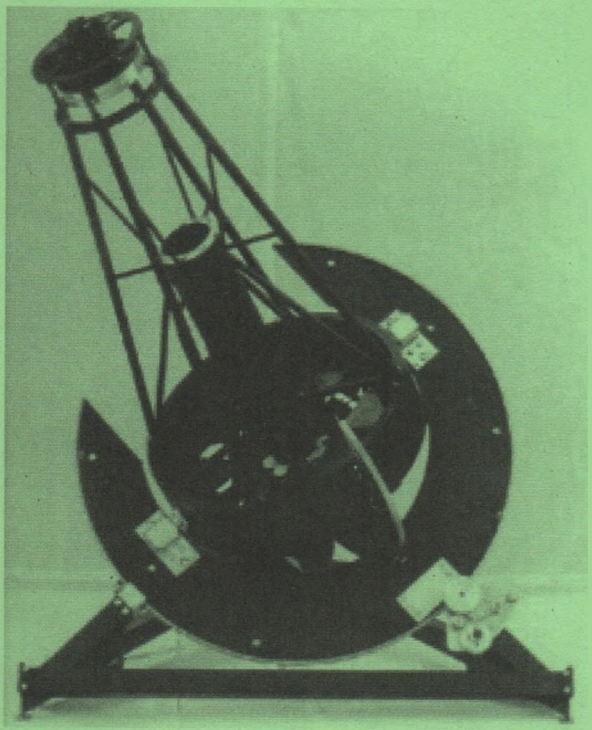
ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

2001



Astronomical Society of Southern Africa

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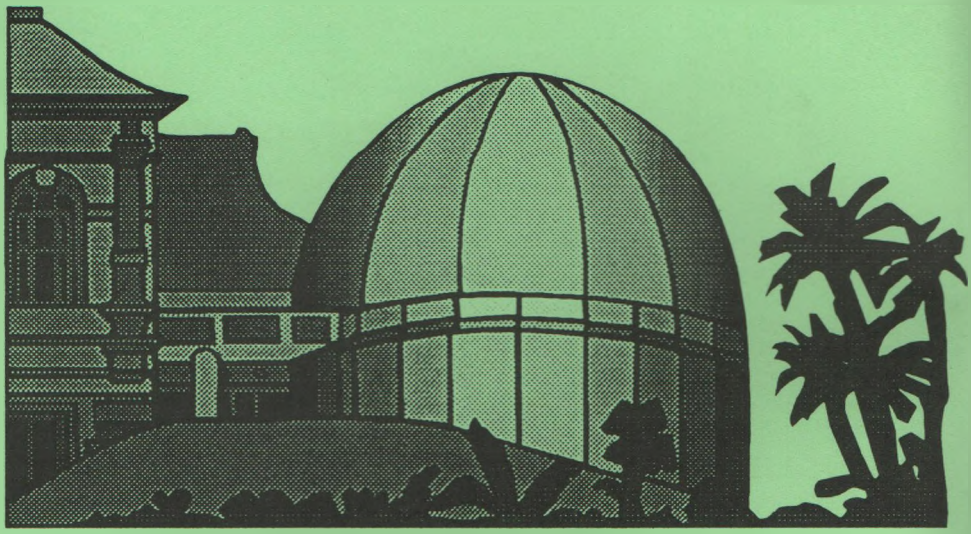

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ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA 2001

The 55th year of publication

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

Front cover
The SAAO-UCT-UNISA Automatic Photoelectric Telescope at SAAO Sutherland. Photo SAAO.

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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 2001, the Handbook of the British Astronomical Association for 2001 and the International Lunar Occultation Centre, Tokyo. Solar eclipse data was extracted from the NASA publication "Total Solar Eclipse of 2001 June 21" by Fred Espenak and Jay Anderson. The star charts on pages 40, 42, 44 and 46 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 41, 43 and 45 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.

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 http//www.saao.ac.za.

BOYDEN OBSERVATORY, situated at Mazelspoort, 25 km from Bloemfontein, is owned by the University of the Orange Free State. Observing facilities include a 1.52-m telescope, which is gradually being upgraded as funds become available, as well as a 0.41-m telescope, a 0.33-m refractor and a 0.20-m solar installation. THE FRIENDS OF BOYDEN is an organisation, founded to foster a wider public appreciation of the historical, cultural and scientific value of Boyden, to promote public interest in the affairs of the Observatory and to raise funds for the restoration and preservation of the installation. The Friends organise a number of activities such as popular lectures on astronomy and viewing sessions at Boyden. Membership of the Friends is open to all interested persons. Contact: Mrs M. Schoch (tel 051-4366 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 facility of the FRD/PU Cosmic Ray Research unit of the Potchefstroom University, under the leadership of Prof B C Raubenheimer. It consists of twelve parabolic mirrors with a total reflecting area of 21 square metres. The weak blue Cerenkov light emitted by high energy gamma rays in the atmosphere is detected by fast coincidence techniques. Radio pulsars, X-ray binaries, Supernova Remnants and Cataclysmic Variables are some of the objects studied.

OBSERVATORIES OPEN TO THE PUBLIC

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

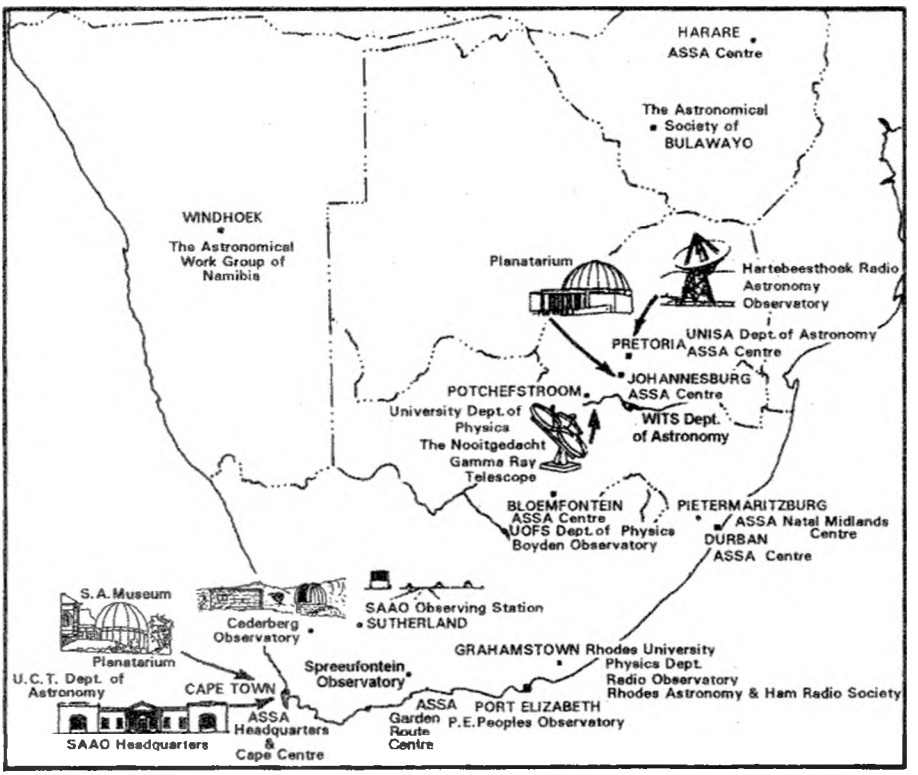
BOYDEN OBSERVATORY, BLOEMFONTEIN. Enquiries as to visits should be made to the Dept. of Physics of the University of the Orange Free State. Tel. 051-401 2924 (Dr. M. Hoffman). Web page http//www.uovs.ac.za/nat/boyden/boyden.html

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.



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

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

PLANETARIA

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

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

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

EDUCATIONAL INSTITUTIONS

Several universities undertake research in astronomy and offer teaching courses. The chair of astronomy at UCT is occupied by Brian Warner, whose department uses the SAAO observing facilities at Sutherland. The Dept. of Applied Mathematics, UCT has a group carrying out research in theoretical cosmology lead by Profs G F R Ellis and D R Matravers. The University of OFS has a Dept. of Physics, headed by Prof.G L P Bernings, incorporated with the Boyden Observatory. The Dept. of Physics and Electronics at Rhodes University, specialises in radio astronomy, and has its own observatory outside Grahamstown. The Dept. of Mathematics, Applied Mathematics and Astronomy at UNISA offers a number of courses in astronomy and astrophysics. Courses in Gamma Ray Astronomy and General Astrophysics form part of the regular honors and masters courses of the Dept. of Physics at Potchefstroom. The Dept. of Computational and Applied Mathematics, University of Witwatersrand, offers an Introductory first year course in Astronomy and a postgraduate course in Cosmology/ Astrophysics. Unique research facilities are available, such as Photomicrographic Tubes, the Schmidt Surveys (in blue and red) and SUN work stations. Contact Prof D.L. Block.

ASTRONOMICAL SOCIETIES

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

THE 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.

AUTONOMOUS LOCAL CENTRES OF THE ASSA hold regular meetings in Cape Town, Durban, Johannesburg, Bloemfontein, Pietermaritzburg, Pretoria, Harare and Sedgefield. Visitors are very welcome at meetings and may, if they wish, join a centre without becoming a full member of the Society. Centre members receive neither society publications, nor "Sky and Telescope". Centres publish newsletters and journals carrying information on meetings, centre activities and topics of interest.

BLOEMFONTEIN CENTRE: Meetings are usually held every second Friday of the month at Boyden Observatory, Mazelspoort. Phoning for confirmation beforehand is essential. The Centre publishes a monthly newsletter 'Die Naghemel'. Secretarial address: PO Box 13004, Brandhof, 9324 or telephone 051-4058730(o/h ask for Braam van Zyl) or 051-4471921(a/h). Web page http://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 19h45 on the second Wednesday of each month at Marist Brothers School, South Ridge Road, Durban. The centre publishes a monthly magazine "Ndaba". Secretarial address: P O Box 20578, Durban North, 4016, or telephone 031-564 7136 / 201 5829 / 44 6089.
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 at 15h00 on the first Saturday of the month except December at St Francis Community Church Hall, Swallow Drive, Sedgefield. Secretarial address: P O Box 2427,Knysna 6570, tel. 044-387-1415.

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 http//www.geocities.com.zimastro.

JOHANNESBURG CENTRE: General meetings, consisting of lectures, films or observing evenings are held on the second Wednesday of each month, excluding December, in the Sir Herbert Baker building in the grounds of the former Republic Observatory, 18A Gill Street, Observatory, Johannesburg at 20h00. There are two small observatories on the site, one houses the 30cm F8 Newtonian Jacobs telescope, and the Papadopoulos Dome houses a combined instrument comprising a 18cm F16 refractor, a 15cm refractor and a 30cm F16 Cassegrain reflector. Informal observing evenings are held every Friday night. The centre publishes a newsletter "Canopus". Secretarial address: P O Box 93145, Yeoville 2143. Tel. 011-7163199/7163038

NATAL MIDLANDS CENTRE (Pietermaritzburg): Regular monthly meetings on the second Wednesday of each month starting at 19h30. The centre operates World's View containing a 30cm reflector. The centre publishes a monthly newsletter, "Stardust". Secretarial address: P O Box 2106, Pietermaritzburg, 3200 tel 033-3433646.

PRETORIA CENTRE: Meetings are held on the fourth Wednesday of each month (except December) at 19h00 at the Christian Brothers' College, Silverton Road, where the centre's observatory containing a 30cm reflecting telescope is situated. Secretarial address: P O Box 11151, Queenswood, 0121, tel: 012-333 9991.

SECTIONS OF THE ASSA

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

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

The objectives of the Computing Section were outlined in MNASSA. Vol 46 Nos. 5 & 6 June 1987 Page 66. Please refer to this write up for detailed information. Persons interested in the activities of the Computing Section are urged to contact the Director of the Computing Section: Mr Tony Hilton, P O Box 68846, Bryanston, 2021. Phone (w) (011) 53 8714 or (h) (011) 465 2257.
Mr Hilton has compiled a comprehensive DATA BASE of all interested person's, equipment, available software etc. If you wish to become a subscriber to this DATA BASE list please contact Mr Hilton for the relevant questionnaire.

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

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

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

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

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h		
Jan	3	1	FIRST QUARTER	
	4	11	Earth at perihelion	
	6	3	Saturn 2°N. of Moon	
	6	16	Jupiter 3°N. of Moon	
	9	22	FULL MOON	Eclipse
	10	11	Moon at perigee	
	13	19	Mercury 2°S. of Neptune	
	16	15	LAST QUARTER	
	17	8	Venus greatest elong. E. (47°)	
	17	22	Mars 4°S. of Moon	
	21	6	Ceres 0°·7S. of Moon	
	22	20	Mercury 0°·4S. of Uranus	
	24	15	NEW MOON	
	24	21	Moon at apogee	
	25	17	Jupiter stationary	
	25	18	Saturn stationary	
	26	5	Mercury 3°N. of Moon	
	26	6	Neptune in conjunction with Sun	
	27	13	Vesta 0°·8S. of Moon	
	28	15	Mercury greatest elong. E. (18°)	
	28	16	Venus 6°N. of Moon	
Feb	1	16	FIRST QUARTER	
	2	12	Saturn 2°N. of Moon	
	3	0	Jupiter 3°N. of Moon	
	3	14	Mercury stationary	
	8	0	Moon at perigee	
	8	9	FULL MOON	
	9	14	Uranus in conjunction with Sun	
	13	2	Mercury in inferior conjunction	
	15	5	LAST QUARTER	
	15	12	Mars 3°S.of Moon	
	18	9	Ceres 0°·5S. of Moon	
	21	0	Moon at apogee	
	21	1	Neptune 2°N. of Moon	
	21	18	Mercury 6°N. of Moon	
	22	3	Venus greatest brilliancy	
	23	10	NEW MOON	
	24	21	Vesta 0°·2S. of Moon	
	25	4	Mercury stationary	
	25	19	Juno 1°·0N. of Moon	
	26	10	Venus 11°N. of Moon	
Mar	1	20	Saturn 2°N. of Moon	
	2	11	Jupiter 3°N. of Moon	
	3	4	FIRST QUARTER	
	4	16	Mars 5°N. of Antares	
	7	13	Venus stationary	
	8	11	Moon at perigee	
	9	19	FULL MOON	
	10	13	Mercury 0°·1 N. of Uranus	
	11	8	Mercury greatest elong. W. (27°)	
	15	23	Mars 1°·8S. of Moon	
	16	23	LAST QUARTER	
	18	9	Ceres 0°·5S. of Moon	
	19	0	Pluto stationary	
	20	10	Neptune 2°N. of Moon	
	20	13	Moon at apogee	
	20	16	Equinox	
	21	16	Uranus 3°N. of Moon	
	22	20	Mercury 2°N. of Moon	
	25	3	NEW MOON	
	27	9	Vesta in conjunction with Sun	
	29	6	Saturn 1°·7N. of Moon	
	29	23	Jupiter 2°N. of Moon	
	30	6	Venus in inferior conjunction	
Apr	1	13	FIRST QUARTER	
	5	12	Moon at perigee	
	6	23	Mercury 10° S. of Venus	
	8	5	FULL MOON	
	10	4	Pallas stationary	
	13	4	Mars 1°·3S. of Moon	
	15	6	Ceres 0°·9 S. of Moon	
	15	18	LAST QUARTER	
	16	16	Jupiter 5°N. of Aldebaran	
	16	18	Neptune 3°N. of Moon	
	17	8	Moon at apogee	
	17	19	Venus stationary	
	18	1	Uranus 3°N. of Moon	
	20	22	Venus 10°N. of Moon	
	23	11	Mercury in superior conjunction	
	23	17	NEW MOON	
	25	18	Saturn 1°·4N. of Moon	
	26	15	Jupiter 1°·8N. of Moon	
	30	4	Juno in conjunction with Sun	
	30	19	FIRST QUARTER	
May	2	6	Moon at perigee	
	4	20	Venus greatest brilliancy	
	7	16	FULL MOON	
	7	19	Mercury 4°N. of Saturn	
	10	21	Mars 1°·9S. of Moon	
	11	4	Neptune stationary	
	11	17	Mars stationary	
	12	12	Mercury 8°N. of Aldebaran	
	14	2	Neptune 3°N. of Moon	
	15	3	Moon at apogee	
	15	10	Uranus 3°N. of Moon	
	15	12	LAST QUARTER	
	16	19	Mercury 3°N. of Jupiter	
	18	23	Ceres stationary	
	19	11	Venus 4°N. of Moon	
	20	23	Vesta 0°·6S. of Moon	
	22	6	Mercury greatest elong. E. (22°)	
	23	5	NEW MOON	
	24	9	Jupiter 1°·3N. of Moon	
	24	21	Mercury 3°N. of Moon	
	25	15	Saturn in conjunction with Sun	
	27	9	Moon at perigee	
	27	20	Pallas at opposition	
	30	0	FIRST QUARTER	
	30	0	Uranus stationary	
Jun	4	7	Mercury stationary	
	4	14	Pluto at opposition	
	6	4	FULL MOON	
	6	21	Mars 4°S. of Moon	
	8	7	Venus greatest elong. W. (46°)	
	10	10	Neptune 3°N. of Moon	
	11	18	Uranus 3°N. of Moon	
	11	22	Moon at apogee	
	13	20	Mars at opposition	
	14	5	LAST QUARTER	
	14	15	Jupiter in conjunction with Sun	
	16	15	Mercury in inferior conjunction	
	18	0	Venus 1°·7N. of Moon	
	20	0	Saturn 0°·9N. of Moon	
	21	10	Solstice	
	21	14	NEW MOON	Eclipse
	22	1	Mars closest approach	
	23	19	Moon at perigee	
	28	5	FIRST QUARTER	
	28	9	Mercury stationary	
Jul	3	12	Mars 6°S.of Moon	
	4	16	Earth at aphelion	
	5	17	FULL MOON	Eclipse
	7	16	Neptune 3°N. of Moon	
	7	21	Ceres at opposition	

DIARY OF PHENOMENA, CONFIGURATIONS OF SUN, MOON AND PLANETS

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

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

THE SUN

BASIC DATA:

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

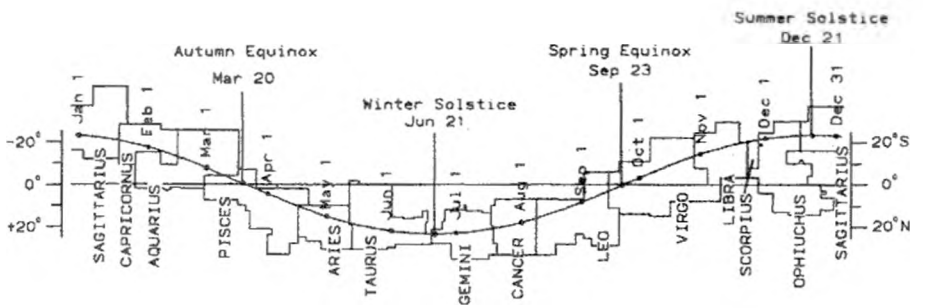
Mass: 1,99 x 10^{30}kg (330 000 times Earth mass)

Surface Temperature: Approximately 6 000°C

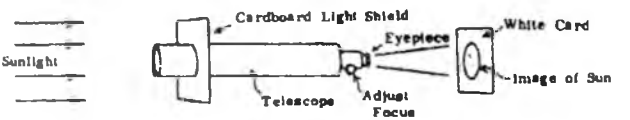
Temperature at centre: Approximately 10 million°C

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 2001 we will be closest to the Sun on January 4 (perihelion - approximate distance 147 million km) and furthest from the Sun on July 4 (aphelion - approximately 152 million km). During the year, the Sun appears to us to make a complete circuit of the sky (i.e. relative to the starry background) as indicated in the diagram.



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



THE SUN'S DECLINATION AT 02 HOURS:

Jan 1	-23° 1'	Apr 11	8°15'	Jul 20	20°41'	Oct 28	-13° 4'
11	-21 50	21	11 48	30	18 33	Nov 7	-16 14
21	-19 56	May 1	15 2	Aug 9	15 54	17	-18 57
31	-17 25	11	17 50	19	12 49	27	-21 6
Feb 10	-14 24	21	20 9	29	9 25	Dec 7	-22 35
20	-10 58	31	21 54	Sep 8	5 45	17	-23 21
Mar 2	-7 16	Jun 10	23 0	18	1 56	27	-23 20
12	-3 23	20	23 26	28	-1 58		
22	0 34	30	23 11	Oct 8	-5 49		
Apr 1	4 29	Jul 10	22 15	18	-9 34		

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

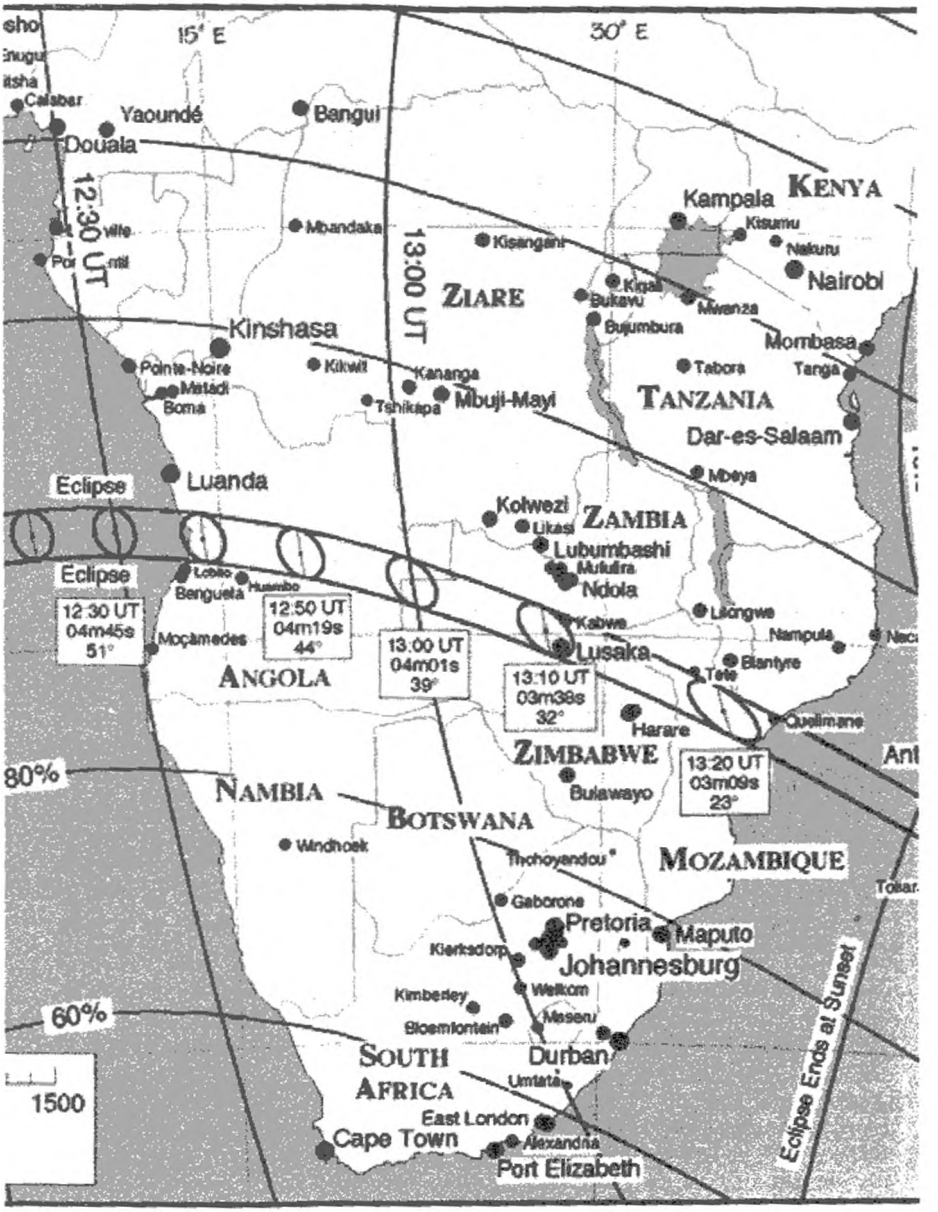
	CAPETOWN		DURBAN		BLOEMFONTEIN		JOHANNESBURG		HARARE		WINDHOEK	
	sunrise	sunset	sunrise	sunset	sunrise	sunset	sunrise	sunset	sunrise	sunset	sunrise	sunset
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
Jan 1	05 38	20 01	04 58	19 01	05 21	19 18	05 18	19 04	05 24	18 35	06 11	19 40
11	05 46	20 02	05 06	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 total eclipse of 21 June will be visible from Southern Africa. The annular eclipse of the 14 December will not be visible.

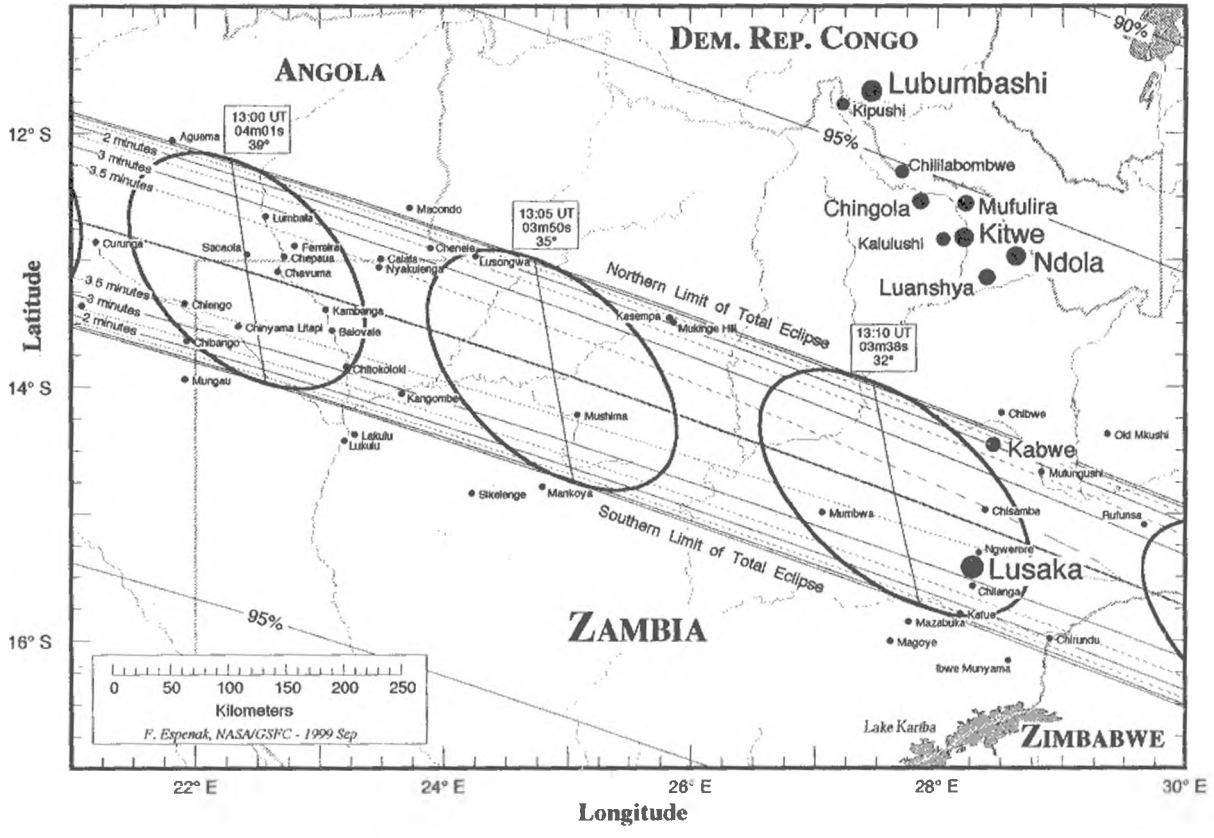
Total Solar Eclipse of 2001 June 21

The Eclipse Path Through Africa



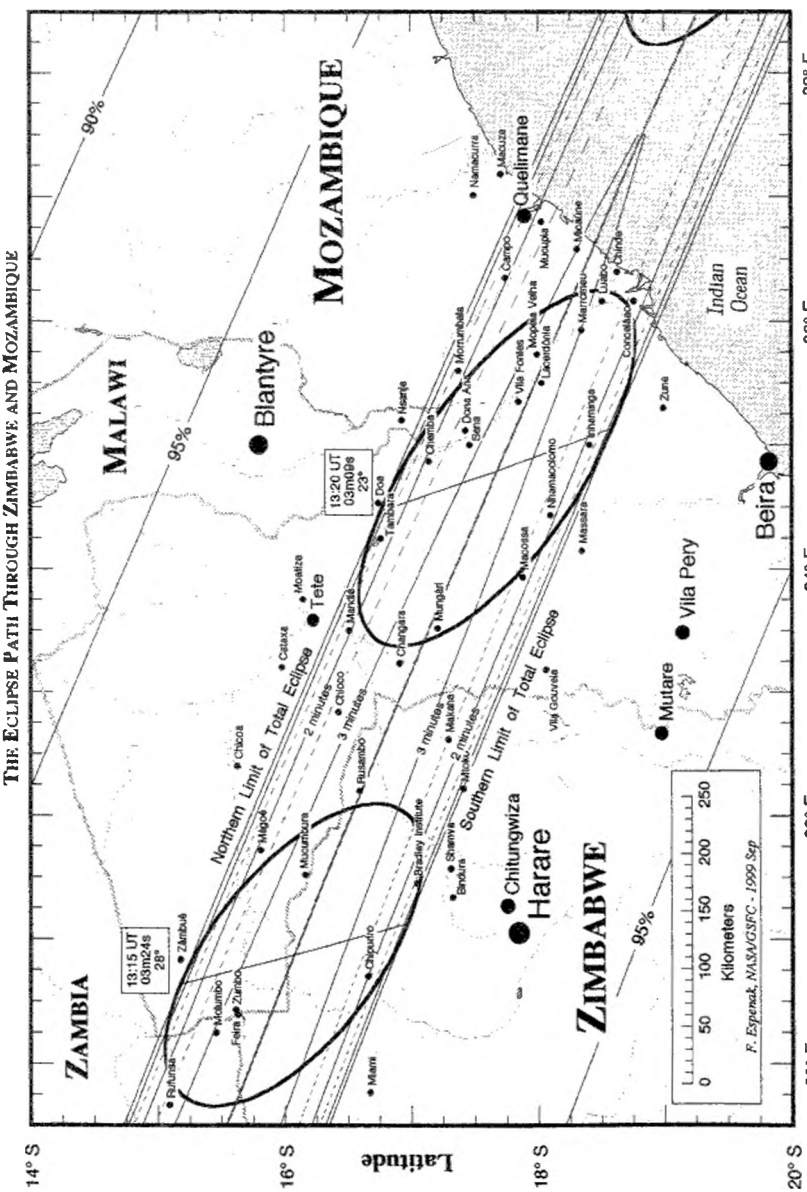
Total Solar Eclipse of 2001 June 21

The Eclipse Path Through Zambia



Total Solar Eclipse of 2001 June 21

The Eclipse Path Through Zimbabwe and Mozambique



PREDICTIONS PARTIAL PHASES

Place	Time First Contact h m s	PA °	Time Maximum Ecllipse h m s	PA °	mag.	Obs.	Time Fourth Contact h m s	PA °
Beira	13 56 34.0	275	15 18 58.7	3	0.964	0.964	16 29 35.2	91
Blantyre	13 58 33.7	269	15 21 08.3	184	0.967	0.968	16 31 36.8	97
Bloemfontein	13 35 21.2	290	14 57 45.1	1	0.653	0.575	16 10 21.3	71
Bulawayo	13 41 23.3	277	15 09 07.5	2	0.890	0.871	16 24 17.3	86
Cape Town	13 17 46.2	295	14 36 51.8	358	0.513	0.410	15 49 28.9	60
Chingola	13 41 25.0	267	15 11 12.6	183	0.957	0.955	16 27 29.6	98
Chitungwiza	13 48 43.7	273	15 14 51.7	3	0.980	0.983	16 28 19.4	92
Durban	13 46 12.3	290	15 05 31.5	2	0.677	0.604	16 15 07.8	73
East London	13 39 58.1	294	14 57 27.3	0	0.587	0.495	16 06 25.7	67
Gaborone	13 34 17.0	284	15 01 00.3	1	0.753	0.697	16 16 23.1	77
Harare	13 48 10.6	274	15 14 30.2	3	0.976	0.978	16 28 07.8	91
Johannesburg	13 39 35.3	286	15 03 45.6	1	0.735	0.675	16 17 00.6	76
Kimberley	13 31 58.9	289	14 55 31.9	0	0.653	0.575	16 09 14.5	71
Kitwe	13 42 17.8	267	15 11 45.0	183	0.961	0.961	16 27 44.5	97
Luanshya	13 42 41.1	267	15 11 58.4	183	0.968	0.969	16 27 49.8	97
Maputo	13 50 03.0	284	15 11 31.0	2	0.784	0.737	16 22 07.9	80
Maseru	13 38 38.5	290	15 00 05.9	1	0.658	0.581	16 11 45.7	71
Mbabane	13 46 46.2	285	15 08 58.1	2	0.762	0.709	16 20 18.9	78
Mtoko	13 51 12.5	273	15 16 29.6	3	1.000	1.000	16 29 13.4	93
Mufulira	13 42 27.5	267	15 11 51.7	183	0.953	0.951	16 27 48.3	98
Ndola	13 43 24.7	267	15 12 26.3	183	0.961	0.960	16 28 03.7	97
Pietermaritzburg	13 44 48.1	289	15 04 44.0	1	0.678	0.605	16 14 50.9	73
Port Elizabeth	13 35 15.0	295	14 52 21.8	360	0.552	0.454	16 01 32.6	64
Pretoria	13 39 59.9	285	15 04 28.9	1	0.748	0.691	16 17 52.5	77
Tete	13 55 00.0	270	15 19 01.5	183	0.996	0.998	16 30 39.7	96
Thohoyandou	13 45 41.7	281	15 10 28.3	2	0.836	0.803	16 23 28.0	83
Umtata	13 41 41.2	292	15 00 22.4	1	0.623	0.538	16 09 58.3	69
Windhoek	13 08 42.4	281	14 42 10.6	358	0.745	0.689	16 05 32.1	75

NOTE: Magnitude is the proportion of the sun's diameter covered by the Moon's disk at maximum eclipse.
Obscuration is the proportion of the sun's disk covered by that of the Moon at maximum eclipse.

PREDICTIONS TOTAL PHASES

Place	First Contact SAST h m s	PA °	Second Contact SAST h m s	PA °	Maximum Eclipse SAST h m s	PA °	Third Contact SAST h m s	PA °	Fourth Contact SAST h m s	PA °	Duration m s
ZAMBIA											
Balovale	13 26 49.9	269	14 59 28.1	109	15 01 21.2	1	15 03 13.7	253	16 22 15.0	93	03 46
Chavuma	13 25 36.8	268	14 58 34.2	86	15 00 33.9	181	15 02 32.9	276	16 21 53.4	93	03 59
Chilanga	13 41 30.0	271	15 09 25.9	130	15 10 51.3	2	15 12 16.1	235	16 26 54.4	93	02 50
Chinyama Litap	13 24 30.7	269	14 58 00.6	124	14 59 42.2	1	15 01 23.0	238	16 21 19.9	92	03 22
Chisamba	13 41 57.8	270	15 09 30.5	83	15 11 16.7	183	15 13 02.1	283	16 27 14.9	94	03 32
Chitokoloki	13 27 07.2	269	14 59 55.6	128	15 01 30.3	1	15 03 04.3	234	16 22 16.7	92	03 09
Feira	13 47 14.7	271	15 12 50.9	73	15 14 28.5	183	15 16 05.4	293	16 28 41.6	94	03 15
Kabwe	13 42 19.4	269	15 10 36.9	36	15 11 35.8	183	15 12 34.2	330	16 27 29.9	95	01 57
Kafue	13 41 09.6	271	15 09 52.4	159	15 10 35.0	2	15 11 17.2	206	16 26 42.9	93	01 25
Kambanga	13 26 43.3	268	14 59 20.1	99	15 01 18.3	1	15 03 15.7	264	16 22 15.1	93	03 56
Kangombe	13 28 26.7	269	15 00 59.0	135	15 02 23.7	1	15 03 47.9	227	16 22 43.7	92	02 49
Kasempa	13 35 08.3	268	15 06 12.8	29	15 07 04.1	182	15 07 55.0	335	16 25 20.5	95	01 42
Lusaka	13 41 33.5	271	15 09 19.3	118	15 10 56.4	2	15 12 32.8	247	16 26 59.8	93	03 14
Lusongwa	13 30 35.0	268	15 02 58.2	35	15 04 03.3	182	15 05 07.9	328	16 23 48.7	94	02 10
Mukinge Hill	13 35 13.5	268	15 06 10.6	32	15 07 07.4	182	15 08 03.7	332	16 25 21.9	95	01 53
Mulungushi	13 43 18.7	270	15 11 00.5	44	15 12 11.2	183	15 13 21.4	321	16 27 45.3	95	02 21
Mumbwa	13 38 15.1	270	15 07 12.7	118	15 08 51.9	2	15 10 30.5	246	16 26 00.6	93	03 18
Mushima	13 32 40.6	269	15 03 29.6	112	15 05 17.4	2	15 07 04.4	252	16 24 16.5	93	03 35
Ngwerere	13 41 43.1	271	15 09 19.3	108	15 11 03.3	3	15 12 46.6	257	16 27 04.1	93	03 27
Nyakulenga	13 28 09.3	268	15 00 34.7	66	15 02 21.8	181	15 04 08.2	297	16 22 53.2	94	03 34
Rufunsa	13 45 26.2	270	15 12 05.5	54	15 13 27.1	183	15 14 48.0	312	16 28 18.0	95	02 42

	First Contact				Second Contact				Maximum Eclipse				Third Contact				Fourth Contact				Duration	
	SAST			PA	SAST			PA	SAST			PA	SAST			PA	SAST			PA		
	h	m	s	°	h	m	s	°	h	m	s	°	h	m	s	°	h	m	s	°	m	s
ZIMBABWE																						
Bradley Instit	13	49	25.2	272	15	14	51.3	161	15	15	29.7	3	15	16	07.6	205	16	28	50.8	93	01	16
Chipuriro	13	47	37.8	272	15	13	29.4	147	15	14	29.0	3	15	15	28.2	218	16	28	27.4	93	01	59
Chirundu	13	43	04.0	271	15	10	48.0	150	15	11	45.9	3	15	12	43.3	216	16	27	16.2	93	01	55
Makaha	13	52	13.9	272	15	15	54.1	134	15	17	08.8	3	15	18	22.9	232	16	29	33.9	93	02	29
Rusambo	13	51	27.7	271	15	15	11.1	92	15	16	50.9	183	15	18	30.1	274	16	29	36.2	94	03	19
MOZAMBIQUE																						
Campo	14	00	41.5	271	15	21	00.2	43	15	21	58.9	184	15	22	57.2	324	16	31	33.9	95	01	57
Changara	13	53	52.5	271	15	16	36.6	85	15	18	13.4	183	15	19	49.5	282	16	30	09.5	94	03	13
Chemba	13	57	37.8	271	15	19	16.7	47	15	20	22.1	184	15	21	27.1	320	16	31	02.6	95	02	10
Chinde	14	00	24.1	273	15	20	09.8	114	15	21	35.9	4	15	23	01.4	253	16	31	09.9	94	02	52
Chioco	13	53	05.5	271	15	16	29.4	60	15	17	51.7	183	15	19	13.5	307	16	30	06.3	95	02	44
Conceiaao	13	59	50.3	273	15	20	04.3	134	15	21	14.4	4	15	22	23.9	233	16	30	58.3	94	02	20
Dona Ana	13	58	04.7	272	15	19	12.0	64	15	20	33.9	184	15	21	55.3	303	16	31	03.5	95	02	43
Inhaminga	13	57	24.2	273	15	19	03.0	150	15	19	55.5	3	15	20	47.5	217	16	30	30.6	93	01	45
Lacerdonia	13	58	41.1	272	15	19	12.9	97	15	20	46.2	4	15	22	18.9	270	16	30	59.3	94	03	06
Luabo	13	59	56.8	273	15	19	55.0	113	15	21	22.2	4	15	22	48.8	255	16	31	06.2	94	02	54
Macossa	13	55	09.7	273	15	17	37.5	139	15	18	44.9	3	15	19	51.9	228	16	30	08.4	93	02	14
Magoe	13	50	32.6	270	15	15	20.9	44	15	16	27.3	183	15	17	33.2	322	16	29	35.4	95	02	12
Mandie	13	54	40.8	271	15	17	48.2	41	15	18	47.0	183	15	19	45.4	326	16	30	29.9	95	01	57
Marromeu	13	59	30.5	273	15	19	39.8	107	15	21	09.8	4	15	22	39.2	260	16	31	03.9	94	02	59
Micaune	14	00	56.3	272	15	20	28.8	84	15	21	59.2	184	15	23	28.9	283	16	31	25.0	95	03	00
Molumbo	13	46	51.8	270	15	12	44.0	66	15	14	16.3	183	15	15	48.0	300	16	28	37.7	95	03	04
Mopeia Velha	13	59	13.1	272	15	19	32.5	88	15	21	05.1	184	15	22	37.2	280	16	31	07.9	94	03	05
Morrumbala	13	59	11.7	271	15	20	20.3	38	15	21	12.9	184	15	22	05.0	330	16	31	20.5	95	01	45
Mucumbura	13	49	54.0	271	15	14	20.8	81	15	15	59.8	183	15	17	38.1	285	16	29	18.3	94	03	17
Mucupia	14	01	32.2	272	15	21	14.5	53	15	22	23.5	184	15	23	31.9	315	16	31	39.4	95	02	17
Mungari	13	54	26.2	272	15	16	52.3	98	15	18	29.2	3	15	20	05.5	269	16	30	12.2	94	03	13
Nhamacolomo	13	56	14.3	273	15	18	14.1	140	15	19	19.6	3	15	20	24.7	227	16	30	20.3	93	02	11
Quelimane	14	01	42.4	271	15	21	44.1	35	15	22	31.0	184	15	23	17.5	333	16	31	44.4	95	01	33
Sena	13	57	47.9	272	15	18	56.6	71	15	20	23.8	184	15	21	50.3	297	16	30	58.7	95	02	54
Tambara	13	56	21.6	271	15	18	57.4	32	15	19	42.9	184	15	20	28.0	335	16	30	51.0	95	01	31
Vila Fontes	13	58	25.6	272	15	19	06.6	89	15	20	40.1	184	15	22	12.9	279	16	30	59.7	94	03	06
Zumbo	13	47	15.0	271	15	12	52.1	72	15	14	28.9	183	15	16	05.1	294	16	28	42.0	94	03	13

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. 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: $7{,}35 \times 10^{22}$ x kg (1/81 of Earth)
Surface Gravity: 0,16 of Earth
Average distance from Earth: 384 000 km, Perigee ±357 000km, Apogee ±407 000km

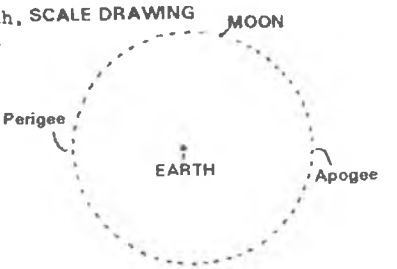
THE SURFACE OF THE MOON

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

THE MOON'S ORBIT

As a result of its motion around the Earth, the Moon appears to make a complete circuit of the heavens in just under a month.

The Moon's orbit around the Earth is slightly elliptical; the Earth is situated at one of the foci of the ellipse. Thus the Earth-Moon distance varies slightly during the course of a revolution. Dates of Apogee, when the moon is furthest from the Earth and of Perigee, when the Moon is closest to the Earth are given on the next page.

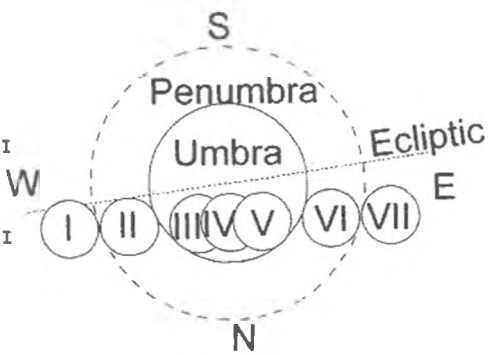


ECLIPSES OF THE MOON

The eclipse data is as follows:

Total Eclipse	d	h	m	
Moon enters penumbra	Jan 9	19	43.5	I
Moon enters umbra	Jan 9	20	42.0	II
Moon enters totality	Jan 9	21	49.5	III
Middle of eclipse	Jan 9	22	20.5	IV
Moon leaves totality	Jan 9	22	51.6	V
Moon leaves umbra	Jan 9	23	59.1	VI
Moon leaves penumbra	Jan 10	0	57.6	VII

Contacts of Umbra with Limb of Moon — Position Angles from the North Point
First 113.9 to East
Last 108.6 to West
Magnitude of the eclipse: 1.195



Partial Elipse	d	h	m
Moon enters penumbra	Jul 5	14	10.8
Moon enters umbra	Jul 5	15	35.1
Middle of eclipse	Jul 5	16	55.2
Moon leaves umbra	Jul 5	18	15.3
Moon leaves penumbra	Jul 5	19	39.7

Contacts of Umbra with Limb of Moon — Position Angles from the North Point
First 43.2 to East
Last 43.4 to West
Magnitude of the eclipse: 0.499

The Moon will rise in partial eclipse over Southern Africa after the Middle of eclipse except for the north western part, mainly Namabia, where it will already have left the umbra.

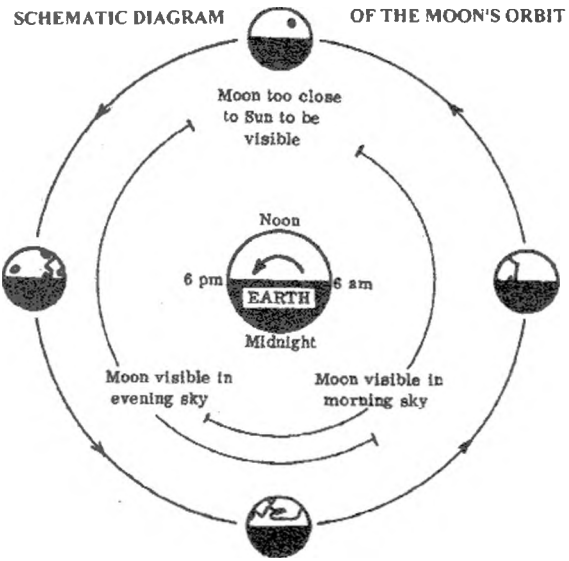
The penumbral eclipse of December 30 will not take place over Southern Africa.

PHASES and VISIBILITY

NEW MOON

	d	h	m
JAN	24	15	07
FEB	23	10	21
MAR	25	3	21
APR	23	17	26
MAY	23	4	46
JUN	21	13	58
JUL	20	21	44
AUG	19	4	55
SEP	17	12	27
OCT	16	21	23
NOV	15	8	40
DEC	14	22	47

SCHEMATIC DIAGRAM OF THE MOON'S ORBIT



FIRST QUARTER

	d	h	m
JAN	3	00	31
FEB	1	16	02
MAR	3	4	03
APR	1	12	49
APR	30	19	08
MAY	30	00	09
JUN	28	5	19
JUL	27	12	08
AUG	25	21	55
SEP	24	11	31
OCT	24	4	58
NOV	23	1	21
DEC	22	22	56

LAST QUARTER

	d	h	m
JAN	16	14	35
FEB	15	5	23
MAR	16	22	45
APR	15	17	31
MAY	15	12	11
JUN	14	5	28
JUL	13	20	45
AUG	12	9	53
SEP	10	20	59
OCT	10	6	20
NOV	8	14	21
DEC	7	21	52

FULL MOON

	d	h	m
JAN	9	22	24
FEB	8	9	12
MAR	9	19	23
APR	8	5	22
MAY	7	15	52
JUN	6	3	39
JUL	5	17	04
AUG	4	7	56
SEP	2	23	43
OCT	2	15	49
NOV	1	7	41
	30	22	49
DEC	30	12	40

MOON at PERIGEE

	d	h		d	h		d	h
Jan	10	11	May	27	9	Oct	15	1
Feb	8	0	Jun	23	19	Nov	11	19
Mar	8	11	Jul	21	23	Dec	7	1
Apr	5	12	Aug	19	8			
May	2	6	Sep	16	18			

MOON at APOGEE

	d	h		d	h		d	h
Jan	24	21	Jun	11	22	Oct	26	22
Feb	21	0	Jul	9	13	Nov	23	18
Mar	20	13	Aug	5	23	Dec	21	15
Apr	17	8	Sep	2	1			
May	15	3		29	8			

TERMINATOR AND LIBRATION

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

LIBRATION

Maximum			Minimum			Maximum			Minimum		
Date	Size	P.A.	Date	Size	P.A.	Date	Size	P.A.	Date	Size	P.A.
d	°	°	d	°	°	d	°	°	d	°	°
Jan 3	10.1	27	Jan 10	1.2	144	Jul 14	9.1	26	Jul 20	3.5	151
Jan 16	10.2	249	Jan 23	1.7	306	Jul 27	9.3	248	Aug 3	3.8	301
Jan 31	9.9	29	Feb 7	2.7	152	Aug 11	8.8	31	Aug 17	4.6	159
Feb 13	10.0	249	Feb 20	2.3	302	Aug 24	9.3	251	Aug 31	4.6	303
Feb 27	9.0	25	Mar 7	3.8	153	Sep 7	7.9	29	Sep 14	5.5	163
Mar 13	9.0	247	Mar 19	2.8	305	Sep 21	8.6	253	Sep 27	5.3	305
Mar 26	8.1	17	Apr 2	3.9	137	Oct 3	7.1	10	Oct 10	5.8	120
Apr 9	8.0	241	Apr 16	3.1	303	Oct 18	7.4	250	Oct 24	5.7	303
Apr 22	8.0	14	Apr 29	2.9	126	Oct 30	7.0	1	Nov 5	4.7	104
May 6	7.5	234	May 13	3.1	300	Nov 12	6.8	215	Nov 19	5.5	291
May 19	8.3	16	May 26	2.3	130	Nov 26	7.2	3	Dec 3	4.0	118
Jun 2	7.9	235	Jun 9	3.0	298	Dec 9	7.0	221	Dec 16	4.9	281
Jun 16	8.8	21	Jun 22	2.6	142	Dec 24	7.5	14	Dec 31	4.5	136
Jun 29	8.7	242	Jul 6	3.3	298						

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.

2001 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	11 27		13 10		12 04	23 03	14 08		14 40	00 21	15 07	02 41
2	12 23	00 20	14 13	00 27	13 07	23 44	15 05	00 18	15 21	01 29	15 40	03 45
3	13 21	00 50	15 18	01 05	14 11		15 56	01 23	15 58	02 37	16 14	04 48
4	14 21	01 21	16 24	01 50	15 14	00 32	16 41	02 31	16 32	03 44	16 50	05 51
5	15 24	01 54	17 30	02 43	16 15	01 27	17 22	03 41	17 06	04 50	17 30	06 53
6	16 30	02 31	18 31	03 44	17 12	02 30	17 59	04 51	17 40	05 55	18 13	07 54
7	17 39	03 14	19 27	04 52	18 03	03 38	18 34	05 59	18 15	07 00	19 01	08 52
8	18 47	04 04	20 16	06 04	18 48	04 50	19 09	07 06	18 53	08 04	19 52	09 45
9	19 53	05 03	20 58	07 17	19 28	06 02	19 44	08 12	19 35	09 06	20 46	10 34
10	20 52	06 09	21 37	08 29	20 05	07 13	20 21	09 17	20 21	10 06	21 42	11 16
11	21 43	07 20	22 12	09 37	20 40	08 21	21 00	10 21	21 10	11 02	22 37	11 54
12	22 28	08 33	22 46	10 43	21 15	09 28	21 44	11 22	22 02	11 53	23 33	12 28
13	23 06	09 43	23 20	11 47	21 50	10 33	22 30	12 19	22 57	12 39		12 59
14	23 42	10 51	23 55	12 49	22 28	11 36	23 20	13 12	23 52	13 19	00 28	13 28
15		11 55		13 48	23 08	12 36		14 00		13 55	01 24	13 57
16	00 15	12 57	00 32	14 46	23 52	13 34	00 13	14 43	00 48	14 28	02 21	14 26
17	00 47	13 58	01 13	15 42		14 29	01 07	15 21	01 43	14 58	03 19	14 57
18	01 21	14 57	01 57	16 34	00 39	15 19	02 03	15 56	02 40	15 28	04 20	15 31
19	01 56	15 55	02 45	17 22	01 29	16 04	02 59	16 28	03 36	15 57	05 24	16 10
20	02 33	16 52	03 36	18 06	02 22	16 45	03 55	16 58	04 35	16 27	06 31	16 56
21	03 15	17 46	04 29	18 46	03 17	17 22	04 51	17 27	05 35	17 00	07 38	17 50
22	04 00	18 37	05 24	19 21	04 12	17 56	05 49	17 57	06 38	17 37	08 43	18 51
23	04 49	19 24	06 20	19 54	05 08	18 27	06 48	18 29	07 43	18 19	09 43	19 59
24	05 41	20 07	07 16	20 25	06 05	18 57	07 49	19 03	08 50	19 08	10 36	21 09
25	06 35	20 45	08 12	20 55	07 01	19 26	08 53	19 41	09 55	20 04	11 21	22 19
26	07 30	21 20	09 08	21 24	07 59	19 57	09 57	20 25	10 56	21 06	12 01	23 28
27	08 25	21 52	10 05	21 54	08 58	20 28	11 02	21 15	11 52	22 13	12 37	
28	09 21	22 22	11 04	22 27	09 59	21 03	12 04	22 12	12 40	23 21	13 10	00 34
29	10 16	22 52			11 01	21 43	13 02	23 15	13 22		13 43	01 38
30	11 13	23 21			12 04	22 28	13 54		14 00	00 29	14 16	02 41
31	12 10	23 52			13 07	23 20			14 34	01 36		

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

2001 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	10 37	23 26	12 13	23 40	11 05	22 17	13 05	23 36	13 40		14 16	01 49
2	11 31	23 58	13 13		12 06	23 00	14 02		14 23	00 43	14 51	02 50
3	12 27		14 16	00 20	13 08	23 49	14 54	00 40	15 02	01 49	15 27	03 51
4	13 25	00 31	15 21	01 06	14 11		15 42	01 46	15 39	02 53	16 05	04 52
5	14 26	01 06	16 26	02 00	15 12	00 45	16 25	02 54	16 15	03 57	16 46	05 53
6	15 30	01 45	17 29	03 01	16 10	01 47	17 04	04 01	16 51	05 00	17 31	06 52
7	16 37	02 30	18 25	04 08	17 02	02 54	17 42	05 07	17 29	06 02	18 19	07 49
8	17 44	03 21	19 16	05 19	17 49	04 04	18 19	06 12	18 09	07 04	19 10	08 42
9	18 49	04 20	20 01	06 30	18 32	05 14	18 56	07 16	18 52	08 05	20 04	09 31
10	19 49	05 26	20 42	07 39	19 12	06 22	19 35	08 19	19 38	09 04	20 58	10 15
11	20 43	06 36	21 20	08 46	19 49	07 28	20 16	09 20	20 28	09 59	21 52	10 54
12	21 29	07 46	21 56	09 49	20 26	08 33	21 01	10 20	21 20	10 50	22 46	11 30
13	22 11	08 55	22 32	10 51	21 04	09 35	21 48	11 16	22 13	11 37	23 39	12 03
14	22 48	10 00	23 09	11 50	21 43	10 36	22 38	12 09	23 07	12 19		12 34
15	23 24	11 02	23 48	12 48	22 25	11 35	23 30	12 58		12 56	00 33	13 05
16	23 58	12 03		13 45	23 09	12 32		13 41	00 01	13 31	01 27	13 36
17		13 01	00 30	14 39	23 57	13 26	00 24	14 21	00 55	14 03	02 24	14 09
18	00 34	13 59	01 15	15 31		14 16	01 17	14 58	01 49	14 34	03 22	14 45
19	01 10	14 55	02 02	16 20	00 47	15 02	02 12	15 31	02 44	15 06	04 24	15 26
20	01 49	15 50	02 53	17 04	01 39	15 44	03 06	16 04	03 40	15 38	05 29	16 13
21	02 32	16 44	03 46	17 45	02 32	16 23	04 00	16 35	04 38	16 13	06 35	17 08
22	03 18	17 35	04 39	18 23	03 26	16 58	04 56	17 07	05 39	16 51	07 39	18 09
23	04 06	18 22	05 33	18 57	04 21	17 31	05 53	17 40	06 42	17 35	08 40	19 16
24	04 58	19 06	06 27	19 30	05 15	18 03	06 52	18 16	07 47	18 25	09 34	20 24
25	05 51	19 46	07 21	20 02	06 10	18 35	07 53	18 56	08 52	19 22	10 22	21 32
26	06 44	20 22	08 15	20 33	07 05	19 07	08 56	19 42	09 53	20 24	11 04	22 38
27	07 38	20 56	09 10	21 05	08 02	19 41	09 59	20 33	10 49	21 29	11 42	23 42
28	08 32	21 28	10 07	21 40	09 00	20 18	11 01	21 30	11 39	22 36	12 18	
29	09 25	21 59			10 01	20 59	11 59	22 32	12 24	23 42	12 53	00 44
30	10 20	22 31			11 02	21 45	12 52	23 37	13 04		13 28	01 45
31	11 15	23 04			12 04	22 37			13 41	00 46		

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

2001 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	10 45	23 22	12 02	23 54	10 51	22 35	12 39		13 21		14 18	01 51
2	11 35	23 59	12 58		11 47	23 22	13 38	00 03	14 09	01 01	14 58	02 47
3	12 25		13 56	00 39	12 46		14 33	01 04	14 54	02 01	15 40	03 42
4	13 18	00 37	14 58	01 29	13 46	00 14	15 25	02 07	15 37	03 00	16 23	04 38
5	14 13	01 17	16 01	02 26	14 47	01 11	16 13	03 10	16 19	03 57	17 08	05 34
6	15 12	02 01	17 04	03 27	15 47	02 13	16 59	04 11	17 01	04 54	17 56	06 29
7	16 15	02 51	18 04	04 33	16 43	03 18	17 42	05 11	17 44	05 51	18 46	07 24
8	17 20	03 46	18 59	05 40	17 35	04 23	18 25	06 10	18 28	06 48	19 37	08 17
9	18 25	04 47	19 50	06 46	18 23	05 27	19 08	07 08	19 15	07 44	20 29	09 06
10	19 27	05 52	20 37	07 49	19 09	06 29	19 52	08 05	20 04	08 40	21 20	09 52
11	20 24	06 59	21 20	08 50	19 53	07 29	20 38	09 02	20 55	09 34	22 11	10 35
12	21 15	08 05	22 02	09 47	20 35	08 27	21 25	09 57	21 46	10 25	23 00	11 15
13	22 02	09 08	22 44	10 43	21 18	09 24	22 14	10 52	22 38	11 13	23 49	11 52
14	22 46	10 07	23 25	11 37	22 02	10 20	23 05	11 44	23 28	11 58		12 28
15	23 27	11 04		12 31	22 47	11 15	23 56	12 33		12 39	00 37	13 04
16		11 58	00 08	13 24	23 34	12 09		13 19	00 18	13 18	01 27	13 40
17	00 07	12 51	00 53	14 16		13 01	00 46	14 02	01 08	13 55	02 17	14 19
18	00 47	13 44	01 40	15 07	00 23	13 51	01 37	14 42	01 57	14 31	03 11	15 00
19	01 28	14 36	02 28	15 55	01 13	14 38	02 27	15 20	02 46	15 07	04 07	15 46
20	02 11	15 29	03 18	16 42	02 03	15 23	03 16	15 57	03 37	15 45	05 07	16 38
21	02 56	16 20	04 09	17 25	02 54	16 05	04 06	16 34	04 30	16 25	06 10	17 35
22	03 43	17 10	04 59	18 07	03 44	16 44	04 56	17 11	05 25	17 09	07 13	18 36
23	04 32	17 58	05 49	18 45	04 33	17 22	05 47	17 50	06 23	17 57	08 15	19 41
24	05 22	18 44	06 38	19 23	05 23	17 59	06 41	18 31	07 24	18 51	09 12	20 46
25	06 13	19 27	07 27	19 59	06 13	18 36	07 37	19 16	08 26	19 49	10 05	21 49
26	07 03	20 07	08 17	20 36	07 03	19 13	08 35	20 05	09 27	20 50	10 52	22 49
27	07 53	20 45	09 07	21 13	07 54	19 52	09 35	20 59	10 25	21 53	11 37	23 47
28	08 42	21 22	09 58	21 52	08 48	20 34	10 35	21 57	11 19	22 56	12 18	
29	09 30	21 58			09 43	21 19	11 34	22 58	12 08	23 56	12 59	00 43
30	10 19	22 35			10 41	22 09	12 29	24 00	12 54		13 39	01 38
31	11 10	23 13			11 40	23 04			13 37	00 54		

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

2001 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	10 52	23 37	12 22	23 57	11 13	22 36	13 09	23 57	13 46		14 29	02 02
2	11 45		13 21		12 13	23 20	14 07		14 31	01 02	15 06	03 02
3	12 39	00 11	14 23	00 39	13 14		15 00	01 00	15 12	02 05	15 43	04 01
4	13 35	00 45	15 27	01 27	14 16	00 10	15 49	02 06	15 51	03 08	16 23	05 00
5	14 34	01 22	16 31	02 21	15 17	01 06	16 33	03 12	16 29	04 10	17 06	05 59
6	15 37	02 03	17 33	03 22	16 15	02 08	17 15	04 17	17 07	05 11	17 51	06 57
7	16 42	02 49	18 31	04 29	17 08	03 15	17 55	05 21	17 46	06 11	18 40	07 53
8	17 49	03 42	19 23	05 39	17 57	04 23	18 33	06 24	18 28	07 11	19 32	08 46
9	18 54	04 42	20 10	06 48	18 42	05 31	19 13	07 26	19 12	08 11	20 24	09 36
10	19 55	05 47	20 53	07 55	19 23	06 37	19 53	08 27	19 59	09 09	21 18	10 20
11	20 49	06 56	21 32	09 00	20 03	07 41	20 36	09 27	20 49	10 04	22 11	11 01
12	21 37	08 05	22 11	10 01	20 42	08 44	21 21	10 25	21 41	10 55	23 03	11 37
13	22 21	09 12	22 48	11 01	21 21	09 44	22 09	11 21	22 34	11 42	23 55	12 12
14	23 00	10 15	23 27	11 59	22 02	10 44	22 59	12 13	23 27	12 24		12 45
15	23 37	11 16		12 55	22 45	11 41	23 51	13 02		13 03	00 47	13 17
16		12 14	00 07	13 51	23 30	12 37		13 47	00 20	13 39	01 40	13 50
17	00 14	13 11	00 50	14 44		13 30	00 44	14 27	01 12	14 13	02 34	14 24
18	00 50	14 06	01 35	15 36	00 18	14 20	01 36	15 05	02 04	14 46	03 31	15 02
19	01 28	15 02	02 24	16 24	01 08	15 07	02 29	15 40	02 57	15 19	04 31	15 45
20	02 09	15 56	03 14	17 10	01 59	15 50	03 22	16 14	03 52	15 53	05 35	16 34
21	02 52	16 49	04 06	17 51	02 52	16 29	04 15	16 47	04 48	16 29	06 39	17 29
22	03 38	17 39	04 58	18 30	03 45	17 06	05 08	17 21	05 47	17 10	07 43	18 31
23	04 27	18 27	05 51	19 06	04 37	17 41	06 04	17 56	06 49	17 55	08 44	19 37
24	05 18	19 11	06 43	19 40	05 30	18 14	07 01	18 34	07 52	18 46	09 40	20 44
25	06 11	19 52	07 36	20 13	06 23	18 48	08 00	19 15	08 56	19 43	10 29	21 50
26	07 03	20 30	08 28	20 46	07 17	19 21	09 01	20 02	09 57	20 45	11 13	22 55
27	07 55	21 05	09 22	21 20	08 12	19 57	10 04	20 54	10 54	21 50	11 53	23 56
28	08 47	21 38	10 17	21 56	09 09	20 35	11 05	21 52	11 45	22 55	12 31	
29	09 40	22 11			10 08	21 18	12 03	22 53	12 31	23 59	13 07	00 56
30	10 32	22 45			11 08	22 05	12 57	23 57	13 13		13 44	01 55
31	11 26	23 19			12 09	22 59			13 52	01 01		

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

2001 TIMES OF MOON RISE AND SET WINDHOEK

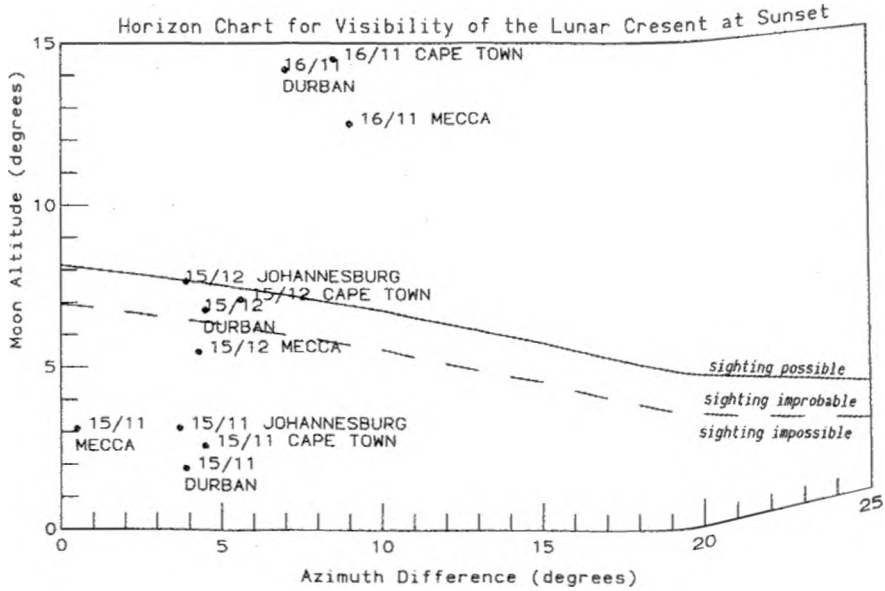
	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	11 40		13 04	00 07	11 55	23 26	13 47		14 26	00 50	15 14	02 48
2	12 31	00 21	14 02	00 46	12 53		14 45	00 51	15 12	01 53	15 53	03 46
3	13 24	00 56	15 02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

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

PREDICTIONS FOR YOUNG CRESCENT VISIBILITY FOR RAMADAAN AND SHAWWALL

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

OCCASION	DATE	CAPE TOWN		JOHANNESBURG		DURBAN		MECCA	
	d m	Alt°	DAzm°	Alt°	DAzm°	Alt°	DAzm°	Alt°	DAzm°
Ramadaan	15 11	2.6	4.5	2.8	3.7	2.4	3.9	3.1	0.5
	16 11	14.5	8.5	15.1	5.8	14.5	7.0	12.5	9.0
Shawwal	14 12								
	15 12	7.1	5.6	7.4	3.9	7.1	4.5	5.9	4.3
	16 12	17.1	11.9	18.2	8.6	17.5	10.0	16.0	10.7



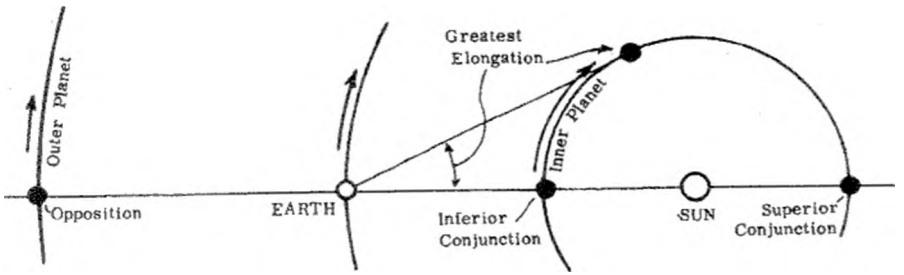
THE PLANETS

BASIC DATA

	Dist from Sun 10^6 km	Period of Revolution years	Mass (Earth = 1)	Equatorial Diameter 10^3 km	Rotation Period	Inclination of Equator to orbit	No. of known satellites
Mercury	58	0.24	0.055	4.98	58.65d	0°	0
Venus	108	0.62	0.815	12.10	243d R	178°	0
Earth	150	1.00	1.000	12.76	23h56m	23°27'	1
Mars	228	1.88	0.107	6.79	24h37m	23°59'	2
Jupiter	778	11.9	318.867	142.80	09h51m	03°04'	16
Saturn	1 426	29.5	95.142	120.00	10h14m	26°44'	18
Uranus	2 868	84.0	14.559	52.00	17.2h	97°52'	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 19 (at mag.+2.4) to April 15 (at mag.-1.2),
June 26 (at mag.+2.8) to July 29 (at mag.-1.5) and
October 21 (at mag.+1.4) to November 18 (at mag.-0.9)

The best conditions for viewing will occur in mid-March as Mercury passes from Capricornus to Aquarius.

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

January 10 (at mag.-1.0) to February 7 (at mag.+1.8),
May 1 (at mag.-1.5) to June 7 (at mag.+3.0),
August 15 (at mag.-1.0) to October 8 (at mag.+2.2) and
December 21 (at mag.-0.8) to December 31 (at mag.-0.8)

The best conditions for viewing will be in September, when Mercury will be found in Virgo.

	d h	d h	d h	d h
Superior Conjunction		Apr 23 11	Aug 6 0	Dec 5 0
Greatest Elongation East	Jan 28 15 (18°)	May 22 6 (22°)	Sep 19 0 (27°)	
Stationary	Feb 3 14	Jun 4 7	Oct 1 22	
Inferior Conjunction	Feb 13 2	Jun 16 15	Oct 14 4	
Stationary	Feb 25 4	Jun 28 9	Oct 22 13	
Greatest Elongation West	Mar 11 8 (27°)	Jul 9 19 (21°)	Oct 29 19 (19°)	

VENUS

Venus will be in the evening sky from the beginning of the year (at mag.-4.3) until late March (at mag.-4.1), reaching greatest brilliancy (at mag.-4.6) on February 22.

It will become a morning sky object from early April (at mag. -4.1), until early December (at mag. -3.9), reaching greatest brilliancy (at mag.-4.5) on May 4.

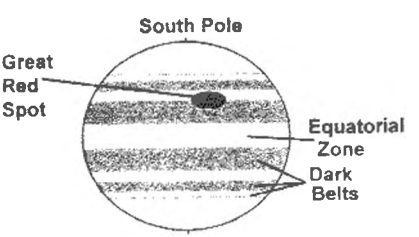
	d h
Greatest Elongation East	Jan 17 8 (47°)
Stationary	Mar 7 13
Inferior Conjunction	Mar 30 6
Stationary	Apr 17 19
Greatest Elongation West	Jun 8 7 (46°)

MARS

Mars, found in Virgo, rises shortly after midnight (at mag.+1.3) at the beginning of the year, passes to Libra at the beginning of the second week of January (at mag. +0.9), into Scorpius in the last week of February (at mag.+0.6), into Ophiuchus at the beginning of March (at mag.+0.5), into Sagittarius after mid-April (at mag.-0.6) and back into Ophiuchus at the beginning of June (at mag.-2.1). It will be an all night object by mid-June (at mag.-2.4). It passes again into Sagittarius in early September (at mag.-0.8) where by mid-October (at mag.-0.1) it will only be seen in the evening sky. The planet passes to Capricornus in late October (at mag.+0.0) and th Aquarius in early December (at mag.+0.5).

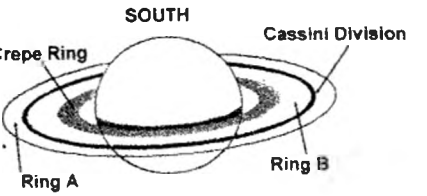
JUPITER

Jupiter (at mag.+2.7) begins the year in Taurus and will be visible for more than half the night until the last week in February when it will only appear in the evening sky. It will be too close to the Sun to be seen by the beginning of June. It re-appears in the morning sky in late June (at mag.-1.9) and in mid-July passes to Gemini, where it remains until the end of the year (at mag.-2.7).



SATURN

Saturn (at mag.+0.1), found in Taurus all year, will be seen for more than half the night from January until mid-February after which it can be seen only in the evening sky (at mag.+0.1). It becomes too close to the Sun to be seen from the second week of May. It will reappear in the morning sky in mid-June (at mag.+0.1). It will be an all night object by the beginning of December (at mag. -0.4).

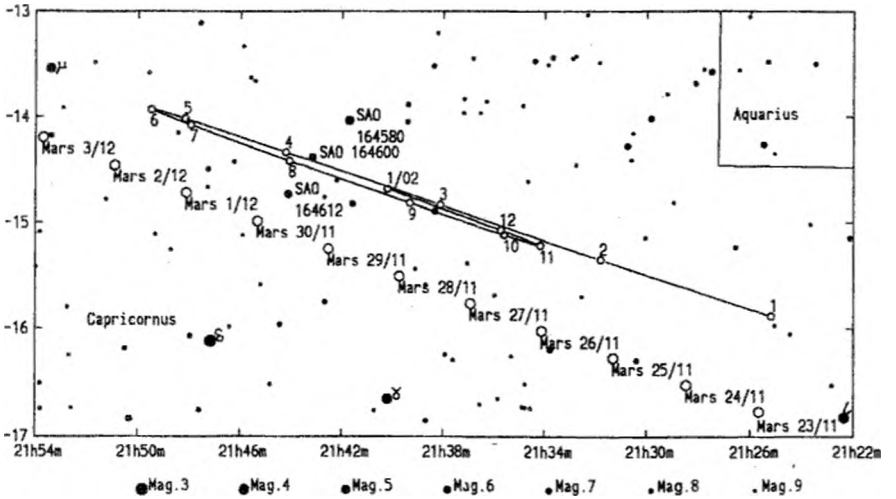


URANUS AND NEPTUNE

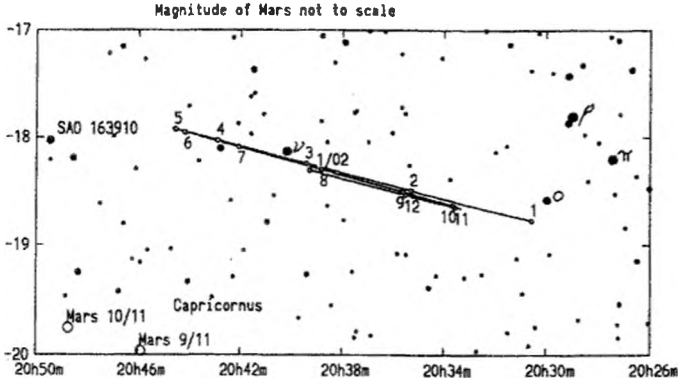
Uranus, visible with optical aid, found throughout the year in Capricornus, will be in the evening sky in January, after which it becomes too close to the Sun to be seen. It will reappear in the morning sky in early March. At opposition on August 15, it will be at magnitude 5.7.

Neptune, visible with optical aid, will set during the evening twilight in January. The planet will be found in the morning sky also in Capricornus, from mid February. At opposition on July 30, it will be at magnitude +7.9. It will be seen only in the evening sky from early November

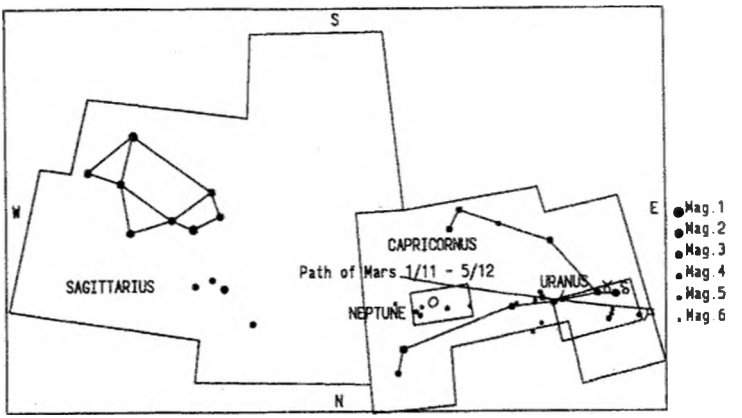
The Path of Uranus.



Magnitude of Mars not to scale



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	- 9 Jan	Jupiter, Saturn and Venus visible
10 Jan	- 7 Feb	Jupiter, Mercury, Saturn and Venus visible
8 Feb	- 26 Mar	Jupiter, Saturn and Venus visible
27 Mar	- 30 Apr	Jupiter and Saturn visible
1 May	- 7 May	Jupiter, Mercury and Saturn visible
7 May		Mercury and Saturn in conjunction
8 May	- 31 May	Jupiter and Mercury visible
16 May		Jupiter and Mercury in conjunction
15 Aug	- 8 Oct	Mars and Mercury visible
3 Dec	- 31 Dec	Mars and Saturn visible

Morning Sky:

19 Feb	- 3 Apr	Mars and Mercury visible
4 Apr	- 15 Apr	Mars, Mercury and Venus visible
6 Apr		Mercury and Venus in conjunction
16 Apr	- 12 Jun	Mars and Venus visible
13 Jun	- 25 Jun	Saturn and Venus visible
25 Jun	- 28 Jun	Mercury, Saturn and Venus visible
29 Jun	- 29 Jul	Jupiter, Mercury, Saturn and Venus visible
15 Jul		Saturn and Venus in conjunction
30 Jul	- 20 Oct	Jupiter, Saturn and Venus visible
6 Aug		Jupiter and Venus in conjunction
21 Oct	- 18 Nov	Jupiter, Mercury, Saturn and Venus visible
19 Nov	- 3 Dec	Jupiter, Saturn and Venus visible

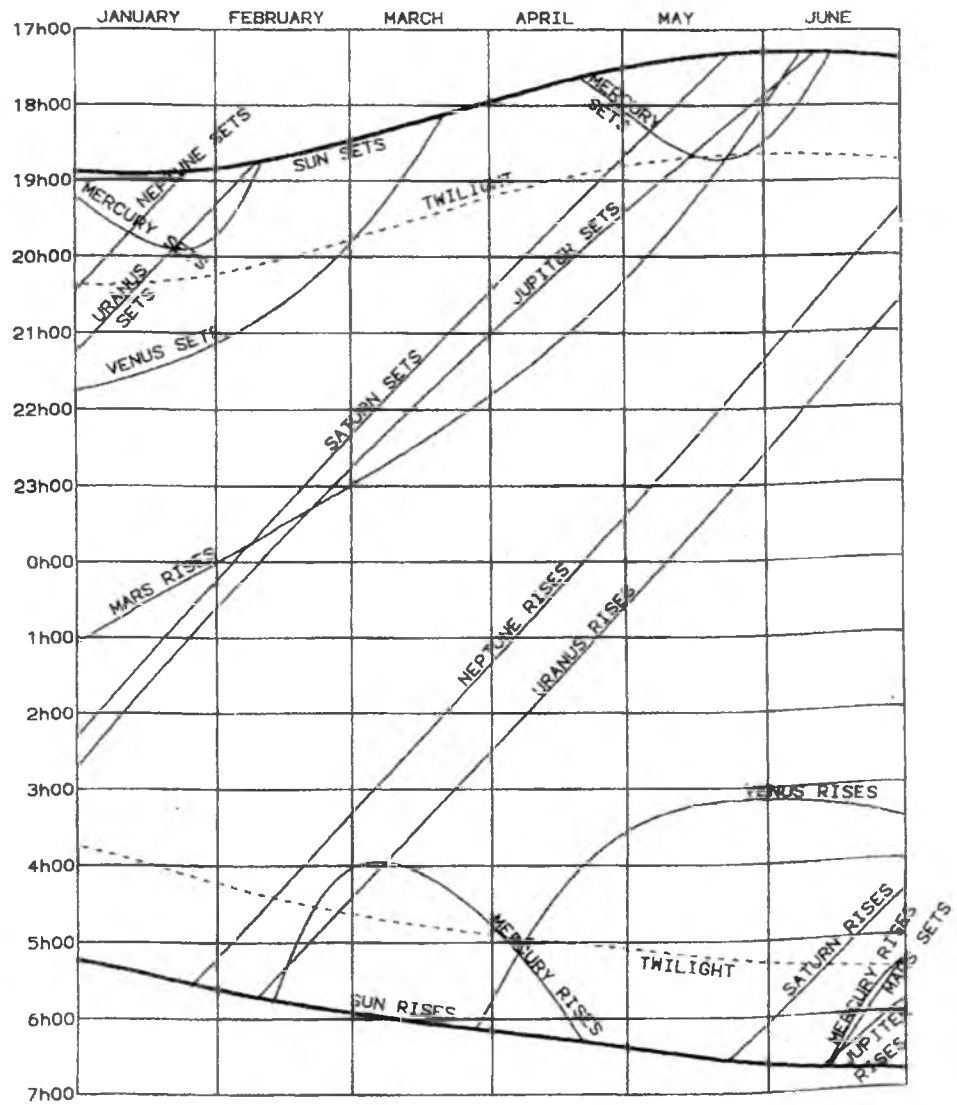
APPARENT PLACES:

	Mercury		Venus		Mars		Jupiter	
	RA	DEC	RA	DEC	RA	DEC	RA	DEC
	h m	° '	h m	° '	h m	° '	h m	° '
Jan 1	19 2.9	-24 38	21 58.9	-13 57	14 12.4	-11 59	4 1.1	19 48
Jan 11	20 13.7	-22 2	22 39.1	-9 23	14 34.9	-13 53	3 58.4	19 43
Jan 21	21 19.7	-16 58	23 15.8	-4 35	14 57.3	-15 37	3 57.0	19 42
Jan 31	22 4.3	-11 1	23 48.8	0 14	15 19.6	-17 11	3 57.1	19 44
Feb 10	21 54.6	-9 9	0 17.2	4 49	15 41.7	-18 34	3 58.5	19 51
Feb 20	21 15.1	-12 37	0 39.3	8 53	16 3.3	-19 45	4 1.3	20 1
Mar 2	21 14.0	-14 55	0 52.5	12 4	16 24.2	-20 45	4 5.3	20 15
Mar 12	21 46.5	-14 16	0 53.0	13 46	16 44.1	-21 35	4 10.5	20 31
Mar 22	22 34.7	-11 5	0 39.6	13 17	17 2.7	-22 15	4 16.6	20 48
Apr 1	23 31.1	-5 44	0 18.3	10 30	17 19.5	-22 48	4 23.6	21 7
Apr 11	0 34.3	1 29	0 2.0	6 48	17 33.9	-23 16	4 31.4	21 25
Apr 21	1 46.1	10 4	23 59.4	4 2	17 45.3	-23 42	4 39.7	21 44
May 1	3 7.2	18 28	0 10.5	2 57	17 52.9	-24 9	4 48.6	22 1
May 11	4 26.1	23 55	0 31.6	3 26	17 55.8	-24 39	4 57.9	22 17
May 21	5 25.9	25 27	0 59.6	5 4	17 53.4	-25 14	5 7.5	22 32
May 31	5 56.8	24 13	1 32.2	7 27	17 45.4	-25 50	5 17.3	22 44
Jun 10	5 54.8	21 33	2 8.3	10 16	17 33.0	-26 21	5 27.3	22 54
Jun 20	5 32.9	19 6	2 47.2	13 13	17 18.5	-26 42	5 37.3	23 2
Jun 30	5 23.7	18 46	3 28.8	16 3	17 5.3	-26 51	5 47.3	23 7
Jul 10	5 46.6	20 34	4 12.9	18 32	16 56.3	-26 51	5 57.1	23 9
Jul 20	6 43.5	22 27	4 59.3	20 27	16 53.2	-26 50	6 6.7	23 10
Jul 30	8 6.1	21 29	5 47.6	21 37	16 56.4	-26 52	6 16.0	23 8
Aug 9	9 31.3	16 33	6 37.3	21 53	17 5.3	-26 56	6 24.9	23 4
Aug 19	10 43.5	9 27	7 27.5	21 11	17 19.1	-27 0	6 33.3	22 59
Aug 29	11 43.4	1 58	8 17.6	19 30	17 37.1	-27 1	6 41.0	22 53
Sep 8	12 34.1	-5 0	9 6.8	16 55	17 58.3	-26 53	6 48.0	22 46
Sep 18	13 15.7	-10 47	9 55.0	13 31	18 22.1	-26 33	6 54.2	22 40
Sep 28	13 42.3	-14 25	10 42.0	9 28	18 47.9	-25 57	6 59.4	22 33
Oct 8	13 36.6	-13 28	11 28.2	4 57	19 15.0	-25 3	7 3.5	22 28
Oct 18	13 0.4	-6 46	12 13.9	0 10	19 43.0	-23 49	7 6.3	22 25
Oct 28	13 3.2	-4 37	12 59.7	-4 42	20 11.5	-22 15	7 7.8	22 23
Nov 7	13 49.7	-9 11	13 46.3	-9 26	20 40.2	-20 23	7 7.9	22 24
Nov 17	14 49.3	-15 11	14 34.2	-13 49	21 8.7	-18 12	7 6.6	22 28
Nov 27	15 52.7	-20 19	15 23.9	-17 39	21 36.9	-15 46	7 3.8	22 33
Dec 7	16 59.1	-23 51	16 15.6	-20 41	22 4.8	-13 7	6 59.9	22 40
Dec 17	18 8.2	-25 20	17 9.1	-22 44	22 32.3	-10 17	6 54.9	22 48
Dec 27	19 18.1	-24 26	18 3.8	-23 39	22 59.4	-7 20	6 49.3	22 57

	Saturn		Uranus		Neptune		Pluto	
	RA	DEC	RA	DEC	RA	DEC	RA	DEC
	h m	° '	h m	° '	h m	° '	h m	° '
Jan 1	3 31.2	16 47	21 25.2	-15 53	20 30.6	-18 46	16 54.6	-12 12
Jan 11	3 29.7	16 45	21 27.2	-15 43	20 32.1	-18 41	16 56.0	-12 14
Jan 21	3 29.0	16 45	21 29.3	-15 33	20 33.6	-18 36	16 57.2	-12 14
Jan 31	3 29.0	16 48	21 31.6	-15 22	20 35.1	-18 30	16 58.3	-12 14
Feb 10	3 29.8	16 54	21 33.8	-15 11	20 36.7	-18 25	16 59.3	-12 14
Feb 20	3 31.3	17 2	21 36.1	-15 0	20 38.2	-18 19	17 0.0	-12 12
Mar 2	3 33.5	17 13	21 38.3	-14 49	20 39.5	-18 14	17 0.5	-12 11
Mar 12	3 36.4	17 25	21 40.4	-14 39	20 40.8	-18 9	17 0.7	-12 8
Mar 22	3 39.8	17 39	21 42.4	-14 29	20 41.9	-18 5	17 0.8	-12 6
Apr 1	3 43.8	17 54	21 44.2	-14 20	20 42.9	-18 2	17 0.6	-12 3
Apr 11	3 48.2	18 10	21 45.8	-14 13	20 43.7	-17 59	17 0.2	-12 0
Apr 21	3 52.9	18 26	21 47.1	-14 6	20 44.2	-17 57	16 59.6	-11 57
May 1	3 57.9	18 43	21 48.2	-14 1	20 44.5	-17 55	16 58.9	-11 55
May 11	4 3.1	18 59	21 48.9	-13 58	20 44.7	-17 55	16 58.0	-11 53
May 21	4 8.4	19 14	21 49.4	-13 56	20 44.5	-17 56	16 57.0	-11 51
May 31	4 13.8	19 29	21 49.5	-13 56	20 44.2	-17 57	16 55.9	-11 49
Jun 10	4 19.2	19 43	21 49.3	-13 57	20 43.7	-17 59	16 54.8	-11 48
Jun 20	4 24.5	19 55	21 48.8	-14 0	20 43.0	-18 2	16 53.8	-11 48
Jun 30	4 29.6	20 6	21 48.0	-14 4	20 42.2	-18 5	16 52.8	-11 49
Jul 10	4 34.4	20 16	21 47.0	-14 10	20 41.2	-18 9	16 51.9	-11 50
Jul 20	4 39.0	20 25	21 45.8	-14 16	20 40.1	-18 13	16 51.1	-11 52
Jul 30	4 43.1	20 32	21 44.4	-14 24	20 39.0	-18 17	16 50.4	-11 54
Aug 9	4 46.8	20 38	21 42.9	-14 32	20 37.9	-18 21	16 50.0	-11 57
Aug 19	4 49.9	20 42	21 41.3	-14 39	20 36.9	-18 25	16 49.8	-12 1
Aug 29	4 52.4	20 45	21 39.8	-14 47	20 35.9	-18 29	16 49.7	-12 6
Sep 8	4 54.2	20 47	21 38.3	-14 54	20 35.0	-18 33	16 49.9	-12 10
Sep 18	4 55.3	20 47	21 37.0	-15 1	20 34.3	-18 35	16 50.3	-12 15
Sep 28	4 55.6	20 47	21 35.9	-15 6	20 33.8	-18 37	16 51.0	-12 21
Oct 8	4 55.2	20 45	21 35.0	-15 10	20 33.5	-18 39	16 51.8	-12 26
Oct 18	4 53.9	20 42	21 34.5	-15 12	20 33.3	-18 39	16 52.8	-12 31
Oct 28	4 52.0	20 38	21 34.2	-15 13	20 33.5	-18 39	16 54.0	-12 36
Nov 7	4 49.5	20 33	21 34.2	-15 13	20 33.8	-18 38	16 55.3	-12 41
Nov 17	4 46.5	20 28	21 34.6	-15 10	20 34.4	-18 36	16 56.7	-12 46
Nov 27	4 43.1	20 22	21 35.4	-15 6	20 35.2	-18 33	16 58.2	-12 50
Dec 7	4 39.7	20 16	21 36.4	-15 1	20 36.1	-18 30	16 59.7	-12 53
Dec 17	4 36.3	20 11	21 37.7	-14 54	20 37.3	-18 26	17 1.3	-12 56
Dec 27	4 33.1	20 6	21 39.3	-14 46	20 38.6	-18 21	17 2.8	-12 59

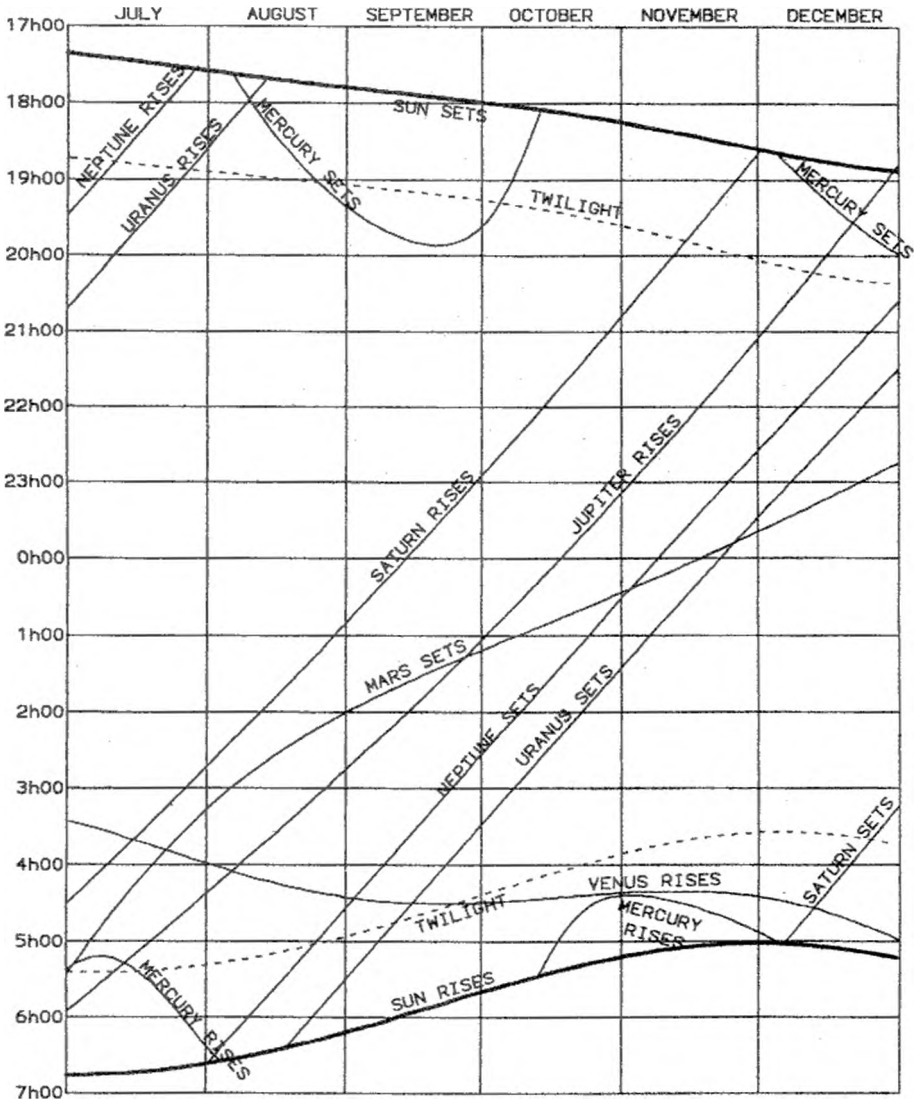
TIMES OF RISING AND SETTING

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.



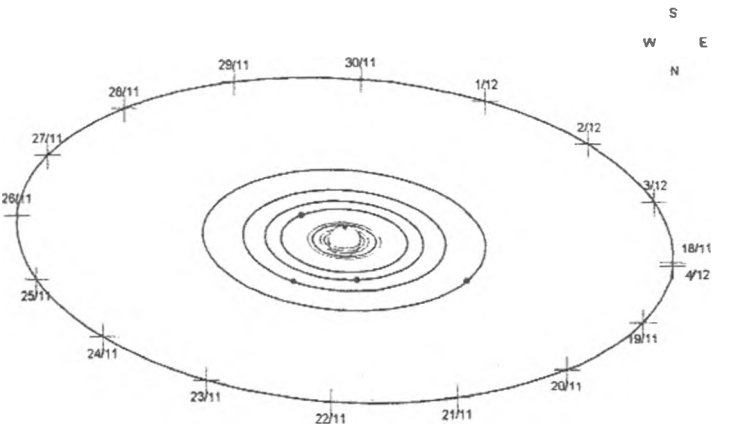
CORRECTION FOR PLACES NOT ON THE 30° E MERIDIAN
Approximate longitude corrections from the 30° East meridian are:

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 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 3. The easiest to find is Titan (magnitude +8.5), according to the diagram and information in the table below.

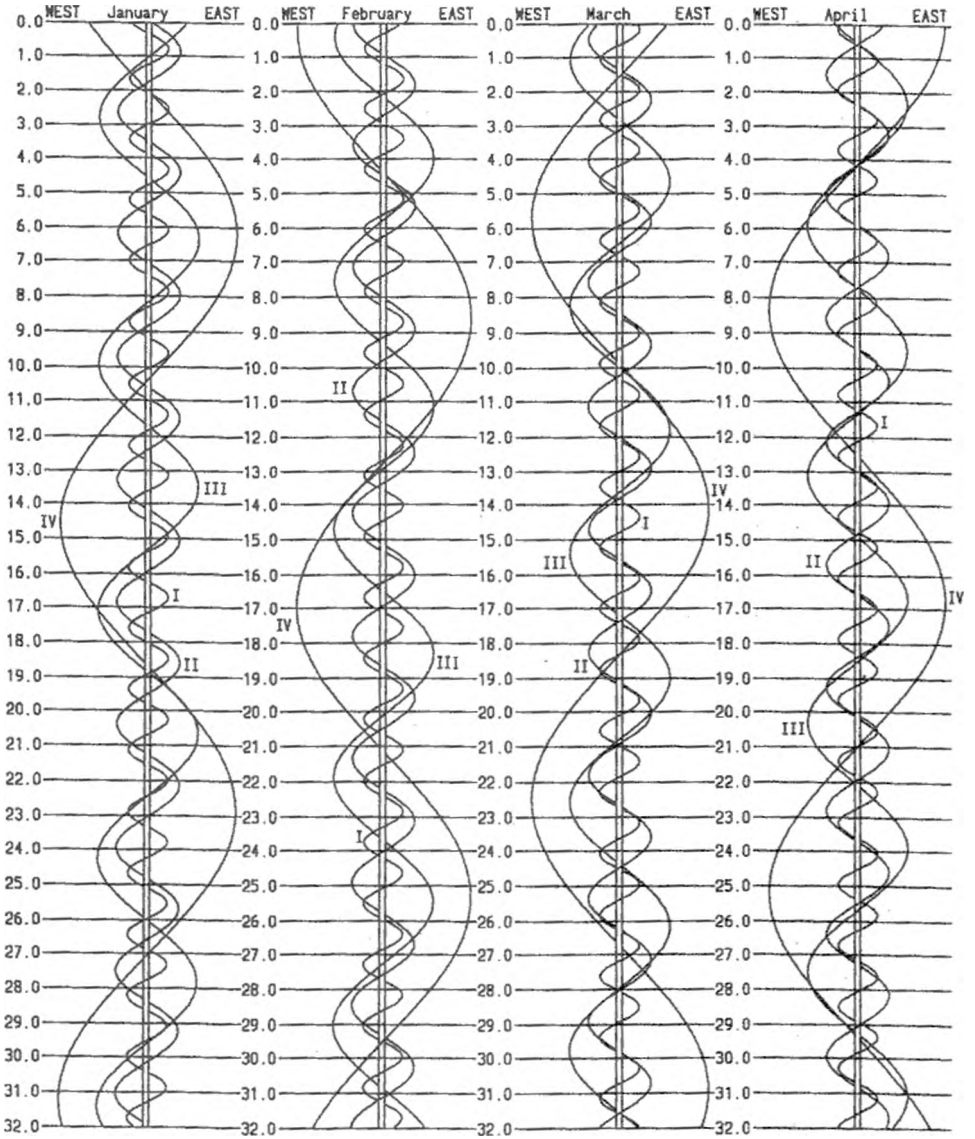


TITAN

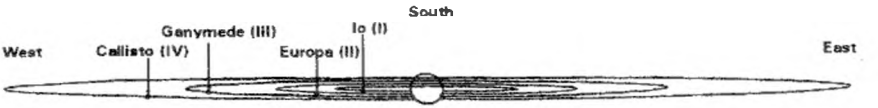
Eastern Elongation			Inferior Conjunction			Western Elongation			Superior Conjunction		
	d	h		d	h		d	h		d	h
Jan	2	13.6	Jan	6	17.2	Jan	10	14.1	Jan	14	09.6
	18	11.8		22	15.6		26	12.6		30	08.2
Feb	3	10.6	Feb	7	14.5	Feb	11	11.6	Feb	15	07.4
	19	09.9		23	13.9		27	11.1	Mar	3	07.0
Mar	7	09.7	Mar	11	13.8	Mar	15	11.1		19	07.1
	23	10.0		27	14.2		31	11.4	Apr	4	07.6
Apr	8	10.7	Apr	12	14.8	Apr	16	12.0		20	08.4
	24	11.7		28	15.7	May	2	12.8	May	6	09.3
May	10	12.8	May	14	16.8		18	13.7		22	10.4
	26	14.0		30	17.9	Jun	3	14.7	Jun	7	11.5
Jun	11	15.3	Jun	15	18.9		19	15.6		23	12.5
	27	16.4	Jul	1	19.9	Jul	5	16.4	Jul	9	13.4
Jul	13	17.4		17	20.7		21	17.0		25	14.1
	29	18.1	Aug	2	21.2	Aug	6	17.4	Aug	10	14.4
Aug	14	18.4		18	21.3		22	17.3		26	14.4
	30	18.2	Sep	3	20.9	Sep	7	16.8	Sep	11	13.8
Sep	15	17.6		19	20.1		23	15.9		27	12.7
Oct	1	16.4	Oct	5	18.7	Oct	9	14.4	Oct	13	11.1
	17	14.6		21	16.8		25	12.4		29	08.9
Nov	2	12.3	Nov	6	14.5	Nov	10	10.0	Nov	14	06.4
	18	09.6		22	11.8		26	07.3		30	03.5
Dec	4	06.7	Dec	8	09.0	Dec	12	04.6	Dec	16	00.7
	20	03.8		24	06.3		28	01.9		31	22.1

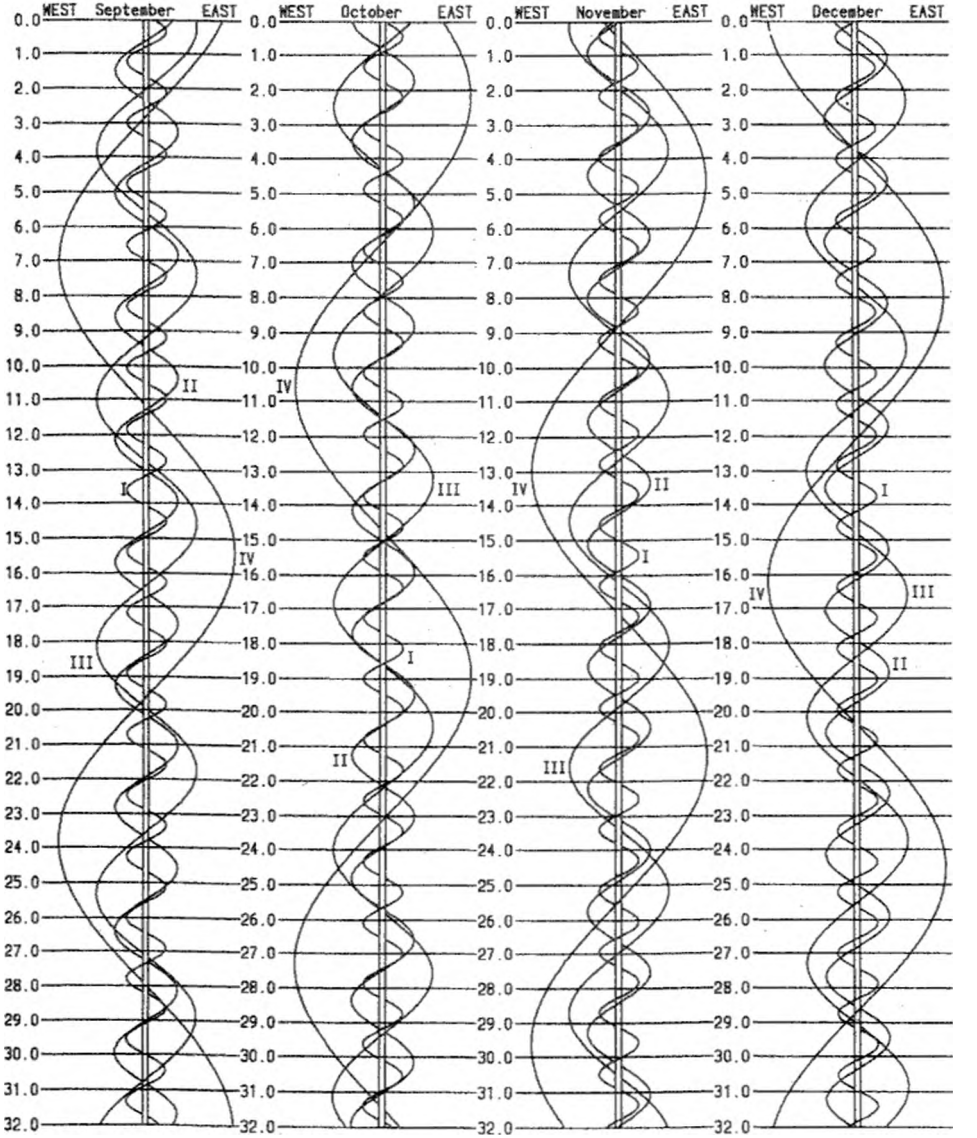
THE MOONS OF JUPITER

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

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

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 2001, 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
McNaught-Hartley	C/1999 T1	2000 December 13	9
Schwassmann-Wachmann 3	73P	2001 January 27	8?
Schaumasse	24P	2001 May 2	10
Borrelly	19P	2001 September 14	9

? Predicted magnitude 12, this comet has a tendency to undergo outbursts in brightness

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

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

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

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

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

METEORS

The name given to particles travelling through space is *meteoroids*. Several thousand tonnes of these particles, mostly smaller than grains of sand, enter the earths atmosphere every day. When a particle enters the atmosphere, it heats up due to the effects of friction and may become visible before burning up. The resultant streak of light is known as a *meteor*. Those which become equal or brighter than 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	DEC °	ZHR	VEL km/s	REC.WATCH BEGIN SAST	END SAST	OBSERVING CONDITIONS 2001
α Crucids	Jan19	Jan06-Jan28	12h48	-63	<5	50	00h00	03h30	Good
♋ Centaurids	Feb 7	Jan28-Feb23	14h00	-40	5	60	22h00	03h30	Full moon
γ Normids	Mar 13	Feb25-Mar22	16h36	-51	5	56	00h00	04h30	Poor
δ Pavonids	Apr 6	Mar11-Apr16	20h32	-63	5	59	02h00	04h30	Unfavourable
April Lyrids	Apr 21	Apr16-Apr24	18h05	+34	15	49	03h00	05h00	Favourable
π Puppids	Apr 23	Apr16-Apr25	07h20	-45	<5	18	19h00	22h00	New moon
α Scorpiids	May 3	Apr11-May12	16h00	-27	5	35	21h00	04h00	Unfavourable
η Aquarids	May 5	Apr21-May12	22h24	-02	30	65	04h00	05h30	Unfavourable
χ Scorpiids	Jun 5	May27-Jun20	16h32	-14	5	21	21h00	04h30	Full moon
Sagittarids	Jun 11	Jun08-Jun16	20h16	-35	<5	52	20h00	05h30	Poor
θ Ophiuchids	Jun 13	Jun08-Jun16	17h48	-20	5	27	20h00	05h30	Good
June Lyrids	Jun 16	Jun11-Jun21	18h32	+35	9	31	23h30	02h00	Good
July Pheonicids	Jul 13	Jul10-Jul16	02h08	-48	<5	47	23h00	05h00	Poor
Capricornids	Jul 26	Jul10-Aug05	21h00	-15	8	?	20h30	05h30	Poor
Piscis Australids	Jul 28	Jul19-Aug17	22h40	-30	8	35	21h30	05h00	Poor
South δ Aquarids	Jul 29	Jul21-Aug29	22h36	-16	30	42	22h00	05h00	Poor
α Capricornids	Jul 30	Jul15-Aug25	20h28	-10	10	25	20h00	04h00	Poor
South ι Aquarids	Aug 5	Jul15-Aug25	22h12	-15	<5	34	22h00	04h30	Unfavourable
North δ Aquarids	Aug 12	Jul14-Aug25	22h28	-05	10	42	23h00	05h00	Poor
North ι Aquarids	Aug 19	Jul15-Sep20	21h48	-06	10	36	20h00	05h00	Favourable
Orionids	Oct 21	Oct02-Nov07	06h20	+16	30	68	00h00	04h00	Favourable
Southern Taurids	Nov 5	Sep15-Dec01	03h20	+14	10	29	21h30	03h30	Unfavourable
Northern Taurids	Nov 12	Sep19-Dec01	04h00	+23	5	31	21h30	03h30	Favourable
Leonids	Nov 17	Nov14-Nov20	10h08	+22	5	70	03h00	04h00	Favourable
Dec. Phoenicids	Dec 6	Dec03-Dec05	01h12	-53	5	22	20h30	02h00	Good
Geminids	Dec 14	Dec04-Dec16	07h28	+33	50	36	23h30	03h00	New moon
Velids	Dec 29	Dec05-Jan07	09h56	-51	5	40	22h30	03h30	Full moon

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

THE STARS

CONSTELLATIONS

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

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

STAR NAMES

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

STELLAR MAGNITUDES AND STELLAR DISTANCES

The apparent brightness of a star - which depends both on its true luminosity and its distance - is indicated by its magnitude. Equal intervals of magnitude represent equal ratios in light intensity.

Distances are often expressed in units of light years - the distance light would travel in a year (equal to 9.5×10^{12}km).

DOUBLE STARS

It now appears that single stars such as our Sun are the exception, the majority of stars being double or multiple - two or more suns in orbit around one another.

STAR CLUSTERS

These are two completely different sorts. Galactic clusters, having of the order of 100 stars, are found close to the plane of the Milky Way. The ones we can see are relatively nearby. Globular clusters are much larger and far more distant. They contain of the order of 100 000 stars each and are seen above and below the Milky Way on that side of the sky towards the centre of our galaxy. So great is their distance that small telescopes fail to resolve individual stars - instead they appear as fuzzy balls.

NEBULAE

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

THE STAR CHARTS

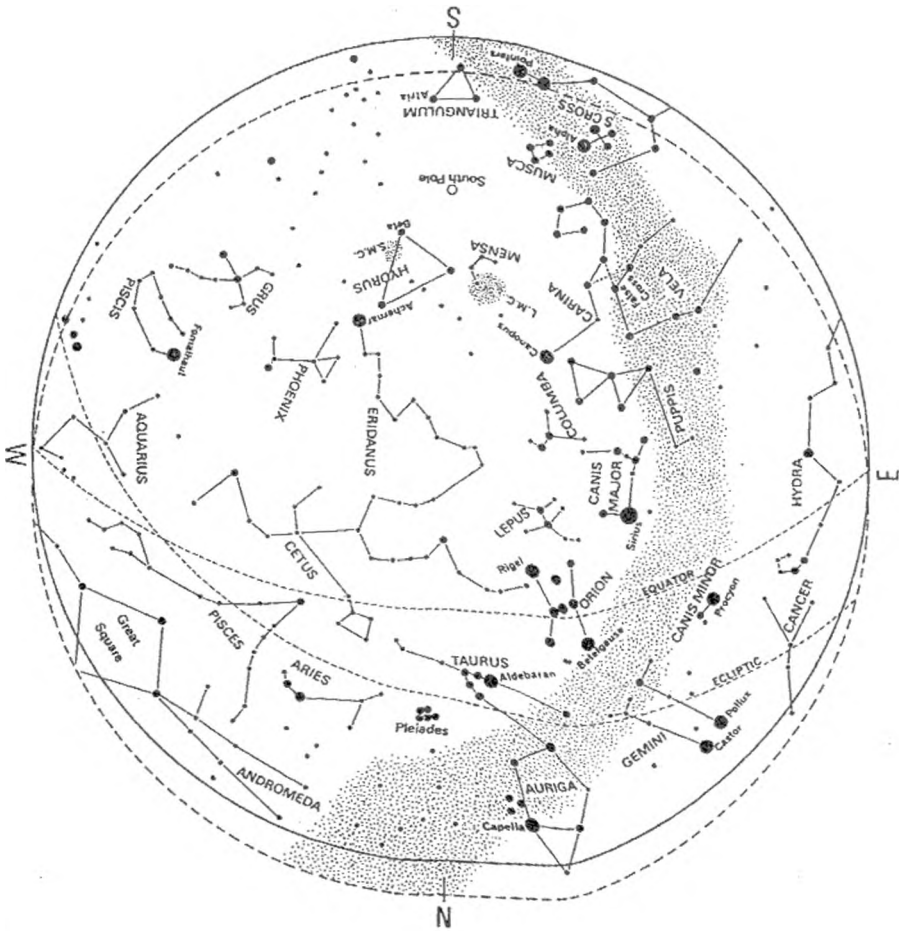
The star charts in this section show the night sky for each of the four seasons of the year. These seasonal charts depict stars down to magnitude 3.5 which is approximately what will be visible to the naked eye in city areas. Charts of 3 of the most interesting regions in the sky (showing stars down to magnitude 5) - the Orion region, visible in Summer; the Scorpius region, visible in Winter and the Southern Cross Region, visible all year round - are featured. They are rich in interesting objects visible to the naked eye, or with the aid of binoculars or a small telescope. To use them locate the constellations in the sky from the seasonal chart and rotate the regional chart to match the orientation of the constellations in the sky.

THE SUMMER SKY

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

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

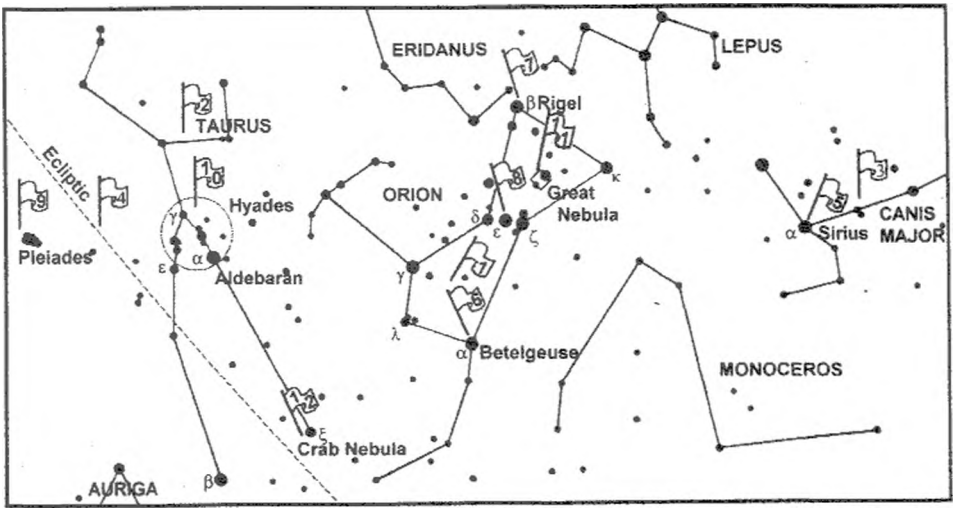
Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.



Courtesy of the

PLANETARIUM SA MUSEUM

THE ORION REGION



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.

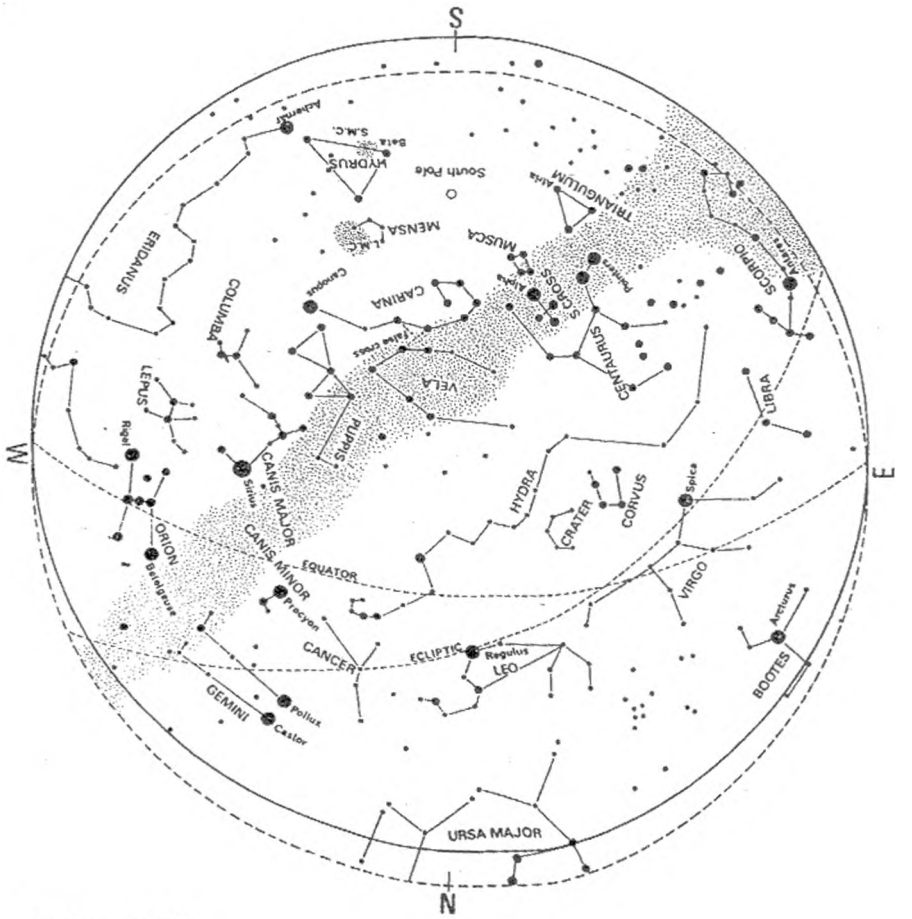
(12) The Crab Nebula, close to ξ ,is the remnant of a supernova recorded by the Chinese in 1054, requires a moderate sized telescope for observation. In its heart is located the extraordinary pulsar which emits a double flash of light 30 times every second. The current belief is that it is a rapidly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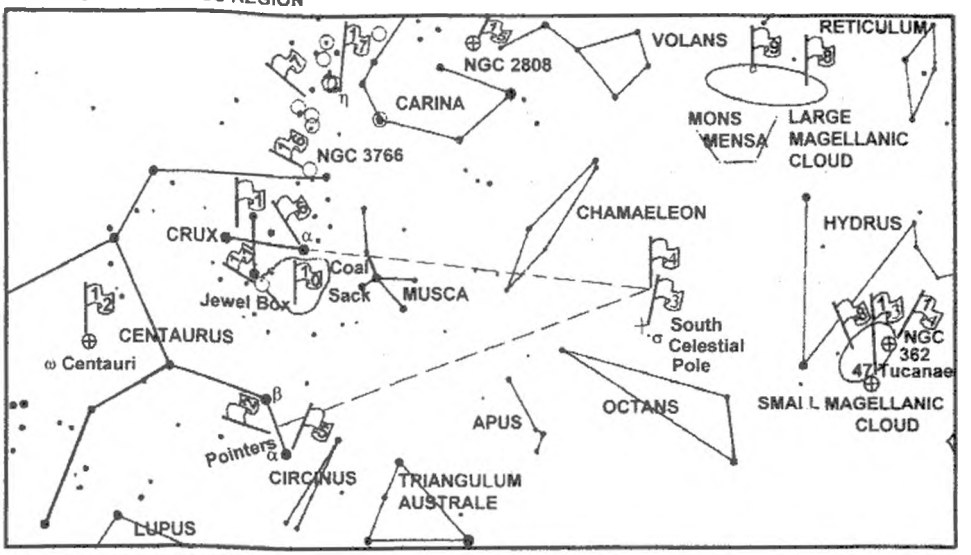
THE SOUTHERN CROSS REGION



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).

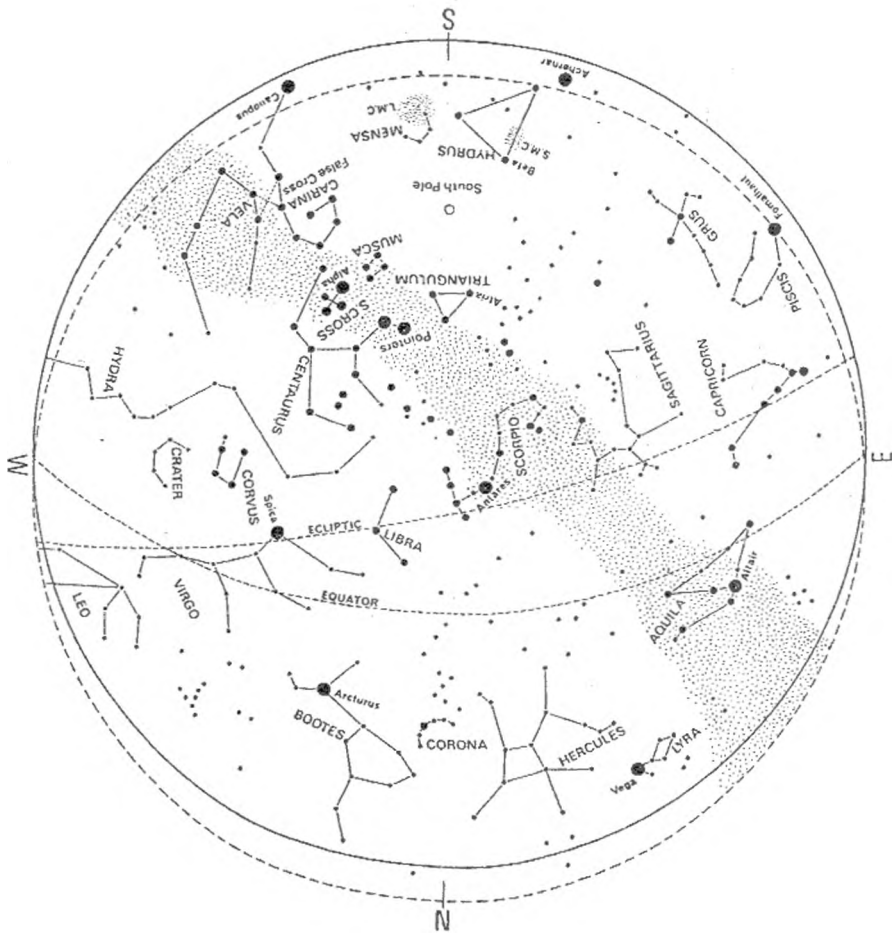
(12) ω Centauri and (13) 47 Tucanae are perhaps the best known globular cluster. Binoculars will show their fuzzy appearance. (14) NGC 362 and (15) NGC 2808 are fainter globular clusters.

THE WINTER SKY

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

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

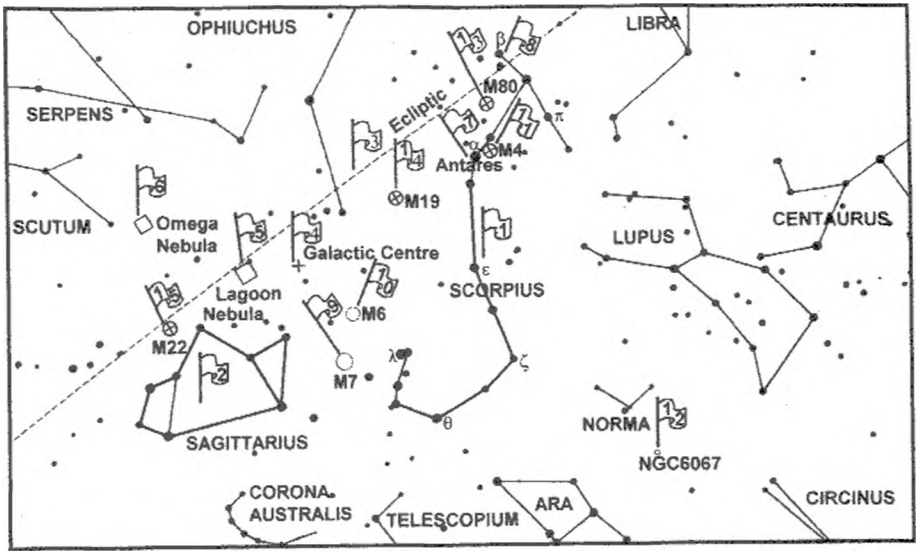
Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.



Courtesy of the

PLANETARIUM SA MUSEUM

THE SCORPIUS REGION



THE SCORPIUS REGION

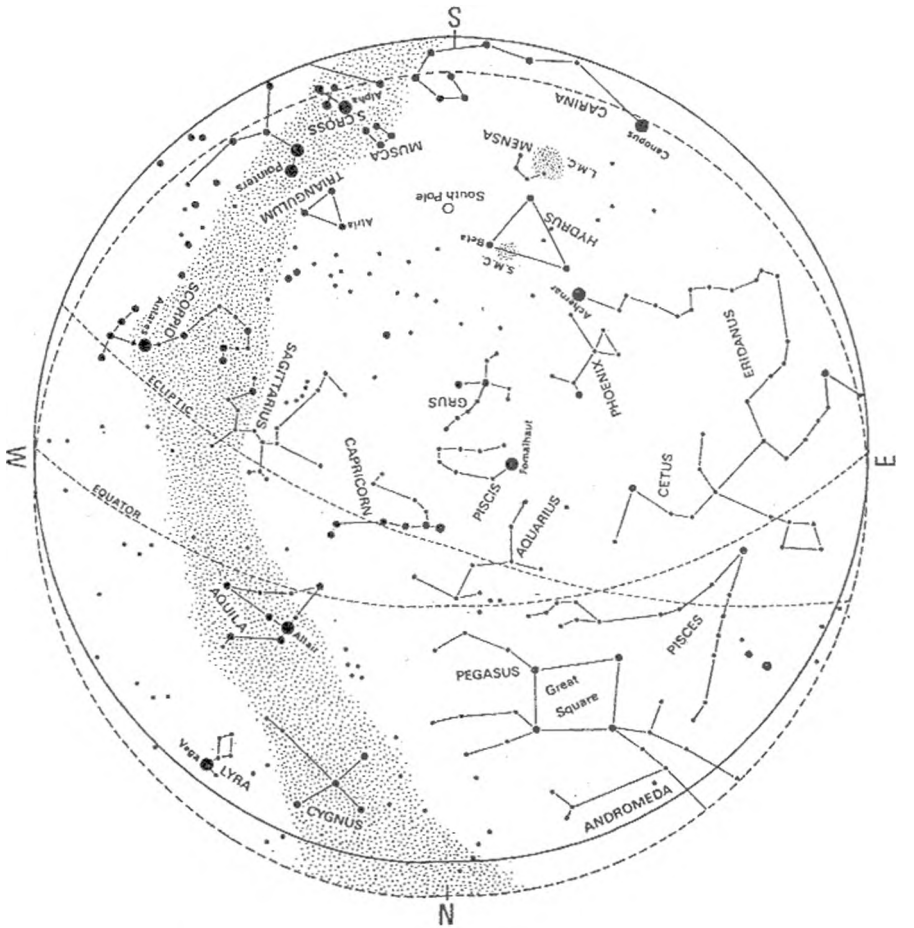
(1) The constellation of Scorpius. The creature is depicted with α in the centre of the body and β and π the claws. The distinctive tail ε - ζ - θ curls round to the sting.
(2) Sagittarius - the figure of the centaur archer is very difficult to make out. A more easily recognisable asterism is the 'teapot'.
(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, P.O. Box 219, Vanrhynsdorp, 8170,
email <astronomer@skywatch.co.za> Tel 027-219 1868

PLANETARY OCCULTATIONS

A number of A.S.S.A. members and professional observatories form part of a worldwide network which observes the above events. The Southern Africa network comprises approximately 12 observers and more observers are badly needed. Very little experience is needed, apart from the ability to locate some of the fainter naked eye stars and familiarity with the user's telescope, which does not have to be a large equatorial. The only other equipment needed is a small FM radio and portable tape recorder.

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

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

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

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

Date	SAST	Name of Planet	Mag	Occulted Star	Mag	RA(2000.0)	Dec	Dur	Al	Az
Jan 04	03 12	6 Hebe	11.0	TYC +03 06274	11.0	12 55 19	+03 27	13	30	NE
Jan 08	20 59	1203 Nanna	14.4	TYC 1312-02132-1	10.9	05 55 06	+15 36	6	20	NE
Jan 28	04 45	44 Amalia	14.5	TYC 5522-01688-1	8.1	12 09 29	-11 51	17	80	N
Jan 30	22 38	280 Philia	14.9	TYC 1960-01272-1	10.4	09 41 34	+23 51	4	20	NE
Feb 20	20 21	636 Erika	14.8	TYC 2467-00368-1	11.7	07 56 44	+31 32	8	20	NE
Feb 25	04 54	196 Philomela	12.5	TYC 6842-01561-1	11.5	18 00 25	-23 27	5	40	E
Mar 01	22 58	927 Ratisbona	14.0	TYC 1968-00406-1	11.6	10 13 23	+24 59	6	20	N
Mar 18	21 48	71 Niobe	12.1	TYC 1906-01098-1	11.3	06 56 59	+29 25	8	20	N
Mar 24	04 47	34 Circe	13.8	TYC 6270-01561-1	11.7	18 29 08	-17 48	6	70	E
Mar 28	19 59	259 Aletheia	13.9	TYC 891--00021-1	8.3	06 31 43	+28 23	13	25	N
Apr 05	23 47	517 Edith	14.7	HIP 66920	8.5	13 42 54	-15 02	7	55	NE
Apr 23	05 15	69 Hesperia	12.4	TYC 5670-00490-1	12.8	17 27 58	-13 16	23	50	NW
Apr 25	04 10	54 Alexandra	12.4	HIP 110169	8.1	22 18 55	-11 33	5	25	NE
May 04	01 43	137 Meliboea	12.1	TYC 5594-00576-1	11.6	15 26 01	-09 12	12	60	N
May 08	02 53	258 Tyche	13.0	TYC 5166-00550-1	11.8	20 19 30	-02 39	4	40	NE
May 13	05 15	435 Ella	14.0	TYC 6846-00227-1	11.1	18 05 39	-25 41	11	35	W
May 22	03 56	564 Dudu	13.3	TYC 6872-00759-1	11.1	18 58 24	-29 43	6	85	SW
May 30	00 52	762 Pulcova	13.1	TYC 7326-00471-1	11.5	15 30 56	-36 30	11	80	W
May 31	22 21	804 Hispania	13.7	TYC 0257-00602-1	10.0	10 44 35	+04 19	10	25	NW
Jun 09	02 58	564 Dudu	12.8	TYC 7417-01443-1	11.6	18 54 43	-34 29	5	40	W
Jun 09	03 32	15 Eunomia	9.8	TYC 7318-00723-1	11.5	15 31 11	-32 28	21	25	NW
Jun 11	02 14	409 Aspasia	0.5	TYC 6235-02669-1	10.5	17 29 39	-16 48	16	60	NW
Jun 20	18 28	308 Polyxo	12.1	TYC 5623-00707-1	11.0	16 03 05	-14 17	19	20	NE
Jun 24	22 36	1241 Dysona	13.9	HIP 83431	5.4	17 03 09	-53 14	7	45	N
Jul 09	04 48	2363 Cebriones	17.1	TYC 0647-00765-1	11.6	02 59 41	+14 00	4	20	NE
Jul 16	05 30	253 Mathilde	13.3	TYC 0581-01034-1	11.6	23 23 21	+02 33	9	40	N
Jul 17	22 56	94 Aurora	12.3	TYC 6931-00092-1	10.3	20 56 59	-27 25	17	40	NE
Jul 24	21 42	72 Feronia	13.5	TYC 4965-00345-1	11.8	13 29 40	-07 03	4	25	W
Jul 27	00 29	1330 Spiridonia	15.4	TYC 5231-00472-1	11.4	22 14 30	-05 08	5	40	NE
Jul 28	21 53	1241 Dysona	14.3	TYC 8330-03260-1	9.3	16 44 08	-47 28	7	50	SE
Aug 03	21 53	21119 C Schw-Wch	16.8	TYC 871-00410-1	11.5	18 44 34	-28 14	5	85	E
Aug 07	18 48	21119 C Schw-Wch	16.9	HIP 91804	9.6	18 43 08	-28 11	5	30	E
Aug 09	22 21	501 Urhixidur	13.1	TYC 7975-00722-1	9.9	20 46 49	-43 45	7	75	E
Aug 13	23 49	167 Urda	13.5	TYC 6305-01516-1	11.5	19 21 24	-19 43	6	45	W
Aug 15	23 10	Mars	1.2	HIP 84314	6.7	17 14 14	-26 59	*	30	W
Aug 27	21 34	602 Marianna	11.6	TYC 6363-00573-1	10.4	21 45 45	-15 23	12	35	NE
Aug 28	04 15	335 Roberta	12.6	TYC 0024-00957-1	10.9	01 26 10	+04 16	26	35	N
Sep 10	01 40	37 Fides	10.5	TYC 4663-00325-1	11.1	00 07 12	-0 22	12	50	N
Sep 10	19 34	Mars	0.7	TYC 6850-00185-1	9.8	18 04 30	-26 49	#	85	W
Sep 10	21 22	9 Felicitas	14.4	TYC 7395-00369-1	11.6	18 05 36	-32 05	11	45	SW

This table continues on page

TOTAL LUNAR OCCULTATIONS

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

An occultation occurs when the disk of the Moon moves in front of a star. Timings of occultations, to a precision of one-tenth of a second if possible are very valuable for studies of the Moon's shape and motion. Since only very modest equipment is required, amateurs can make important contributions in this field. Persons interested in making and reporting occultation observations are urged to contact the Director of the Society's Occultation Section:
Mr B. Fraser, PO Box 68525, Bryanston 2021 Tel:(011) 803 8291

Predictions of occultations of all stars brighter than magnitude 7.5 supplied by Hydrographic Dept., Tokyo are given below. The main set of tables give predictions for three stations, namely:

	Clarke 1880	
	Longitude	Latitude
Cape Town	18°.475 E	33°.933 S
Johannesburg	28°.075 E	26°.182 S
Harare	31°.000 E	17°.800 S

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

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

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

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

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

EXPLANATIONS OF ABBREVIATIONS USED IN THE TABLES:

Z.C.	-	the number of the star in the Zodiacal Catalogue. An "m" following the number indicates the star is not single.
Mag.	-	the visual magnitude
Ph	-	the Phase: D = Disappearance, R = Reappearance
h.m.	-	the time of the occultation in UT
a,b	-	parameters in minutes for predicting times other than at standard stations (as explained above in the text)
P.A.	-	The Position Angle on the Moon's limb measured eastward from the north point

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

					CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
DATE		Z.C.	Mag.	Ph	ELG	UT	a.	b.	P.A.	UT	a.	b.	P.A.	UT	a.	b.	P.A.
M	D				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
JAN	4	362	6.5	DD	113	21 17.7	-1.5	1.4	75	21 41.7	-1.0	1.7	62	22 0.7	-0.9	2.3	39
JAN	6	639	6.0	DD	140	23 5.1	-1.3	0.2	116	23 20.4	-1.0	0.8	91	23 32.4	-1.1	1.4	65
JAN	8	946	3.2	DD	164									17 2.3	-2.2	-2.8	132
JAN	14	1689	5.5	RD	238					0 20.5	-2.9	0.4	249	0 26.3	-2.5	-0.8	280
JAN	29	66	6.8	DD	57									18 20.8	-1.2	-0.2	109
JAN	30	192	5.3	DD	69	18 35.4			358								
JAN	31	303	6.6	DD	80									18 10.3	-2.6	-0.7	113
JAN	31	308	6.7	DD	80	18 32.0	-1.7	1.6	66	18 59.9	-1.3	1.9	57	19 21.1	-1.0	2.5	36
FEB	2	577	6.0	DD	106	21 1.3	-1.4	1.7	61	21 30.1	-1.2	2.6	36				
FEB	5	1050	5.8	DD	144	18 36.6	-1.3	0.6	46	19 1.7	-1.8	2.5	30				
FEB	14	2223	4.0	RD	268	23 59.5	-1.4	0.2	235	24 6.1	-1.1	-1.1	275	23 57.6	-0.7	-1.6	301
FEB	16	2361	4.9	RD	280									0 9.5			220
FEB	18	2635	5.7	RD	303	2 21.5	0.8	-3.8	341								
MAR	2	654	6.0	DD	86									17 30.4	-2.8	-1.5	124
MAR	2	668	3.6	DD	87									19 50.5	-0.5	-1.4	134
MAR	3	817	4.8	DD	100	20 10.1			156	20 12.5	-1.1	0.0	116	20 18.6	-1.3	0.6	89
MAR	4	982	6.8	DD	111	17 49.0	-2.2	-0.2	89	18 14.0	-2.6	0.7	74	18 33.0	-3.0	2.2	49
MAR	4	983	6.0	DD	111	17 53.1	-2.4	-0.9	114	18 13.0	-2.6	-0.1	98	18 23.3	-2.8	0.7	76
MAR	5	1144	6.6	DD	126					20 51.7	-1.0	-1.4	144	20 48.6	-1.7	-0.4	114
MAR	16	2456	6.2	RD	261	2 28.9	-2.9	0.8	244	2 52.4	-2.6	-1.1	286	2 43.2	-2.1	-2.9	319
MAR	18	2725	5.8	RD	283	0 22.8	-0.2	-1.3	277	0 10.2	0.1	-2.2	312				
MAR	27	354	5.5	DD	31					16 24.9			9				
MAR	29	617	6.6	DD	56									17 25.8	-0.9	-1.2	128
MAR	30	766	6.0	DD	68	17 11.8	-2.0	0.7	91	17 38.0	-1.8	1.4	70	17 59.7	-2.1	2.7	41
MAR	31	923	6.9	DD	81	17 10.4	-2.3	1.9	41								
MAR	31	929	5.8	DD	82					19 14.5	-0.5	-1.0	138	19 13.5	-1.0	0.0	106
MAR	31	931	6.7	DD	82									19 43.3	-0.3	-0.8	129
APR	4	1514	6.1	DD	137	23 47.6	-1.2	1.2	87								
APR	10	2128	5.8	RD	205	1 19.2	-1.5	-2.0	323								
APR	10	2247	5.6	RD	216	22 39.3	-0.8	-2.4	320								
APR	12	2401	5.6	RD	230					1 59.8	-3.3	1.9	246	2 14.1	-2.9	-0.4	282
APR	14	2822	5.6	RD	263	23 50.6	0.4	-3.5	328								
APR	16	2961	6.0	RD	275					3 29.6	-2.7	4.9	205				
APR	17	3078	4.9	RD	285									0 49.0	-1.8	2.5	212
APR	27	887	7.1	DD	51	17 4.5	-1.6	1.3	75	17 36.0	-2.0	3.0	39				
APR	28	1050	5.8	DD	64									17 14.6	-0.9	-1.3	136
MAY	1	1462	7.4	DD	105									20 28.3			182
MAY	2	1586	7.5	DD	118	19 40.5	-1.2	-1.4	145	19 49.9	-2.0	-0.2	107	20 2.4	-3.5	1.9	70
MAY	2	1598	6.4	DD	120	22 53.6	-0.6	0.0	122	23 4.7	-0.8	1.3	82				
MAY	4	1813	6.0	DD	143					17 48.0	-0.9	-2.8	159	17 31.8	-1.5	-2.0	133
MAY	9	2456	6.2	RD	207	19 46.0	-0.3	-1.4	284	19 34.6	-0.1	-2.2	317	19 9.6			355
MAY	10	2595	5.7	RD	220					20 56.6			215	21 9.6	-1.7	-0.2	261
MAY	11	2747	5.0	RD	231	20 18.2	0.3	-1.7	297	19 55.0			340				
MAY	11	2749	5.0	RD	231	20 34.1	0.7	-2.7	326								
MAY	11	2754	5.9	RD	231					21 8.1	-1.1	-0.1	248	21 6.0	-0.7	-1.0	279
MAY	27	1308	4.7	DD	62	18 48.5	-0.7	0.4	111	19 3.9	-1.0	1.6	70				
MAY	30	1689	5.5	DD	103	21 45.8	-0.7	0.2	116	21 59.2	-0.8	1.6	76				
JUN	1	1897	7.4	DD	126					16 2.6	-0.4	-3.2	168				
JUN	3	2128	5.8	DD	150					15 37.4	0.0	-2.4	151				
JUN	4	2271	4.3	DD	165	19 42.3	-1.4	-1.8	120	19 54.3	-3.0	0.1	80				

					CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
DATE M D	Z.C.	Mag.	Ph	ELG °	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 17	298	7.2	DO	304	3 14.4			336								
JUN 25	1514	6.1	DO	58					18 8.7	-0.1	-1.4	153	18 3.0	-0.6	-0.4	119
JUN 29	2005	7.0	DO	112	21 40.4	-0.9	-1.2	145	21 45.7	-0.9	0.1	112	21 53.4	-0.9	1.2	78
JUL 1	2128	5.8	DO	126	0 18.4	-0.2	2.8	58								
JUL 2	2361	4.9	DO	146	16 51.6			47								
JUL 3	2401	5.6	DO	151	2 39.3			171								
JUL 3	2498	4.5	DO	158	17 9.8	-1.5	-0.1	63								
JUL 8	3078	4.9	RD	207	1 56.6	-1.6	2.5	226	2 29.1	-1.3	2.2	233	2 48.3	-1.6	1.4	251
JUL 8	3197	6.5	RD	217	23 18.2	-2.5	-4.3	308								
JUL 10	3428	5.2	RD	238					20 44.7	-0.2	-1.5	283				
JUL 14	249	4.7	RD	273	1 42.3	-1.1	-0.1	245	1 55.6	-2.0	-0.1	256	1 57.5	-3.3	-1.5	282
JUL 26	1965	6.5	DO	83	20 40.7	-0.5	-1.7	159	20 38.7	-0.4	-0.3	125	20 40.6	-0.4	0.5	94
JUL 27	2072	6.7	DO	93					16 42.7	-0.6	-4.0	172	16 23.2	-2.0	-2.0	136
JUL 27	2089	6.8	DO	96	22 38.0	0.0	2.6	60								
JUL 28	2196	6.7	DO	107									19 12.2	-1.5	-4.6	168
JUL 28	2208	7.4	DO	108	21 10.8	-1.4	0.8	98	21 31.7	-0.8	2.0	69				
JUL 29	2331	6.4	DO	118					18 7.4	-2.0	-2.5	139	18 1.1	-3.0	-0.8	106
JUL 29	2345	6.9	DO	120	21 26.5	-1.8	-2.9	156	21 31.3	-1.6	-0.6	124	21 35.1	-1.3	0.4	95
JUL 30	2472	6.9	DO	132					21 55.6			161	21 44.2	-2.1	-0.9	120
JUL 31	2595	5.7	DO	141	17 56.1	-1.4	-2.2	124	18 4.8	-2.7	-0.3	86	18 25.2	-4.4	4.1	44
AUG 1	2754	5.9	DO	153	18 5.4	-1.6	-0.9	88	18 30.7	-3.3	2.6	45				
AUG 11	322	5.7	RD	255	0 12.8	-0.5	1.2	210	0 29.0	-1.1	1.2	221	0 41.7	-1.9	0.8	241
AUG 11	327	4.5	RD	255	1 27.8	-0.9	1.3	213	1 50.3	-1.4	1.7	218	2 8.8	-2.2	1.4	234
AUG 13	577	6.0	RD	279					1 34.3	0.4	2.9	187	1 53.0	-0.8	1.7	213
AUG 14	SATURN	0.2	DB	291					0 56.3	-1.1	-1.7	108	0 50.9	-0.8	-0.4	82
AUG 14	SATURN	0.2	RD	291	1 36.3	0.7	2.1	192	1 46.2	0.0	1.5	206	1 56.8	-0.8	0.9	230
AUG 23	2035	7.1	DO	64	17 15.2	-1.6	-0.2	115	17 36.0	-1.6	1.6	77				
AUG 23	2043	6.6	DO	65	19 23.9	-0.7	0.0	121	19 32.2	-0.4	0.8	94				
AUG 23	2047	6.7	DO	65	19 48.5	-0.6	-0.6	139								
AUG 26	2425	5.9	DO	101	17 50.9	-3.0	2.3	61								
AUG 27	2557	6.2	DO	112	18 2.0	-2.7	0.7	77	18 49.5	-2.5	5.7	35				
AUG 27	2567	7.1	DO	114					21 7.6			150	21 2.1	-1.8	-0.5	114
AUG 28	2706	5.8	DO	123					16 6.1	-1.8	-1.8	112	16 5.4	-2.7	0.1	80
AUG 28	2714	6.1	DO	124									19 8.4			149
SEP 5	170	6.2	RD	214	22 25.8	-1.2	0.7	228	22 47.7	-1.9	1.0	236	23 1.5	-2.9	0.6	254
SEP 6	192	5.3	RD	217	4 28.1	-0.8	2.6	209								
SEP 8	404	5.2	DO	237									0 1.2			333
SEP 8	404	5.2	RD	237	0 7.4	-2.2	-1.1	274	0 25.3	-3.3	-1.0	278	0 16.0			314
SEP 22	2401	5.6	DO	72	21 30.8	0.6	2.4	49								
SEP 24	2682	7.0	DO	96	21 17.8	-0.4	2.2	58	21 35.5	0.2	2.2	47				
SEP 26	2961	6.0	DO	118	22 12.4	-1.0	1.6	73	22 31.8	-0.5	1.5	68	22 46.3	0.0	1.8	50
SEP 27	3078	4.9	DO	128	19 12.4	-2.2	1.8	53	19 50.0	-1.7	2.9	40	20 23.2	-0.3	4.4	14
OCT 7	752	4.7	RD	241									20 54.9	0.7	2.2	199
OCT 9	936	5.9	RD	257	3 25.8	-2.3	0.1	260								
OCT 20	2457	6.3	DO	51					17 2.0	-0.7	2.7	53				
OCT 20	2472	6.9	DO	52	19 54.4	0.2	1.8	64								
OCT 23	MARS	-0.1	DO	88									21 43.1			151
OCT 26	3284	7.1	DO	118					17 33.1	-3.7	-1.1	101	17 42.8	-3.2	0.8	76
OCT 28	3425	4.6	DO	132	0 12.7	-0.5	1.8	64	0 28.6	0.0	1.7	56				
NOV 11	1701	5.1	RD	304	2 27.2	-0.6	-2.1	319	2 15.2	-0.7	-2.8	340				

					CAPE TOWN E 18.5 S 33.9				JOHANNESBURG E 28.1 S 26.2				HARARE E 31.0 S 17.8			
DATE	Z.C.	Mag.	Ph	ELG	UT	a.	b.	P.A.	UT	a.	b.	P.A.	UT	a.	b.	P.A.
M D				°	h m	m	m	°	h m	m	m	°	h m	m	m	°
NOV 12	1813	6.0	RD	318									2 22.5			236
NOV 18	2714	6.1	DD	44	19 32.6	-0.3	0.5	113								
NOV 23	3358	7.2	DD	99					18 30.5	-3.5	0.0	101	18 43.7	-2.6	0.9	83
NOV 25	49	6.3	DD	121	19 32.5	0.2	4.2	357	20 3.3	0.1	4.2	359				
NOV 26	165	6.7	DD	131					17 51.0			116	17 52.5	-3.6	-0.1	88
NOV 26	170	6.2	DD	132									20 34.3			115
NOV 28	404	5.2	DD	155	20 8.6			130	20 34.9			129	20 33.9	-4.0	-0.5	100
DEC 2	839	5.3	RD	195	1 50.7	-1.6	0.1	297	1 55.9			333				
DEC 4	1155	6.3	RD	221					2 6.7	-3.0	1.7	239	2 23.6	-2.5	0.4	268
DEC 18	3078	4.9	DD	46	20 26.0	0.5	1.8	46								
DEC 25	354	5.5	DD	123	20 16.7			125	20 42.4	-2.9	-0.7	117	20 50.0	-2.3	0.5	93
DEC 26	469	7.3	DD	135	20 26.2	-1.7	1.7	42	20 59.0	-1.8	2.4	36	21 29.8	-1.5	4.2	12
DEC 27	614	5.7	DD	148	21 43.0	-2.4	0.5	92	22 10.3	-2.1	1.0	80	22 27.3	-2.0	1.7	59

PLANETARY OCCLTATIONS continued

Date	SAST	Name of Planet	Mag	Occulted Star	Mag	RA(2000.0) Dec	Dur	Al	Az
Sep 15	18 53	15 Eunomia	10.9	TYC 6787-02362-1	11.8	16 01 00 -26 27 11		50	W
Sep 15	22 03	246 Asporina	13.0	TYC 5713-00157-1	11.5	19 21 31 -11 04 7		50	NW
Sep 30	03 30	22 Kalliope	11.3	TAC +22#01049 11	11.4	05 46 19 +22 56 15		25	NE
Oct 06	19 52	146 Lucina	13.1	TYC 7462-00183-1	11.4	20 52 21 -32 41 20		85	SE
Oct 11	02 51	39 Laetitia	9.3	TYC 4685-02079-1	10.8	01 34 50 -02 45 15		40	NW
Oct 27	20 53	410 Chloris	13.0	TY 6887-01212-1	9.9	19 17 28 -28 29 4		35	NW
Oct 28	03 59	1024 Hale	14.4	TYC 1850-01464-1	10.8	05 12 56 +24 29 6		30	N
Oct 30	02 00	388 Charybdis	12.9	TYC 1787-00717-1	9.2	03 05 57 +25 15 10		20	N
Nov 18	22 38	972 Cohnia	12.7	TYC 1810-01063-1	10.0	03 30 21 +29 08 8		20	NE
Nov 28	00 45	1031 Arctica	14.4	TYC 0153-02407-1	9.4	06 52 38 +03 14 7		40	NE
Dec 03	00 40	Saturn	0.4	TYC 1275-00354-1	10.8	04 40 58 +20 18 @		30	N
Dec 16	01 16	694 Ekard	13.1	TYC 0145-01717-1	10.3	06 25 55 +06 56 7		40	N
Dec 19	02 27	838 Seraphina	15.1	TYC 0220-00266-1	8.6	08 48 13 +05 27 8		40	N

Note: *,# and@ are 1109, 5701 and 5985 seconds, the disappearance times respectively behind Mars and Saturn. These events will not be easy to observe in small telescopes due to the relative faintness of the occulted stars.

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 mmn refractor is ideal for average events, but instruments with a larger aperture have often shown their superiority under difficult conditions. Timing is best carried out with a portable tape recorder and a small FM radio tuned to a pre-arranged transmission.

It will be seen from the maps that many grazing occultations occur in regions which are rather far removed from the main cities, and which cannot easily be reached by teams of observers from one of the ASSA centres. It is worth remembering, however, that a team of many observers,while ideal, is by no means essential, that a single good observer is worth more than many unsuccessful ones, and that one good observation is worth infinitely more than no observation at all.

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

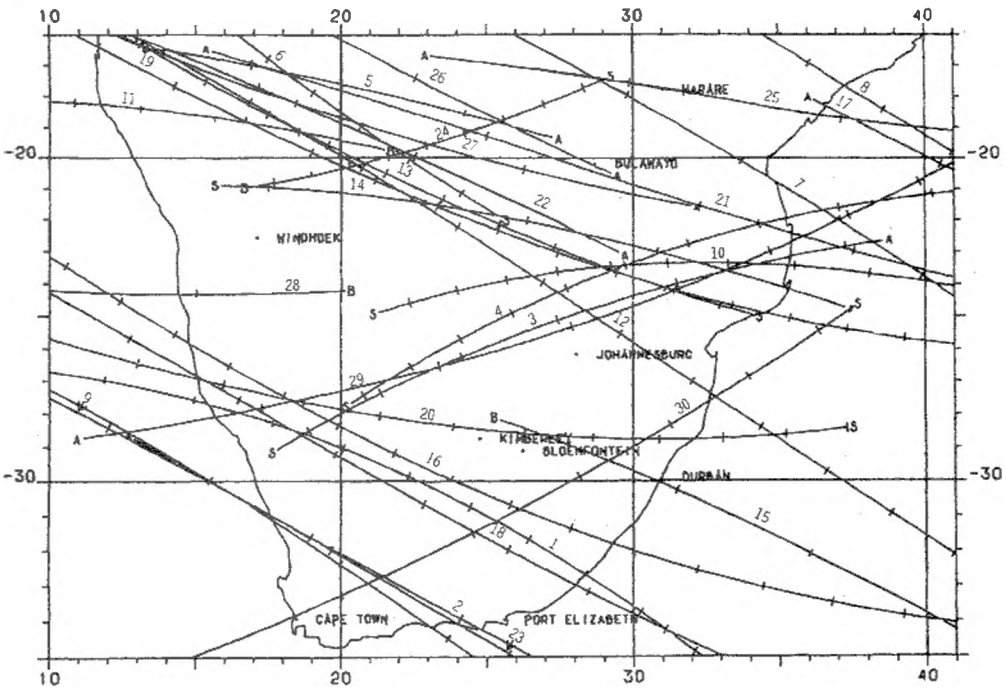
Mr Brian Fraser, PO Box 68525, Bryanston 2021. Tel: (011) 803 8291

EXPLANATION OF THE COLUMN HEADINGS IN THE TABLES:

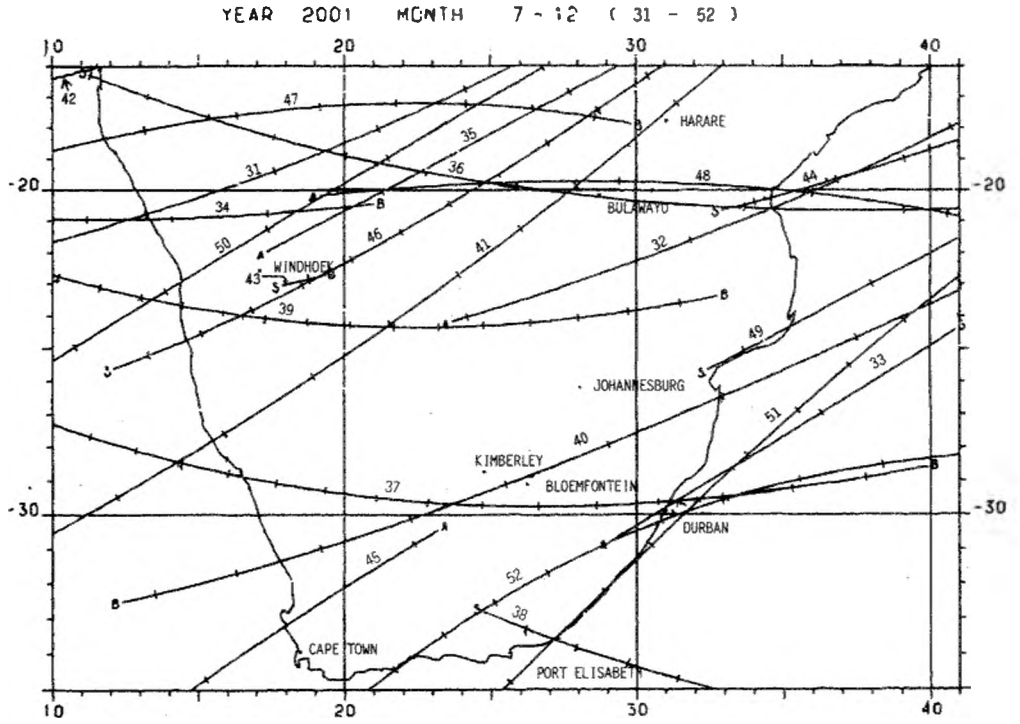
SEQ	: Sequential number in the year. The same number is attached to the corresponding track on the map.
NZC NO	: Zodiacal Catalogue number of the star.
MAG	: Magnitude of the star.
MON, DAY, H, M, S	: Month, day, hour, minute and second in SAST for the west end of the track.
SUNLIT (%)	: Percentage of 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 etc.

YEAR 2001 MONTH 1 - 6 (1 - 30)



SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(Z)	LIMIT		
1	1689	5.47	1	14	1	27	18.78	-76.37	S	( )	( )
2	2408	6.89	1	20	4	30	26.48	-16.31	S	( )	( )
3	66	6.78	1	29	20	12	36.92	22.55	S	(S)	(A)
4	303	6.55	1	31	19	58	38.18	41.15	S	(S)	( )
5	577	5.96	2	2	23	51	41.61	63.51	N	(B)	(A)
6	2005	7.04	2	13	5	16	33.22	-70.48	S	( )	(S)
7	2361	4.85	2	16	1	56	6.46	-40.69	S	( )	( )
8	2498	4.46	2	17	3	32	5.42	-30.78	S	( )	( )
9	2785	6.83	2	19	4	38	58.41	-14.59	S	( )	( )
10	654	5.96	3	2	19	26	40.19	45.95	S	(S)	( )
11	668	3.63	3	2	21	38	0.59	46.64	S	( )	(B)
12	2446	7.18	3	16	1	35	48.63	-57.86	S	( )	( )
13	2588	6.92	3	17	4	28	41.49	-47.07	S	( )	(S)
14	617	6.62	3	29	19	21	28.95	21.37	S	(S)	(A)
15	923	6.89	3	31	19	56	23.06	41.72	N	(B)	( )
16	2401	5.60	4	12	2	43	32.52	-82.36	S	( )	( )
17	2661	7.06	4	13	22	42	39.04	-66.06	S	(A)	( )
18	2675	7.08	4	14	1	36	45.82	-65.00	S	( )	( )
19	2682	6.99	4	14	2	53	31.28	-64.60	S	( )	( )
20	2961	5.96	4	16	4	30	12.27	-45.01	S	( )	(S)
21	3078	4.93	4	17	2	19	4.28	-36.37	S	(A)	( )
22	887	7.05	4	27	19	44	42.30	18.25	N	( )	(A)
23	2754	5.89	5	11	22	41	16.73	-80.91	S	(A)	( )
24	2916	6.84	5	13	5	11	58.67	-71.06	N	(B)	(S)
25	3284	7.06	5	16	1	39	30.82	-43.83	S	(A)	( )
26	1308	4.73	5	27	21	23	18.08	25.75	N	( )	(A)
27	1689	5.47	5	31	0	8	45.03	60.56	N	( )	(A)
28	3490	7.08	6	14	2	22	35.79	-50.39	S	( )	(B)
29	178	6.82	6	16	3	41	39.59	-30.71	N	(A)	( )
30	298	7.16	6	17	5	15	33.70	-21.25	N	( )	(S)



SEQ	NZC NO	MAG	MON	DAY	H	M	S	SUNLIT(%)	LIMIT		
31	249	4.68	7	14	3	2	9.67	-46.55	N	( )	( )
32	362	6.54	7	15	2	24	45.58	-36.79	N	(A)	( )
33	784	6.16	7	18	5	25	33.15	-9.44	N	(A)	(S)
34	2208	7.37	7	28	23	37	48.87	64.94	N	( )	(B)
35	1052	6.84	8	16	5	38	5.10	-12.16	N	(A)	( )
36	2035	7.08	8	23	19	29	47.96	27.58	N	(S)	( )
37	2425	5.91	8	26	19	55	46.95	59.38	N	( )	(B)
38	2549	6.64	8	27	18	25	48.14	68.66	N	(S)	( )
39	2557	6.24	8	27	20	14	17.91	69.23	N	( )	(B)
40	2567	7.07	8	27	22	57	52.03	69.77	S	(B)	( )
41	404	5.16	9	8	1	27	26.55	-76.88	N	( )	( )
42	1097	6.66	10	10	5	51	28.59	-49.97	N	( )	( )
43	2457	6.29	10	20	19	18	18.43	17.93	N	(S)	(B)
44	2589	4.76	10	21	18	2	40.66	26.22	S	(S)	( )
45	2921	6.08	10	24	0	19	30.00	47.52	S	( )	(A)
46	3031	5.89	10	24	19	46	41.40	55.91	S	(S)	( )
47	1334	7.01	11	8	3	55	40.06	-54.45	N	( )	(B)
48	1701	5.06	11	11	3	41	19.89	-21.72	N	(A)	( )
49	2694	6.39	11	18	18	43	23.91	12.49	S	(S)	( )
50	2857	6.67	11	19	20	38	43.39	20.59	S	( )	( )
51	3358	7.18	11	23	20	39	9.45	57.43	S	( )	( )
52	354	5.53	12	25	22	37	14.25	77.34	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	34	May 11	11	55	14	Sep 18	11	53	1
11	12	6	54	21	11	55	28	28	11	49	32
21	12	10	16	31	11	56	34	Oct 8	11	46	26
31	12	12	23	Jun 10	11	58	20	18	11	44	4
Feb 10	12	13	8	20	12	0	27	28	11	42	43
20	12	12	37	30	12	2	34	Nov 7	11	42	36
Mar 2	12	11	2	Jul 10	12	4	16	17	11	43	55
12	12	8	38	20	12	5	16	27	11	46	35
22	12	5	45	30	12	5	20	Dec 7	11	50	25
Apr 1	12	2	45	Aug 9	12	4	23	17	11	55	5
11	11	59	55	19	12	2	30	27	12	0	2
21	11	57	34	29	11	59	49	31	12	1	58
May 1	11	55	58	Sep 8	11	56	32				

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	6 44	3 46	May 11	15 16	12 18	Sep 18	23 49	20 51
11	7 23	4 25	21	15 56	12 58	28	0 28	21 30
21	8 2	5 5	31	16 35	13 37	Oct 8	1 8	22 10
31	8 42	5 44	Jun 10	17 14	14 17	18	1 47	22 49
Feb 10	9 21	6 24	20	17 54	14 56	28	2 26	23 29
20	10 1	7 3	30	18 33	15 36	Nov 7	3 6	0 8
Mar 2	10 40	7 43	Jul 10	19 13	16 15	17	3 45	0 48
12	11 20	8 22	20	19 52	16 54	27	4 25	1 27
22	11 59	9 1	30	20 32	17 34	Dec 7	5 4	2 6
Apr 1	12 38	9 41	Aug 9	21 11	18 13	17	5 44	2 46
11	13 18	10 20	19	21 50	18 53	27	6 23	3 25
21	13 57	11 0	29	22 30	19 32	31	6 43	3 41
May 1	14 37	11 39	Sep 8	23 9	20 12			

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

TELESCOPE SETTING

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

A LIST OF BRIGHT STARS FOR CHECKING TELESCOPE CIRCLES (2001.5)

Star	R.A. h m	Dec. ° ′	Mag.	Sp.	Star	R.A. h m	Dec. ° ′	Mag.	Sp.
ACHERNAR	1 37.7	-57 14	0.6	B5	PROCYON	7 39.3	5 13	0.5	F5
ALDEBARAN	4 36.0	16 31	1.1	K5	REGULUS	10 8.4	11 58	1.3	B8
RIGEL	5 14.6	-8 12	0.3	B8	SPICA	13 25.3	-11 10	1.2	B2
BETELGEUSE	5 55.2	7 24	0.4	M0	ARCTURUS	14 15.7	19 11	0.2	K0
CANOPUS	6 23.9	-52 42	-0.9	F0	ANTARES	16 29.5	-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 2001

	JAN. 2451	FEB. 2451	MAR. 2451	APR. 2452	MAY 2452	JUN. 2452	JUL. 2452	AUG. 2452	SEP. 2452	OCT. 2452	NOV. 2452	DEC. 2452
1	911	942	970	001	031	062	092	123	154	184	215	245
2	912	943	971	002	032	063	093	124	155	185	216	246
3	913	944	972	003	033	064	094	125	156	186	217	247
4	914	945	973	004	034	065	095	126	157	187	218	248
5	915	946	974	005	035	066	096	127	158	188	219	249
6	916	947	975	006	036	067	097	128	159	189	220	250
7	917	948	976	007	037	068	098	129	160	190	221	251
8	918	949	977	008	038	069	099	130	161	191	222	252
9	919	950	978	009	039	070	100	131	162	192	223	253
10	920	951	979	010	040	071	101	132	163	193	224	254
11	921	952	980	011	041	072	102	133	164	194	225	255
12	922	953	981	012	042	073	103	134	165	195	226	256
13	923	954	982	013	043	074	104	135	166	196	227	257
14	924	955	983	014	044	075	105	136	167	197	228	258
15	925	956	984	015	045	076	106	137	168	198	229	259
16	926	957	985	016	046	077	107	138	169	199	230	260
17	927	958	986	017	047	078	108	139	170	200	231	261
18	928	959	987	018	048	079	109	140	171	201	232	262
19	929	960	988	019	049	080	110	141	172	202	233	263
20	930	961	989	020	050	081	111	142	173	203	234	264
21	931	962	990	021	051	082	112	143	174	204	235	265
22	932	963	991	022	052	083	113	144	175	205	236	266
23	933	964	992	023	053	084	114	145	176	206	237	267
24	934	965	993	024	054	085	115	146	177	207	238	268
25	935	966	994	025	055	086	116	147	178	208	239	269
26	936	967	995	026	056	087	117	148	179	209	240	270
27	937	968	996	027	057	088	118	149	180	210	241	271
28	938	969	997	028	058	089	119	150	181	211	242	272
29	939		998	029	059	090	120	151	182	212	243	273
30	940		999	030	060	091	121	152	183	213	244	274
31	941		1000		061		122	153		214		275

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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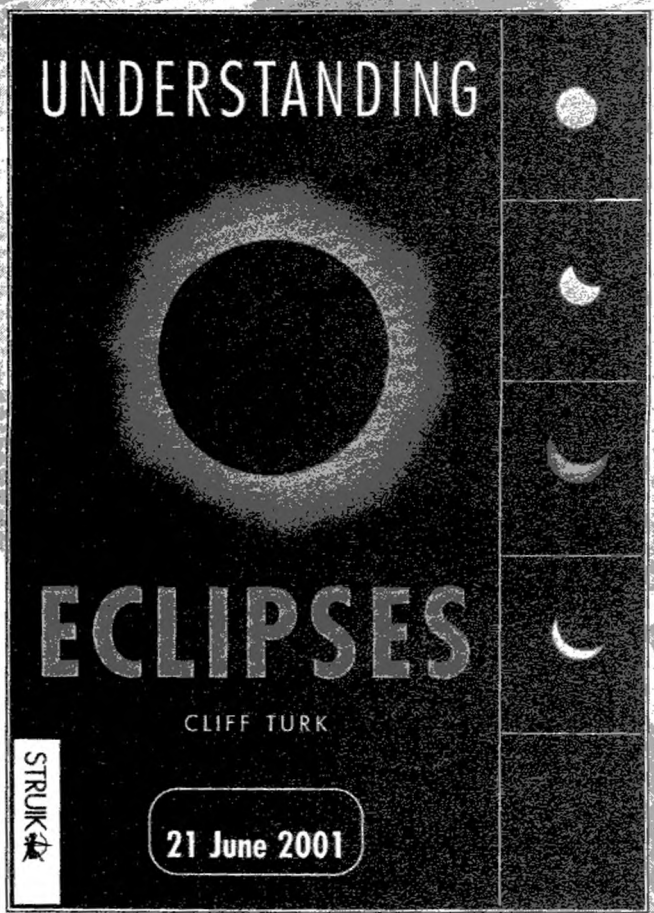

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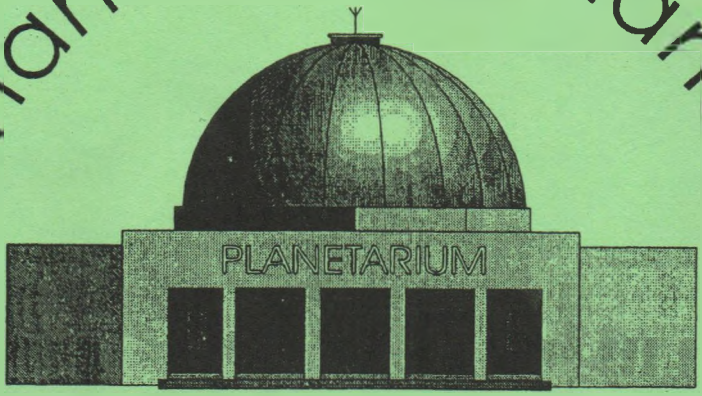

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