21	53	I.Sh.I.			23	15	II.Tr.I.		12	19	04	II.Tr.I.			23	07	I.Ec.R.
		23	13	I.Sh.E.		19	01	28	II.Sh.E.			20	04	II.Sh.I.		08	20	18	I.Sh.E.
	22	00	-1	I.Tr.E.			01	41	II.Tr.E.			21	31	II.Tr.E.		10	21	29	III.Tr.E.
		21	19	I.Oc.R.		20	04	41	I.Sh.I.			22	34	II.Sh.E.			23	42	III.Sh.I.
	23	03	22	III.Sh.I.			04	47	I.Tr.I.		13	01	44	I.Oc.D.		11	01	48	III.Sh.E.
		05	38	III.Sh.E.			19	45	II.Oc.R.			22	51	I.Tr.I.		12	22	36	II.Oc.D.
	24	01	50	II.Sh.I.		21	02	01	I.Ec.D.			23	24	I.Tr.I.		14	00	28	I.Tr.I.
		03	23	II.Tr.I.			04	15	I.Oc.R.		14	01	00	I.Tr.E.			01	35	I.Sh.I.
		04	22	II.Sh.E.			19	26	III.Sh.I.			01	34	I.Sh.E.			19	46	II.Sh.I.
		05	48	II.Tr.E.			19	54	III.Tr.I.			20	10	I.Oc.D.			20	02	II.Tr.E.
	25	23	52	II.Oc.R.			21	36	III.Tr.E.			22	53	I.Ec.R.			21	45	I.Oc.D.
	26	21	58	III.Oc.R.			21	39	III.Sh.E.		15	19	09	III.Oc.D.			22	16	II.Sh.E.
	27	04	28	I.Sh.I.			23	09	I.Sh.I.			19	27	I.Tr.E.		15	01	03	I.Ec.R.
		05	10	I.Tr.I.			23	13	I.Tr.I.			20	03	I.Sh.E.			20	04	I.Sh.I.
	28	01	49	I.Ec.D.		22	01	20	I.Sh.E.			21	08	III.Oc.R.			21	05	I.Tr.E.
		04	38	I.Oc.R.			01	22	I.Tr.E.			21	27	III.Ec.D.			22	14	I.Sh.E.
		22	57	I.Sh.I.			20	30	I.Ec.D.			23	38	III.Ec.R.		16	19	32	I.Ec.R.
		23	36	I.Tr.I.			22	41	I.Oc.R.		18	02	19	II.Oc.D.		17	22	57	III.Tr.I.
	29	01	07	I.Sh.E.		23	19	48	I.Tr.E.		19	21	20	II.Tr.I.		18	01	10	III.Tr.E.
		01	44	I.Tr.E.			19	49	I.Sh.E.			22	40	II.Sh.I.		20	01	03	II.Oc.D.
		23	04	I.Oc.R.		26	01	29	II.Tr.I.			23	48	II.Tr.E.		21	19	45	III.Ec.R.
Oct	01	04	26	II.Sh.I.			01	33	II.Sh.I.		20	01	10	II.Sh.E.			20	-1	II.Tr.I.
		05	40	II.Tr.I.			03	54	II.Tr.E.			03	29	I.Oc.D.			22	22	II.Sh.I.
	02	22	34	II.Ec.D.			04	05	II.Sh.E.		21	00	37	I.Tr.I.			22	29	II.Tr.E.
	03	02	08	II.Oc.R.		27	19	33	II.Oc.D.			01	19	I.Sh.I.			23	35	I.Oc.D.
		21	17	III.Ec.D.			22	15	II.Ec.R.			02	46	I.Tr.E.		22	00	52	II.Sh.E.
		23	33	III.Ec.R.		28	03	50	I.Oc.D.			03	29	I.Sh.E.			20	47	I.Tr.I.
		23	42	III.Oc.D.			23	08	III.Tr.I.			19	28	II.Ec.R.			22	00	I.Sh.I.
	04	00	19	III.Oc.R.			23	29	III.Sh.I.			21	55	I.Oc.D.			22	57	I.Tr.E.
		20	16	II.Sh.E.		29	00	54	III.Tr.E.		22	00	48	I.Ec.R.		23	00	10	I.Sh.E.
		21	12	II.Tr.E.			00	57	I.Tr.I.			19	04	I.Tr.I.			19	22	II.Ec.R.
	05	03	43	I.Ec.D.			01	04	I.Tr.I.			19	48	I.Sh.I.			21	27	I.Ec.R.
	06	00	51	I.Sh.I.			01	41	III.Sh.E.			21	13	I.Tr.E.		28	21	41	III.Ec.D.
		01	20	I.Tr.I.			03	05	I.Tr.E.			21	58	I.Sh.E.			22	28	II.Tr.I.
		03	02	I.Sh.E.			03	15	I.Sh.E.			22	30	III.Oc.D.			23	46	III.Ec.R.
		03	28	I.Tr.E.			22	16	I.Oc.D.		23	00	33	III.Oc.R.		29	00	58	II.Tr.E.
		22	12	I.Ec.D.		30	00	35	I.Ec.R.			01	30	III.Ec.D.			00	58	II.Sh.I.
	07	00	48	I.Oc.R.			19	23	I.Tr.I.			19	17	I.Ec.R.			22	39	I.Tr.I.
		19	46	I.Tr.I.			19	33	I.Sh.I.		26	23	38	II.Tr.I.			23	56	I.Sh.I.
		21	30	I.Sh.E.			21	31	I.Tr.E.		27	01	16	II.Sh.I.		30	00	49	I.Tr.E.
		21	54	I.Tr.E.			21	44	I.Sh.E.			02	06	II.Tr.E.			19	23	II.Oc.R.
	10	01	10	II.Ec.D.		31	19	04	I.Ec.R.		28	02	24	I.Tr.I.			19	28	II.Ec.D.
		04	24	II.Oc.R.	Nov	02	03	42	II.Tr.I.			22	07	II.Ec.R.			19	55	I.Oc.D.

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 at opposition on November 6. 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	2	23.6	Jan	6	22.7	Jan	10	17.7
Jan	14	17.9		18	22.6		22	21.8		26	16.9
	30	17.3	Feb	3	22.2	Feb	7	21.4	Feb	11	16.6
Feb	15	17.2		19	22.1		23	21.4		27	16.7
Mar	3	17.4	Mar	7	22.4	Mar	11	21.6	Mar	15	17.0
	19	18.0		23	23.0		27	22.1		31	17.6
Apr	4	18.7	Apr	8	23.8	Apr	12	22.8	Apr	16	18.3
	20	19.6		25	00.7		28	23.5	May	2	19.0
May	6	20.6	May	11	01.6	May	15	00.2		18	19.8
	22	21.5		27	02.5		31	00.9	Jun	3	20.5
Jun	7	22.3	Jun	12	03.2	Jun	16	01.4		19	21.0
	23	22.9		28	03.7	Jul	2	01.7	Jul	5	21.3
Jul	9	23.3	Jul	14	03.8		18	01.7		21	21.3
	25	23.2		30	03.7	Aug	3	01.4	Aug	6	20.9
Aug	10	22.8	Aug	15	03.1		19	00.6		22	20.0
	26	21.8		31	01.9	Sep	3	23.4	Sep	7	18.7
Sep	11	20.3	Sep	16	00.3		19	21.7		23	16.8
	27	18.3	Oct	1	22.2	Oct	5	19.6	Oct	9	14.6
Oct	13	16.0		17	19.8		21	17.1		25	12.1
	29	13.3	Nov	2	17.1	Nov	6	14.5	Nov	10	09.4
Nov	14	10.5		18	14.4		22	11.9		26	06.8
	30	07.8	Dec	4	11.8	Dec	8	09.5	Dec	12	04.4
Dec	16	05.5		20	09.6		24	07.5		28	02.4

COMETS AND METEORS

COMETS

Located at the outer extremes of the solar system is a cloud of material, probably left over from the formation of the solar system itself. This cloud, known as the Oort Cloud, is believed to be the reservoir from which the comets emanate. At such vast distances from the sun this material, consisting of gases and dust, is preserved in the same state as when the sun and planets were formed, and thus a study of comets is important to understanding the birth of the solar system.

Every now and then, part of the material may break away from the cloud, and under the influence of gravity, accelerates towards the sun as a comet. These comets, travelling in parabolic orbits, are known as long period comets and by definition have orbital periods greater than 200 years, though the actual periods are generally a few thousand years or more. Occasionally the orbits of comets travelling in the same plane as the planets may be perturbed by the gravitational effects of the major planets, mainly Jupiter, into elliptical orbits. These comets have shorter periods, by definition less than 200 years, and since their orbits are known fairly precisely, their returns can be predicted with some degree of accuracy. The table below lists comets predicted to appear during 1999, and which are predicted to become brighter than about magnitude 12. The table does not of course include any new comets which might possibly be discovered during the year.

COMET	DESIGNATION	PERIHELION DATE	PREDICTED MAXIMUM MAGNITUDE
Hale-Bopp	C/1995 O1	1997 April 1	11
Linear	C/1998 M5	1999 January 24	10
Williams	C/1998	1998 October 17	9
Giacobini-Zinner	21P	1998 November 21	10
Tempel 2	10P	1999 September 8	10
Machholz 2A	P/1994 P1	1999 December 7	7

In the cold depths of space, comets are no more than chunks of frozen gases, ices and dust. However, in the vicinity of the sun the constituents of the nucleus vaporise, and the gases and dust form a coma around the nucleus. Under the influence of the solar wind the gas and dust in the coma is swept away to form the tail, such that the tail always points away from the sun.

The Director of the Comet and Meteor Section welcomes all observations of comets, but to be of scientific value the observer should concentrate on the following:

- Estimates of the total visual magnitude of the comet, preferably made over the entire apparition to allow construction of a light curve
- Estimates of the diameter of the coma
- Estimates of the degree of condensation of the comet
- Estimates of the length and position angle of the tail
- Detailed visual descriptions, sketches and photographs of the comet

In making the above observations it is essential that the observer uses the standard procedures developed and used by observers world-wide. Detailed notes on observing techniques and visibility of comets may be obtained from the Director at the address below. *Beginning observers should note that comets are notoriously unpredictable, and that the predicted brightness in the above table is given as a guide only.* The magnitude given is the total magnitude of the coma and the brightness is spread out across the whole diameter of the comet. For this reason the comet will appear much fainter than a star of the same magnitude. As a guide, a comet of magnitude 10-11 would appear about as bright as a star of magnitude 12-13.

Details on how to observe either comets or meteors are available from the Director of the Comet and Meteor Section, T P Cooper, P O Box 14740, Bredell, 1623.
Tel. 011-967-2250.
email: tpcoope@mweb.co.za

METEORS

The name given to particles travelling through space is *meteoroids*. Several thousand tonnes of these particles, mostly smaller than grains of sand, enter the earths atmosphere every day. When a particle enters the atmosphere, it heats up due to the effects of friction and may become visible before burning up. The resultant streak of light is known as a *meteor*. Those which become equal or brighter than Venus are termed *fireballs*. In general, meteors appear in the upper atmosphere, at an altitude of between 80-120 km and disappear at between 60-80 km. Heavier and slower fireballs may descend below this, and bodies which reach the earths surface are called *meteorites*.

Most meteors entering the atmosphere are *sporadic*, particles travelling through space in isolation. However, several meteor *showers*, streams of particles which are left behind by comets in their passage around the sun, may be observed throughout the year. The table below lists the showers requiring observation.

SHOWER	MAX DATE	SHOWER DURATION	RADIANT RA 2000.0	RADIANT DEC °	ZHR	VEL km/s	REC.WATCH BEGIN SAST	REC.WATCH END SAST	OBSERVING CONDITIONS 1999
α Crucids	Jan19	Jan06-Jan28	12h48	-63	<5	50	00h00	03h30	Favourable
* Centaurids	Feb 8	Jan28-Feb23	14h00	-40	5	60	22h00	03h30	Poor
γ Normids	Mar 14	Feb25-Mar22	16h36	-51	5	56	00h00	04h30	Favourable
δ Pavonids	Apr 8	Mar11-Apr16	20h32	-63	5	59	02h00	04h30	Poor
April Lyrids	Apr 22	Apr16-Apr24	18h05	+34	15	49	03h00	05h00	Favourable
π Puppids	Apr 23	Apr16-Apr25	07h20	-45	<5	18	19h00	22h00	Poor
α Scorpiids	May 3	Apr11-May12	16h00	-27	5	35	21h00	04h00	Unfavourable
η Aquarids	May 4	Apr21-May12	22h24	-02	30	65	04h00	05h30	Unfavourable
χ Scorpiids	Jun 5	May27-Jun20	16h32	-14	5	21	21h00	04h30	Unfavourable
Sagittarids	Jun 11	Jun08-Jun16	20h16	-35	<5	52	03h30	05h30	Good
θ Ophiuchids	Jun 13	Jun08-Jun16	17h48	-20	5	27	20h00	05h30	Favourable
June Lyrids	Jun 16	Jun11-Jun21	18h32	+35	9	31	23h30	02h00	Favourable
July Pheonicids	Jul 13	Jul10-Jul16	02h08	-48	<5	47	00h00	05h00	New Moon
Capricornids	Jul 26	Jul10-Aug05	21h00	-15	8	?	20h30	05h30	Unfavourable
Piscis Australids	Jul 28	Jul19-Aug17	22h40	-30	8	35	21h30	05h00	Full Moon
South δ Aquarids	Jul 29	Jul21-Aug29	22h36	-16	30	42	22h00	05h00	Full Moon
α Capricornids	Jul 30	Jul15-Aug25	20h28	-10	10	25	20h00	04h00	Unfavourable
South ι Aquarids	Aug 5	Jul15-Aug25	22h12	-15	<5	34	22h00	04h30	Poor
North δ Aquarids	Aug 12	Jul14-Aug25	22h28	-05	10	42	23h00	05h00	New moon
North ι Aquarids	Aug 20	Jul15-Sep20	21h48	-06	10	36	20h00	05h00	Good
Orionids	Oct 21	Oct02-Nov07	06h20	+16	30	66	02h00	04h00	Poor
Southern Taurids	Nov 3	Sep15-Dec01	03h20	+14	10	29	21h30	03h30	Good
Northern Taurids	Nov 13	Sep19-Dec01	04h00	+23	5	31	21h30	03h30	Favourable
Leonids	Nov 17	Nov14-Nov20	10h08	+22	5	70	03h00	04h00	Favourable
Dec. Phoenicids	Dec 5	Dec03-Dec05	01h12	-53	5	22	20h30	01h00	Favourable
Geminids	Dec 14	Dec04-Dec16	07h28	+33	50	36	23h30	03h00	Good
Velids	Dec 29	Dec05-Jan07	09h56	-51	5	40	22h30	03h30	Poor

Notes to Table: 1.)The radiant of most showers drifts slightly eastward each night. The position given is for night of maximum. 2.)The ZHR is the expected maximum rate under observing conditions when stars of magnitude 6.5 can be discerned and with the radiant at the zenith. Rates under poorer conditions and when the radiant is low will consequently be lower. 3.)Showers listed as favourable are the best prospects for observation. Those listed as good may be observed under slight hindrance from the moon

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 9.5×10^{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

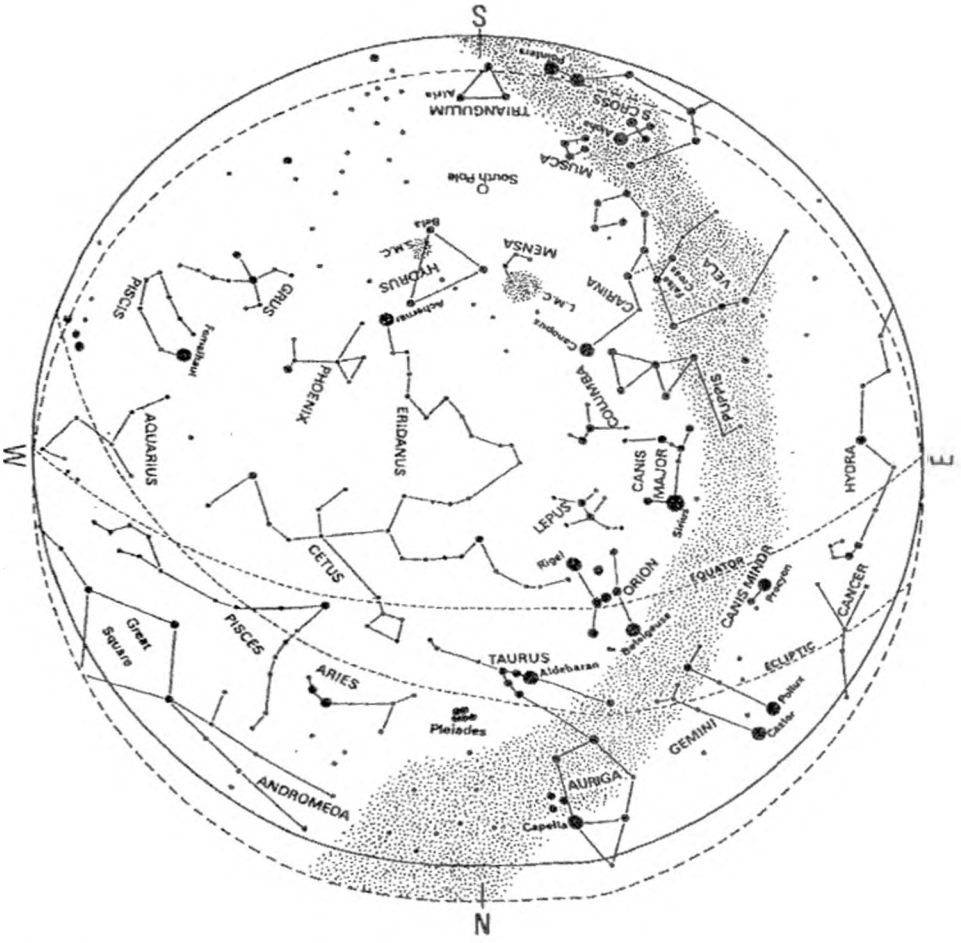
The star charts in this section show the night sky for each of the four seasons of the year. These seasonal charts depict stars down to magnitude 3.5 which is approximately what will be visible to the naked eye in city areas. Charts of 3 of the most interesting regions in the sky (showing stars down to magnitude 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

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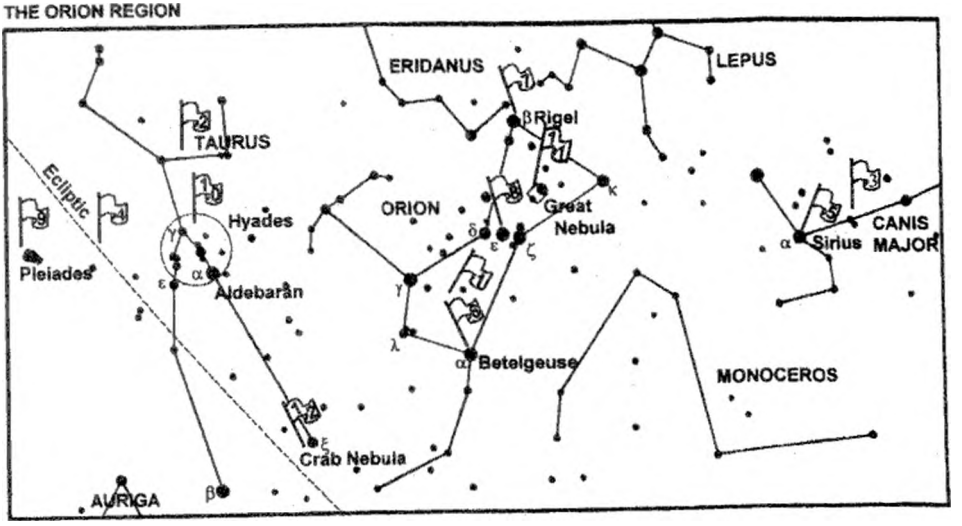
THE ORION REGION



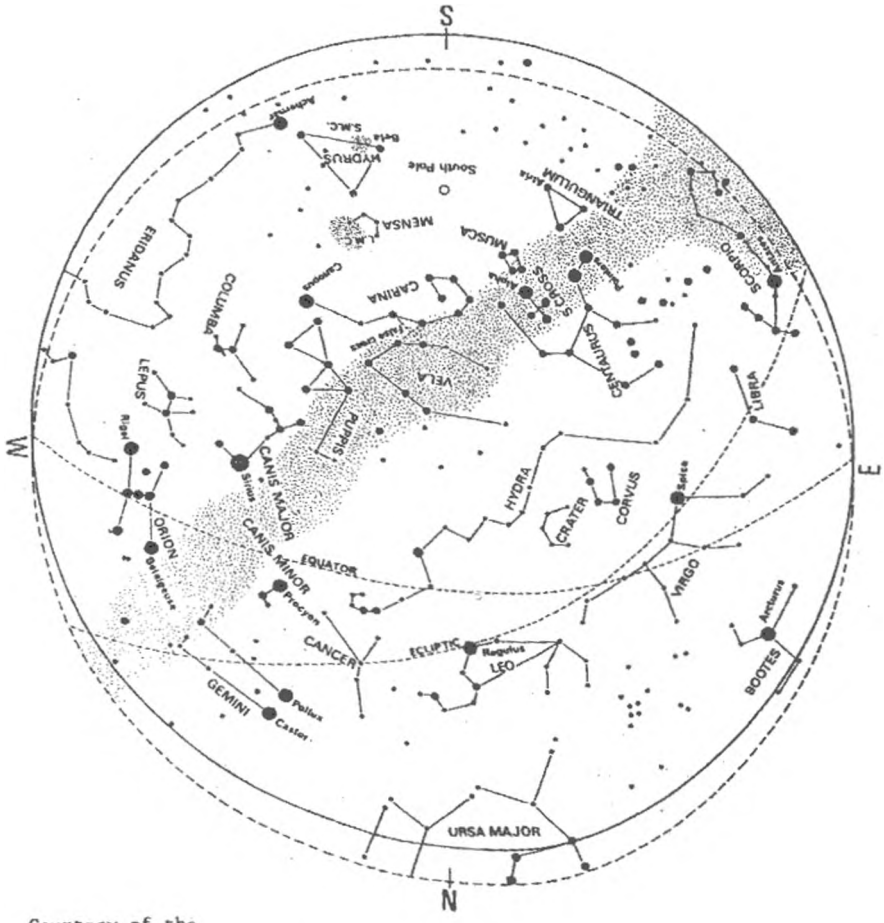
(1) The constellation of Orion. The figure of the legendary hunter of Greek mythology is unfortunately upside down when seen from Southern Africa. The faint stars by λ represent the head, α and γ the shoulders, δ - ε - η the belt, and β and κ the legs. Orion forms part of the "great hunting scene" in 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) 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.
(6) 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.
(7) Rigel, despite being physically smaller than Betelgeuse, is more luminous (higher surface temperature - bluish colour) and more distant.
(8) The stars in Orion's belt are distant hot blue stars.
(9) 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.
(10) The Hyades is another nearby galactic cluster, but Aldebaran is not a member (it lies closer to us).
(11) 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.
(12) The Crab Nebula, close to ξ Taurii, is the remnant of a supernova recorded by the Chinese in 1054, requires a moderate sized telescope for observation. In its heart is located the extraordinary 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.



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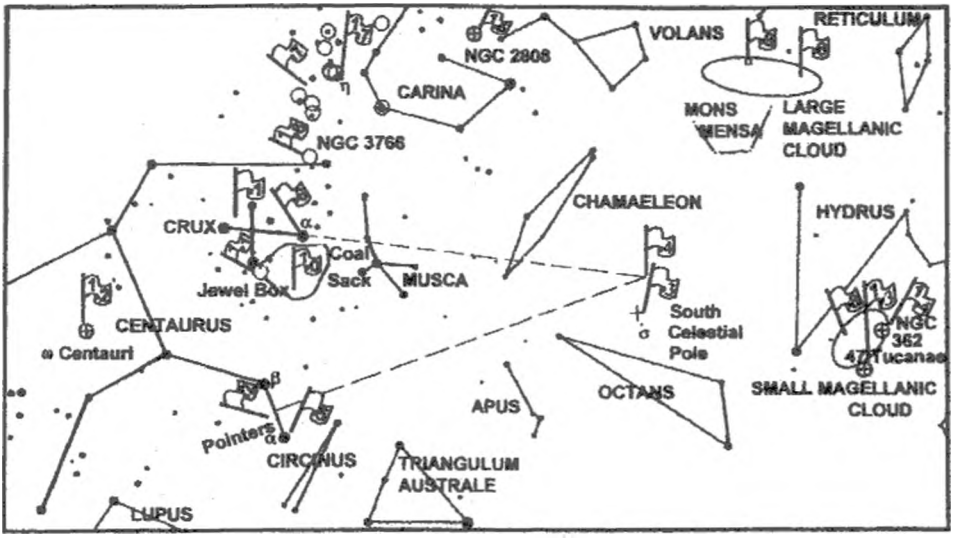
THE SOUTHERN CROSS REGION



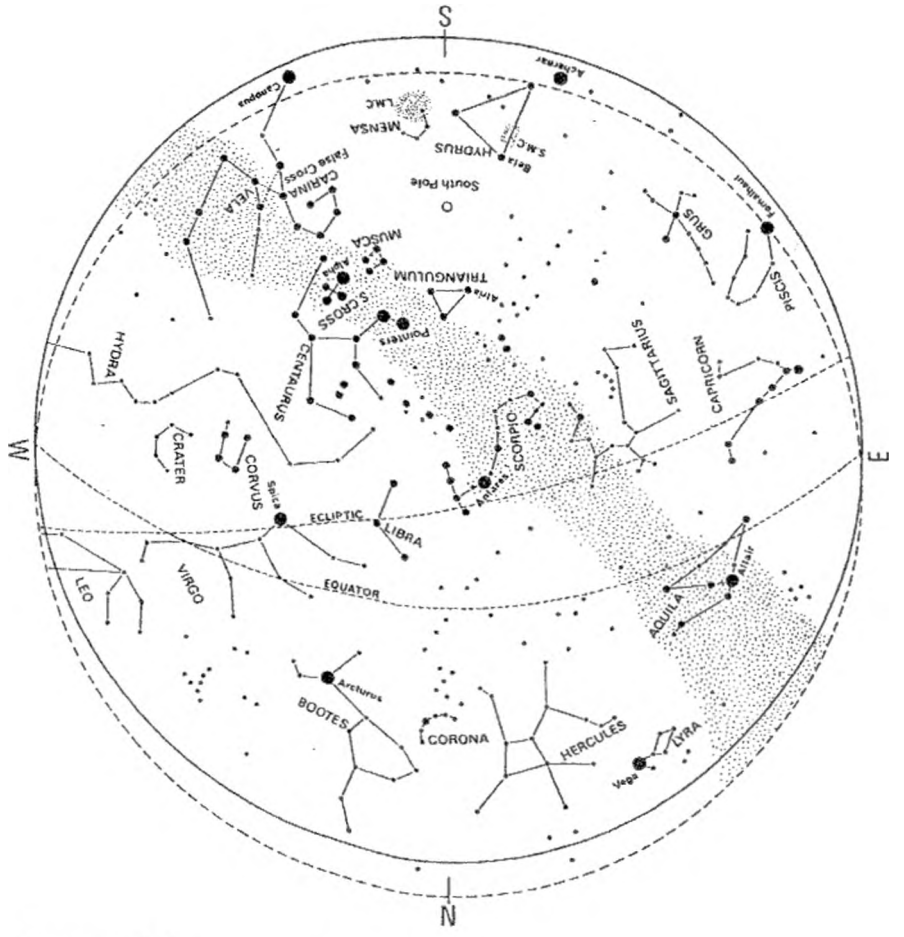
(1) Crux, the Southern Cross, is one of the most compact patterns of bright stars to be found in the sky. It lies on the border of that region of the sky which never sets as seen from Southern Africa.
(2) The two "Pointer" stars lie close to the Cross. (A similar pattern to the Southern Cross - called the False Cross, shown in the Autumn Sky chart - 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. Nearby is σ Octantis, the nearest star to the Pole which is visible to the naked eye at magnitude 5.5.
(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)β Crucis can also be resolved as a double star by a small telescope (separation 5 seconds of arc).
(7) The region indicated is one of the brightest section of the entire Milky Way with many star clusters.
(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 cluster. Binoculars will show their fuzzy appearance. (14) NGC 362 and (15) NGC 2808 are fainter globular clusters.
(16) NGC 3766 - 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

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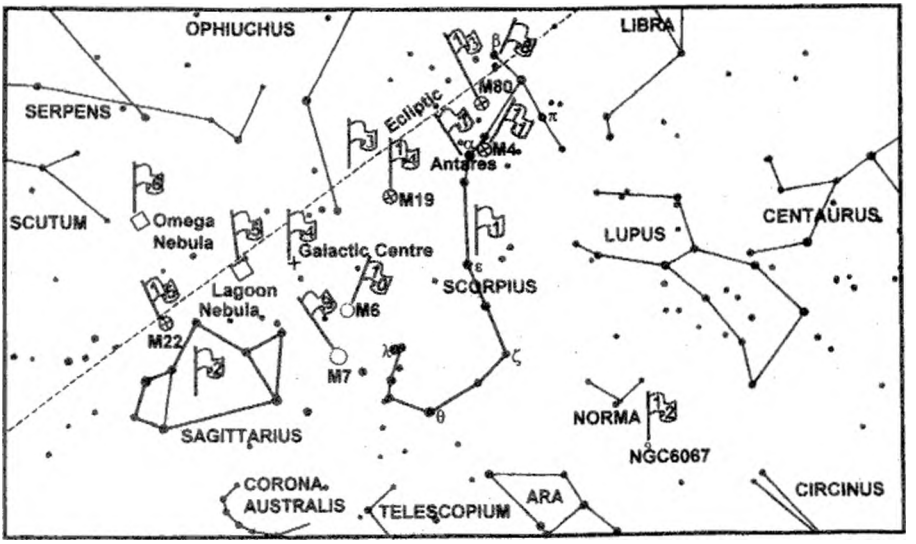
THE SCORPIUS REGION



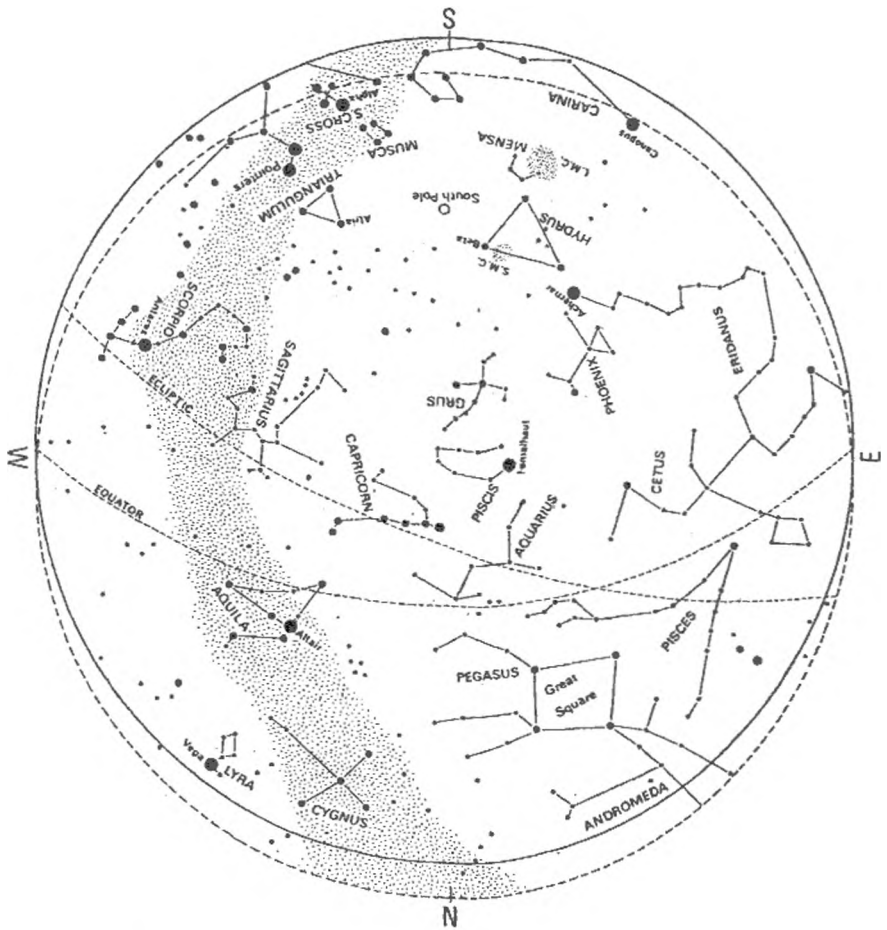
(1) The constellation of Scorpius. The creature is depicted with α in the centre of the body and β and π the claws. The distinctive tail ε - ζ - θ curls round to the sting.
(2) Sagittarius - the figure of the centaur archer is very difficult to make out. A more easily recognisable asterism is the 'teapot'.
(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, see the chart opposite. Luminous nebulae include (5) the Lagoon nebula and (6) the Omega nebula. These are best seen with the aid of binoculars.
(7) Antares - a distant red giant, several hundred times the diameter of our Sun - is so named because its red colour rivals that of the planet Mars.
(8) β Scorpii can be resolved as a double star (separation 16 sec of arc) with a small telescope. In fact the brighter component is in itself a triple star, and the fainter component a double star!
This region includes a number of galactic clusters including (9) M7, (10) M6, (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 (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

PLANETARIUM  SA MUSEUM

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 044-343-1736.

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.

DEEP SKY SECTION

The Deep-Sky Observing Section is dedicated to observing objects outside our solar system: clusters, nebulae and galaxies. New members receive a brief observing guide explaining some of the basics of deep-sky observing.

In order to promote visual observing, the Section offer a Bennett Certificate to those who observe the comet-like objects listed by the late Jack Bennett, past director of the Comet and Meteor Section. These and other observations will contribute to the long-term goal of the Section, namely the production of a handbook of southern deep-sky objects.

ASSA members who would like more information or who would like to join the Section are encouraged to write to the Director :

Mr Auke Slotegraaf, PO Box 608, Stellenbosch, 7599. (Tel. 021-887-887-8)

TOTAL LUNAR 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 B. Fraser, PO Box 68525, Bryanston 2021 Tel:(011) 803 8291

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:

	Clarke 1880	
	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 $\Delta\phi$ degrees north of one of the standard stations given above may be found from:

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

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

Observers who want to observe occultations of stars fainter than the ones listed, can contact Mr Fraser for additional data.

					CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
DATE	Z.C.	Mag.	Ph	ELG	UT	a.	b.	P.A.	UT	a.	b.	P.A.	UT	a.	b.	P.A.
M D				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
JAN 6	1625	5.9	RD	240					21 43.8	-0.8	-2.2	315	21 22.0	-0.8	-4.2	347
JAN 20	3325	6.7	DD	38	18 29.7	-0.5	0.8	104								
JAN 22	55	6.4	DD	64	19 23.4	-0.4	2.8	21								
JAN 23	202	7.0	DD	78	20 43.9	-0.5	1.6	66								
JAN 24	322	5.7	DD	89					17 43.3	-2.3	0.9	81	17 59.6	-2.0	1.5	62
JAN 24	327	4.5	DD	90	18 26.2	-1.9	1.2	72	18 53.9	-1.6	1.6	62	19 14.4	-1.3	2.3	40
JAN 25	464	6.4	DD	104	20 3.8	-1.8	0.4	104	20 24.6	-1.4	0.9	86	20 38.7	-1.3	1.5	63
JAN 27	764	5.0	DD	130	19 42.2			151	19 51.6	-2.6	-1.1	124	19 54.7	-2.6	0.0	98
JAN 28	913	5.2	DD	141									16 54.0	-2.4	-1.7	116
JAN 28	915	4.7	DD	142					17 18.0	-1.2	1.1	44	17 42.5			9
JAN 28	940	5.7	DD	145					22 43.8			175	22 25.7	-1.3	-0.9	125
FEB 10	2372	4.4	RD	287					2 10.9			226	2 22.7	-2.2	-0.5	268
FEB 11	2495	6.0	RD	298	1 17.6	0.2	-2.2	316								
FEB 13	2791	5.4	RD	321					2 45.0	-1.5	1.9	216	2 53.1	-0.9	-0.1	256
FEB 24	888	6.0	DD	112	20 12.9	-1.9	0.3	102	20 36.3	-1.8	1.2	76	20 57.5	-2.2	2.9	43
FEB 24	895	5.9	DD	113	21 46.6	-0.8	-0.2	127	21 56.9	-0.8	0.7	95	22 8.5	-1.1	1.5	64
FEB 26	1186	6.1	DD	139	21 19.1	-2.1	0.1	102	21 46.2	-2.5	1.5	69				
MAR 11	2578	6.4	RD	279	3 33.4	-1.4	-3.2	318								
MAR 12	2715	6.5	RD	289	0 34.2	-0.7	0.2	230	0 37.0	-0.5	-0.8	268	0 28.4	-0.2	-1.5	298
MAR 13	2863	6.1	RD	300					0 39.6	-0.6	0.5	231	0 40.7	-0.3	-0.4	265
MAR 22	684	6.2	DD	68	18 15.8	-1.9	3.5	24								
MAR 25	1135	6.8	DD	106					17 21.4			177	16 55.6	-2.8	-2.1	132
MAR 25	1138	7.1	DD	106					17 15.6	-2.6	-0.8	110	17 21.3	-3.0	0.2	85
MAR 26	1275	5.6	DD	120	19 53.6	-2.0	-0.5	117	20 15.5	-2.4	0.8	84	20 42.7			40
APR 3	2141	6.1	RD	212					19 3.6	-0.3	-1.0	274	18 53.9	-0.2	-1.5	299
APR 5	2279	6.2	RD	226	1 50.6	-1.8	-2.8	324								
APR 9	2814	5.0	RD	269	0 40.4	0.1	-3.9	329								
APR 9	2825	6.4	RD	270	3 30.6	-2.3	-0.3	264					3 18.2			349
APR 22	1245m	7.5	DD	90	19 21.2	-0.8	-1.1	146	19 28.1	-1.2	0.1	109	19 37.5	-1.7	1.2	77
APR 24	1481	7.4	DD	116	21 44.1			190	21 29.3	-0.7	-0.8	133	21 29.8	-1.2	0.2	101
MAY 5	2629	6.3	RD	229	1 35.6	-3.2	4.3	218	2 20.8	-2.8	1.2	255	2 32.5	-3.1	-0.5	285
MAY 6	2902	6.0	RD	250					23 52.4	-1.9	0.4	244	23 55.6	-1.9	-0.9	277
MAY 9	3173	5.3	RD	275	2 40.6	-1.7	-0.9	269	2 48.9	-2.7	-2.6	297				
MAY 10	3307	4.9	RD	286	0 47.1	-0.3	-1.1	271	0 36.2	-0.4	-3.1	308				
MAY 10	3310	6.4	RD	286	0 57.4	-0.7	2.1	200	1 12.3	-1.0	0.3	238	1 14.2	-1.1	-0.6	270
MAY 13	192	5.3	RD	326					3 41.6	-0.7	-0.2	253	3 38.5	-1.1	-1.2	283
MAY 19	1186	6.1	DD	59									17 29.0			172
MAY 19	1193	5.4	DD	59	18 34.1	-1.9	2.8	52								
MAY 20	1321	6.7	DD	71	16 31.7	-2.7	1.1	70								
MAY 20	1327	6.8	DD	72	18 37.8	0.1	-2.3	166	18 35.0	-0.9	-0.3	122	18 39.5	-1.3	0.6	90
MAY 20	1331	5.9	DD	73	19 41.5	-0.1	-1.0	150	19 42.3	-0.5	0.2	110	19 49.5	-0.8	1.2	76
MAY 22	1562	7.3	DD	97					20 39.4	-0.5	-1.1	143	20 36.4	-0.9	-0.1	110
JUN 2	2734	5.4	RD	211									2 47.4	-1.0	3.6	216
JUN 3	2981m	5.2	RD	231					21 44.8	-1.5	0.9	230	21 50.6	-1.4	-0.4	264
JUN 3	2987m	5.0	RD	232	22 44.3	-1.0	-1.7	284	22 32.0			328				
JUN 15	1123	7.2	DD	26	16 19.4	-0.9	0.7	99								
JUN 15	1127	5.9	DD	27	17 6.5	-0.1	-0.4	136								
JUN 18	1506	7.1	DD	65					16 0.6	-1.6	-1.3	135	15 59.5	-2.4	-0.3	105
JUN 19	1625	5.9	DD	79	19 25.9			190	19 11.6	-0.7	-0.8	135	19 11.4	-1.1	0.1	102
JUN 20	1741	7.2	DD	91	20 50.2	0.0	-3.3	175	20 42.2	-0.6	-0.6	130	20 43.1	-0.7	0.4	98

					CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
DATE	Z.C.	Mag.	Ph	ELG	UT	a.	b.	P.A.	UT	a.	b.	P.A.	UT	a.	b.	P.A.
M D				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
JUN 23	2048	7.2	DD	122					15 57.1	-1.8	-1.7	113	15 54.9	-2.9	-0.2	84
JUN 25	2279	6.2	DD	146	19 31.3			52								
JUL 6	76	5.9	RD	264	0 21.6	-0.8	-0.5	254	0 26.3	-1.6	-1.2	276				
JUL 8	368	6.3	RD	292	4 18.9	-0.5	2.2	196								
JUL 10	650	5.7	RD	318									2 55.2	-0.1	1.4	214
JUL 10	653	4.8	RD	319	3 25.7	-1.3	-3.0	307								
JUL 21	2133	5.6	DD	107					22 7.1	-0.9	-2.3	156	21 59.5	-0.7	-0.5	120
JUL 21	2137	6.4	DD	107	22 23.6	-0.7	1.0	96	22 38.4	-0.1	1.7	70				
JUL 21	2141	6.1	DD	107	22 47.5	-0.5	1.5	83								
JUL 22	2240	6.8	DD	117	19 23.0	-2.9	1.5	74								
JUL 23	2372	4.4	DD	128	20 46.0			35								
JUL 25	2629	6.3	DD	150	19 26.2	-2.1	-1.7	114	19 45.3	-3.0	0.4	81	20 11.2	-3.5	4.2	42
JUL 30	3206	5.2	RD	200	4 6.3	-0.6	1.9	239								
AUG 1	3463	6.4	RD	222	0 2.8	-2.1	-0.1	258	0 25.2	-3.0	-0.3	271	0 24.8			302
AUG 2	170	6.2	RD	246					21 50.9	-0.5	0.0	244	21 50.1	-0.8	-0.8	273
AUG 3	192	5.3	RD	249	2 26.8	-2.5	-0.4	269	2 51.8	-3.1	-0.2	275	2 53.2			304
AUG 8	915	4.7	RD	315									2 19.3	-0.4	0.2	245
AUG 20	2441	6.5	DD	108	18 8.2			164	18 7.2	-2.7	-1.4	121	18 11.7	-3.2	0.4	89
AUG 21	2571	6.9	DD	119	18 37.0	-2.5	-0.8	105	19 5.1	-2.8	1.3	75	19 35.1	-2.2	4.7	38
AUG 22	2729	6.9	DD	132									22 19.7	-2.4	-1.7	131
AUG 24	2981m	5.2	DD	153	16 59.9	-0.7	-1.9	111	17 1.8	-1.5	-0.3	77	17 13.7	-2.3	2.2	41
AUG 24	2987m	5.0	DD	153	18 30.7			1								
SEP 13	2048	7.2	DD	45	17 54.1	-0.9	2.4	67								
SEP 16	2399	5.0	DD	78					18 20.8	-2.2	-2.8	148	18 15.3	-1.9	-0.5	113
SEP 17	2531	7.3	DD	91	21 21.9	0.0	3.1	43	21 46.2			16				
SEP 20	2935	7.0	DD	122	18 0.3	-2.4	0.5	72	18 35.6	-2.4	2.5	48	19 15.7			10
SEP 20	2959	7.2	DD	125	23 50.7	-1.0	0.3	116	24 0.1	-0.4	0.4	105				
SEP 27	368	6.3	RD	214					22 35.8	0.2	3.9	182	23 1.8	-1.3	2.3	209
SEP 29	653	4.8	RD	240	22 11.5	-0.6	-0.8	263	22 12.8	-1.2	-1.1	276	22 3.3	-2.4	-3.0	307
SEP 30	684	6.2	RD	243	3 21.6	-1.8	1.8	218								
OCT 1	837	6.1	RD	256	3 13.3	-2.6	-1.2	300								
OCT 1	991	6.1	RD	267									23 18.1			193
OCT 13	2352	6.7	DD	48					16 59.4	-1.5	-1.2	134	16 59.7	-1.2	0.1	104
OCT 15	2611	6.8	DD	70	18 46.1			15								
OCT 16	2760	6.7	DD	81	19 40.9			163	19 42.2	-1.9	-1.3	133	19 42.9	-1.1	0.1	104
OCT 17	2886	5.1	DD	91					17 3.9	-2.9	0.4	90	17 20.9	-2.5	1.8	64
OCT 17	2902	6.0	DD	93	21 11.3			10								
OCT 17	2908	6.9	DD	93	22 31.3	-0.8	-0.2	128								
OCT 18	3017	5.3	DD	103	18 12.0			149	18 23.2	-3.6	-1.6	119	18 28.7	-2.8	0.3	91
OCT 19	3167	7.1	DD	116	22 16.3			139	22 27.0	-1.5	-0.6	124	22 30.1	-0.8	0.4	98
OCT 20	3177	6.0	DD	117	0 40.1	-0.2	0.3	117								
OCT 20	3310	6.4	DD	129	23 0.2	-0.8	1.8	61	23 19.8	-0.3	1.8	53	23 36.8	0.1	2.2	33
OCT 21	3421	5.1	DD	138	17 46.3	-1.8	-0.5	83	18 6.3	-2.2	0.6	67	18 23.6	-2.0	2.0	44
OCT 27	610	6.2	RD	211	1 3.8			314								
OCT 29	1086	6.5	DD	249									21 56.4			7
OCT 29	1086	6.5	RD	250					22 32.3	-1.3	-1.9	300	22 11.6			340
NOV 10	2441	6.5	DD	29	18 6.7	0.3	2.7	48								
NOV 14	2981m	5.2	DD	73	20 59.9	0.3	2.4	38								
NOV 15	URANUS	5.8	DD	80					11 2.8			154	10 39.8	-0.5	-1.4	107
NOV 15	3118	6.9	DD	85	21 36.4	-1.1	-0.5	130								

					CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
DATE	Z.C.	Mag.	Ph	ELG	UT	a.	b.	P.A.	UT	a.	b.	P.A.	UT	a.	b.	P.A.
M D				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
NOV 17	3375	6.9	DD	108	21 32.0	-0.9	1.8	61	21 52.5	-0.4	1.8	54	22 9.8	-0.1	2.2	34
NOV 19	83	6.9	DD	131					17 29.5	-2.4	0.0	81	17 41.1	-2.2	1.1	60
NOV 25	881	5.9	RD	206	1 55.6	-2.2	2.6	213	2 31.3	-1.8	1.5	244				
NOV 26	1047	5.2	RD	219	1 8.7	-2.2	-0.4	284	1 25.3	-2.2	-1.0	305	1 11.1			344
NOV 27	1322	6.1	RD	244					22 32.4	-1.2	-1.4	290	22 21.4	-1.5	-2.3	314
DEC 11	2940	7.3	DD	42	19 10.7			147								
DEC 15	3463	6.4	DD	88	20 11.4	-0.3	3.1	17	20 37.7			5				
DEC 16	37	7.5	DD	99					18 54.9			359				
DEC 17	170	6.2	DD	112					19 2.8			143	18 55.9	-3.3	-0.4	103
DEC 17	170	6.2	RD	112					19 10.0			153				
DEC 17	192	5.3	DD	114	23 0.7	-0.6	1.4	80								
DEC 18	303	6.6	DD	125	18 47.7	-2.3	0.2	81	19 14.6	-2.4	0.8	77	19 31.0	-2.2	1.5	60
DEC 18	308	6.7	DD	125	20 16.2	-1.0	2.7	18	20 49.8	-0.8	3.8	9				
DEC 18	322	5.7	DD	127	23 1.2	-1.0	1.5	74	23 20.9	-0.6	1.7	57	23 39.5	-0.5	2.5	29
DEC 19	327	4.5	DD	128	0 0.3	-0.6	2.0	48								
DEC 19	454	5.8	DD	140	22 11.0	-1.6	1.7	51	22 40.9	-1.3	2.4	36				
DEC 20	610	6.2	DD	154	23 0.9	-1.7	1.9	42	23 38.1			15				
DEC 24	1129	5.3	RD	199	2 24.6	-1.5	0.5	278	2 36.3	-0.8	-0.6	311	2 16.9			3

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.

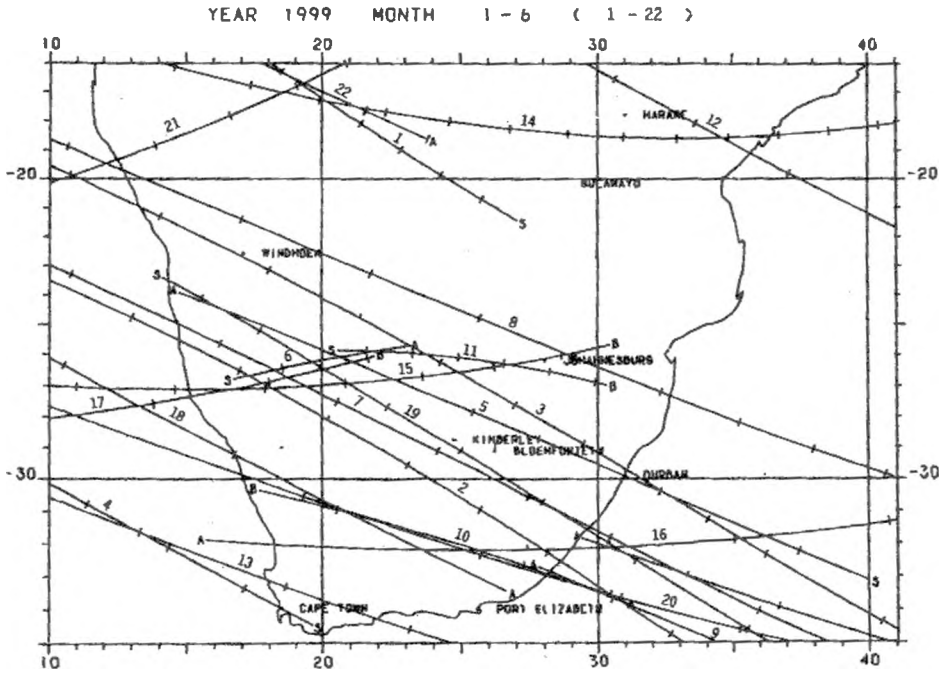
Interested observers - especially those living in the more distant regions - who wish to be informed of favourable grazes occurring in their neighbourhood, are therefore invited to contact the co-ordinator for grazing occultations:

Mr Brian Fraser, PO Box 68525, Bryanston 2021. Tel: (011) 803 8291

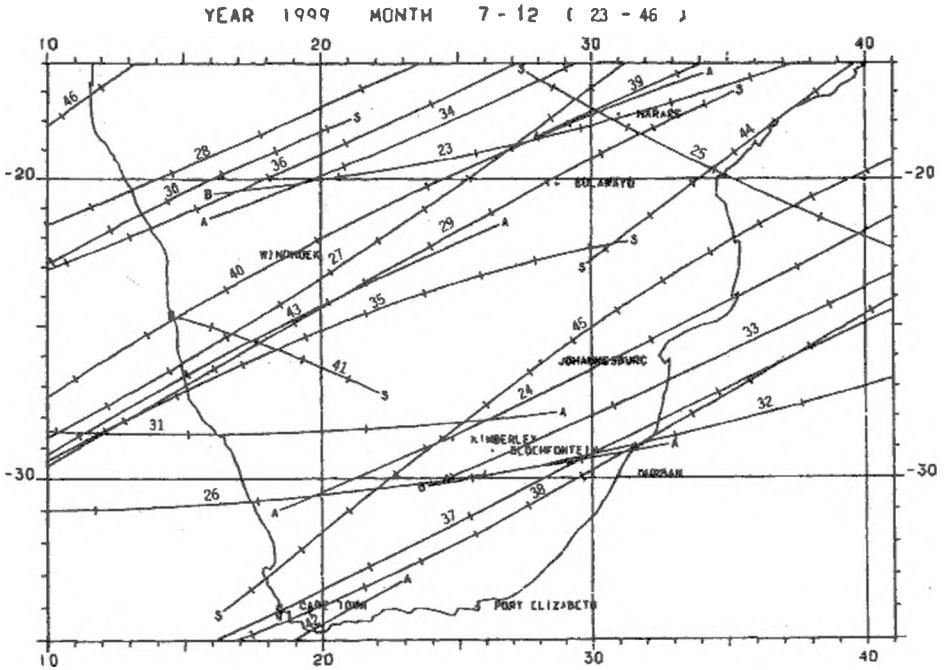
EXPLANATION OF THE COLUMN HEADINGS IN THE TABLES:

SEQ	: Sequential number in the year. The same number is attached to the corresponding track on the map.
N2C 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 occulted 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(I)	LIMIT		
1	2133	5.63	2	8	5	3	32.16	-53.21	S	( )	(S)
2	2240	6.83	2	9	2	46	45.06	-44.28	S	( )	( )
3	2372	4.40	2	10	3	30	51.73	-34.68	S	( )	( )
4	2508	6.29	2	11	5	27	44.37	-25.29	S	( )	(S)
5	2791	5.41	2	13	4	25	52.37	-10.52	S	(A)	(S)
6	15	7.31	2	18	19	58	33.94	7.39	S	(S)	(A)
7	2573	7.30	3	11	2	44	23.13	-42.80	S	( )	( )
8	2724	6.55	3	12	3	29	35.40	-32.98	S	( )	( )
9	2863	6.14	3	13	2	23	56.02	-24.36	S	(A)	( )
10	684	6.24	3	22	20	37	10.92	31.09	N	(B)	(A)
11	1135	6.79	3	25	19	6	52.55	64.11	S	(S)	(B)
12	1275	5.57	3	26	22	53	4.28	74.92	N	( )	( )
13	2902	5.99	5	7	1	7	24.17	-66.63	S	( )	( )
14	2908	6.87	5	7	2	49	4.72	-66.13	S	( )	( )
15	3177	5.99	5	9	4	28	40.36	-45.44	S	( )	(B)
16	3449	7.26	5	11	3	40	40.42	-25.16	S	(A)	( )
17	3463	6.39	5	11	5	51	6.51	-24.39	S	( )	(B)
18	1193	5.36	5	19	20	49	27.07	23.98	N	( )	(A)
19	1321	6.72	5	20	18	51	32.73	33.60	N	(S)	( )
20	2981m	5.24	6	3	23	10	16.86	-80.78	S	( )	( )
21	128	7.29	6	9	5	43	46.01	-28.07	N	( )	( )
22	1123	7.22	6	15	18	57	46.47	5.00	N	( )	(A)



SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(%)	LIMIT		
23	76	5.93	7	6	1	46	32.09	-54.79	N	(B)	( )
24	653	4.84	7	10	5	8	22.05	-11.97	N	(A)	( )
25	1576	5.27	7	16	18	2	58.44	15.24	N	(S)	( )
26	2133	5.63	7	22	0	13	14.60	63.98	S	( )	(A)
27	192	5.28	8	3	3	40	27.99	-67.81	N	( )	( )
28	2734	5.37	8	23	1	17	0.29	83.50	S	( )	( )
29	726	6.79	9	3	4	31	16.60	-47.38	N	( )	(S)
30	730	5.12	9	3	6	4	36.89	-46.88	N	( )	(S)
31	2048	7.19	9	13	20	14	37.75	14.37	N	( )	(A)
32	2399	5.04	9	16	20	37	33.95	39.44	S	(B)	( )
33	648	3.93	9	29	23	17	59.75	-74.44	N	(A)	( )
34	653	4.84	9	29	23	38	28.48	-74.25	N	(A)	( )
35	837	6.09	10	1	4	26	13.58	-61.73	N	( )	(S)
36	2757	5.06	10	16	21	8	26.61	41.62	S	( )	( )
37	2760	6.73	10	16	21	41	15.95	41.79	S	( )	( )
38	3017	5.33	10	18	20	18	31.58	61.01	S	( )	( )
39	1086	6.46	10	30	0	2	26.10	-66.81	N	(A)	( )
40	3245	6.90	11	16	23	12	52.15	54.63	S	( )	(A)
41	1343	6.57	11	28	4	41	11.89	-69.82	S	(B)	(S)
42	2940	7.26	12	11	21	18	30.73	12.37	S	( )	(A)
43	3071	6.54	12	12	21	18	22.12	19.35	S	( )	(A)
44	165	6.69	12	17	19	7	52.61	67.92	S	(S)	( )
45	170	6.20	12	17	20	32	19.28	68.51	S	(S)	( )
46	178	6.82	12	17	21	48	12.81	68.82	S	( )	( )

PLANETARY 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 12 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 two or more observers, 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.

Note : In the table below: "Mag" stands for visual magnitude and "Dur" is the approximate duration of the occultation in seconds, should an observer be in the centre of the track of the shadow.
"Az" and "Al" are the approximate azimuths and altitudes as seen from Bloemfontein.

OCCULTATIONS OF STARS BY MINOR PLANETS

Date	SAST	STAR	RA (2000.0)	Dec	Mag.	Planet	Mag.	Dur	Al	Az
d	h m		h m s	° '				s	°	
Jan 27	20 42	TAC-05 02791	06 00 54	-05 09	11.6	132 Aethra	11.4	7	50	NE
Feb 15	01 00	TYC1359 00224	07 23 46	+21 31	10.7	17 Thetis	12.0	11	25	W
Feb 21	21 16	TYC0724 00328	05 54 44	+12 12	11.2	676 Melitta	14.9	12	35	N
Mar 10	00 31	TYC0294 00127	12 59 06	+03 29	10.4	8 Flora	9.9	14	30	NE
Mar 29	06 36	TYC6282 00804	19 02 08	-16 04	10.8	48 Doris	13.0	11	85	N
Apr 03	21 44	TAC-08 05615	12 08 07	-08 58	11.1	176 Iduna	13.2	7	35	NE
Apr 12	18 53	HIP 58741	12 02 52	-07 41	6.4	176 Iduna	13.3	8	20	NE
Apr 24	02 08	TYC5042 00369	16 15 18	-03 51	9.8	511 Davida	11.8	28	70	N
May 10	02 50	TYC7415 00069	18 44 30	-35 21	10.6	93 Minerva	11.6	39	70	S
May 11	04 34	TYC0481 02652	19 58 30	+00 19	10.1	483 Seppina	14.1	8	45	N
May 15	01 36	GSC0908 00363	14 11 26	+14 48	11.7	5145 Pholus	18.6	7	30	NW
May 15	02 30	TYC6260 01645	17 37 34	-21 10	10.9	535 Montague	13.4	11	85	N
May 24	05 10	TAC-17 09136	19 46 04	-17 13	10.5	50 Virginia	13.5	24	75	NW
May 26	19 29	TAC+19 02601	08 40 49	+19 08	10.9	103 Hera	13.5	3	30	NW
Jun 02	18 46	TYC5529 00774	12 20 59	-11 29	10.9	266 Aline	14.3	18	70	NE
Jun 22	19 26	TYC0253 00663	10 35 39	+00 39	10.1	156 Xanthippe	13.4	4	40	W
Jul 19	00 02	TYC5768 00172	20 43 36	-13 26	10.2	28 Bellona	11.7	9	50	E
Jul 21	00 46	TYC450 00595	21 07 24	-17 12	9.9	184 Dejopeja	13.2	6	80	NE
Jul 25	01 07	TYC6836 00174	17 47 34	-26 21	9.1	451 Patientia	11.7	24	35	NW
Aug 06	23 30	TYC7892 00191	17 36 58	-42 13	10.2	1048 Feodosia	13.6	39	40	SW
Aug 16	18 11	HIP74175	15 09 21	-25 41	8.5	654 Zelinda	13.4	7	85	SW
Aug 17	21 26	TYC0554 00216	21 31 03	+05 56	9.4	219 Thusnelda	11.0	8	35	NE
Aug 19	04 00	TYC5229 00023	22 27 47	-02 46	10.5	38 Leda	12.6	6	35	NW
Sep 25	00 04	TYC0636 00468	02 06 52	+14 29	11.2	377 Campania	12.6	15	30	NE
Oct 14	22 03	TYC6285 04369	18 48 44	-17 02	8.3	48 Doris	13.0	11	30	W
Oct 14	23 29	HIP91758	18 42 40	-15 31	7.1	56 Melete	12.5	4	15	NW
Oct 19	23 46	TYC1187 00173	00 34 26	+16 43	9.8	193 Ambrosia	11.8	5	25	N
Oct 24	20 08	GSC6286 00156	18 57 54	-17 09	12.2	48 Doris	13.1	9	45	W
Oct 29	20 23	TAC+04 00188	00 29 15	+04 31	10.9	85 Io	10.8	24	30	NE
Nov 12	00 34	TYC1326 01717	06 14 38	+21 24	10.2	803 Picka	14.9	7	30	NE
Nov 20	01 38	TYC1340 00051	06 25 00	+21 14	11.1	683 Lanzia	13.7	12	30	NE
Dec 02	04 20	HIP22021	04 44 04	+12 59	7.7	627 Charis	14.1	4	15	NW
Dec 24	02 36	TYC0123 01048	05 42 00	+04 22	10.4	238 Hypatia	12.2	13	25	NW
Dec 28	22 07	TAC+18 01040	05 43 18	+18 37	11.1	690 Wratislavia	11.9	11	30	NE

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	2	19	May 11	11	55	18	Sep 18	11	53	13
11	12	6	42	21	11	55	29	28	11	49	42
21	12	10	8	31	11	56	32	Oct 8	11	46	35
31	12	12	19	Jun 10	11	58	16	18	11	44	11
Feb 10	12	13	8	20	12	0	23	28	11	42	45
20	12	12	42	30	12	2	30	Nov 7	11	42	36
Mar 2	12	11	9	Jul 10	12	4	13	17	11	43	50
12	12	8	47	20	12	5	16	27	11	46	25
22	12	5	56	30	12	5	22	Dec 7	11	50	13
Apr 1	12	2	55	Aug 9	12	4	28	17	11	54	51
11	12	0	4	19	12	2	38	27	11	59	48
21	11	57	43	29	11	59	58	31	12	1	44
May 1	11	56	4	Sep 8	11	56	44				

CORRECTION FOR PLACES NOT ON THE 30° MEIDIAN

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

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 46	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 22	20	17 51	14 54	28	2 23	23 27
20	9 58	7 1	30	18 30	15 34	Nov 7	3 3	0 6
Mar 2	10 37	7 40	Jul 10	19 10	16 13	17	3 42	0 46
12	11 16	8 20	20	19 49	16 52	27	4 22	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 58	29	22 27	19 30	31	6 36	3 39
May 1	14 34	11 37	Sep 8	23 6	20 10			

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 (1999.5)

Star	R.A. h · m	Dec. ° ′	Mag.	Sp.	Star	R.A. h m	Dec. ° ′	Mag.	Sp.
ACHERNAR	1 37.7	-57 15	0.6	B5	PROCYON	7 39.3	5 14	0.5	F5
ALDEBARAN	4 35.9	16 30	1.1	K5	REGULUS	10 8.3	11 58	1.3	B8
RIGEL	5 14.5	-8 12	0.3	B8	SPICA	13 25.1	-11 9	1.2	B2
BETELGEUSE	5 55.1	7 24	0.4	M0	ARCTURUS	14 15.6	19 11	0.2	K0
CANOPUS	6 24.0	-52 42	-0.9	F0	ANTARES	16 29.3	-26 26	1.2	M1
SIRIUS	6 45.1	-16 43	-1.6	A0	ALTAIR	19 50.7	8 52	0.9	A5

JULIAN DATE AT 1400 HOURS - SAST 1999

	JAN. 2451	FEB. 2451	MAR. 2451	APR. 2451	MAY 2451	JUN. 2451	JUL. 2451	AUG. 2451	SEP. 2451	OCT. 2451	NOV. 2451	DEC. 2451
1	180	211	239	270	300	331	361	392	423	453	484	514
2	181	212	240	271	301	332	362	393	424	454	485	515
3	182	213	241	272	302	333	363	394	425	455	486	516
4	183	214	242	273	303	334	364	395	426	456	487	517
5	184	215	243	274	304	335	365	396	427	457	488	518
6	185	216	244	275	305	336	366	397	428	458	489	519
7	186	217	245	276	306	337	367	398	429	459	490	520
8	187	218	246	277	307	338	368	399	430	460	491	521
9	188	219	247	278	308	339	369	400	431	461	492	522
10	189	220	248	279	309	340	370	401	432	462	493	523
11	190	221	249	280	310	341	371	402	433	463	494	524
12	191	222	250	281	311	342	372	403	434	464	495	525
13	192	223	251	282	312	343	373	404	435	465	496	526
14	193	224	252	283	313	344	374	405	436	466	497	527
15	194	225	253	284	314	345	375	406	437	467	498	528
16	195	226	254	285	315	346	376	407	438	468	499	529
17	196	227	255	286	316	347	377	408	439	469	500	530
18	197	228	256	287	317	348	378	409	440	470	501	531
19	198	229	257	288	318	349	379	410	441	471	502	532
20	199	230	258	289	319	350	380	411	442	472	503	533
21	200	231	259	290	320	351	381	412	443	473	504	534
22	201	232	260	291	321	352	382	413	444	474	505	535
23	202	233	261	292	322	353	383	414	445	475	506	536
24	203	234	262	293	323	354	384	415	446	476	507	537
25	204	235	263	294	324	355	385	416	447	477	508	538
26	205	236	264	295	325	356	386	417	448	478	509	539
27	206	237	265	296	326	357	387	418	449	479	510	540
28	207	238	266	297	327	358	388	419	450	480	511	541
29	208		267	298	328	359	389	420	451	481	512	542
30	209		268	299	329	360	390	421	452	482	513	543
31	210		269		330		391	422		483		544

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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