ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

2002

Astronomical Society of Southern Africa

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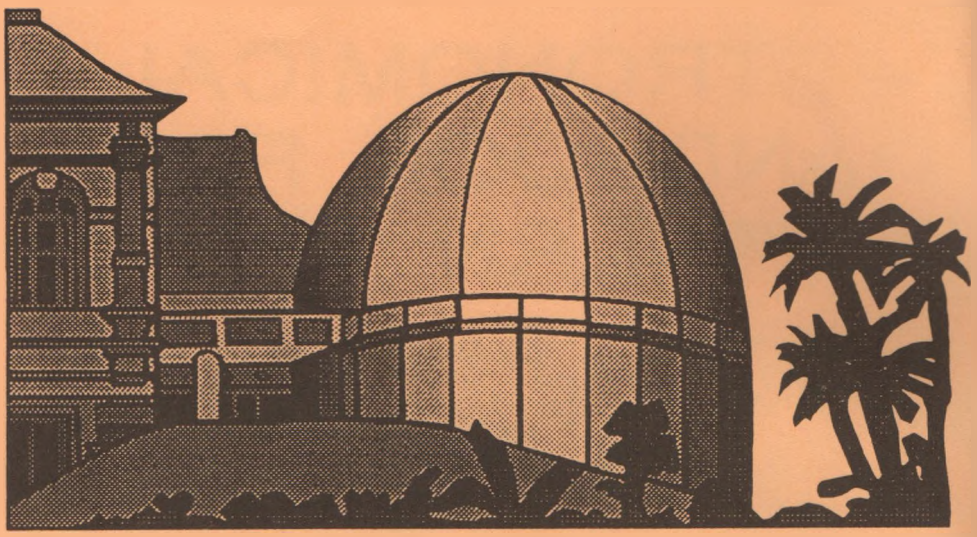

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ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA 2002

The 56th 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.

This edition is in memory of
Danie Overbeek
1920 - 2001
The dedicated observer

He had a long association with the handbook, first as a member of the Transvaal Computing Section in the 1950's, later as Director of Occultations 1988 - 1998, Director of Planetry Occultations 1983 - 2001 and member of the ASSA Editorial Board.

Front cover
Louis Barendse with his eclipse equipment - 2 Minoltas, a SRT 101 and SRT 303, one with a 680mm f12 Perkin Elmer lens, the other a Meyer-Optic Orestegor 200mm f4, all on a Meade tripod with manual drive.
Photo: 21 June 2001 Lusaka

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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 2002, the Handbook of the British Astronomical Association for 2002 and the International Lunar Occultation Centre, Tokyo. Solar eclipse data was compiled from the NASA publication "Total Solar Eclipse of 2002 December 4" by Fred Espenak and Jay Anderson, the website "www.eclipse.za.net and "Understanding Eclipses" by Cliff Turk. The star charts on pages 42, 44, 46 and 48 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 43, 45 and 47 were adapted from charts output by Skymap 2.29 for Windows. The Planetary 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. Assistance 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. Web page:www.saao.ac.za.

BOYDEN OBSERVATORY, situated at Mazelspoort, 25 km from Bloemfontein, is owned by the Dept of Physics of the University of the Free State. Observing facilities include a 1.52-m telescope, which was upgraded to a research telescope in October 2001, 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 051-4366 342), Dr M.Hoffman (tel 051-401 2924, email hofmanm@fsk.nw.uovs.ac.za), Dr 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 faciiity 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.

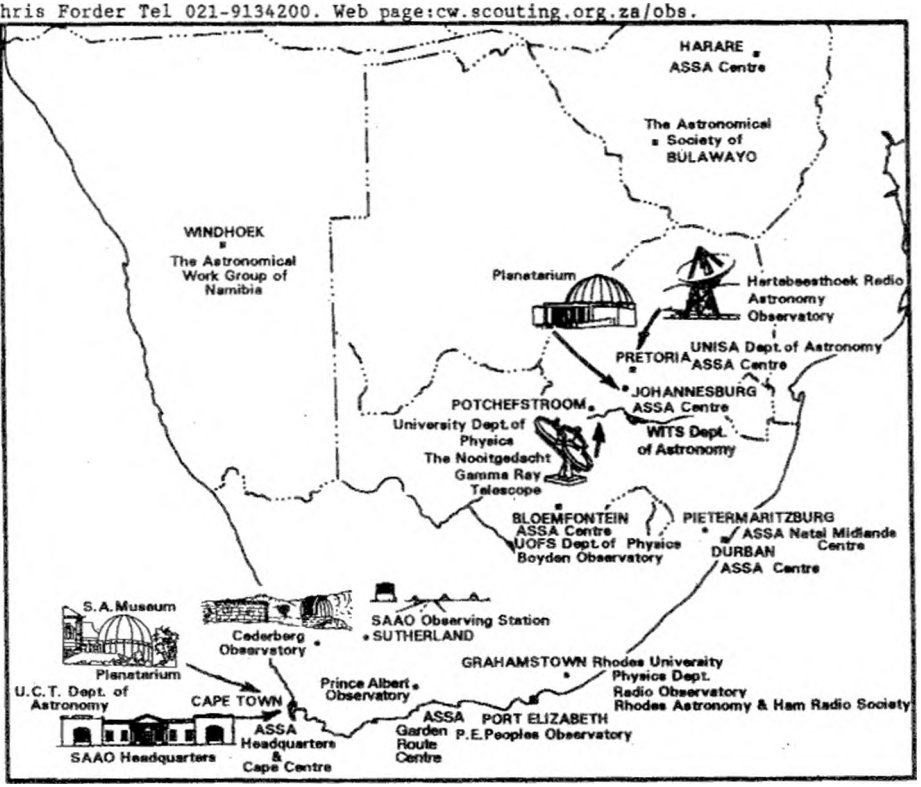
BOYDEN OBSERVATORY, BLOEMFONTEIN. Enquiries as to visits should be made to the Dept. of Physics of the University of the Free State. Tel. 051-401 2924 (Dr. M. Hoffman). Web page:www.uovs.ac.za/nat/boyden/boyden.html

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. Web page:cw.scouting.org.za/obs.



THE PRINCE ALBERT OBSERVATORY is open to the public by appointment. Facilities include a 4" solar telescope, a 10" Meade LX200 and a 16" Meade on an equatorial platform. Contact Mr. Albert Jansen at 3 Market Street, Prince Albert 6930, tel. 023-541 1871, email:agjansen@cybertrade.co.za.

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. Web page:www.museums.org.za/sam/planet/planetar.htm

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 the Free State has a Dept. of Physics, headed by Prof.H C Swart, which offers post graduate studies in astro physics and a graduate program in astronomy in collaboration with UNISA. 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 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.

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 R20.00 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. Web page:www.saao.ac.za/assa.

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 monthly at Boyden Observatory, Mazelspoort. Phoning for confirmation beforehand is essential. The Centre publishes a monthly newsletter 'Die Naghemel' as well as a web site "Space Tides" www. spacetides.cjb.net. Secretarial address: PO Box 13004, Brandhof, 9324 or telephone 051-4058730 or 051-4367555(Braam van Zyl). Web page:www.geocities.com/assabfn.

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.

DURBAN CENTRE: Regular monthly meetings are held at 19h15 on the second Wednesday of each month at Marist Brothers College, South Ridge Road, Durban. The centre publishes a monthly magazine "Ndaba". Secretarial address: P O Box 20578, Durban North, 4016, or telephone 031-564 7136 / 201 5829. Web page:www.astronomical.lia.net.

GARDEN ROUTE CENTRE. This centre covers the coastal area between Mossel Bay and Plettenberg Bay, holding regular monthly meetings every month except December at 15:00 in the hall of St Francis Church, Swallow Drive, Sedgefield. Secretarial address: P O Box 2272,Knysna 6570, tel. 044-382-5912, e-mail: robind@pixie.co.za

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. The centre publishes a newsletter Cloudy Nights. Secretarial address:P O Box UA 428, Union Avenue, Harare, Zimbabwe. Web page:www.geocities.com.zimastro/assa.html.

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. Web page:www.aqua.co.za/assa_jhb/assa001q.htm.

NATAL MIDLANDS CENTRE (Pietermaritzburg): Regular monthly meetings on the second Wednesday of each month starting at 19h30 at the Girl GuideCamp,Worlds View. The centre publishes a monthly newsletter, "Stardust". Secretarial address: P O Box 2106, Pietermaritzburg, 3200 tel 033-3433646. Web page:www.botany.unp.ac.za/nmc.htm.

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.
Web page:mafadi.aero.csir.co.za/assa/index.html.

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

ASSA Symposium

The Pretoria Centre of ASSA is organising the 5th ASSA Symposium, which will be held from Friday November 29 until Sunday December 1. The Symposium is being held to coincide with the Total Solar Eclipse on Wednesday December 4, visible from the northern parts of South Africa and southern Zimbabwe. Persons interested in participating may contact the Chairman of the Organising Committee, Tim Cooper at tpcoope@mweb.co.za or by writing to P O Box 14740, Bredell, 1623.

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h	
Jan	1	8	Jupiter at opposition
	2	9	Moon at perigee
	2	16	Earth at perihelion
	6	6	LAST QUARTER
	9	0	Pallas in conjunction with Sun
	9	7	Mercury 1°·3 S. of Neptune
	12	1	Mercury greatest elong. E. (19°)
	13	15	NEW MOON
	14	14	Venus in superior conjunction
	15	4	Mercury 4° N. of Moon
	16	0	Uranus 4° N. of Moon
	16	19	Vesta stationary
	18	11	Mercury stationary
	18	11	Moon at apogee
	19	0	Mars 5° N. of Moon
	21	20	FIRST QUARTER
	24	18	Saturn 0°·08 S. of Moon
	26	21	Jupiter 0°·9 S. of Moon
	27	21	Mercury in inferior conjunction
	28	16	Neptune in conjunction with Sun
	29	1	FULL MOON
	30	11	Moon at perigee
Feb	4	16	LAST QUARTER
	8	12	Mercury stationary
	8	12	Saturn stationary
	10	7	Mercury 5° N. of Moon
	11	3	Juno at opposition
	12	10	NEW MOON
	13	19	Uranus in conjunction with Sun
	15	0	Moon at apogee
	16	15	Ceres in conjunction with Sun
	17	2	Mars 5° N. of Moon
	20	14	FIRST QUARTER
	20	15	Vesta 0°·6 S. of Moon
	21	2	Saturn 0°·2 S. of Moon
	21	18	Mercury greatest elong. W. (27°)
	23	4	Jupiter 0°·9 S. of Moon
	24	15	Mercury 0°·5 S. of Neptune
	27	11	FULL MOON
	27	22	Moon at perigee
Mar	1	17	Jupiter stationary
	6	3	LAST QUARTER
	9	5	Mercury 1°·2 S. of Uranus
	10	11	Neptune 4° N. of Moon
	11	19	Uranus 4° N. of Moon
	12	3	Mercury 3° N. of Moon
	14	3	Moon at apogee
	14	4	NEW MOON
	18	3	Mars 4° N. of Moon
	20	12	Saturn 0°·5 S. of Moon
	20	12	Vesta 0°·5 S. of Moon
	20	21	Equinox
	21	8	Pluto stationary
	22	4	FIRST QUARTER
	22	14	Jupiter 1°·1 S. of Moon
	23	14	Juno stationary
	28	10	Moon at perigee
	28	20	FULL MOON
	31	18	Saturn 4° N. of Aldebaran
Apr	4	17	LAST QUARTER
	6	18	Neptune 4° N. of Moon
	7	11	Mercury in superior conjunction
	8	3	Uranus 4° N. of Moon
	10	7	Moon at apogee
	12	21	NEW MOON
	14	19	Venus 3° N. of Moon
	16	1	Mars 2° N. of Moon
	16	22	Saturn 0°·8 S. of Moon
	17	12	Vesta 0°·7 S. of Moon
	19	1	Jupiter 1°·6 S. of Moon
	20	15	FIRST QUARTER
	25	18	Moon at perigee
	27	5	FULL MOON
	29	15	Mars 6° N. of Aldebaran
May	4	2	Neptune 4° N. of Moon
	4	6	Mercury greatest elong. E. (21°)
	4	9	LAST QUARTER
	4	16	Venus 6° N. of Aldebaran
	4	19	Mars 2° N. of Saturn
	5	12	Uranus 4° N. of Moon
	7	20	Venus 2° N. of Saturn
	7	21	Moon at apogee
	10	23	Venus 0°·3 N. of Mars
	12	13	NEW MOON
	13	16	Neptune stationary
	13	23	Mercury 3° N. of Moon
	14	10	Saturn 1°·1 S. of Moon
	14	21	Mars 0°·6 N. of Moon
	15	1	Venus 0°·8 N. of Moon
	15	14	Vesta 1°·1 S. of Moon
	16	7	Mercury stationary
	16	14	Jupiter 2° S. of Moon
	19	22	FIRST QUARTER
	23	18	Moon at perigee
	26	14	FULL MOON
	27	9	Mercury in inferior conjunction
	31	10	Neptune 4° N. of Moon
Jun	1	20	Uranus 4° N. of Moon
	3	2	LAST QUARTER
	3	9	Uranus stationary
	3	20	Venus 1°·6 N. of Jupiter
	4	15	Moon at apogee
	7	7	Pluto at opposition
	8	13	Mercury stationary
	9	1	Pallas statiouary
	9	13	Saturn in conjunction with Sun
	9	16	Mercury 3° S. of Moon
	9	22	Venus 5° S. of Pollux
	11	2	NEW MOON
	12	14	Mars 0°·9 S. of Moon
	13	6	Jupiter 2° S. of Moon
	13	23	Venus 1°·5 S. of Moon
	18	2	FIRST QUARTER
	19	9	Moon at perigee
	21	15	Solstice
	21	17	Mercury greatest elong. W. (23°)
	24	6	Mercury 2° N. of Aldebaran
	25	0	FULL MOON Penumbral Eclipse
	27	18	Neptune 4° N. of Moon
	29	4	Uranus 4° N. of Moon
Jul	2	10	Moon at apogee
	2	13	Mercury 0°·2 S. of Saturn
	2	19	LAST QUARTER
	3	8	Mars 0°·8 N. of Jupiter
	4	19	Mars 6° S. of Pollux
	6	6	Earth at aphelion
	8	15	Saturn 1°·7 S. of Moon
	10	12	NEW MOON
	10	12	Venus 1°·1 N. of Regulus
	13	14	Venus 4° S. of Moon
	14	15	Moon at perigee
	17	7	FIRST QUARTER
	20	3	Jupiter in conjunction with Sun
	21	4	Mercury in superior conjunction

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

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

	d	h	
Oct	11	15	Saturn stationary
	13	8	FIRST QUARTER
	13	10	Mercury greatest elong. W. (18°)
	14	16	Neptune 5° N. of Moon
	16	0	Uranus 4° N. of Moon
	20	7	Moon at apogee
	20	13	Neptune stationary
	21	9	FULL MOON
	26	11	Saturn 3° S. of Moon
	27	11	Mercury 4° N. of Spica
	29	7	LAST QUARTER
	30	0	Jupiter 4° S. of Moon
	31	14	Venus in inferior conjunction
Nov	1	2	Vesta 1°·3 S. of Moon
	2	20	Mars 4° S. of Moon
	3	14	Juno 0°·6 N. of Moon
	4	3	Moon at perigee
	4	14	Uranus stationary
	4	23	NEW MOON
	11	0	Neptune 5° N. of Moon
	11	23	FIRST QUARTER
	12	7	Uranus 5° N. of Moon
	14	7	Mercury in superior conjunction
	16	13	Moon at apogee
	19	6	Venus stationary
	20	4	FULL MOON — Penumbral Eclipse
	20	7	Mars 3° N. of Spica
	22	14	Saturn 3° S. of Moon
	26	9	Jupiter 4° S. of Moon
	27	18	LAST QUARTER
	29	5	Vesta 0°·04 N. of Moon
	29	20	Ceres stationary
Dec	1	12	Mars 3° S. of Moon
	1	15	Venus 2° S. of Moon
	2	11	Moon at perigee
	4	10	NEW MOON — Eclipse
	4	23	Jupiter stationary
	7	3	Venus greatest brilliancy
	8	10	Neptune 5° N. of Moon
	9	16	Uranus 5° N. of Moon
	9	19	Pluto in conjunction with Sun
	11	18	FIRST QUARTER
	14	6	Moon at apogee
	17	19	Saturn at opposition
	19	17	Saturn 3° S. of Moon
	19	21	FULL MOON
	22	3	Solstice
	23	14	Jupiter 4° S. of Moon
	26	7	Mercury greatest elong. E. (20°)
	27	3	LAST QUARTER
	30	3	Mars 1°·2 S. of Moon
	30	3	Moon at perigee
	30	11	Venus 2° N. of Moon

THE SUN

BASIC DATA:

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

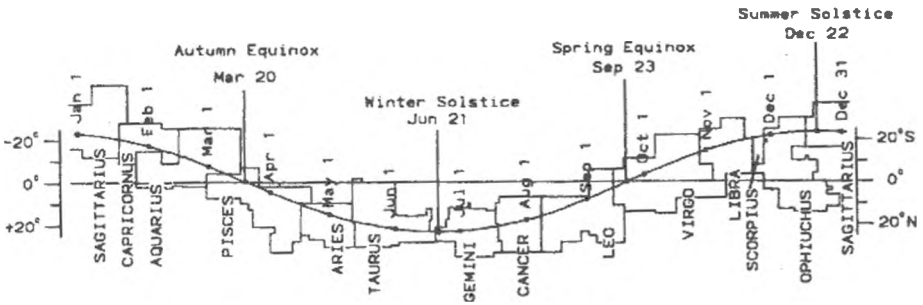
Mass: 1,99 x 10^{30}kg (330 000 times Earth mass)

Surface Temperature: Approximately 6 000°C

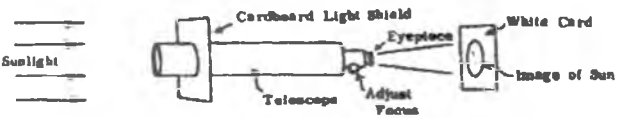
Temperature at centre: Approximately 10 million°C

The Sun is our nearest star. It is composed chiefly of hydrogen and is in a gaseous state throughout. So hot and dense is its interior that nuclear reactions occur there - thus producing the energy that is eventually radiated from its surface. At times its surface is disturbed by sunspots (which may persist for some weeks) and short-lived flares.

The Earth's orbit round the Sun is not quite circular. In 2002 we will be closest to the Sun on January 2 (perihelion - approximate distance 147 million km) and furthest from the Sun on July 6 (aphelion - approximately 152 million km). During the year, the Sun appears to us to make a complete circuit of the sky (i.e. relative to the starry background) as indicated in the diagram.



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



THE SUN'S DECLINATION AT 02 HOURS:

Jan 11	-21°51'	Apr 21	11°44'	Jul 30	18°3'	Nov 7	-16°10'
21	-19 59	May 1	14 58	Aug 9	15 57	17	-18 54
31	-17 29	11	17 47	19	12 53	27	-21 4
Feb 10	-14 28	21	20 7	29	9 29	Dec 7	-22 34
20	-11 3	31	21 52	Sep 8	5 49	17	-23 20
Mar 2	-7 20	Jun 10	22 59	18	2 0	27	-23 21
12	-3 28	20	23 26	28	-1 53		
22	0 29	30	23 12	Oct 8	-5 45		
Apr 1	4 24	Jul 10	22 17	18	-9 29		
11	8 11	20	20 44	28	-13 0		

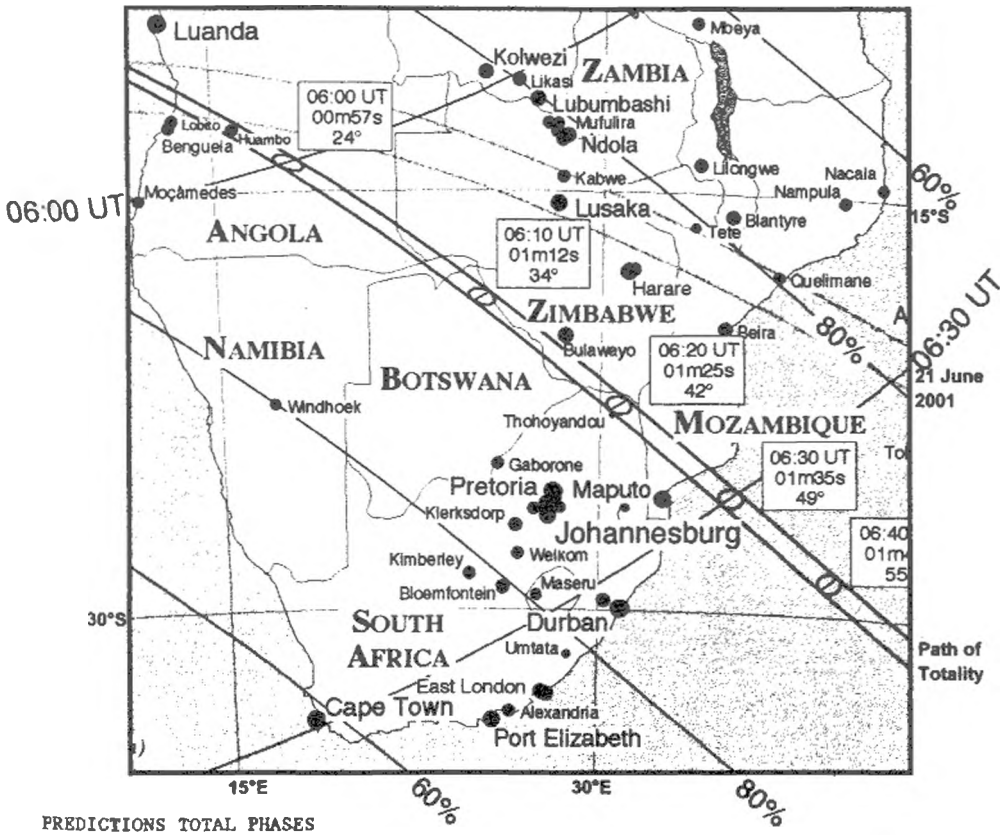
TIMES OF SUNRISE AND SUNSET FOR THE MAIN CITIES OF SOUTHERN AFRICA

	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

The annular eclipse of 10-11 June will not be visible from Southern Africa. The total eclipse of the 4 December will be visible.

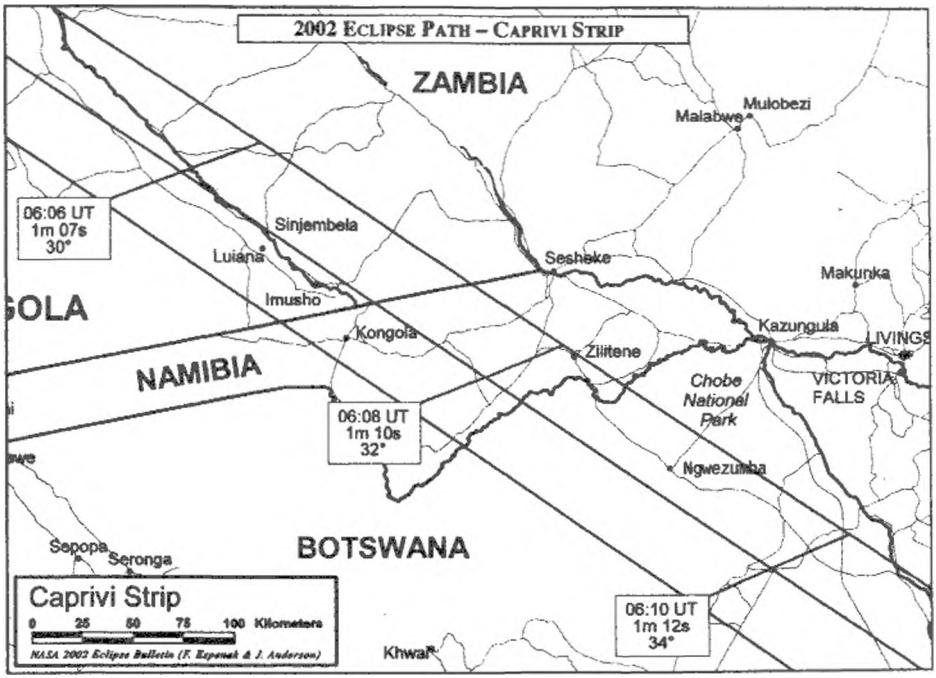
The Total Solar Eclipse of 4 December 2002 over Southern Africa

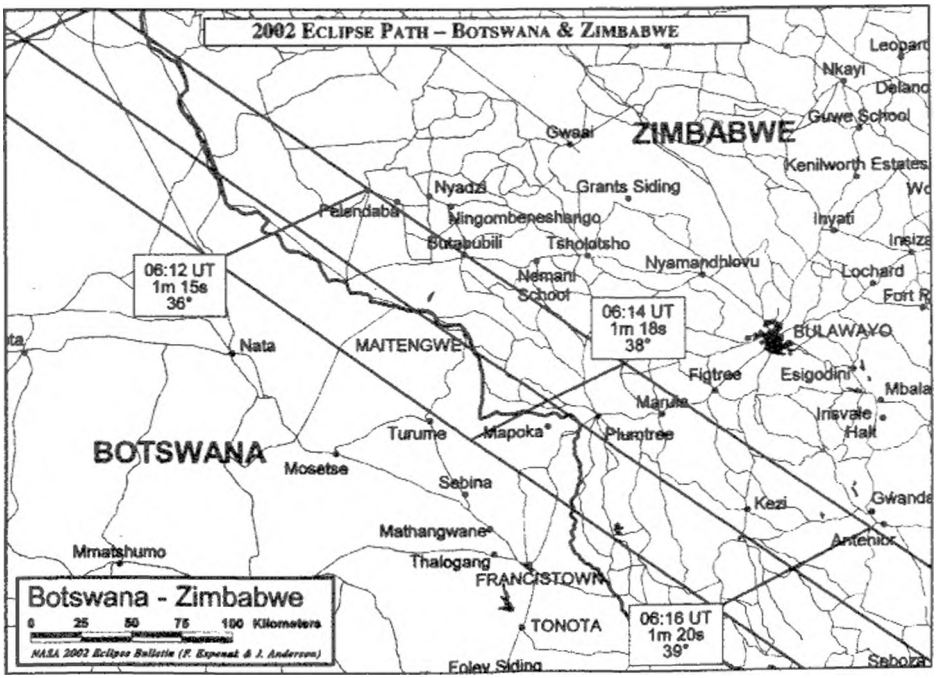


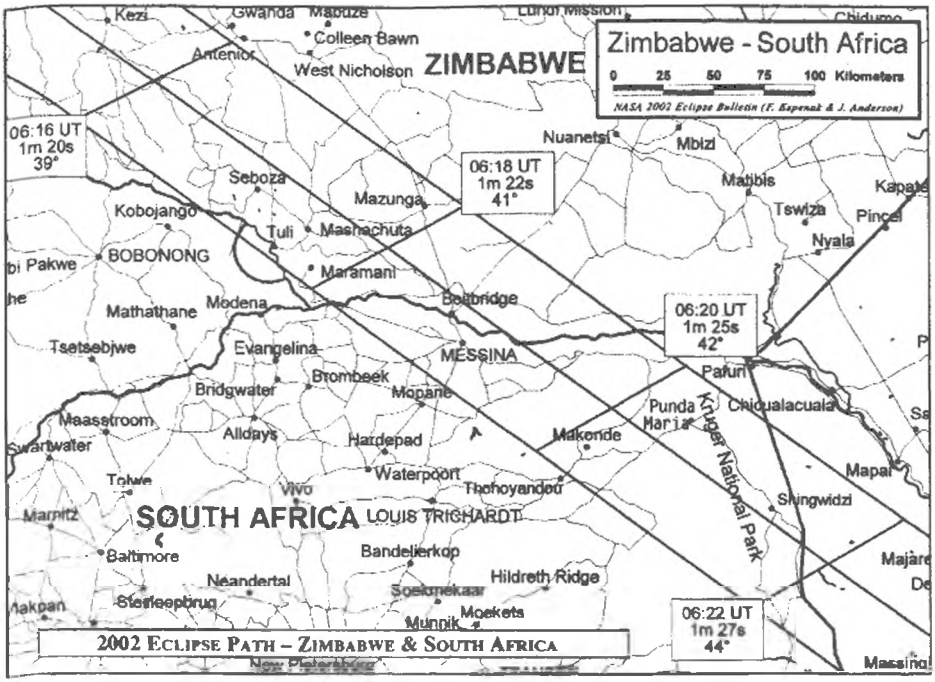
PREDICTIONS TOTAL PHASES

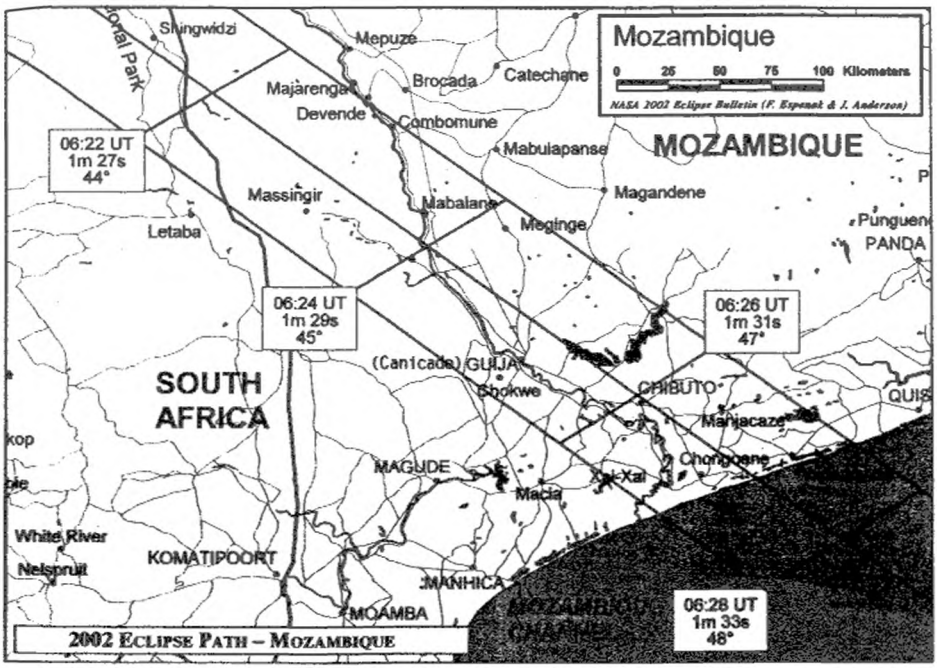
Place	First Contact SAST	Alt	Second Contact SAST	Third Contact SAST	Fourth Contact SAST	Alt	Duration
	h m s	°	h m s	h m s	h m s	°	m s
ANGOLA*							
Huambo	06 59 08	8	07 57 23	07 58 16	09 03 46	36	0 52
ZAMBIA							
Sinjembela	07 03 50	17	08 05 55	08 07 02	09 17 31	47	1 08
CAPRIVI							
Kongola	07 04 24	17	08 06 47	08 07 44	09 18 35	48	0 56
BOTSWANA							
Ngwezumba	07 05 18	19	08 08 24	08 09 31	09 21 18	50	1 07
ZIMBABEWE							
Beit Bridge	07 11 35	26	08 17 51	08 19 12	09 34 50	59	1 21
Plumtree	07 08 39	23	08 13 32	08 14 49	09 28 49	55	1 17
SOUTH AFRICA							
Messina	07 11 48	26	08 18 10	08 19 24	09 35 08	59	1 14
Punda Maria	07 12 38	27	08 19 33	08 20 52	09 37 17	60	1 19
Shingwedzi	07 13 23	28	08 20 33	08 21 59	09 38 39	61	1 26
MOZAMBIQUE*							
Canicado/Guija	07 16 03	30	08 24 20	08 25 42	09 43 35	64	1 22
Mabalane	07 14 58	30	08 22 54	08 24 19	09 41 52	63	1 25
Xai-Xai	07 17 16	31	08 26 08	08 27 13	09 45 43	65	1 05

* Correct for local time in Angola by subtracting 1 hour from the SAST time.
Correct for local time in Mozambique by adding 1 hour to the SAST time.

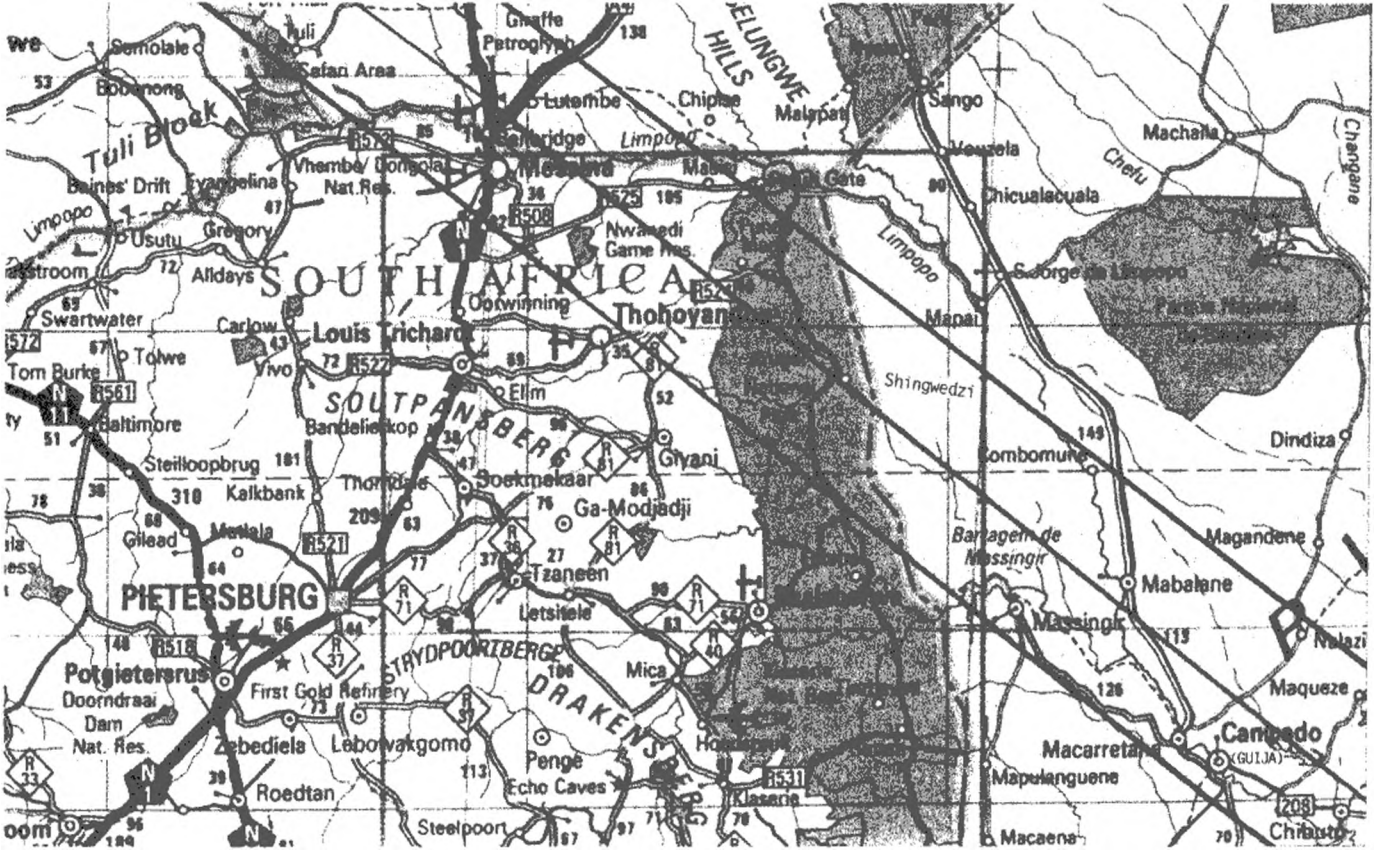

2002 Eclipse Path – Caprivi Strip
ZAMBIA
Malabwe
Mulobezi
06:06 UT
1m 07s
30°
Sinjembela
Luiana
Sesheke
Makunka
Imusho
Kongola
Kazungula
LIVINGS
Zilitene
NAMIBIA
Chobe
National
Park
VICTORIA
FALLS
06:08 UT
1m 10s
32°
Ngwezumba
Sepopa
Seronga
BOTSWANA
Caprivi Strip
0 25 50 75 100 Kilometers
NASA 2002 Eclipse Bulletin (F. Espenak & J. Anderson)
06:10 UT
1m 12s
34°
Khwai

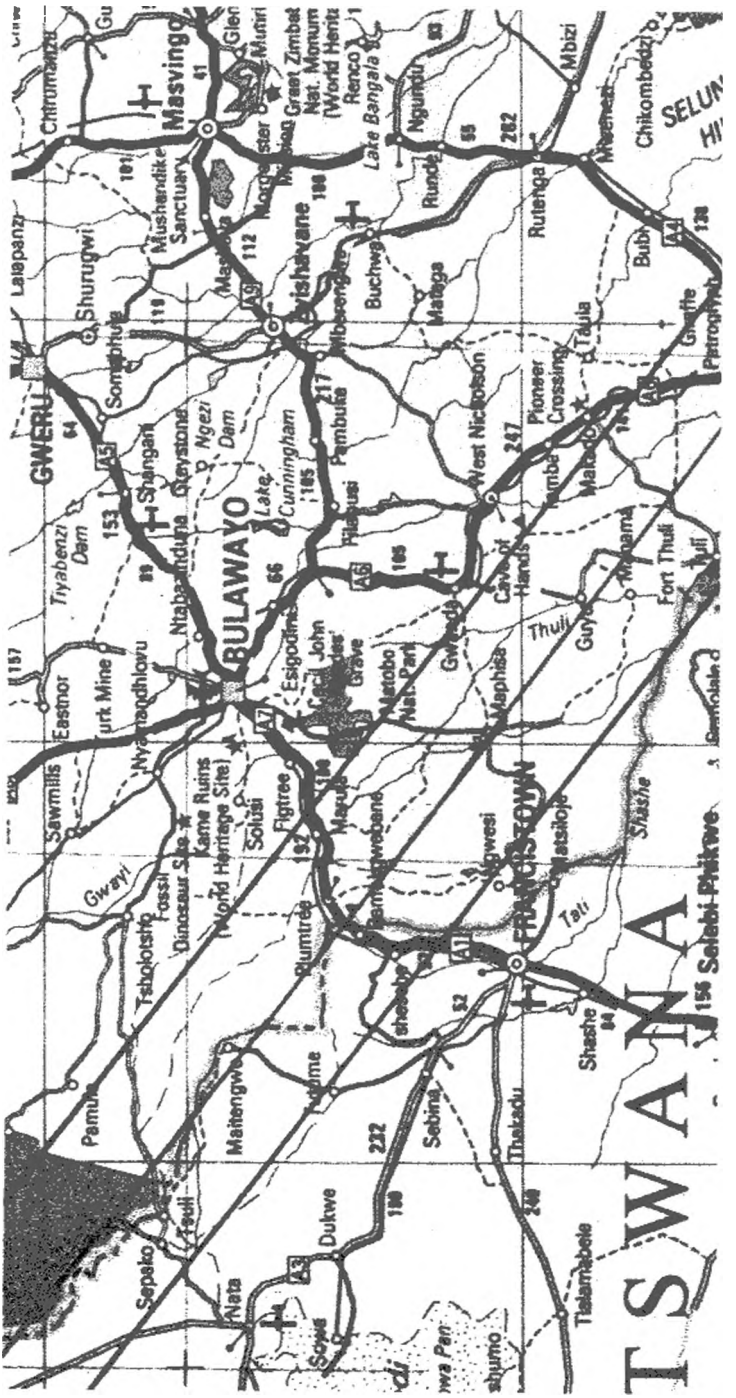

2002 Eclipse Path – Botswana & Zimbabwe
Leopard
Nkayi
Delano
Guwe School
Gwaai
ZIMBABWE
Kenilworth Estates
Nyadza
Grants Siding
Pelendaba
Mingombeneshango
Inyati
Botabubili
Tsholotsho
Nyamandhlovu
Lochard
Nemani
School
06:12 UT
1m 15s
36°
06:14 UT
1m 18s
38°
BULAWAYO
Nata
MAITENGWE
Figtree
Esigodini
Mbala
Manula
Insvale
Halt
Turume
Mapoka
Plumtree
BOTSWANA
Mosetse
Sebina
Kezi
Gwanda
Mathangwane
Antelope
Mmatshumo
Thalogang
FRANCISTOWN
Botswana - Zimbabwe
0 25 50 75 100 Kilometers
NASA 2002 Eclipse Bulletin (F. Espenak & J. Anderson)
TONOTA
06:16 UT
1m 20s
39°
Foley Siding
Saboza


Zimbabwe - South Africa
0 25 50 75 100 Kilometers
NASA 2002 Eclipse Bulletin (F. Espenak & J. Anderson)
ZIMBABWE
SOUTH AFRICA
LOUIS TRICHARDT
MESSINA
BOBONONG
Kezi
Gwanda
Colleen Bawn
Antelope
West Nicholson
Nuanetsi
Mbizi
Matibis
Tswiza
Nyala
Seboza
Mazunga
Kobojango
Tuli
Mashachuta
Maramani
Mathathane
Modena
Beitbridge
Tsetsebjwe
Evangelina
Bridgwater
Brombeek
Mopane
Maasstroom
Alldays
Hardepad
Makonde
Punda Maria
Kruger National Park
Chiqualacuala
Mapai
Swartwater
Tshwe
Vivo
Waterpoort
Thohoyandou
Marnitz
Baltimore
Bandelierkop
Neandertal
Hildreth Ridge
Soekmekaar
Sterkspruit
Moekets
Munnik
Pafuri
Shingwidzi
06:16 UT
1m 20s
39°
06:18 UT
1m 22s
41°
06:20 UT
1m 25s
42°
06:22 UT
1m 27s
44°
2002 Eclipse Path – Zimbabwe & South Africa


Mozambique
0 25 50 75 100 Kilometers
NASA 2002 Eclipse Bulletin (F. Espenak & J. Anderson)
MOZAMBIQUE
SOUTH AFRICA
Shingwidzi
Mepuze
Brocada
Catechene
Majarengan
Devende
Combomune
Mabulapanse
Massingir
Mabalane
Magandene
Meginge
Letaba
Punguene
PANDA
(Canicado) GUIJA
Chokwe
CHIBUTO
Manjacaze
Chongoene
Xai-Xai
MAGUDE
Macia
White River
Nelspruit
KOMATIPOORT
MANHICA
MOAMBA
06:22 UT
1m 27s
44°
06:24 UT
1m 29s
45°
06:26 UT
1m 31s
47°
06:28 UT
1m 33s
48°
2002 Eclipse Path – Mozambique

SOUTHERN ZIMBABWE & BOTSWANA - SOUTH AFRICA - WESTERN MOZAMBIQUE




ZIMBABWE - BOTSWANA
GWERU
BULAWAYO
Masvingo
Shurugwi
Somabhula
Shangani
Esigodini
Pambuka
Mbizi
Rutenga
Beitbridge
Plumtree
Francistown
Selebi Phikwe
Sebina
Thakadu
Tsabong
Nata
Kazungula
Kasane
Victoria Falls
Hwange
Dukwe
Maitengwe
Tuli
Shashe
Thuli
Lake Cunningham
Ngezi Dam
Tyabenzi Dam
Mushandike Sanctuary
Great Zimbabwe Nat. Monument (World Heritage Site)
Matobo Nat. Park
Khami Ruins (World Heritage Site)
Dinosaur Site
Fossil Tree
Lake Bangala
Pioneer Crossing
Fort Thuli
Chikombedzi
Selu
Hi
TSWANA

PREDICTIONS PARTIAL PHASES

Place	Eclipse Begins h m	Maximum Eclipse h m	Eclipse Ends h m	Sun Alt °	Sun Az °	Ecl. Mag.	Ecl. Obs.
ANGOLA*							
Benguela	07 00	07 57	09 02	19	109	0.977	0.974
Lobito	06 59	07 57	09 02	19	110	0.985	0.984
Luanda	06 56	07 53	08 57	16	111	0.946	0.935
Mocamedes (Namibe)	07 03	08 00	09 04	19	109	0.897	0.874
NAMIBIA							
Walvis Bay	07 13	08 11	09 15	26	105	0.755	0.695
Windhoek	07 12	08 11	09 18	28	104	0.800	0.751
ZAMBIA							
Lusaka	07 03	08 07	09 21	36	107	0.880	0.852
ZIMBABWE							
Bulawayo	07 08	08 14	09 30	39	103	0.987	0.987
Chitungwiza	07 06	08 13	09 29	40	104	0.886	0.860
Gweru	07 08	08 14	09 30	40	103	0.950	0.942
Harare	07 06	08 13	09 29	40	104	0.892	0.868
Mutare	07 08	08 16	09 33	43	103	0.891	0.867
BOTSWANA							
Francistown	07 10	08 15	09 30	38	102	0.991	0.993
Gaborone	07 15	08 20	09 33	38	100	0.886	0.860
Selebi Phikwe	07 11	08 17	09 31	39	101	0.978	0.977
SOUTH AFRICA							
Benoni	07 18	08 24	09 39	42	97	0.891	0.867
Bloemfontein	07 23	08 27	09 39	41	95	0.793	0.743
Cape Town	07 32	08 29	09 33	35	95	0.587	0.492
Carletonville	07 18	08 23	09 37	41	97	0.873	0.844
Durban	07 25	08 32	09 48	46	92	0.851	0.817
East London	07 30	08 35	09 47	44	90	0.740	0.677
Germiston	07 18	08 24	09 38	41	97	0.889	0.864
Johannesburg	07 18	08 24	09 38	41	97	0.886	0.860
Kimberley	07 22	08 25	09 36	39	96	0.783	0.730
Klerksdorp	07 19	08 24	09 37	40	97	0.849	0.813
Mafikeng	07 17	08 21	09 34	39	99	0.857	0.823
Pietermaritzburg	07 24	08 31	09 47	45	93	0.848	0.812
Port Elizabeth	07 32	08 35	09 44	42	90	0.688	0.613
Pretoria	07 17	08 23	09 38	41	98	0.899	0.877
Umtata	07 27	08 33	09 47	44	91	0.783	0.730
Welkom	07 20	08 25	09 39	41	96	0.829	0.788
MOZAMBIQUE*							
Beira	07 11	08 20	09 39	46	102	0.874	0.846
Maputo	07 18	08 27	09 46	46	96	0.965	0.961
Nacala	07 10	08 18	09 36	49	107	0.643	0.559
Nampula	07 09	08 17	09 35	48	107	0.683	0.607
Tete	07 06	08 13	09 29	42	106	0.810	0.764

NOTE Ecl. Mag. ie. Magnitude is the proportion of the sun's diameter covered by the Moon's disk at maximum eclipse.
Ecl. Obs. ie. Obscuration is the proportion of the sun's disk covered by that of the Moon at maximum eclipse.
* Correct for local time in Angola by subtracting 1 hour from the SAST time.
Correct for local time in Mozambique by adding 1 hour to the SAST time.

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 ASSA, c/o SAAO, P O Box 9, Observatory, 7935

The Moon

BASIC DATA

Diameter: 3 480 km (0,27 of Earth)
Mass: 7,35 x 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

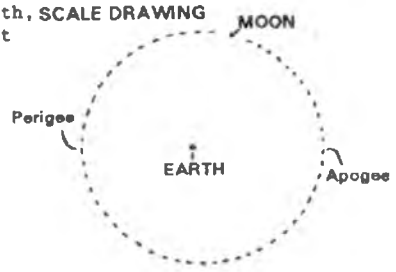
THE SURFACE OF THE MOON

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

One of the three lunar eclipses that of 26 May will not take place over Southern Africa. All are penumbral. The eclipse data is as follows:

Penumbral Eclipse	d	h	m
Moon enters penunbra	Jun 24	22	18.4
Middle of eclipse	Jun 24	23	27.1
Moon leaves penumbra	Jun 25	0	35.4

Contacts of Umbra with Limb of Moon	Position Angles from the North Point
First	27.4 to East
Last	19.2 to West

Magnitude of the eclipse: 0.235

Penumbral Eclipse	d	h	m
Moon enters penunbra	Nov 20	1	32.0
Middle of eclipse	Nov 20	3	46.5
Moon leaves penumbra	Nov 20	6	01.1

Contacts of Umbra with Limb of Moon	Position Angles from the North Point
First	27.0 to East
Last	64.5 to West

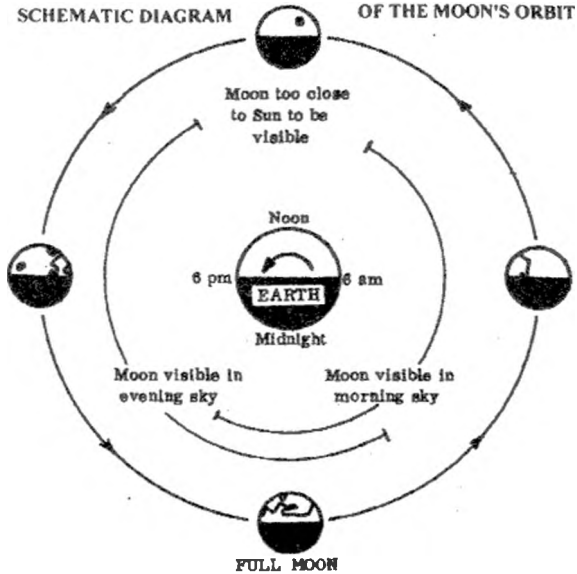
Magnitude of the eclipse: 0.886

PHASES and VISIBILITY

NEW MOON

	d	h	m
JAN	13	15	29
FEB	12	9	41
MAR	14	4	02
APR	12	21	21
MAY	12	12	45
JUN	11	1	46
JUL	10	12	26
AUG	8	21	15
SEP	7	5	10
OCT	6	13	18
NOV	4	22	34
DEC	4	9	34

SCHEMATIC DIAGRAM OF THE MOON'S ORBIT



FIRST QUARTER

	d	h	m
JAN	21	19	46
FEB	20	14	02
MAR	22	4	28
APR	20	14	48
MAY	19	21	42
JUN	18	2	29
JUL	17	6	47
AUG	15	12	12
SEP	13	20	08
OCT	13	7	33
NOV	11	22	52
DEC	11	17	49

LAST QUARTER

	d	h	m
JAN	6	5	55
FEB	4	15	33
MAR	6	3	24
APR	4	17	29
MAY	4	9	16
JUN	3	2	05
JUL	2	19	19
AUG	1	12	22
AUG	31	4	31
SEP	29	19	03
OCT	29	7	28
NOV	27	17	46
DEC	27	2	31

FULL MOON

	d	h	m
JAN	29	00	50
FEB	27	11	17
MAR	28	20	25
APR	27	5	00
MAY	26	13	51
JUN	24	23	42
JUL	24	11	07
AUG	23	00	29
SEP	21	15	59
OCT	21	9	20
NOV	20	3	34
DEC	19	21	10

MOON at PERIGEE

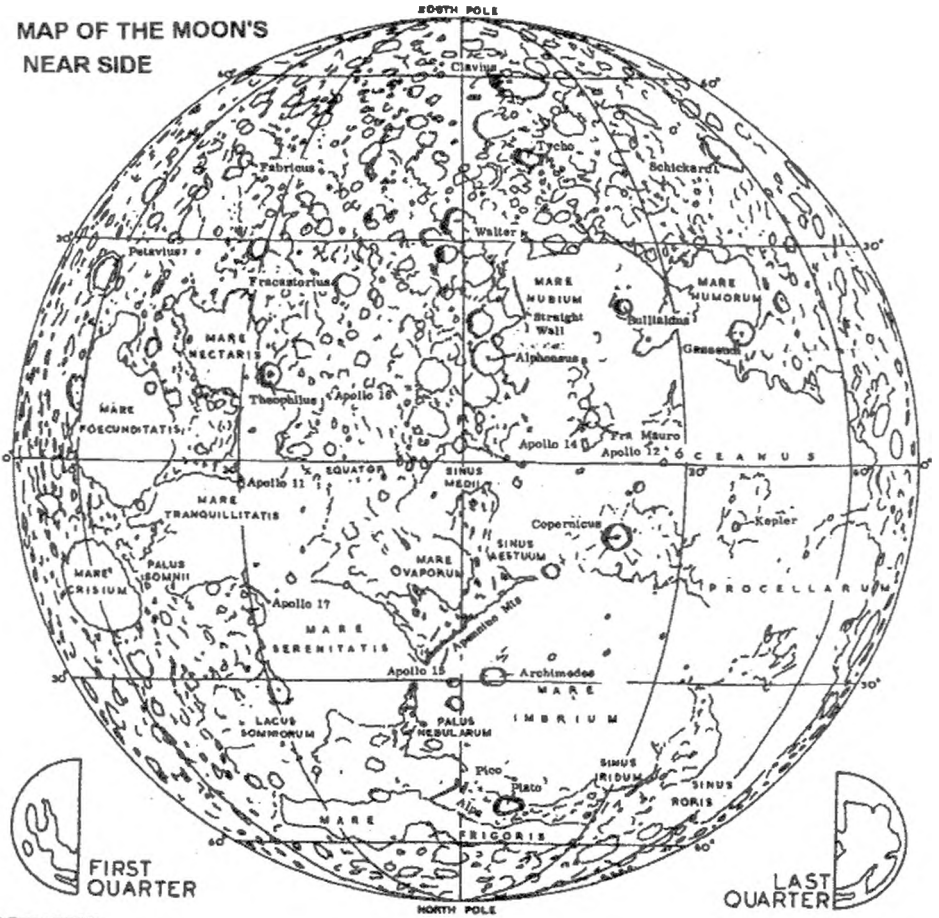
	d	h		d	h		d	h
Jan	2	9	May	23	18	Oct	6	15
	30	11	Jun	19	9	Nov	4	3
Feb	27	22	Jul	14	15	Dec	2	11
Mar	28	10	Aug	11	1		30	3
Apr	25	18	Sep	8	5			

MOON at APOGEE

	d	h		d	h		d	h
Jan	18	11	Jun	4	15	Oct	20	7
Feb	15	0	Jul	2	10	Nov	16	13
Mar	14	3		30	4	Dec	14	6
Apr	10	7	Aug	26	20			
May	7	21	Sep	23	5			

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

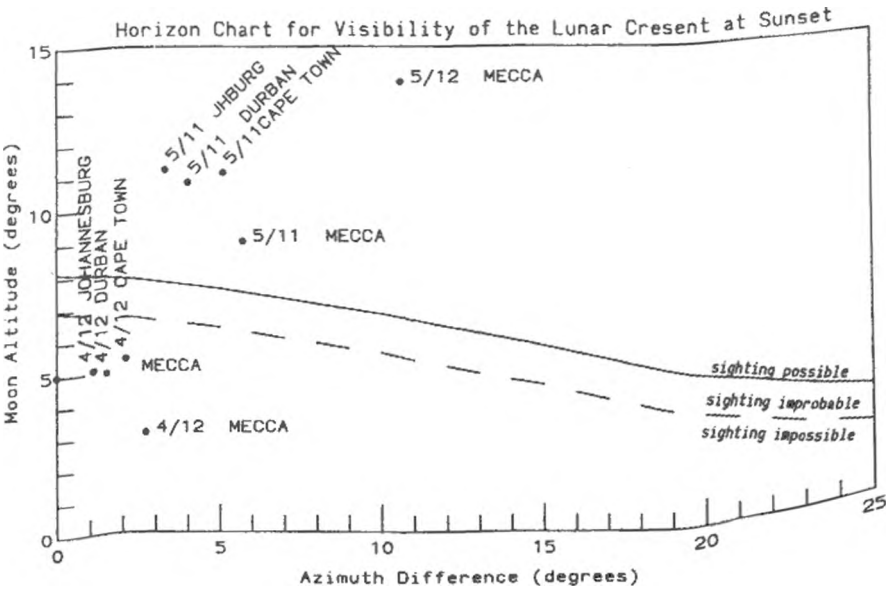
	Maximum			Minimum			Maximum			Maximum		
Date	Size	P.A.	Date	Size	P.A.	Date	Size	P.A.	Date	Size	P.A.
d	°	°	d	°	°	d	°	°	d	°	°
Jan 6	7.6	234	Jan 12	4.9	287	Jul 14	6.8	191	Jul 20	4.7	264
Jan 22	7.7	35	Jan 28	5.6	158	Jul 26	7.1	312	Aug 1	5.5	27
Feb 3	8.0	246	Feb 10	5.6	296	Aug 7	7.0	147	15.95	5.9	263
Feb 21	7.9	80	Feb 27	6.4	190	Aug 22	7.2	307	28.55	5.1	22
Mar 4	7.9	258	Mar 11	6.4	308	Sep 4	8.1	137	Sep 9.75	5.9	233
Mar 23	8.2	125	Mar 29	6.3	221	Sep 17	8.0	296	25.13	4.5	24
Apr 3	7.6	278	Apr 14	5.7	34	Oct 2	9.0	143	Oct 7.77	5.0	234
Apr 21	8.2	149	Apr 27	5.4	237	Oct 14	8.9	293	22.89	3.7	30
May 3	7.6	296	May 13	5.1	51	Oct 30	9.3	151	Nov 5.00	3.7	237
May 19	7.7	166	May 25	4.5	246	Nov 11	9.3	294	19.58	3.1	37
Jun 1	7.5	305	Jun 9	4.9	61	Nov 26	8.8	159	Dec 3.09	2.6	239
Jun 16	7.1	181	Jun 22	4.1	255	Dec 9	9.0	297	16.98	2.9	38
Jun 29	7.3	311	Jul 6	5.3	50	Dec 24	8.0	166	30.81	2.0	250

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.

PREDICTIONS FOR YOUNG CRESCENT VISIBILITY FOR RAMADAAN AND SHAWWAL

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°
Ramadaan	4 11								
	5 11	11.1	5.1	11.2	3.3	10.8	4.0	9.0	5.7
Shawwall	4 12	5.4	2.1	5.1	1.1	5.0	1.5	3.1	2.7
	5 12	17.4	8.0	17.9	5.1	17.5	6.3	13.9	10.6



2002 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	22 08	07 29	22 39	09 53	21 08	08 41	21 32	10 58	21 51	11 53	23 31	12 48
2	22 52	08 39	23 12	11 01	21 43	09 51	22 18	12 05	22 48	12 47		13 20
3	23 31	09 50	23 46	12 08	22 19	11 01	23 09	13 07	23 47	13 34	00 28	13 49
4		10 59		13 14	22 57	12 08		14 04		14 14	01 24	14 16
5	00 06	12 06	00 21	14 19	23 39	13 14	00 03	14 54	00 45	14 49	02 18	14 42
6	00 39	13 11	01 00	15 22		14 17	00 59	15 37	01 42	15 19	03 13	15 09
7	01 11	14 16	01 42	16 23	00 25	15 16	01 56	16 14	02 38	15 47	04 09	15 36
8	01 45	15 21	02 29	17 19	01 16	16 08	02 53	16 47	03 33	16 14	05 06	16 07
9	02 20	16 25	03 20	18 10	02 10	16 55	03 50	17 16	04 27	16 40	06 06	16 42
10	03 00	17 28	04 15	18 55	03 06	17 36	04 45	17 44	05 22	17 07	07 07	17 22
11	03 44	18 28	05 12	19 35	04 03	18 12	05 39	18 10	06 19	17 36	08 09	18 10
12	04 33	19 24	06 09	20 10	04 59	18 44	06 34	18 36	07 17	18 08	09 10	19 05
13	05 26	20 14	07 05	20 41	05 55	19 12	07 29	19 04	08 17	18 44	10 06	20 06
14	06 22	20 58	08 01	21 09	06 50	19 40	08 26	19 34	09 18	19 27	10 57	21 12
15	07 20	21 36	08 56	21 36	07 45	20 06	09 24	20 07	10 19	20 16	11 42	22 20
16	08 17	22 09	09 50	22 03	08 39	20 33	10 24	20 45	11 17	21 12	12 21	23 28
17	09 13	22 39	10 45	22 30	09 35	21 01	11 24	21 29	12 11	22 14	12 57	
18	10 08	23 07	11 40	22 59	10 31	21 32	12 24	22 20	12 59	23 20	13 30	00 35
19	11 03	23 34	12 37	23 31	11 29	22 06	13 20	23 18	13 41		14 02	01 42
20	11 57		13 37		12 29	22 46	14 13		14 19	00 28	14 35	02 49
21	12 53	00 01	14 38	00 08	13 30	23 33	15 00	00 22	14 54	01 36	15 10	03 57
22	13 50	00 29	15 40	00 51	14 29		15 42	01 30	15 28	02 44	15 49	05 05
23	14 49	01 00	16 41	01 43	15 26	00 27	16 20	02 39	16 01	03 52	16 33	06 13
24	15 51	01 35	17 38	02 42	16 18	01 29	16 55	03 50	16 36	05 01	17 23	07 19
25	16 55	02 15	18 30	03 49	17 05	02 36	17 30	05 01	17 13	06 11	18 19	08 21
26	17 59	03 04	19 15	05 01	17 47	03 48	18 05	06 12	17 55	07 22	19 18	09 16
27	19 00	04 01	19 56	06 15	18 25	05 01	18 41	07 23	18 43	08 31	20 18	10 03
28	19 55	05 06	20 33	07 29	19 01	06 14	19 22	08 34	19 36	09 36	21 18	10 44
29	20 44	06 16			19 36	07 26	20 07	09 44	20 33	10 35	22 17	11 19
30	21 26	07 29			20 12	08 37	20 56	10 51	21 33	11 26	23 13	11 49
31	22 04	08 42			20 50	09 48			22 33	12 10		

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

2002 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	21 11	07 07	21 58	09 16	20 30	08 02	21 09	10 03	21 32	10 52	23 04	11 54
2	21 59	08 14	22 36	10 20	21 10	09 08	21 57	11 07	22 28	11 47	23 58	12 30
3	22 43	09 21	23 14	11 23	21 50	10 12	22 49	12 07	23 25	12 36		13 03
4	23 22	10 25	23 53	12 24	22 32	11 16	23 43	13 04		13 18	00 49	13 33
5	23 59	11 28		13 25	23 17	12 18		13 54	00 20	13 56	01 40	14 03
6		12 29	00 35	14 25		13 18	00 38	14 40	01 14	14 31	02 31	14 33
7	00 36	13 30	01 20	15 24	00 05	14 15	01 33	15 20	02 06	15 02	03 23	15 05
8	01 14	14 30	02 09	16 19	00 56	15 08	02 27	15 56	02 57	15 32	04 16	15 39
9	01 53	15 30	03 00	17 11	01 50	15 57	03 20	16 29	03 47	16 02	05 12	16 18
10	02 36	16 30	03 54	17 58	02 44	16 40	04 11	17 00	04 39	16 33	06 10	17 01
11	03 22	17 29	04 49	18 40	03 38	17 19	05 02	17 30	05 31	17 06	07 09	17 50
12	04 13	18 24	05 43	19 18	04 32	17 54	05 53	18 00	06 25	17 41	08 09	18 46
13	05 06	19 15	06 37	19 52	05 24	18 27	06 44	18 32	07 21	18 21	09 06	19 46
14	06 01	20 01	07 29	20 25	06 16	18 57	07 37	19 05	08 20	19 06	09 59	20 49
15	06 56	20 42	08 20	20 55	07 06	19 28	08 31	19 42	09 18	19 57	10 47	21 54
16	07 50	21 19	09 10	21 25	07 57	19 58	09 28	20 23	10 16	20 53	11 30	22 57
17	08 43	21 52	10 01	21 56	08 48	20 30	10 25	21 09	11 11	21 53	12 10	
18	09 35	22 24	10 53	22 29	09 41	21 04	11 23	22 01	12 01	22 56	12 48	00 00
19	10 26	22 54	11 46	23 05	10 36	21 42	12 20	22 58	12 48		13 24	01 02
20	11 16	23 25	12 42	23 45	11 32	22 24	13 13		13 30	00 00	14 02	02 04
21	12 08	23 57	13 41		12 30	23 13	14 03	00 00	14 09	01 04	14 41	03 07
22	13 01		14 41	00 30	13 29		14 49	01 05	14 47	02 07	15 24	04 11
23	13 57	00 31	15 41	01 23	14 26	00 08	15 32	02 10	15 25	03 11	16 12	05 16
24	14 55	01 09	16 39	02 22	15 20	01 08	16 12	03 16	16 04	04 15	17 04	06 20
25	15 56	01 53	17 33	03 28	16 10	02 14	16 51	04 22	16 46	05 20	18 00	07 20
26	16 59	02 43	18 23	04 36	16 56	03 21	17 31	05 28	17 32	06 27	18 58	08 16
27	18 00	03 41	19 08	05 46	17 39	04 29	18 12	06 34	18 23	07 32	19 56	09 05
28	18 57	04 45	19 50	06 55	18 20	05 37	18 57	07 41	19 17	08 36	20 53	09 49
29	19 49	05 53			19 00	06 44	19 45	08 47	20 14	09 34	21 48	10 27
30	20 36	07 02			19 41	07 51	20 37	09 52	21 12	10 27	22 40	11 02
31	21 18	08 10			20 23	08 57			22 09	11 13		

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

2002 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	21 06	06 46	21 46	09 02	20 17	07 48	20 49	09 57	21 09	10 49	22 46	11 48
2	21 52	07 54	22 22	10 08	20 54	08 56	21 36	11 02	22 06	11 43	23 41	12 22
3	22 34	09 03	22 58	11 12	21 32	10 03	22 27	12 04	23 04	12 31		12 53
4	23 11	10 09	23 35	12 16	22 13	11 08	23 21	13 00		13 13	00 34	13 22
5	23 47	11 14		13 18	22 56	12 12		13 50	00 00	13 50	01 26	13 51
6		12 17	00 16	14 20	23 44	13 14	00 17	14 35	00 55	14 22	02 19	14 19
7	00 22	13 20	00 59	15 19		14 12	01 13	15 14	01 49	14 52	03 13	14 49
8	00 57	14 22	01 47	16 15	00 34	15 05	02 08	15 48	02 42	15 21	04 08	15 22
9	01 35	15 24	02 38	17 07	01 28	15 52	03 02	16 20	03 35	15 49	05 05	15 58
10	02 16	16 25	03 33	17 53	02 23	16 35	03 56	16 49	04 27	16 18	06 05	16 40
11	03 01	17 25	04 28	18 34	03 19	17 12	04 48	17 18	05 22	16 49	07 05	17 29
12	03 51	18 20	05 24	19 11	04 14	17 46	05 41	17 46	06 18	17 23	08 05	18 24
13	04 44	19 11	06 19	19 44	05 07	18 17	06 34	18 16	07 15	18 01	09 02	19 24
14	05 40	19 56	07 13	20 15	06 00	18 46	07 28	18 48	08 15	18 45	09 54	20 29
15	06 36	20 36	08 05	20 44	06 53	19 15	08 24	19 23	09 14	19 35	10 41	21 34
16	07 31	21 11	08 57	21 12	07 45	19 43	09 22	20 02	10 12	20 31	11 23	22 40
17	08 26	21 43	09 50	21 41	08 38	20 14	10 21	20 47	11 07	21 32	12 01	23 45
18	09 19	22 13	10 43	22 12	09 33	20 46	11 19	21 39	11 57	22 36	12 36	
19	10 12	22 42	11 39	22 46	10 29	21 22	12 16	22 36	12 41	23 41	13 11	00 49
20	11 04	23 11	12 36	23 25	11 27	22 03	13 09	23 39	13 22		13 46	01 53
21	11 57	23 41	13 36		12 26	22 51	13 58		13 59	00 47	14 24	02 58
22	12 52		14 37	00 09	13 25	23 45	14 42	00 45	14 35	01 53	15 05	04 04
23	13 49	00 14	15 37	01 01	14 22		15 23	01 52	15 11	02 59	15 51	05 11
24	14 49	00 50	16 35	02 00	15 15	00 47	16 01	03 00	15 48	04 05	16 42	06 15
25	15 52	01 33	17 28	03 06	16 04	01 53	16 38	04 08	16 28	05 12	17 37	07 17
26	16 55	02 22	18 16	04 16	16 49	03 02	17 16	05 16	17 12	06 20	18 36	08 12
27	17 56	03 19	18 59	05 28	17 30	04 12	17 55	06 25	18 01	07 28	19 35	09 01
28	18 52	04 23	19 39	06 39	18 08	05 22	18 37	07 34	18 55	08 32	20 34	09 43
29	19 43	05 32			18 46	06 32	19 24	08 42	19 52	09 31	21 30	10 20
30	20 28	06 43			19 25	07 41	20 15	09 48	20 50	10 23	22 24	10 53
31	21 08	07 53			20 05	08 49			21 49	11 08		

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

2002 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	20 44	07 12	21 45	09 08	20 19	07 51	21 12	09 37	21 39	10 21	23 04	11 28
2	21 35	08 16	22 27	10 07	21 03	08 52	22 03	10 38	22 34	11 16	23 54	12 08
3	22 22	09 19	23 09	11 05	21 47	09 52	22 56	11 37	23 29	12 06		12 44
4	23 06	10 19	23 52	12 03	22 33	10 52	23 50	12 32		12 51	00 42	13 18
5	23 47	11 18		13 00	23 21	11 51		13 24	00 22	13 32	01 30	13 52
6		12 15	00 37	13 57		12 49	00 44	14 11	01 12	14 10	02 17	14 25
7	00 28	13 11	01 25	14 54	00 11	13 45	01 37	14 54	02 01	14 45	03 05	15 01
8	01 10	14 08	02 15	15 48	01 03	14 38	02 28	15 33	02 48	15 19	03 55	15 38
9	01 53	15 05	03 07	16 40	01 56	15 27	03 17	16 09	03 35	15 52	04 47	16 20
10	02 39	16 02	04 00	17 29	02 49	16 12	04 05	16 44	04 23	16 26	05 42	17 06
11	03 27	16 58	04 53	18 13	03 41	16 54	04 53	17 18	05 12	17 03	06 39	17 57
12	04 19	17 53	05 45	18 54	04 31	17 32	05 40	17 51	06 02	17 42	07 37	18 53
13	05 12	18 45	06 35	19 32	05 20	18 08	06 27	18 26	06 55	18 24	08 35	19 53
14	06 06	19 32	07 24	20 07	06 08	18 43	07 16	19 03	07 51	19 12	09 29	20 54
15	06 59	20 16	08 11	20 41	06 55	19 16	08 07	19 43	08 47	20 04	10 20	21 55
16	07 51	20 56	08 58	21 15	07 43	19 50	09 00	20 27	09 44	21 00	11 07	22 54
17	08 40	21 33	09 46	21 49	08 30	20 25	09 56	21 15	10 40	21 59	11 51	23 53
18	09 29	22 08	10 34	22 25	09 20	21 03	10 52	22 08	11 33	23 00	12 33	
19	10 16	22 42	11 24	23 04	10 11	21 44	11 48	23 05	12 22	24 00	13 14	00 51
20	11 03	23 16	12 17	23 47	11 04	22 29	12 43		13 08		13 56	01 48
21	11 51	23 51	13 12		12 00	23 19	13 36	00 05	13 52	01 00	14 39	02 47
22	12 41		14 10	00 35	12 58		14 25	01 07	14 34	01 59	15 26	03 47
23	13 33	00 29	15 10	01 29	13 55	00 15	15 12	02 09	15 16	02 58	16 17	04 48
24	14 28	01 10	16 09	02 29	14 51	01 14	15 56	03 10	16 00	03 57	17 10	05 49
25	15 27	01 57	17 06	03 33	15 44	02 17	16 40	04 11	16 46	04 58	18 07	06 49
26	16 28	02 49	17 59	04 38	16 34	03 21	17 24	05 12	17 35	06 00	19 04	07 45
27	17 29	03 48	18 48	05 44	17 21	04 26	18 10	06 14	18 28	07 03	20 00	08 36
28	18 28	04 51	19 35	06 48	18 07	05 29	18 58	07 17	19 24	08 04	20 54	09 22
29	19 23	05 57			18 51	06 31	19 49	08 20	20 21	09 03	21 46	10 04
30	20 14	07 02			19 36	07 33	20 43	09 22	21 17	09 57	22 35	10 41
31	21 01	08 06			20 23	08 35			22 12	10 45		

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

2002 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	21 50	08 00	22 43	10 04	21 16	08 48	22 01	10 43	22 26	11 30	23 55	12 33
2	22 40	09 06	23 22	11 06	21 57	09 52	22 51	11 45	23 22	12 24		13 11
3	23 24	10 11		12 06	22 39	10 55	23 43	12 45		13 14	00 47	13 45
4		11 14	00 02	13 06	23 23	11 56		13 41	00 18	13 57	01 37	14 17
5	00 06	12 15	00 43	14 05		12 57	00 37	14 32	01 12	14 36	02 26	14 48
6	00 45	13 14	01 26	15 04	00 09	13 56	01 32	15 18	02 04	15 12	03 15	15 20
7	01 23	14 13	02 13	16 01	00 58	14 53	02 26	15 59	02 54	15 45	04 06	15 53
8	02 02	15 11	03 02	16 57	01 50	15 46	03 18	16 36	03 44	16 17	04 58	16 29
9	02 44	16 10	03 54	17 48	02 43	16 34	04 09	17 11	04 33	16 48	05 52	17 09
10	03 28	17 09	04 48	18 36	03 37	17 18	04 59	17 43	05 23	17 20	06 49	17 54
11	04 15	18 06	05 42	19 19	04 30	17 58	05 49	18 15	06 13	17 55	07 47	18 44
12	05 06	19 01	06 35	19 58	05 23	18 35	06 38	18 47	07 06	18 32	08 46	19 40
13	06 00	19 52	07 27	20 34	06 13	19 09	07 28	19 20	08 01	19 13	09 43	20 40
14	06 54	20 39	08 17	21 07	07 03	19 41	08 19	19 54	08 58	19 59	10 37	21 43
15	07 48	21 21	09 07	21 39	07 52	20 13	09 12	20 33	09 56	20 51	11 26	22 45
16	08 41	21 59	09 56	22 11	08 41	20 45	10 07	21 15	10 53	21 47	12 11	23 47
17	09 33	22 34	10 45	22 44	09 31	21 18	11 03	22 02	11 48	22 47	12 52	
18	10 23	23 07	11 35	23 18	10 23	21 54	12 00	22 55	12 40	23 49	13 32	00 48
19	11 12	23 39	12 27	23 55	11 16	22 33	12 57	23 52	13 27		14 10	01 48
20	12 01		13 22		12 11	23 17	13 51		14 11	00 51	14 50	02 49
21	12 51	00 11	14 19	00 36	13 08		14 42	00 54	14 52	01 53	15 31	03 50
22	13 43	00 44	15 18	01 23	14 06	00 06	15 29	01 57	15 32	02 55	16 16	04 52
23	14 37	01 20	16 18	02 17	15 03	01 02	16 14	03 01	16 12	03 56	17 05	05 55
24	15 34	02 00	17 17	03 16	15 58	02 02	16 56	04 05	16 53	04 59	17 58	06 57
25	16 35	02 45	18 12	04 21	16 50	03 07	17 37	05 08	17 37	06 02	18 54	07 58
26	17 36	03 37	19 03	05 29	17 37	04 13	18 18	06 12	18 24	07 06	19 52	08 53
27	18 37	04 35	19 50	06 37	18 22	05 19	19 02	07 17	19 16	08 11	20 49	09 43
28	19 35	05 39	20 34	07 43	19 05	06 25	19 48	08 22	20 11	09 13	21 44	10 28
29	20 29	06 46			19 47	07 30	20 38	09 27	21 08	10 12	22 38	11 07
30	21 17	07 54			20 29	08 35	21 31	10 30	22 05	11 05	23 29	11 43
31	22 01	09 00			21 14	09 39			23 01	11 52		

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

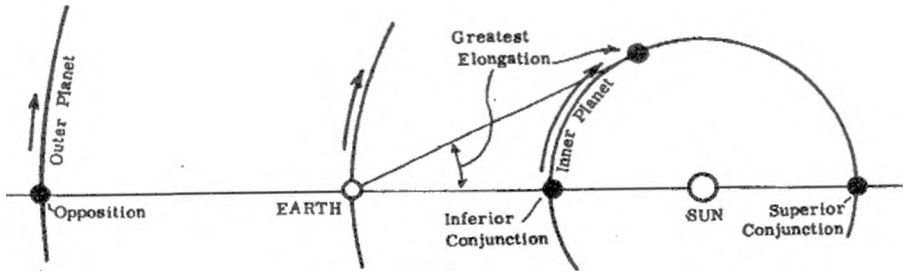
THE PLANETS

BASIC DATA

	Dist from Sun 10^6 km	Revolution years	Mass (Earth = 1)	Diameter 10^3 km	Period	Equatorial of Equator to orbit	Rotation 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'	18
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:

February 3 (at mag.+2.0) to March 29 (at mag.-1.0),
June 6 (at mag.+2.9) to July 13 (at mag.-1.4) and
October 5 (at mag.+1.5) to October 31 (at mag.-1.0)

The best conditions for viewing will occur from mid February until mid March when Mercury will be found in Capricornus and later in Aquarius.

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

January 1 (at mag.-0.8) to January 22 (at mag.+1.7),
April 16 (at mag.-1.5) to May 17 (at mag.+2.3),
July 29 (at mag.-1.2) to September 21 (at mag.+2.3) and
December 1 (at mag.-0.7) to December 31 (at mag.-0.1)

The best conditions for viewing will be from mid August to mid September, when Mercury will be found first in Leo and later in Virgo.

	d h		d h		d h		d h	
Superior Conjunction			Apr 7 11		Jul 21 4		Nov 14 7	
Greatest Elongation East	Jan 12 1	(19°)	May 4 6	(21°)	Sep 1 12	(27°)	Dec 26 7	(20°)
Stationary	Jan 18 11		May 16 7		Sep 14 16			
Inferior Conjunction	Jan 27 21		May 27 9		Sep 27 21			
Stationary	FeB 8 12		Jun 8 13		Oct 6 4			
Greatest Elongation West	Feb 21 18	(27°)	Jun 21 17	(23°)	Oct 13 10	(18°)		

VENUS

Venus will make its first appearance of the year in the evening sky in late February (at mag.-3.9) where it remains until the last week in October. It reachs greatest brilliancy (at mag.-4.6) on September 26.

It will re-appears in the morning sky at the end of the first week of November (at mag. -4.1) reaching greatest brilliancy (at mag.-4.6) on December 7.

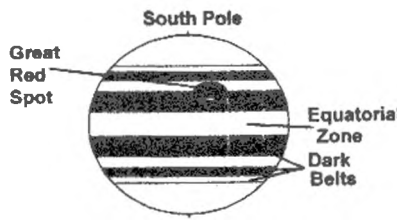
	d h			d h
Superior conjunction	Jan 14 14	Inferior Conjunction		Oct 31 14
Greatest Elongation East	Aug 22 15 (46°)	Stationary		Nov 19 6
Stationary	Oct 10 11			

MARS

Mars, visible (at mag.+0.8) in the evening sky, begins the year in the constellation of Aquarius, passing to Pisces in the second week of January (at mag.+0.9), into Aries in late February (at mag.+1.3), into Taurus in early April (at mag.+1.5) and into Gemini in late May (at mag.+1.7) where, during the second half of May, it becomes too close to the sun to be seen. It reappears in the morning sky, in Leo (at mag.+1.8), in late September. It passes to Virgo in the first week of October and into Libra in mid December (at mag.+1.6).

JUPITER

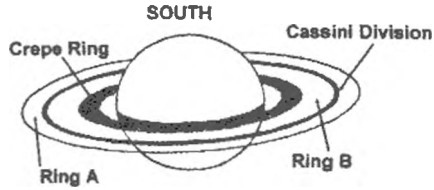
Jupiter (at mag.-2.7) begins the year as an all night object in Gemini becomming an evening sky object from late March (at mag.-2.2). It will be too close to the Sun to be seen in early July. It re-appears in the morning sky in early August (at mag.-1.8) having passed in the meantime into Cancer. It passes in mid November into Leo (at mag.-2.2) and can be seen for more than half the night and passes back into Cancer in mid December (at mag.-2.4).



SATURN

Saturn (at mag.+0.7), found in Taurus, will be seen for more than half the night until late February (at mag.+0.0) after which it becomes an evening sky object

until the second half of May when it will be too close to the Sun to be seen. It will reappear in the morning sky in late June (at mag.+0.1). It passes into Orion at the beginning of September and back into Taurus (at mag.+0.3) in the second half of November, where it remains for the rest of the year. It will be an all night object by the middle of December (at mag. -0.5).

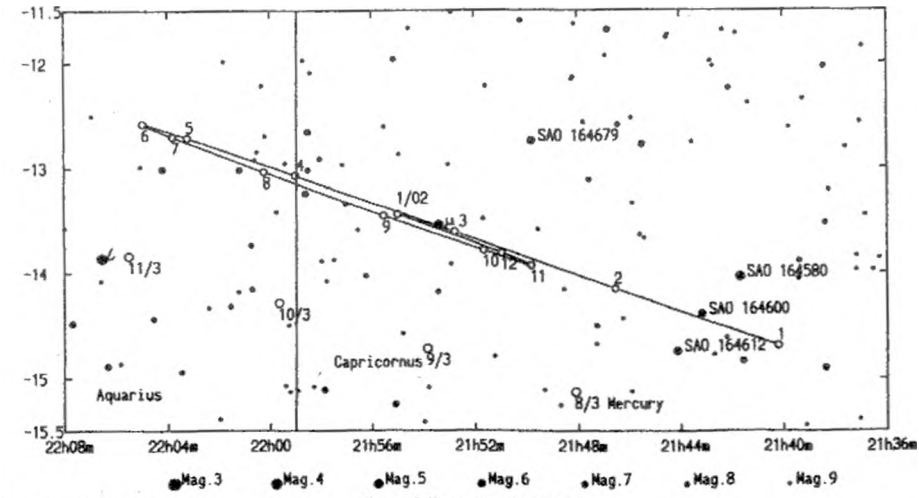


URANUS AND NEPTUNE

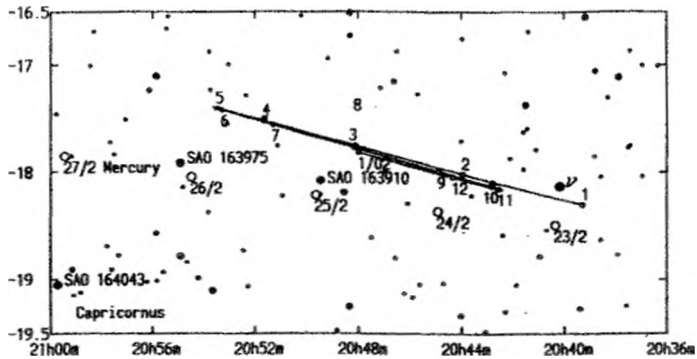
Uranus visible with optical aid and found in Capricornus, will be an evening sky object until the fourth week of January. It will reappear in the morning sky in the second week of March and pass into Aquarius at the end of March and back into Capricornus in mid August. At opposition on August 20, it will be at magnitude 5.6. It becomes an evening sky object from mid November.

Neptune, visible with optical aid, will set during the evening twilight for the after mid January. The planet will be found in the morning sky still in Capricornus, after mid February. At opposition on August 2, it will be at magnitude +7.9. It becomes an evening sky object in early November.

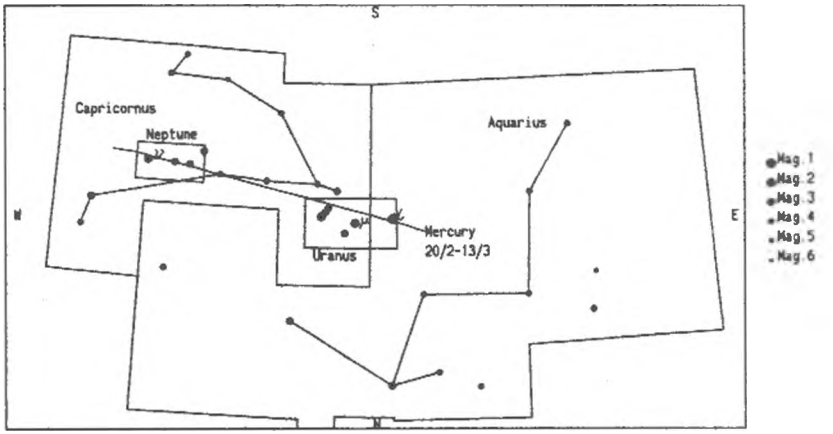
The Path of Uranus.



The Path of Neptune.



Sky Chart for the Paths of Uranus and Neptune



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 - 22 Jan Jupiter, Mars, Mercury and Saturn visible
23 Jan - 24 Feb Jupiter, Mars, and Saturn visible
25 Feb - 15 Apr Jupiter, Mars Saturn and Venus visible
16 Apr - 17 May Jupiter, Mars, Mercury, Saturn and Venus visible
 4 May          Mars and Saturn in conjunction
 7 May          Saturn and Venus in conjunction
10 May          Mars and Venus in conjunction
18 May - 22 May Jupiter, Mars, Saturn and Venus visible
23 May - 24 Jun Jupiter, Mars and Venus visible
 3 Jun          Jupiter and Venus in conjunction
25 Jun -  6 Jul Jupiter and Venus visible
 2 Jul          Mercury and Saturn in conjunction
 3 Jul          Jupiter and Mars in conjunction
29 Jul - 21 Sep Mercury and Venus visible
17 Dec - 31 Dec Mercury and Saturn visible
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Morning Sky:

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28 Jun - 13 Jul Mercury and Saturn visible
 3 Aug - 24 Sep Jupiter and Saturn visible
25 Sep -  4 Oct Jupiter, Mars and Saturn visible
 5 Oct - 31 Oct Jupiter, Mars, Mercury and Saturn visible
 1 Nov -  6 Nov Jupiter, Mars and Saturn visible
 7 Nov - 17 Dec Jupiter, Mars, Saturn and Venus visible
18 Dec - 31 Dec Jupiter, Mars and Venus visible
```

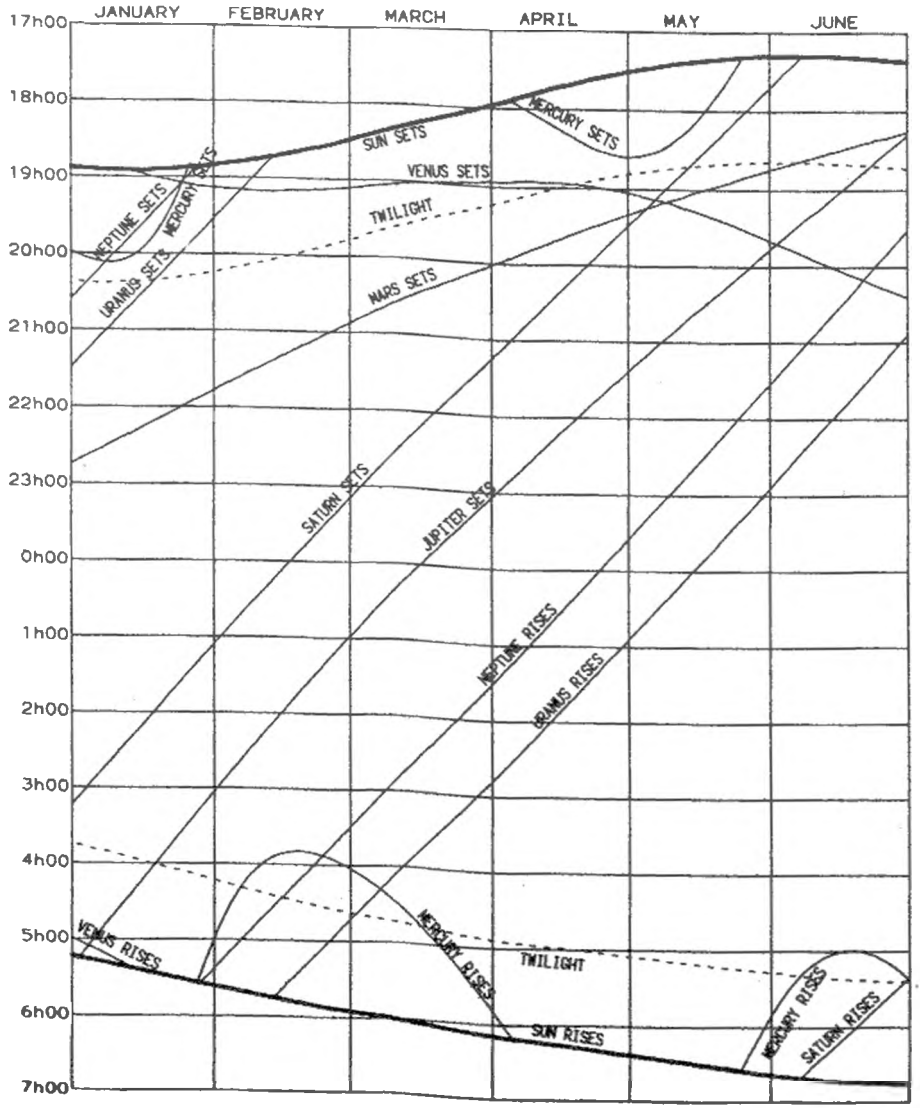
APPARENT PLACES:

	Mercury		Venus		Mars		Jupiter	
	RA	DEC	RA	DEC	RA	DEC	RA	DEC
	h m	° ′	h m	° ′	h m	° ′	h m	° ′
Jan 1	19 51.9	-23 2	18 31.3	-23 39	23 12.8	-5 50	6 46.4	23 1
Jan 11	20 48.8	-18 43	19 25.9	-22 45	23 39.5	-2 46	6 40.6	23 8
Jan 21	21 3.9	-14 54	20 19.4	-20 41	0 6.0	0 17	6 35.2	23 14
Jan 31	20 20.7	-15 48	21 11.0	-17 37	0 32.4	3 19	6 30.7	23 19
Feb 10	20 1.4	-18 9	22 0.5	-13 42	0 58.9	6 17	6 27.3	23 23
Feb 20	20 27.6	-18 45	22 48.2	-9 11	1 25.5	9 7	6 25.2	23 25
Mar 2	21 15.0	-17 8	23 34.4	-4 16	1 52.3	11 49	6 24.5	23 27
Mar 12	22 11.4	-13 22	0 19.8	0 51	2 19.4	14 19	6 25.3	23 27
Mar 22	23 12.9	-7 30	1 5.2	5 57	2 46.8	16 36	6 27.4	23 27
Apr 1	0 19.5	0 15	1 51.1	10 50	3 14.7	18 39	6 30.9	23 25
Apr 11	1 32.8	9 21	2 38.3	15 18	3 42.9	20 24	6 35.5	23 23
Apr 21	2 49.2	17 48	3 27.0	19 8	4 11.4	21 52	6 41.1	23 18
May 1	3 52.6	22 52	4 17.5	22 8	4 40.2	23 0	6 47.6	23 12
May 11	4 27.9	23 57	5 9.5	24 7	5 9.2	23 49	6 54.9	23 4
May 21	4 29.0	21 50	6 2.3	24 59	5 38.3	24 17	7 2.8	22 54
May 31	4 9.4	18 13	6 54.9	24 40	6 7.3	24 25	7 11.2	22 41
Jun 10	4 0.7	16 24	7 46.3	23 11	6 36.0	24 13	7 20.0	22 26
Jun 20	4 19.7	17 45	8 35.7	20 41	7 4.5	23 41	7 29.0	22 8
Jun 30	5 7.0	20 53	9 22.5	17 18	7 32.4	22 51	7 38.3	21 48
Jul 10	6 21.4	23 23	10 6.7	13 14	7 59.9	21 43	7 47.7	21 26
Jul 20	7 52.6	22 26	10 48.4	8 41	8 26.8	20 20	7 57.1	21 2
Jul 30	9 17.6	17 35	11 27.9	3 51	8 53.0	18 42	8 6.5	20 36
Aug 9	10 26.6	10 50	12 5.4	-1 6	9 18.7	16 52	8 15.7	20 8
Aug 19	11 22.1	3 47	12 41.1	-6 0	9 43.9	14 51	8 24.7	19 40
Aug 29	12 5.9	-2 37	13 14.8	-10 39	10 8.5	12 41	8 33.4	19 10
Sep 8	12 35.6	-7 25	13 45.9	-14 54	10 32.7	10 23	8 41.7	18 41
Sep 18	12 40.3	-8 44	14 12.8	-18 34	10 56,6	7 59	8 49.6	18 12
Sep 28	12 11.5	-4 0	14 33.2	-21 24	11 20.2	5 30	8 56.8	17 44
Oct 8	11 55.3	1 12	14 43.3	-23 4	11 43.6	2 58	9 3.4	17 18
Oct 18	12 30.9	-1 9	14 39.2	-23 2	12 7.0	0 24	9 9.2	16 55
Oct 28	13 29.2	-7 33	14 21.9	-20 47	12 30.4	-2 9	9 14.2	16 35
Nov 7	14 31.3	-14 10	14 1.4	-16 53	12 53.9	-4 41	9 18.1	16 19
Nov 17	15 34.6	-19 42	13 50.8	-13 14	13 17.7	-7 10	9 21.0	16 8
Nov 27	16 40.1	-23 37	13 54.9	-11 17	13 41.7	-9 34	9 22.6	16 3
Dec 7	17 47.5	-25 32	14 11.8	-11 9	14 6.2	-11 52	9 23.0	16 3
Dec 17	18 53.9	-25 7	14 37.8	-12 18	14 31.0	-14 2	9 22.1	16 10
Dec 27	19 48.1	-22 27	15 10.5	-14 11	14 56.4	-16 2	9 19.9	16 22

	Saturn		Uranus		Neptune		Pluto	
	RA	DEC	RA	DEC	RA	DEC	RA	DEC
	h m	° ′	h m	° ′	h m	° ′	h m	° ′
Jan 1	4 31.7	20 4	21 40.2	-14 41	20 39.3	-18 18	17 3.5	-13 0
Jan 11	4 29.3	20 1	21 42.1	-14 32	20 40.7	-18 13	17 4.9	-13 1
Jan 21	4 27.5	19 59	21 44.2	-14 21	20 42.3	-18 7	17 6.2	-13 2
Jan 31	4 26.5	19 59	21 46.3	-14 10	20 43.8	-18 2	17 7.3	-13 2
Feb 10	4 26.2	20 1	21 48.6	-13 59	20 45.3	-17 56	17 8.3	-13 1
Feb 20	4 26.7	20 5	21 50.8	-13 47	20 46.8	-17 50	17 9.0	-13 0
Mar 2	4 28.0	20 11	21 53.0	-13 36	20 48.2	-17 45	17 9.6	-12 58
Mar 12	4 30.1	20 17	21 55.1	-13 24	20 49.5	-17 40	17 9.9	-12 56
Mar 22	4 32.8	20 26	21 57.2	-13 14	20 50.7	-17 35	17 10.0	-12 54
Apr 1	4 36.1	20 35	21 59.0	-13 4	20 51.7	-17 31	17 9.9	-12 52
Apr 11	4 40.0	20 44	22 0.7	-12 56	20 52.5	-17 28	17 9.5	-12 49
Apr 21	4 44.4	20 54	22 2.1	-12 48	20 53.1	-17 26	17 9.0	-12 47
May 1	4 49.2	21 4	22 3.2	-12 43	20 53.5	-17 24	17 8.3	-12 44
May 11	4 54.2	21 14	22 4.1	-12 38	20 53.6	-17 24	17 7.4	-12 42
May 21	4 59.5	21 23	22 4.7	-12 36	20 53.6	-17 24	17 6.4	-12 41
May 31	5 5.0	21 32	22 4.9	-12 35	20 53.3	-17 25	17 5.4	-12 39
Jun 10	5 10.6	21 40	22 4.9	-12 35	20 52.9	-17 27	17 4.3	-12 39
Jun 20	5 16.1	21 47	22 4.5	-12 38	20 52.2	-17 30	17 3.2	-12 38
Jun 30	5 21.6	21 52	22 3.9	-12 42	20 51.4	-17 33	17 2.2	-12 39
Jul 10	5 27.0	21 57	22 3.0	-12 47	20 50.5	-17 37	17 1.3	-12 40
Jul 20	5 32.1	22 1	22 1.8	-12 53	20 49.4	-17 41	17 0.4	-12 42
Jul 30	5 36.9	22 4	22 0.5	-13 1	20 48.3	-17 46	16 59.8	-12 44
Aug 9	5 41.4	22 6	21 59.1	-13 8	20 47.3	-17 50	16 59.3	-12 47
Aug 19	5 45.4	22 8	21 57.5	-13 17	20 46.2	-17 54	16 59.0	-12 51
Aug 29	5 48.8	22 8	21 56.0	-13 25	20 45.2	-17 58	16 58.9	-12 55
Sep 8	5 51.7	22 8	21 54.5	-13 33	20 44.3	-18 2	16 59.0	-12 59
Sep 18	5 53.9	22 8	21 53.2	-13 40	20 43.5	-18 5	16 59.4	-13 4
Sep 28	5 55.3	22 8	21 52.0	-13 46	20 43.0	-18 7	17 0.0	-13 9
Oct 8	5 56.0	22 7	21 51.0	-13 50	20 42.6	-18 9	17 0.8	-13 14
Oct 18	5 55.9	22 7	21 50.3	-13 54	20 42.4	-18 10	17 1.7	-13 19
Oct 28	5 55.0	22 6	21 49.9	-13 55	20 42.5	-18 10	17 2.9	-13 24
Nov 7	5 53.3	22 6	21 49.8	-13 55	20 42.8	-18 9	17 4.1	-13 28
Nov 17	5 51.0	22 5	21 50.1	-13 54	20 43.3	-18 7	17 5.5	-13 32
Nov 27	5 48.1	22 5	21 50.6	-13 50	20 44.0	-18 4	17 7.0	-13 36
Dec 7	5 44.8	22 4	21 51.5	-13 45	20 44.9	-18 1	17 8.5	-13 40
Dec 17	5 41.3	22 3	21 52.7	-13 39	20 46.0	-17 57	17 10.1	-13 42
Dec 27	5 37.7	22 3	21 54.2	-13 31	20 47.3	-17 52	17 11.6	-13 45

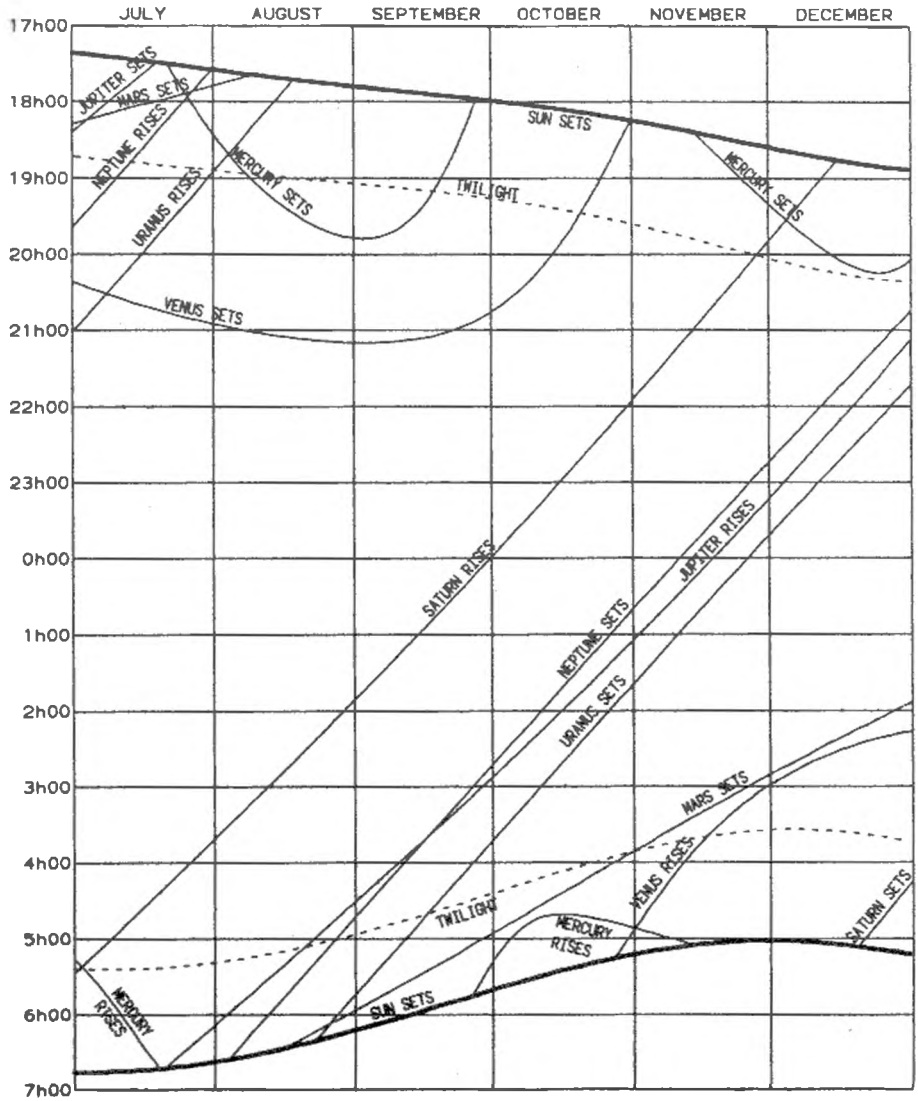
TIMES OF RISING AND SETTING

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.



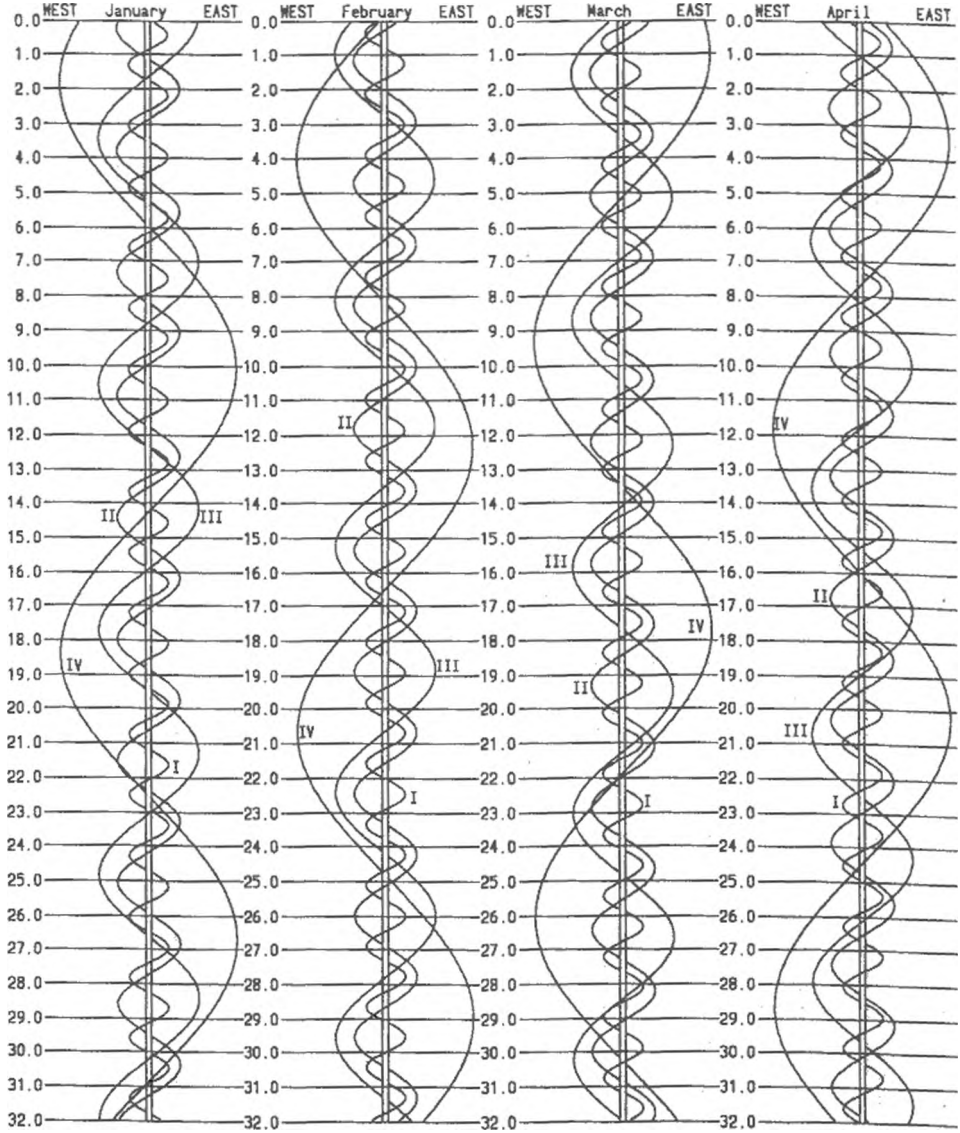
CORRECTION FOR PLACES NOT ON THE 30° E MERIDIAN
Approximate longitude corrections from the 30° East meridian are:

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

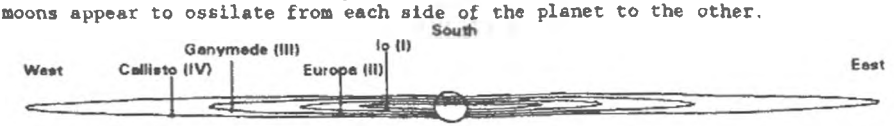


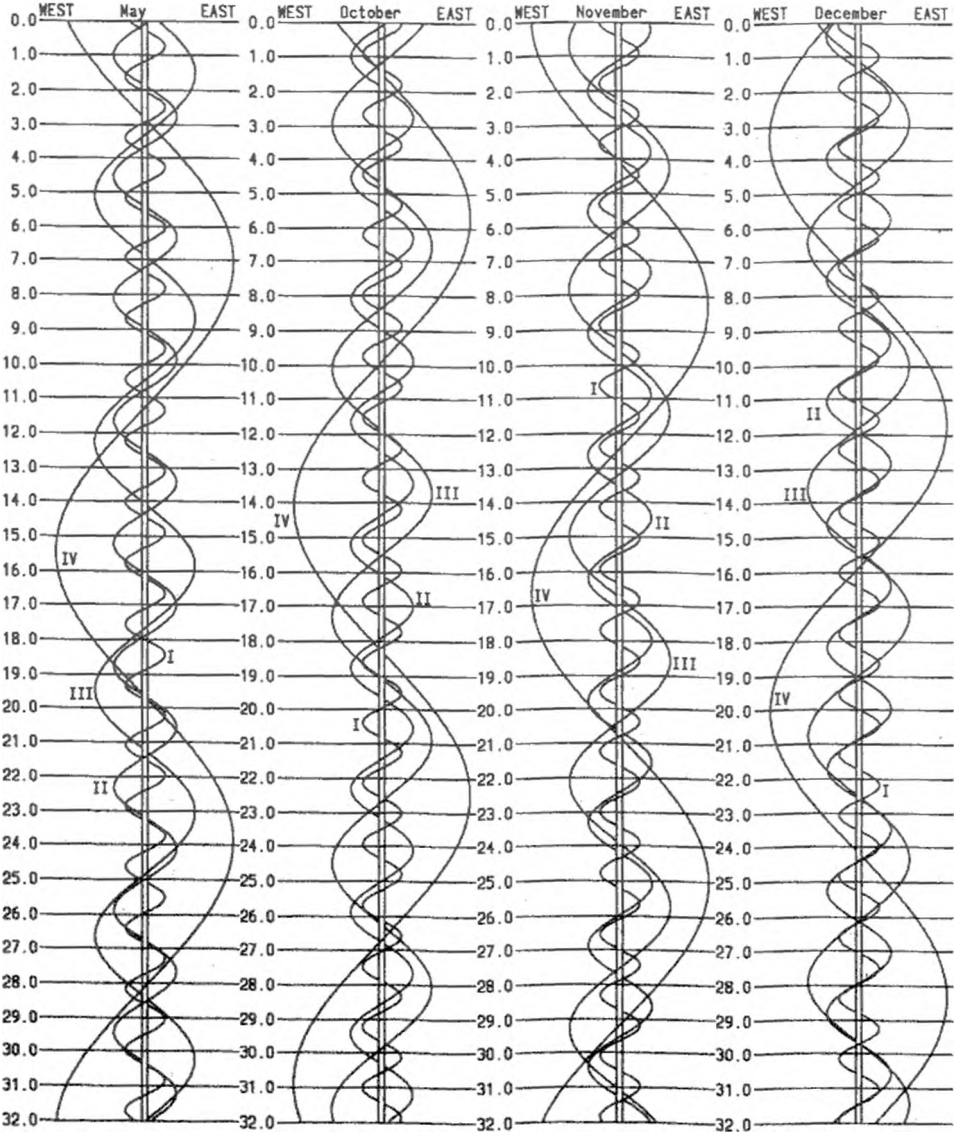
THE MOONS OF JUPITER

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

	d	h	m	
Apr	24	19	11	IV.Sh.I.
		20	05	II.Ec.R.
		20	24	I.Oc.D.
	25	18	45	I.Sh.I.
		19	50	I.Tr.E.
		21	01	I.Sh.E.
	29	21	36	III.Ec.R.
May	02	19	25	IV.Oc.R.
		19	34	I.Tr.I.
		20	41	I.Sh.I.
	03	20	15	I.Ec.R.
	06	21	09	III.Oc.R.
	08	20	19	II.Oc.D.
	10	18	51	I.Oc.D.
		20	08	II.Sh.E.
	11	18	19	I.Tr.E.
		19	21	I.Sh.E.
	17	19	33	III.Sh.E.
		19	55	II.Sh.I.
		20	50	II.Tr.E.
		20	51	I.Oc.D.
	18	19	00	I.Sh.I.
		20	20	I.Tr.E.
	19	18	33	I.Ec.R.
		20	34	IV.Ec.D.
	24	20	00	III.Tr.E.
		20	15	III.Sh.I.
	25	20	04	I.Tr.I.
	26	19	57	II.Ec.R.
Jun	02	19	21	I.Oc.D.
	03	18	52	I.Tr.E.
		19	37	I.Sh.E.
	05	18	43	IV.Ec.R.
	10	18	37	I.Tr.I.
		19	15	I.Sh.I.
	11	18	33	II.Tr.E.
		18	45	I.Ec.R.
	18	18	31	II.Tr.I.
Aug	15	06	06	III.Ec.D.
	20	05	44	IV.Sh.E.
		06	03	IV.Tr.I.
	23	05	58	I.Ec.D.
	24	05	36	I.Sh.E.
		06	10	I.Tr.E.
	26	06	-1	III.Tr.E.
	31	05	13	I.Sh.I.

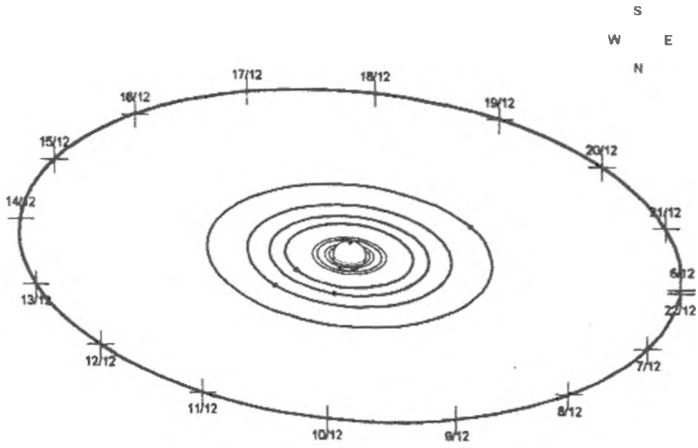
	d	h	m	
Aug	31	05	53	I.Tr.I.
Sep	01	05	19	I.Oc.R.
	03	05	41	II.Ec.D.
	09	04	40	I.Tr.E.
	12	05	17	II.Sh.E.
	13	05	00	III.Oc.R.
	16	04	22	I.Tr.I.
		05	46	I.Sh.E.
	19	05	01	II.Sh.I.
	20	05	29	III.Ec.R.
		05	45	III.Oc.D.
	21	04	57	II.Oc.R.
	23	05	23	I.Sh.I.
	24	05	47	I.Oc.R.
Oct	01	03	46	III.Tr.E.
		04	23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

	d	h	m	
Nov	02	05	21	III.Ec.R.
	03	01	46	I.Tr.E.
	04	01	43	IV.Oc.R.
	06	04	52	II.Ec.D.
	08	01	40	II.Tr.I.
		02	-1	II.Sh.E.
		04	33	II.Tr.E.
	09	02	47	I.Ec.D.
	10	01	23	I.Tr.I.
		02	24	I.Sh.E.
		03	39	I.Tr.E.
	13	00	50	III.Tr.I.
		04	25	III.Tr.E.
	15	01	42	II.Sh.I.
		04	15	II.Tr.I.
		04	35	II.Sh.E.
	16	04	41	I.Ec.D.
	17	02	01	I.Sh.I.
		02	04	II.Oc.R.
		03	15	I.Tr.I.
		04	17	I.Sh.E.
	18	02	44	I.Oc.R.
	20	02	45	IV.Ec.D.
		03	16	III.Sh.E.
		04	42	III.Tr.I.
	22	04	18	II.Sh.I.
	24	03	54	I.Sh.I.
		04	34	II.Oc.R.
		05	06	I.Tr.I.
	25	01	03	I.Ec.D.
		04	35	I.Oc.R.
	26	00	39	I.Sh.E.
		01	50	I.Tr.E.
	27	03	41	III.Sh.I.
	29	00	21	IV.Tr.I.
		05	06	IV.Tr.E.
Dec	01	01	49	II.Ec.D.
		02	06	III.Oc.R.
	02	02	56	I.Ec.D.
	03	00	16	I.Sh.I.
		01	24	I.Tr.I.
		01	26	II.Tr.E.
		02	32	I.Sh.E.
		03	40	I.Tr.E.
	04	00	53	I.Oc.R.
	07	01	33	IV.Ec.R.

	d	h	m	
Dec	08	01	14	III.Ec.R.
		02	09	III.Oc.D.
		04	22	II.Ec.D.
	09	04	50	I.Ec.D.
	10	01	00	II.Tr.I.
		01	41	II.Sh.E.
		02	09	I.Sh.I.
		03	13	I.Tr.I.
		03	54	II.Tr.E.
		04	25	I.Sh.E.
		23	19	I.Ec.D.
	11	02	43	I.Oc.R.
		23	56	I.Tr.E.
	15	01	35	III.Ec.D.
		05	12	III.Ec.R.
	17	01	23	II.Sh.I.
		03	25	II.Tr.I.
		04	02	I.Sh.I.
		04	17	II.Sh.E.
		05	00	I.Tr.I.
	18	01	12	I.Ec.D.
		04	31	I.Oc.R.
		22	30	I.Sh.I.
		23	05	III.Tr.E.
		23	27	I.Tr.I.
	19	00	46	I.Sh.E.
		01	00	II.Oc.R.
		01	44	I.Tr.E.
		22	58	I.Oc.R.
	23	23	18	IV.Oc.D.
	24	04	-1	II.Sh.I.
		04	10	IV.Oc.R.
	25	03	06	I.Ec.D.
		22	45	II.Ec.D.
		23	-1	III.Tr.I.
		23	07	III.Sh.E.
	26	00	23	I.Sh.I.
		01	14	I.Tr.I.
		02	36	III.Tr.E.
		02	40	I.Sh.E.
		03	19	II.Oc.R.
		03	30	I.Tr.E.
	27	00	44	I.Oc.R.
		21	52	II.Tr.E.
		21	57	I.Tr.E.

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 December 17. 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	5	01.1	Jan	9	03.8	Jan	12	23.6	Jan	16	19.8
	16	22.9		25	01.8		28	21.7	Feb	1	18.0
Feb	5	21.2	Feb	10	00.3	Feb	13	20.4		17	16.8
	1	20.2		25	23.3	Mar	1	19.6	Mar	5	16.1
Mar	9	19.7	Mar	13	22.9		17	19.2		21	16.0
	5	19.7		29	23.0	Apr	2	19.3	Apr	6	16.3
Apr	6	20.2	Apr	14	23.5		18	19.8		22	16.9
	6	21.0		31	00.2	May	4	20.5	May	8	17.9
May	2	22.1	May	17	01.2		20	21.5		24	19.0
	8	23.4	Jun	2	02.4	Jun	5	22.5	Jun	9	20.1
Jun	4	00.7		18	03.5		21	23.5		25	21.3
	25	02.0	Jul	4	04.6	Jul	8	00.5	Jul	11	22.4
Jul	6	03.1		20	05.5		24	01.3		27	23.3
Aug	1	04.0	Aug	5	06.2	Aug	9	01.8	Aug	13	00.0
	7	04.7		21	06.6		25	02.1		29	00.2
Sep	2	04.9	Sep	6	06.6	Sep	10	02.0	Sep	14	00.1
	8	04.6		22	06.1		26	01.4		29	23.4
Oct	4	03.9	Oct	8	05.2	Oct	12	00.3	Oct	16	22.2
	16	02.5		24	03.7		27	22.7		31	20.5
Nov	5	00.6	Nov	9	01.7	Nov	12	20.6	Nov	16	18.2
	16	22.1		24	23.2		28	18.1	Dec	2	15.5
Dec	6	19.3	Dec	10	20.5	Dec	14	15.4		18	12.7
	2	16.4		26	17.6		30	12.6			

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 2002, 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	Possible Maximum Magnitude
Borrelly	19P	2001 September 14	11-12
LINEAR	C/2000 WM1	2002 January 22	6
Pons-Winnecke	7P	2002 August 19	10-11
Wirtanen	46P	2002 August 26	10-11
Kopff	22P	2002 December 12	11
LINEAR-NEAT	C/2001 HT50	2003 July 8	12

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. 011-987-2250.
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 magnitude -3 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 2002
Alpha Crucids	Jan19	Jan06-Jan28	12h48	-63	<5	50	00h00	03h30	Favourable
Alpha Centaurids	Feb 8	Jan28-Feb23	14h00	-40	5	60	22h00	03h30	Good
Gamma Normids	Mar 13	Feb25-Mar22	16h36	-51	8	56	00h00	04h30	Favourable
Delta Pavonids	Apr 6	Mar11-Apr16	20h32	-63	5	59	02h00	04h30	Marginal
April Lyrids	Apr 22	Apr16-Apr24	18h05	+34	15	49	03h00	05h00	Favourable
Pi Puppids	Apr 23	Apr16-Apr25	07h20	-45	<5	18	19h00	22h00	Poor
Alpha Scorpiids	May 3	Apr11-May12	16h00	-27	5	35	21h00	04h00	Poor
Eta Aquarids	May 5	Apr21-May12	22h24	-02	50	65	04h00	05h30	Poor
Chi Scorpiids	Jun 5	May27-Jun20	16h32	-14	5	21	21h00	04h30	Good
Sagittarids	Jun 11	Jun08-Jun16	20h16	-35	<5	52	20h00	05h30	New Moon
Theta 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	23h00	05h00	Favourable
Piscis Australids	Jul 28	Jul19-Aug17	22h40	-30	8	35	21h30	05h00	Unfavourable
Sth delta Aquarids	Jul 29	Jul21-Aug29	22h36	-16	30	42	22h00	05h00	Unfavourable
alpha Capricornids	Jul 30	Jul15-Aug25	20h28	-10	10	25	20h00	04h00	Unfavourable
Sth iota Aquarids	Aug 5	Jul15-Aug25	22h12	-15	<5	34	22h00	04h30	Good
Nth delta Aquarids	Aug 12	Jul14-Aug25	22h28	-05	10	42	23h00	05h00	Favourable
Nth iota Aquarids	Aug 19	Jul15-Sep20	21h48	-06	10	36	20h00	05h00	Unfavourable
Orionids	Oct 21	Oct02-Nov07	06h20	+16	30	68	00h00	04h00	Full moon
Southern Taurids	Nov 5	Sep15-Dec01	03h20	+14	10	29	21h30	03h30	New moon
Northern Taurids	Nov 12	Sep19-Dec01	04h00	+23	5	31	21h30	03h30	Good
Leonids	Nov 18	Nov14-Nov20	10h08	+22	10*	70	03h00	04h00	Unfavourable
Dec. Phoenicids	Dec 6	Dec03-Dec05	01h12	-53	5	22	20h30	02h00	Favourable
Geminids	Dec 14	Dec04-Dec16	07h28	+33	50	36	23h30	03h00	Poor
Velids	Dec 29	Dec05-Jan07	09h56	-51	5	40	22h30	03h30	Marginal

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. 4.) *ZHR for Leonids is for non-storm activity. Under storm conditions, predicted for 2002 November 18/19, rates may be as high as several hundred per hour for a brief period.

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

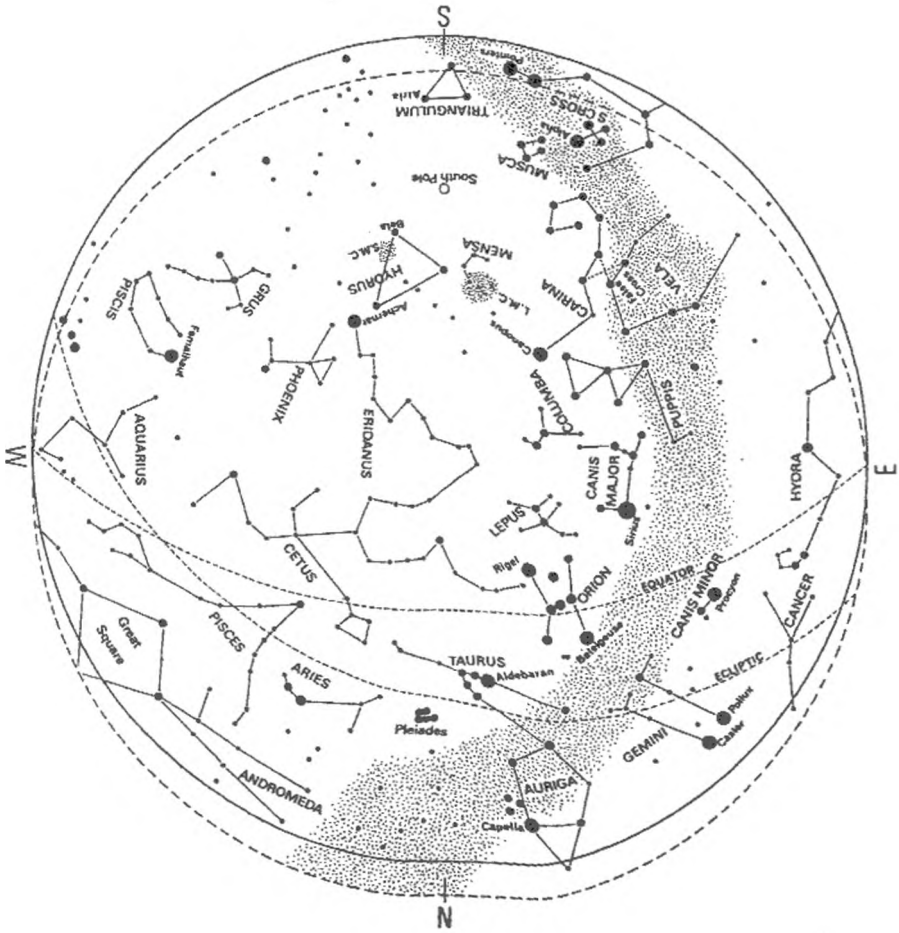
The star charts in this section show the night sky for each of the four seasons of the year. These seasonal charts depict stars down to magnitude 3.5 which is approximately what will be visible to the naked eye in city areas. Charts of 3 of the most interesting regions in the sky (showing stars down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

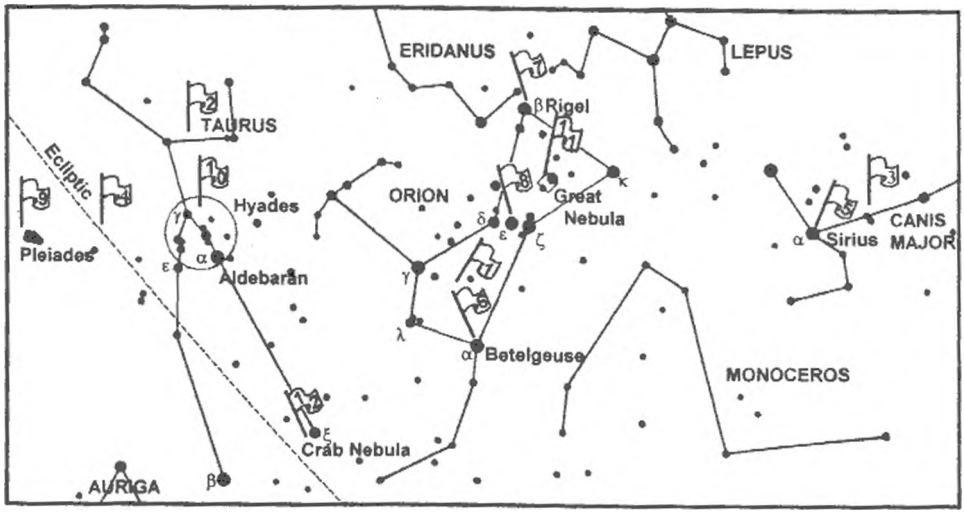
The chart below represents the sky in Cape Town on December 1 at midnight, January 1 at 10 pm and February 1 at 8 pm. Corrections for places other than Cape Town are

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.



PLANETARIUM  SA MUSEUM



THE ORION REGION

(1) The constellation of Orion. The figure of the legendary hunter of Greek mythology is unfortunately upside down when seen from Southern Africa. The faint stars by λ represent the head, α and γ the shoulders, δ - ε - ζ 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 β 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.

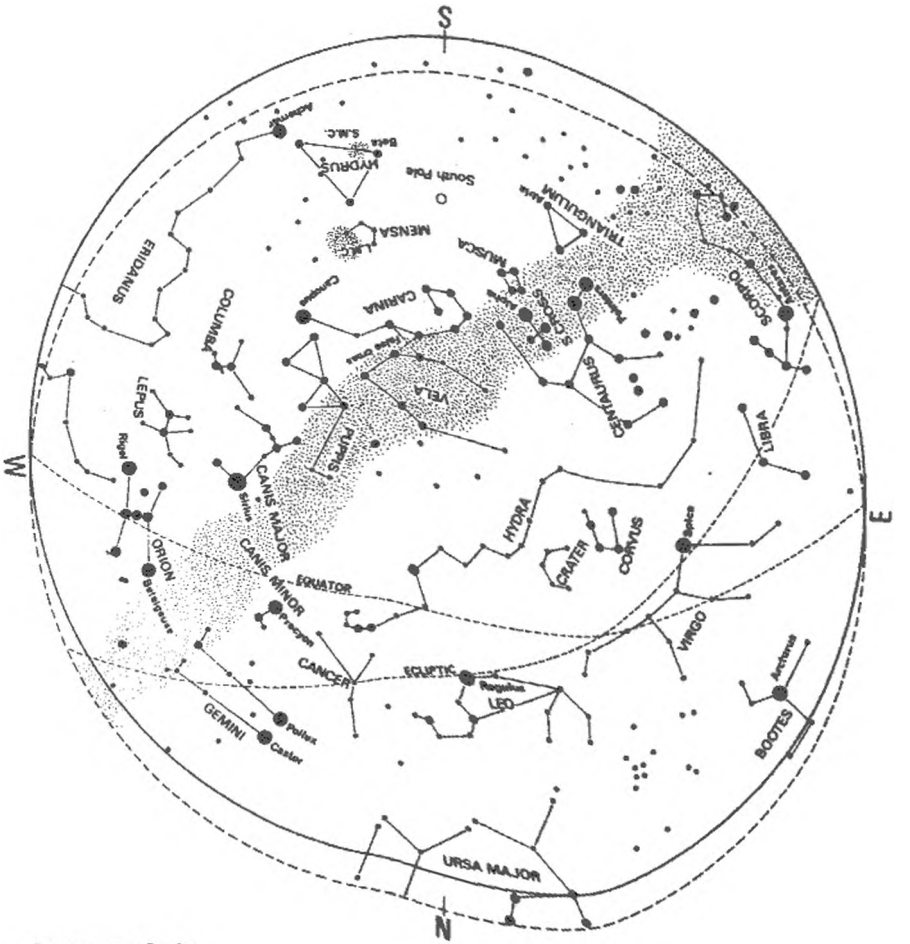
(12) The Crab Nebula, close to ξ ,is the remnant of a supernova recorded by the Chinese in 1054, requires a moderate sized telescope for observation. In its heart is located the extraordinary pulsar which emits a double flash of light 30 times every second. The current belief is that it is a rapidly 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 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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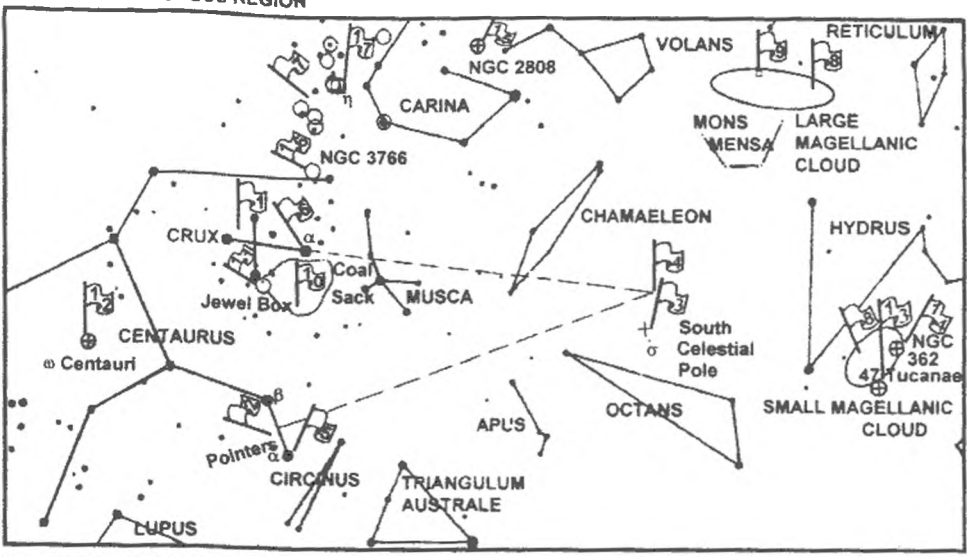
THE SOUTHERN CROSS REGION



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.

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

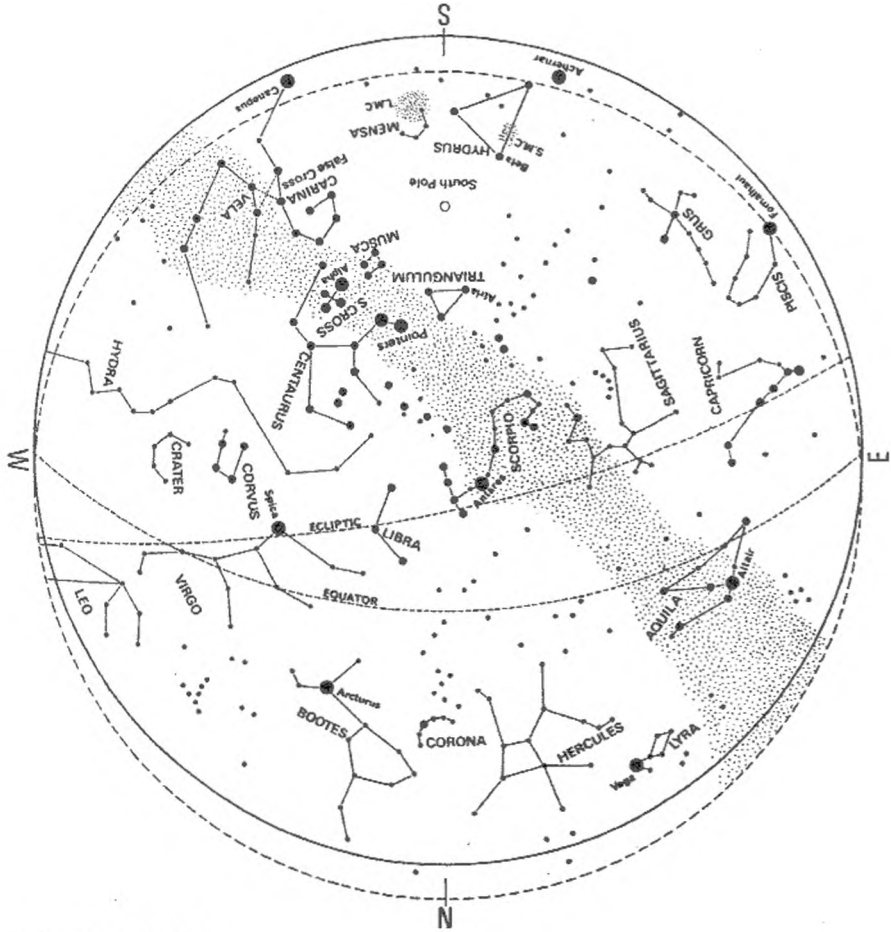
(17) The η Carinae nebula - site of a slow supernova that brightened to magnitude -0.8 in 1843 and is now of magnitude 6.4.

THE WINTER SKY

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

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

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



Courtesy of the

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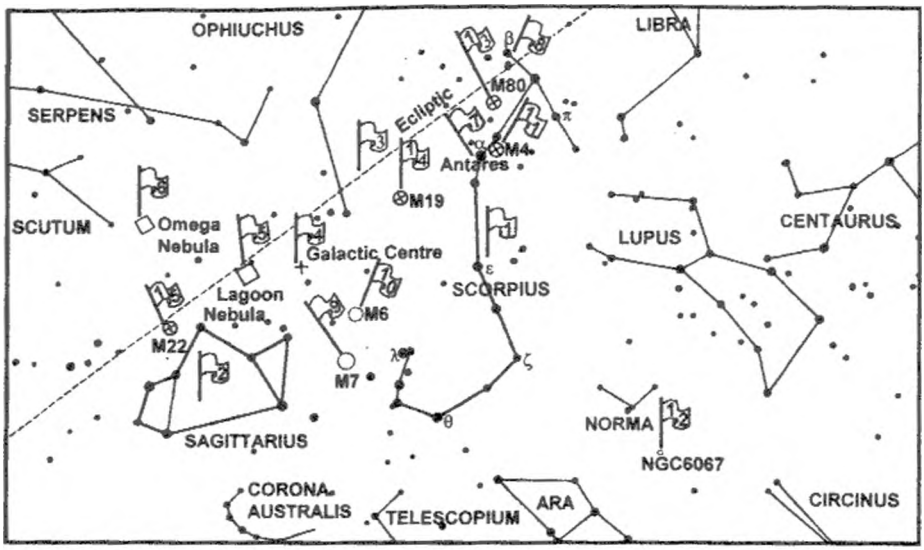
THE SCORPIUS REGION



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).

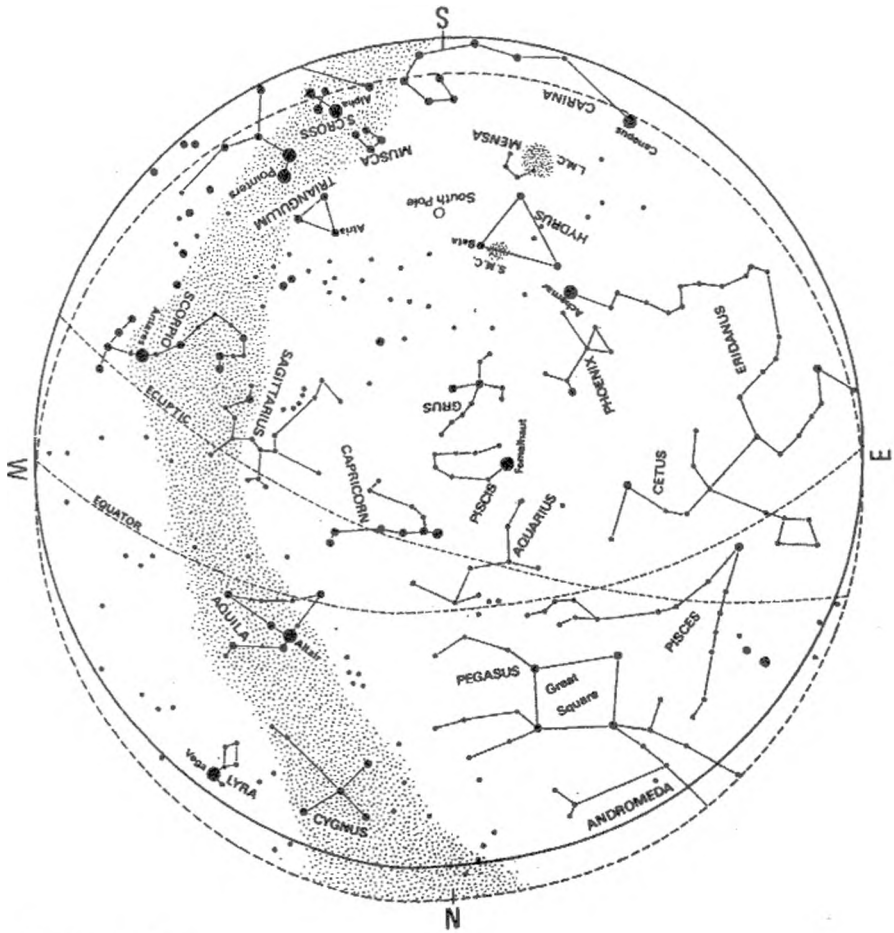
Further from the plane of the Milky Way are some globular clusters: (13) M80 (14) M19 (15) M22.

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.



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VARIABLE STAR OBSERVING

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

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

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

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

Visual estimates of magnitude are made by comparing the variable with two or more comparison stars, respectively brighter and fainter than the unknown variable. Suitable comparison stars are shown on special charts, which have been prepared for each variable, mainly by the two variable star organisations mentioned above. The use of these charts is essential for accurate, standardized observations and intending new observers are therefore advised to obtain the necessary data by contacting the Director of the Variable Star Section,

Mr. J. Hers, P.O. Box 48, Sedgefield, 6573, Telephone 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)

IMAGING SECTION

This new section was formed in 1999. ASSA members who would like more information or would like to join the section should contact the Director:

Mr Dany Duprez, 3 Swallow Lane, Tokai, 7945, Tel.021-7154107,
Cell 0824118737, email <gsdd@infoseek.co.za>

DOUBLE STAR SECTION

This is the Society's most recently formed Section and regular news bulletins are published as well as information on the section's web page at: http://www.skywatch.co.za. Even without specialised equipment, it is possible for both amateur and professional astronomers to contribute to the work of the Section as there is a long list of suspected double stars in the southern hemisphere which still have to be confirmed as such. Accurate measurements are an advantage but just confirmation of duplicity is a step in the right direction. Anyone interested should contact the Director:

Mr Chris de Villiers, email: astronomer@skywatch.co.za

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:

Mr B Frazer P.O.Box 1017, Henley-on-Klip, 1962. Tel H (016) 366-0955,
W (011) 871-0370, email fraserb@intekom.co.za

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.

Date		SAST		Name of Planet	Occulted Star		Mag	RA(2000.0)			Dec		Dur	d mag	Al	Az
m	d	h	m					h	m	s	°	'	s		°	°
1	7	3	2.3	712Boliviana	TYC	0715-01351-1	9.91	05	47	28	7	32	17.9	1.7	41	311
1	8	3	5.8	667Denise	TYC	5378-00407-1	11.09	06	42	18	-8	5	6.7	1.9	37	282
1	18	1	31.5	712Boliviana	TYC	0127-00157-1	11.08	05	40	38	7	21	28.6	1.1	28	297
2	21	5	6.3	1266Tone	TAC	-07#06447	10.9	11	21	18	-7	42	5.	3.6	34	280
2	27	18	36.6	22Kalliope	TYC	2389-00110-1	11.5	05	06	40	31	51	15.5	0.7	30	7
3	26	22	5.9	31Euphrosyne	TYC	0886-01135-1	12.09	13	04	03	10	9	15.7	0.4	35	52
3	28	22	43	122Gerda	TYC	1368-00801-1	10.49	07	31	55	20	20	9.7	3	42	41
4	1	3	28.9	216Kleopatra	HIP	76787	8.65	15	40	40	-16	45	13.9	4.1	78	341
4	7	19	48.5	914Palisana	TYC	0154-00175-1	11.64	06	30	08	5	37	4.4	2.9	43	311
4	17	18	14.1	1143Odysseus	HIP	54541	7.83	11	09	40	2	27	13.8	7.3	33	66
4	27	18	17.1	12Victoria	HIP	42084	9.07	08	34	40	9	22	8.6	3.4	52	0
4	28	17	56.7	88Thisbe	TYC	1343-01174-1	11.54	06	52	28	21	6	8.5	1.9	37	335
5	6	6	17.8	1002Olbersia	HIP	103902	6.42	21	03	10	-27	44	3.5	9.5	90	307
5	9	19	18.8	712Boliviana	TYC	0767-01453-1	11.61	07	21	18	10	47	4	2.2	31	305
5	20	19	12.1	743Eugenisis	HIP	57011	8.5	11	41	18	-1	46	15.1	6.6	43	64
5	29	20	28.8	804Hispania	TYC	7850-00885-1	11.53	15	58	56	-44	45	12.4	0.9	49	127
6	29	4	17.4	1069Planckia	PPM	182038	10	00	15	36	-4	25	3.4	5.4	57	48
6	29	23	6.1	464Megaira	TYC	6359-01340-1	10.59	21	18	34	-20	55	13.8	2.7	70	287
7	2	1	0.9	0Pluto	TYC	5651-01553-1	11.69	17	01	52	-12	39	115.1	2.2		
7	7	3	27.9	409Aspasia	TYC	1199-00093-1	11.68	01	04	18	18	04	8.6	1.4	29	46
7	8	20	2	1328Devota	TYC	6280-01635-1	10.8	18	44	08	-16	12	4.2	4.7	38	90
7	11	3	5.7	589Croatia	HIP	98259	7.72	19	57	57	-6	26	7.7	6	50	296
7	13	4	31	200Dynamene	TYC	1218-01666-1	10.52	02	18	50	19	15	4.7	2.9	30	42
7	26	5	40.5	293Brasilia	TYC	7952-01397-1	10.19	20	15	36	-39	47	4.4	4.4	22	235
7	31	21	25.4	358Apollonia	TYC	6259-02572-1	11.63	18	02	48	-18	50	11.2	2.6	59	80
8	2	22	8.5	487Venetia	TYC	6237-00868-1	11.04	17	12	45	-18	14	13.4	1.9	66	290
8	8	2	39.7	109Felicitas	TYC	1216-01351-1	10.3	02	33	56	16	36	4.6	2.8	28	49
8	10	0	25.4	513Centesima	TYC	5174-00035-1	10.79	20	16	34	-7	24	4.3	3.4	63	316
8	11	5	32.3	1264Letaba	TYC	2266-01555-1	11.93	00	29	52	32	24	17	2.3	22	330
8	28	5	1.4	511Davida	TYC	0729-01457-1	11.52	06	00	33	14	18	11	0.8	32	48
9	7	24	45.2	110Lydia	TYC	6856-00326-1	10.19	18	17	23	-29	45	10.7	2.4	45	254
9	12	22	4.2	804Hispania	TYC	7356-00322-1	11.59	16	21	03	-36	44	6	1.7	50	245
9	25	20	56.7	312Pierretta	TYC	6373-00641-1	11.09	21	29	40	-22	27	10.4	2	82	47
10	3	19	20	13Egeria	TYC	7935-01884-1	11.3	19	25	38	-40	40	14.8	1.2	75	207
10	18	19	4	59Elpis	HIP	84450	9.84	17	15	54	-15	56	5	3.8	40	272
10	22	2	22	86Semele	TYC	0020-00024-1	11.43	01	19	29	00	38	14.3	1	39	296
10	26	2	47.9	977Philippa	TYC	1309-00799-1	11.77	05	35	08	21	04	14.1	3.2	40	12
11	2	2	33.7	46Hestia	TYC	0647-00843-1	11.37	02	59	50	14	03	15	0.5	37	318

Date		SAST		Name of Planet	Occulted Star		Mag	RA(2000.0)			Dec		Dur	d mag	Alt	Az
m	d	h	m					h	m	s	°	′	s		°	°
11	5	20	57.5	5Astraea	TYC	0648-00954-1	10.64	03	04	33	08	13	11	0.5	30	60
11	6	20	3	195Eurykleia	TYC	6884-00149-1	8.27	19	29	50	-27	26	3.1	6.6	44	258
11	16	4	26.7	233Asterope	TYC	1315-00693-1	11.71	06	17	44	16	30	15.7	1.2	39	328
11	19	20	27.6	190Ismene	TYC	6313-01415-1	10.59	19	57	32	-16	29	3.6	4.4	30	266
12	1	4	30	714Ulula	TYC	0763-03141-1	11.83	07	17	27	08	01	4.9	1.4	46	321
12	13	0	39.6	891Gunhild	HIP	12728	9.08	02	43	37	-00	20	6.5	5.4	36	292
12	17	19	44.9	137Meliboea	TYC	0001-00925-1	9.6	00	07	55	00	47	9.8	3.7	56	325
12	17	23	56.7	445Edna	TYC	2432-00645-1	10.93	06	10	54	36	17	6.1	2.7	25	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 Frazer P.O.Box 1017, Henley-on-Klip, 1962. Tel H (016) 366-0955, W (011) 871-0370, email fraserb@intekom.co.za

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:

Approximate time = 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				JOHANNESBURG				HARARE			
					E 18.5	S 33.9			E 28.1	S 26.2			E 31.0	S 17.8		
DATE		I.C.	Mag.	Ph	ELG	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	17	3392	7.1	DD	47					18 2.5	0.1	2.8	20	18 30.7			350
JAN	19	83	6.9	DD	69	20 24.1	-0.3	2.2	42								
JAN	20	192	5.3	DD	79					17 33.9	-2.3	1.3	77	17 52.7	-1.9	1.7	62
JAN	25	839	5.3	DD	138	20 9.1	-2.1	0.8	60	20 41.8	-2.5	2.0	45				
JAN	25	853	7.0	DD	140	22 56.3	-2.1	2.4	42								
JAN	26	1023	6.5	DD	153									22 27.2			158
JAN	26	1030	3.2	DD	153	23 57.5	-1.8	1.6	65								
JAN	30	1570	5.6	RD	207	20 27.0	-0.9	-2.7	337								
JAN	31	1701	5.1	RD	222	21 42.1	-0.8	-2.1	322	21 30.2	-0.7	-3.1	347				
FEB	1	1813	6.0	RD	235									21 11.2	-0.9	-0.1	256
FEB	8	2630m	5.1	RD	313	3 24.8	-1.0	-0.7	255					3 9.3	-0.1	-2.7	324
FEB	14	3478	6.5	DD	27									16 59.3	-0.2	1.7	52
FEB	17	269	7.3	DD	59	18 24.6	-0.8	3.0	18	19 1.5			351				
FEB	18	384	5.7	DD	71	19 46.4	-0.9	1.8	67								
FEB	20	628	4.8	DD	94	21 0.1	-1.2	1.9	58								
FEB	21	761	6.7	DD	104					17 15.5	-2.4	1.3	54	17 38.8	-2.4	2.8	33
FEB	22	936	5.9	DD	119									22 7.1	-0.1	-1.3	139
FEB	23	1099m	6.0	DD	132	22 20.3	-1.1	-0.1	124	22 34.3	-1.3	0.8	91	22 49.7	-2.0	2.1	56
FEB	23	1097	6.7	DD	132					22 35.1	-0.6	-0.5	130	22 36.6	-1.1	0.2	100
MAR	1	1773	5.1	DD	204					0 34.2			193				
MAR	1	1773	5.1	RD	204					1 6.7			242	1 21.8	-2.2	-0.3	285
MAR	5	2432	6.8	DD	269	23 42.8			190								
MAR	21	880	7.2	DD	87	19 38.1	-1.5	1.1	86	20 4.8	-1.6	2.2	53				
MAR	21	882	5.0	DD	87	20 16.7	-0.9	0.5	112	20 31.5	-0.9	1.2	80				
MAR	22	1030	3.2	DD	98					18 49.4	-0.7	-2.9	157	18 40.3	-1.8	-0.9	122
MAR	23	1170m	3.7	DD	111									18 45.7	-1.3	-2.7	153
MAR	23	1180	7.1	DD	112	20 50.7	-1.2	-0.1	124	21 5.7	-1.5	0.8	89	21 23.9	-2.6	2.9	51
MAR	25	1435	6.6	DD	137	17 21.6			188	17 6.7	-1.7	-2.7	151	16 53.8	-1.9	-1.7	127
MAR	25	1436	6.9	DD	137					18 10.2	-1.2	-3.7	170	17 52.0	-2.0	-2.1	140
MAR	26	1570	5.6	DD	151	18 9.5	-1.5	-0.4	71								
APR	1	2232	7.2	DD	226									1 2.3			195
APR	4	2836	5.6	RD	274	23 30.8	0.2	-1.6	294	23 7.3			340				
APR	4	2834	5.0	RD	274									23 8.4	-1.2	1.1	228
APR	19	1117	5.1	DD	80									17 1.8	-1.5	-2.0	143
APR	21	1408	7.4	DD	108	22 0.3	-1.7	2.2	66								
APR	24	1773	5.1	DD	149					22 26.1	-1.0	-1.5	147	22 21.2	-1.7	-0.6	115
APR	29	2322	4.3	RD	207	1 46.0	-1.4	-3.8	343								
APR	30	2589	4.8	RD	229	20 0.3	0.3	-1.5	296	19 41.5	0.8	-2.4	331				
APR	30	2602	5.5	RD	230	21 11.5			223	21 20.3	-0.9	-0.8	268	21 12.9	-0.5	-1.5	297
APR	30	2607	5.9	RD	230	21 35.4			214	21 51.3	-1.2	-0.7	266	21 45.3	-0.8	-1.5	296
MAY	1	2767	6.4	RD	242									20 37.6			218
MAY	1	2771m	5.7	RD	242					21 44.1	-1.3	0.6	232	21 46.8	-0.8	-0.5	267
MAY	2	2790	6.2	RD	244	0 54.9	-1.7	-1.2	279	0 55.6	-1.7	-3.5	318				
MAY	16	1085	7.0	DD	50	16 46.4	-1.8	1.1	83	17 23.3			35				
MAY	19	1484	3.6	DD	90									19 47.3	0.8	-3.4	179
MAY	21	1739	6.5	DD	119	23 13.0	-0.7	0.9	96								
MAY	22	1856	6.6	DD	132	23 40.2			183	23 30.0	-0.5	-0.8	137	23 28.7	-0.7	0.1	105
MAY	23	1965	6.5	DD	143	18 36.5	-2.7	0.0	74								
MAY	29	2719m	5.8	RD	213	1 44.6	-2.2	1.5	247	2 14.1	-2.2	0.6	269	2 20.6	-2.8	-1.0	296
MAY	29	2861	5.7	RD	223									21 15.0	-1.8	0.8	239

DATE	I.C.	Mag.	Pb	KLG	CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
M D				°	UT h m	a. m	b. m	P.A. °	UT h m	a. m	b. m	P.A. °	UT h m	a. m	b. m	P.A. °
JUN 16	1570	5.6	DD	73	16 51.1	-2.8	0.8	81								
JUN 17	1689	5.5	DD	86									16 51.7	-0.5	-3.0	170
JUN 20	1950	5.8	DD	116	0 4.3	-0.3	-1.0	151								
JUN 20	2056	7.4	DD	127	20 12.5	-0.3	-4.1	178	20 5.6	-1.8	-1.3	131	20 5.8	-2.5	0.0	99
JUN 22	2322	4.3	DD	153	18 35.2	-1.6	-1.2	101	19 2.7			46				
JUN 26	2834	5.0	ED	196	4 36.1	0.0	2.1	229								
JUN 27	3089	5.3	ED	217					23 10.1			182	23 49.4	-2.5	2.3	225
JUN 28	3092	6.2	ED	218	0 14.2	-2.8	-2.9	301								
JUN 29	3228	6.5	ED	230	1 46.9	-2.5	0.3	259	2 16.5	-3.1	0.3	269	2 23.0	-5.2	-2.1	295
JUL 5	384	5.7	ED	297	5 9.6	-1.5	0.8	231								
JUL 12	1408	7.4	DD	30					16 16.1	-2.1	2.8	59				
JUL 15	1773	5.1	DD	71	18 17.3	-0.2	-2.5	171	18 13.4	-1.0	-0.6	128	18 15.9	-1.4	0.4	94
JUL 17	2020	6.6	DD	98	19 11.6	-0.7	-3.0	169	19 10.2	-1.5	-0.8	126	19 13.4	-2.0	0.4	93
JUL 17	2022	5.5	DD	98									20 3.3	-0.9	-3.3	168
JUL 22	2602	5.5	DD	152	1 32.9	-0.5	1.2	86	1 44.8	0.0	1.2	77	1 55.6	0.4	1.6	54
JUL 22	2607	5.9	DD	152	2 2.3	-0.6	0.6	108	2 10.2	-0.1	0.6	98				
JUL 26	3304	6.4	ED	210	23 24.8	-2.1	0.7	243	23 53.1	-2.8	0.7	255	24 4.1	-4.1	-0.6	278
JUL 27	3413	6.4	ED	221									21 34.9	-1.4	2.2	212
JUL 28	3428	5.2	ED	222	1 20.6	-2.4	0.7	252	1 52.7	-2.7	1.1	254	2 8.2	-3.6	0.3	271
AUG 2	445	7.3	DD	277					1 7.0			338				
AUG 12	1856	6.6	DD	54	17 15.9	-1.1	-0.3	124	17 30.2	-1.3	1.2	85				
AUG 13	1978	6.6	DD	67					16 35.1	-2.6	1.5	78				
AUG 13	1985	7.1	DD	68									18 48.2	-0.7	-2.4	160
AUG 15	2232	7.2	DD	94	17 19.1	-1.8	-1.6	132	17 34.7	-2.5	0.3	94	17 57.9			49
AUG 17	2523	4.9	DD	118	16 32.1	-0.2	-4.5	163	16 21.5	-1.9	-1.7	117	16 20.6	-2.9	-0.1	85
AUG 18	2678	6.2	DD	131					16 32.1			163				
AUG 19	2861	5.7	DD	145					22 26.0			146	22 20.6	-2.6	-0.4	109
AUG 21	3106	5.4	DD	165									16 3.0	-0.2	-1.4	111
AUG 26	76	5.9	ED	216	3 57.7	-1.2	2.1	229								
AUG 30	510	7.2	DD	258									0 34.0			343
AUG 30	517	6.4	ED	259									2 37.7			172
AUG 30	633	5.4	ED	269					23 48.5	-0.9	-0.6	260	23 44.4	-1.7	-1.4	285
SEP 10	2064	6.5	DD	51									17 37.9	-0.9	-2.7	162
SEP 11	2209	5.9	DD	66	20 45.9			40								
SEP 12	2302	2.9	DD	73									9 41.4	1.0	-3.4	175
SEP 12	2302	2.9	MB	73									10 13.5	-1.9	0.9	239
SEP 13	2491	6.7	DD	90									18 17.3	-2.6	-2.4	140
SEP 13	2507	6.7	DD	91	20 53.4	-1.2	0.1	118	21 4.3	-0.6	0.4	104	21 10.9	-0.2	0.9	81
SEP 14	2659	6.4	DD	103	20 19.1	-1.2	2.2	59	20 45.8	-0.3	2.7	44				
SEP 15	2809m	4.9	DD	114	17 57.0	-2.5	-4.1	141	18 6.9	-3.0	-0.9	107	18 15.6	-2.9	0.8	79
SEP 15	2834	5.0	DD	117	23 33.1	-0.1	1.6	67	23 44.4	0.3	1.5	61				
SEP 15	2835	7.1	DD	117	23 42.3	0.2	2.2	45								
SEP 17	3092	6.2	DD	139	21 14.4	-1.5	2.4	45	21 46.1	-1.0	2.6	40	22 11.9	-0.1	3.2	21
SEP 18	3228	6.5	DD	151									23 48.1	-2.3	-0.4	111
SEP 28	742	6.0	ED	251	1 11.3			308	1 26.4			313				
OCT 9	2275	5.9	DD	45									16 38.6	-0.7	2.8	52
OCT 10	2434	5.6	DD	59					17 17.9	-1.5	-0.1	113	17 24.8	-1.2	0.8	86
OCT 12	2780	6.9	DD	86	21 3.1	-0.9	0.7	105	21 14.1	-0.4	0.6	98	21 20.8	0.0	0.8	79
OCT 14	3037	7.3	DD	107									16 30.6			155
OCT 15	3175	4.6	DD	119	17 43.7	-2.9	-1.6	105	18 7.8	-3.2	0.0	89	18 22.9	-2.8	1.3	67

DATE		I.C.	Mag.	Ph	ELG	CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
M	D				°	UT h m	a. m	b. m	P.A. °	UT h m	a. m	b. m	P.A. °	UT h m	a. m	b. m	P.A. °
OCT	16	3304	6.4	DD	130					17 58.3	-1.5	3.0	25	18 36.8	0.4	6.0	355
OCT	17	3428	5.2	DD	142	19 41.5	-2.2	1.0	61	20 13.6	-2.3	1.6	59	20 36.2	-1.8	2.3	45
OCT	24	709	4.3	RD	220	23 50.8	0.2	3.0	186	24 18.4	-0.8	3.6	191	24 48.5	-2.3	2.6	214
OCT	29	1270	6.1	RD	268	1 32.8	-1.2	-0.6	254	1 43.6	-2.0	-0.6	266	1 43.4	-2.4	-1.1	286
OCT	29	1274	5.7	RD	269	3 18.9	-2.2	-0.4	263								
NOV	6	2376	4.6	DD	26	17 58.8	0.4	2.6	48								
NOV	8	2672	2.9	DD	50	13 14.8	-2.5	1.4	59								
NOV	8	2672	2.9	RR	51	14 27.0	-2.4	-2.0	308								
NOV	8	2703	7.4	DD	53	18 42.6			158	18 45.8	-1.5	-1.2	138	18 44.5	-0.6	-0.1	111
NOV	9	2861	5.7	DD	65	17 59.0	-0.2	3.6	26	18 25.9	0.8	4.1	14				
NOV	9	2864	4.7	DD	65	18 1.2	-1.3	1.5	75	18 22.5	-0.7	1.5	68	18 38.0	-0.1	1.9	49
NOV	10	3009	7.1	DD	78	20 26.2	-0.1	2.1	48	20 41.2	0.2	1.9	44	20 57.2	0.8	2.4	24
NOV	12	3284	7.1	DD	102	22 33.0	-0.3	1.7	67								
NOV	15	76	5.9	DD	134	21 36.3	-1.8	1.7	63	22 6.0	-1.5	1.8	63	22 25.8	-1.1	2.0	49
NOV	26	1363	5.2	RD	250	0 48.5	-1.5	0.0	240	1 6.6	-2.4	-0.2	259	1 9.9	-2.7	-0.8	281
NOV	26	1365	6.1	RD	250	1 26.3	-2.0	0.0	243	1 48.6	-2.7	-0.3	266	1 51.9	-2.8	-1.0	288
DEC	6	2792	6.8	DD	32					17 37.1			16				
DEC	8	3089	5.3	DD	58									19 29.2			137
DEC	8	3092	6.2	DD	58	19 45.4	0.3	2.4	30	19 58.7	0.7	2.3	24				
DEC	9	3214	6.6	DD	68									16 58.4	-2.9	0.1	99
DEC	9	3228	6.5	DD	70	20 8.4	-0.8	1.1	94	20 21.4	-0.3	0.9	89				
DEC	11	3478	6.5	DD	92	20 4.8	-0.8	2.3	40	20 28.7	-0.4	2.3	38	20 49.8	0.0	2.7	21
DEC	25	1570	5.6	RD	245	1 56.2	-2.3	-0.8	277	2 9.1	-2.0	-1.4	307	1 58.5	-1.5	-2.5	333
DEC	31	2302	2.9	RD	323					1 30.9	-0.1	-0.5	259	1 24.9	0.1	-0.9	284

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.

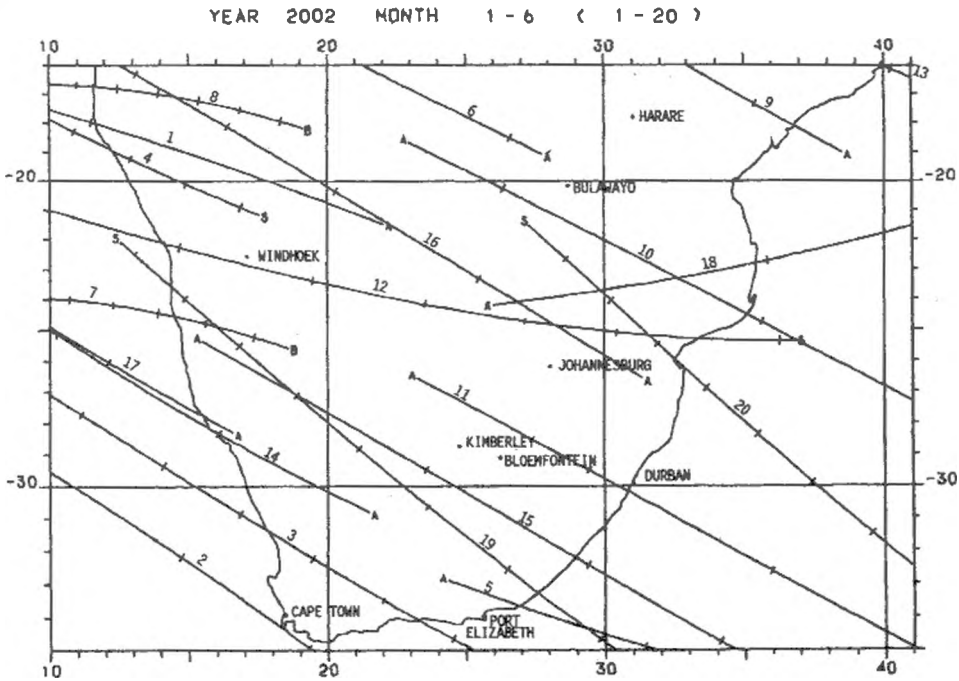
Interested observers - especially those living in the more distant regions - who wish to be informed of favourable grazes occurring in their neighbourhood, are therefore invited to contact the co-ordinator for grazing occultations:

Mr B Frazer P.O.Box 1017, Henley-on-Klip, 1962. Tel H (016) 366-0955,
W (011) 871-0370, email fraserb@intekom.co.za

EXPLANATION OF THE COLUMN HEADINGS IN THE TABLES:

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



SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(X)	LIMIT		
1	628	4.80	2	20	23	43	54.82	53.44	N	( )	(A)
2	2432	6.83	3	6	1	41	5.06	-50.04	S	( )	( )
3	2584	6.85	3	7	4	23	9.73	-38.61	S	( )	( )
4	2593	6.72	3	7	6	7	53.75	-38.09	S	( )	(S)
5	3150	6.54	3	11	4	36	58.52	-7.45	S	(A)	( )
6	880	7.16	3	21	22	31	41.21	46.66	N	( )	(A)
7	1030	3.18	3	22	20	22	38.57	56.95	S	( )	(B)
8	1170m	3.68	3	23	20	11	42.30	67.68	S	( )	(B)
9	1180	7.06	3	23	23	43	24.30	68.40	N	( )	(A)
10	2834	5.01	4	5	0	49	5.99	-46.06	S	(A)	( )
11	2835	7.08	4	5	0	56	54.02	-46.04	S	(A)	( )
12	3116	6.69	4	7	4	46	2.67	-25.97	S	( )	(S)
13	1251	5.87	4	20	17	48	59.65	51.25	N	( )	( )
14	1408	7.37	4	22	0	14	40.71	64.71	N	( )	(A)
15	2771m	5.73	5	1	23	20	24.55	-72.70	S	(A)	( )
16	1085	7.01	5	16	19	19	5.67	17.87	N	( )	(A)
17	1373	6.09	5	18	22	38	26.97	38.47	N	( )	(A)
18	192	5.28	6	6	3	5	18.18	-21.91	N	(A)	( )
19	1570	5.64	6	16	18	58	32.72	34.82	N	(S)	( )
20	1687	6.55	6	17	18	0	42.53	45.78	N	(S)	( )

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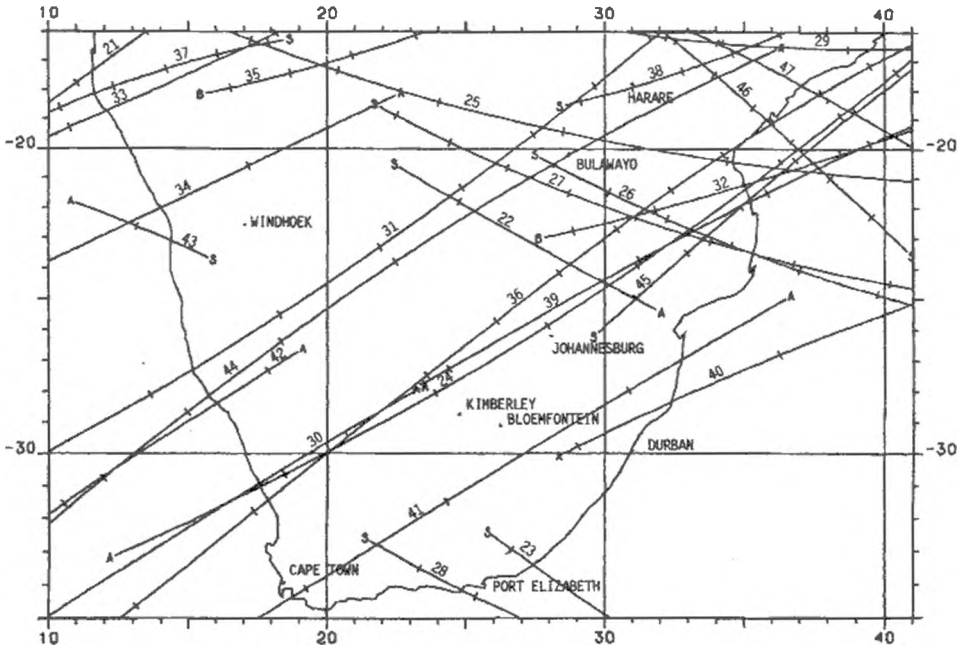

SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(%)	LIMIT		
21	384	5.68	7	5	6	27	42.99	-26.64	N	( )	( )
22	1408	7.37	7	12	18	28	9.33	6.27	N	(S)	(A)
23	1533	7.17	7	13	17	54	6.48	12.95	N	(S)	( )
24	445	7.26	8	2	3	1	19.91	-43.31	N	(A)	( )
25	1856	6.56	8	12	19	38	40.41	20.34	N	( )	( )
26	1976	6.90	8	13	18	18	37.64	30.14	N	(S)	( )
27	1978	6.59	8	13	18	43	23.39	30.33	N	(S)	( )
28	2097	7.10	8	14	18	30	25.55	41.46	N	(S)	( )
29	2232	7.23	8	15	20	16	15.72	53.29	N	( )	( )
30	2719	5.76	8	19	3	20	30.86	84.85	S	( )	(A)
31	510	7.22	8	30	2	17	6.33	-59.86	N	( )	( )
32	2491	6.70	9	13	20	38	11.25	49.69	S	(B)	( )
33	2510	6.26	9	13	23	59	21.86	50.94	S	( )	( )
34	2513	4.28	9	14	0	31	19.80	51.17	S	( )	(A)
35	2652	6.43	9	14	21	12	55.92	60.75	S	(B)	( )
36	742	5.99	9	28	2	44	25.07	-66.06	N	( )	( )
37	900	4.90	9	29	5	58	55.64	-55.38	N	( )	(S)
38	3037	7.26	10	14	18	28	31.91	64.76	S	(S)	( )
39	1131	7.15	10	28	1	24	29.19	-62.51	N	(A)	( )
40	1263	7.10	10	29	1	59	45.72	-51.92	N	(A)	( )
41	2703	7.44	11	8	20	48	1.86	19.36	S	( )	(A)
42	2879	6.60	11	9	23	9	30.59	29.53	S	( )	(A)
43	2088	6.24	12	2	5	33	45.95	-6.31	S	(A)	(S)
44	3089	5.27	12	8	21	11	23.39	22.63	S	( )	(A)
45	3214	6.61	12	9	19	11	6.31	31.03	S	(S)	( )
46	1689	5.47	12	26	3	48	28.43	-60.48	S	( )	(S)
47	2032	7.29	12	29	2	44	3.22	-27.12	S	( )	( )

TIME SYSTEMS

This section is intended to serve established amateurs and professional astronomers - i.e. those having some knowledge of time and coordinate systems. Space in 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	26	May 11	11	55	15	Sep 18	11	53	6
11	12	6	48	21	11	55	27	28	11	49	36
21	12	10	13	31	11	56	31	Oct 8	11	46	30
31	12	12	20	Jun 10	11	58	17	18	11	44	7
Feb 10	12	13	8	20	12	0	25	28	11	42	43
20	12	12	39	30	12	2	31	Nov 7	11	42	36
Mar 2	12	11	4	Jul 10	12	4	14	17	11	43	52
12	12	8	41	20	12	5	15	27	11	46	29
22	12	5	50	30	12	5	20	Dec 7	11	50	19
Apr 1	12	2	48	Aug 9	12	4	25	17	11	54	57
11	11	59	59	19	12	2	33	27	11	59	54
21	11	57	38	29	11	59	52	31	12	1	51
May 1	11	55	59	Sep 8	11	56	38				

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 h m	At 21 hrs h m		At 0 hrs h m	At 21 hrs h m		At 0 hrs h m	At 21 hrs h m
Jan 1	8 42	3 45	May 11	17 14	12 18	Sep 18	1 47	20 50
11	9 21	4 24	21	17 54	12 57	28	2 26	21 30
21	10 1	5 4	31	18 33	13 36	Oct 8	3 6	22 9
31	10 40	5 43	Jun 10	19 13	14 16	18	3 45	22 48
Feb 10	11 20	6 23	20	19 52	14 55	28	4 25	23 28
20	11 59	7 2	30	20 32	15 35	Nov 7	5 4	0 7
Mar 2	12 38	7 42	Jul 10	21 11	16 14	17	5 44	0 47
12	13 18	8 21	20	21 50	16 54	27	6 23	1 26
22	13 57	9 0	30	22 30	17 33	Dec 7	7 2	2 5
Apr 1	14 37	9 40	Aug 9	23 9	18 12	17	7 42	2 45
11	15 16	10 19	19	23 49	18 52	27	8 21	3 24
21	15 56	10 59	29	0 28	19 31	31	6 37	3 40
May 1	16 35	11 38	Sep 8	1 8	20 11			

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 (2002.5)

Star	R.A. h m	Dec. ° ′	Mag.	Sp.	Star	R.A. h m	Dec. ° ′	Mag.	Sp.
ACHERNAR	1 37.8	-57 13	0.6	B5	PROCYON	7 39.4	5 13	0.5	F5
ALDEBARAN	4 36.0	16 31	1.1	K5	REGULUS	10 8.5	11 57	1.3	B8
RIGEL	5 14.6	-8 12	0.3	B8	SPICA	13 25.3	-11 10	1.2	B2
BETELGEUSE	5 55.3	7 24	0.4	M0	ARCTURUS	14 15.8	19 10	0.2	K0
CANOPUS	6 24.0	-52 42	-0.9	F0	ANTARES	16 29.6	-26 26	1.2	M1
SIRIUS	6 45.2	-16 43	-1.6	A0	ALTAIR	19 50.9	8 52	0.9	A5

JULIAN DATE AT 1400 HOURS - SAST 2002

	JAN. 2452	FEB. 2452	MAR. 2452	APR. 2452	MAY 2452	JUN. 2452	JUL. 2452	AUG. 2452	SEP. 2452	OCT. 2452	NOV. 2452	DEC. 2452
1	276	307	335	366	396	427	457	488	519	549	580	610
2	277	308	336	367	397	428	458	489	520	550	581	611
3	278	309	337	368	398	429	459	490	521	551	582	612
4	279	310	338	369	399	430	460	491	522	552	583	613
5	280	311	339	370	400	431	461	492	523	553	584	614
6	281	312	340	371	401	432	462	493	524	554	585	615
7	282	313	341	372	402	433	463	494	525	555	586	616
8	283	314	342	373	403	434	464	495	526	556	587	617
9	284	315	343	374	404	435	465	496	527	557	588	618
10	285	316	344	375	405	436	466	497	528	558	589	619
11	286	317	345	376	406	437	467	498	529	559	590	620
12	287	318	346	377	407	438	468	499	530	560	591	621
13	288	319	347	378	408	439	469	500	531	561	592	622
14	289	320	348	379	409	440	470	501	532	562	593	623
15	290	321	349	380	410	441	471	502	533	563	594	624
16	291	322	350	381	411	442	472	503	534	564	595	625
17	292	323	351	382	412	443	473	504	535	565	596	626
18	293	324	352	383	413	444	474	505	536	566	597	627
19	294	325	353	384	414	445	475	506	537	567	598	628
20	295	326	354	385	415	446	476	507	538	568	599	629
21	296	327	355	386	416	447	477	508	539	569	600	630
22	297	328	356	387	417	448	478	509	540	570	601	631
23	298	329	357	388	418	449	479	510	541	571	602	632
24	299	330	358	389	419	450	480	511	542	572	603	633
25	300	331	359	390	420	451	481	512	543	573	604	634
26	301	332	360	391	421	452	482	513	544	574	605	635
27	302	333	361	392	422	453	483	514	545	575	606	636
28	303	334	362	393	423	454	484	515	546	576	607	637
29	304		363	394	424	455	485	516	547	577	608	638
30	305		364	395	425	456	486	517	548	578	609	639
31	306		365		426		487	518		579		640

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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1976 A D Thackeray
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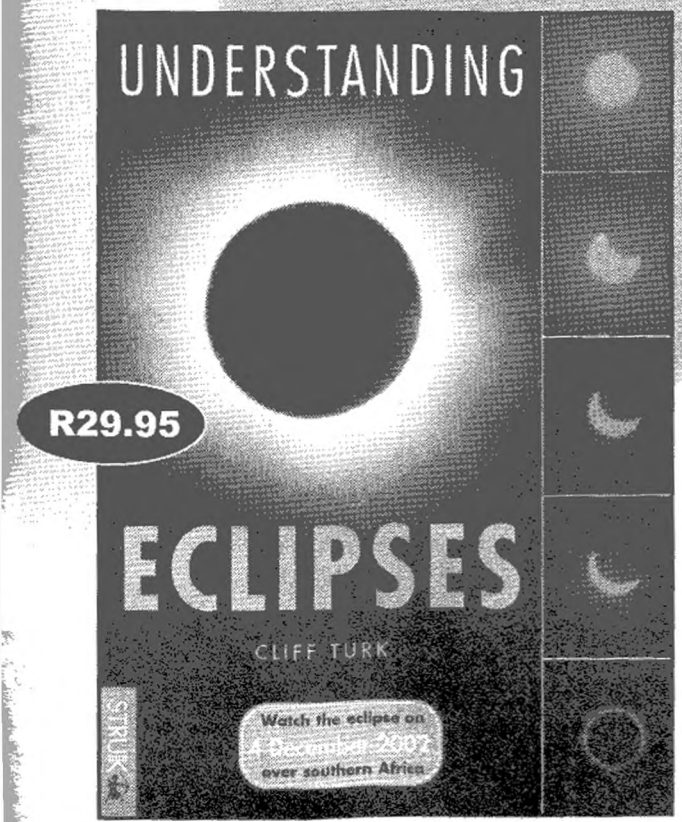

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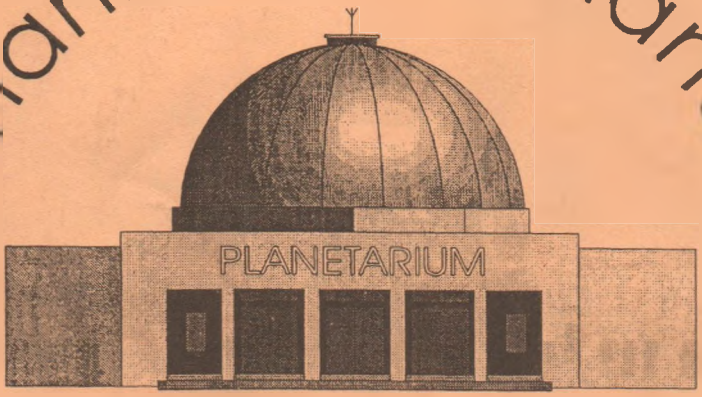

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