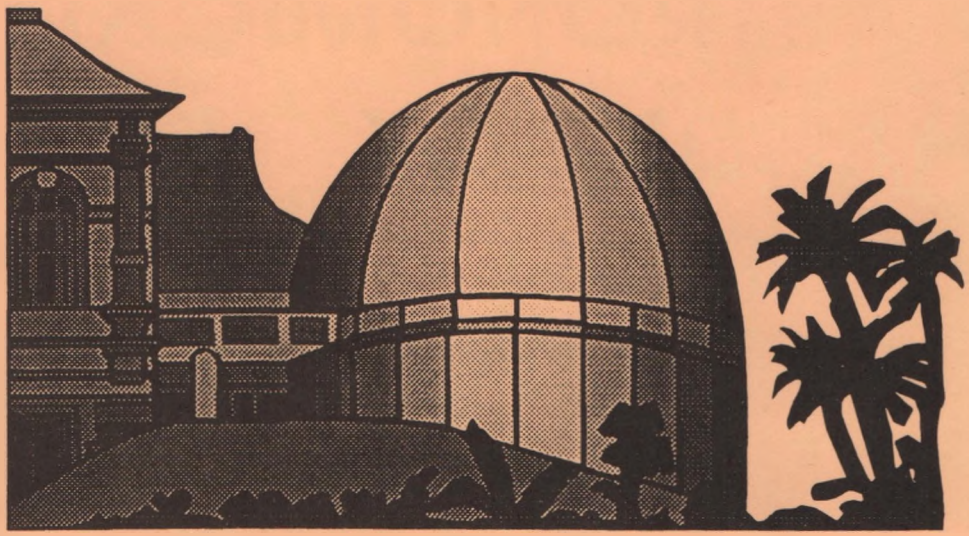
# ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

# 1998

Astronomical Society of Southern Africa

ASSA

9 770571 719007



# PLANETARIUM

S A MUSEUM

25 Queen Victoria Street, ✉ 61 Cape Town 8000, ☎ (021) 24 3330

- Public shows
- Shows especially for young children
- Monthly sky updates
- Astronomy courses
- School shows
- Music concerts
- Club bookings
- Corporate launch venue

For more information telephone 24 3330

# ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA 1998

The 52nd 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 5" Hirst Moonwatch Telescope of the Cederberg Observatory at the Cape Centre 'sidewalk astronomy' outing held at the Victoria and Albert Waterfront in November 1995.
Photograph: C R G Turk



ISSN 0571-7191

CONTENTS



NOTE

All times are SAST unless otherwise stated. Right Ascension and Declination are given for equinox of date unless otherwise stated.

This handbook is produced for the Astronomical Society of Southern Africa. The data it contains has been adapted for Southern Africa from data obtained from The Astronomical Almanac for 1998, the Handbook of the British Astronomical Association for 1998 and the International Lunar Occultation Centre, Tokyo. The star charts on pages 36, 38, 40 and 42 are from "A Beginner's Guide to the Southern Stars" by J.S. Bondietti, published by the South African Museum. The star charts on pages 37, 39 and 40 were adapted from charts output by Skymap 2.29 for Windows. The Minor Planet Occultations were provided by Edwin Goffin, who wishes to thank Dr. Josef de Kerfo, General Manager of Agfa-Gevaert IVV (Mortsel, Belguim) for making the computing facilities available. The Editor is indebted to the South African Astronomical Observatory for supplying the visibility criteria data of The Horizon Chart for the Visibility of the Lunar Cresent at Sunset. 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.

BOYDEN OBSERVATORY, situated at Mazelspoort, 25 km from Bloemfontein, is owned by the Dept of Physics and Astronomy of the University of the Orange Free State. Observing facilities include a 1.52-m telescope, which is gradually being upgraded as funds become available, as well as a 0.41-m telescope, a 0.33-m refractor and a 0.20-m solar installation. THE FRIENDS OF BOYDEN is an organisation, founded to foster a wider public appreciation of the historical, cultural and scientific value of Boyden, to promote public interest in the affairs of the Observatory and to raise funds for the restoration and preservation of the installation. The Friends organise a number of activities such as popular lectures on astronomy and viewing sessions at Boyden. Membership of the Friends is open to all interested persons. Contact Mrs M. Schoch (tel 051-311 061) or Mr M. Hoffman (tel 051-401 2924 or on email at nwfsmjh@med.uovs.ac.za).

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 and Astronomy of the University of the Orange Free State. Tel 051-401 2324 (Mr. M. Hoffman).

THE HARTEBEESTHOEK RADIO ASTRONOMY OBSERVATORY has visiting days for the public once a month on a Sunday at 15:00. It is essential to book, phone 011-642 4692

between 9:00 and 12:00 during the week for more details.

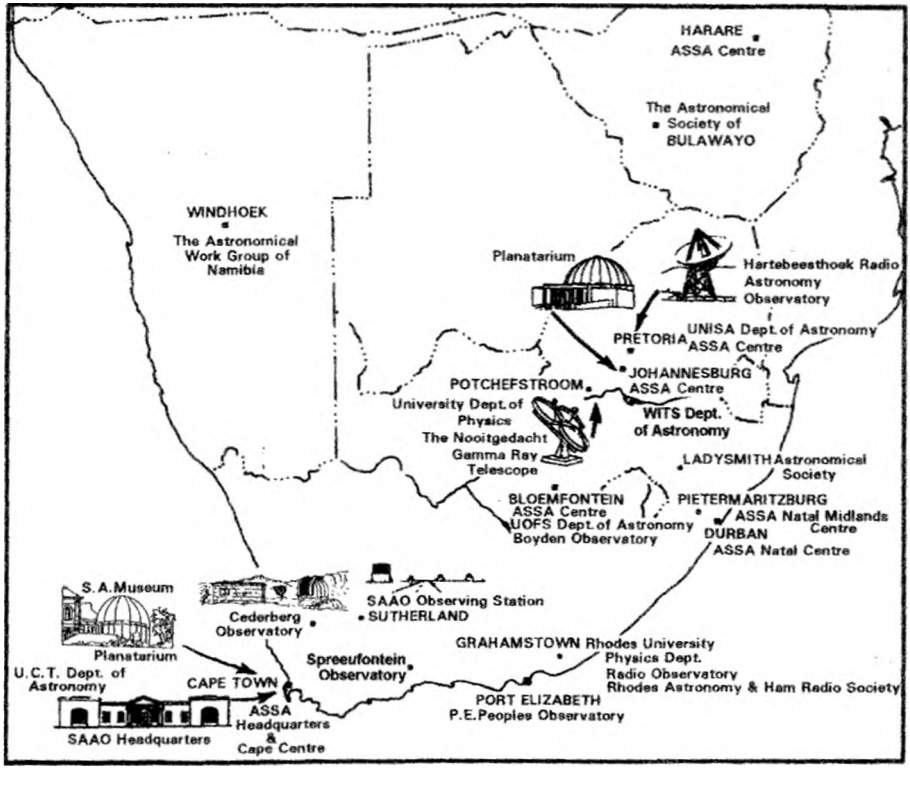
THE NOOITGEDACHT TELESCOPE, POTCHEFSTROOM. Interested individuals or groups are welcome to contact Prof. B G Raubenheimer to arrange visits.

The PORT ELIZABETH PEOPLES OBSERVATORY SOCIETY. The Observatory, situated on the corner of Westview Drive and MacFarlane Road, is open to the public on the 1st and 3rd Wednesdays of every month and on every Wednesday during December and January. Admission is free. Donations are accepted to help with running costs. Viewing evenings are arranged for groups at other times during the month.

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

THE SPREEUFONTEIN OBSERVATORY is an astronomical guest house on a farm in the Great Karoo 75km SSW of Beaufort West, 30km from the N1 National road. Vacilities include a 10" Meade LX200 and 16" Meade Dobsonian Starfinder. Contact Mr A. Jansen, Markstraat 3, Prins Albert, 6930, Tel/Fax 04436-871.

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 and Astronomy, headed by Prof. P E Viljoen, incorporated with the Boyden Observatory. The Dept. of Physics and Electronics at Rhodes University, under Prof. E E Baart, specialises in radio astronomy, and has its own observatory outside Grahamstown. The Dept. of Mathematics, Applied Mathematics and Astronomy at UNISA offers a number of courses in astronomy and astrophysics. 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. Derek Shaw, 2 Sinclair Ave., Bulawayo - Tel. 75439.

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

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

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

THE ASTRONOMICAL SOCIETY OF SOUTHERN AFRICA. This Society is a body consisting of both amateur and professional astronomers. Membership is open to all interested persons, regardless of knowledge or experience. In addition to this Handbook, the

Society issues the "Monthly Notes of the Astronomical Society of Southern Africa" (MNASSA). The Society's has an entrance fee of R40.00 and an annual subscription of R80.00. Members may also subscribe at a reduced rate to the popular monthly magazine "Sky and Telescope" published in the USA, which provides information on professional and amateur activities, together with news of space research and other related subjects. This additional amount for "Sky and Telescope's" yearly subscription is subject to the Rand Dollar exchange rate, details of which are regularly published in MNASSA. A prospectus and application form may be obtained from the Honorary Secretary, Astronomical Society of Southern Africa, P O Box 9, Observatory 7935, or telephone 021-7612112 (Mrs. A. Joubert).

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

BLOEMFONTEIN CENTRE: Meetings are usually held every second Friday of the month at Boyden Observatory, Mazelspoort. Phoning for confirmation beforehand is essential. The Centre publishes a monthly newsletter 'Clear Skys'. Secretarial address: P O Box 1599, Bloemfontein, 9300 or telephone 051-4012924(o/h) or 051-4471921(a/h).

CAPE CENTRE (Cape Town): Formal meetings, involving lectures on the latest Astronomical topics are held on the second Wednesday of the month (except in January and December). Informal meetings are held on other Wednesdays except during January and December. Meetings are held at the SAAO, Observatory Road, Observatory at 20h00. The Centre publishes a monthly newsletter, the "Cape Observer". Secretarial address: P.O.Box 13018, Mowbray, 7705, or tel. 021-6852664.

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

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

NATAL CENTRE (Durban): Regular monthly meetings are held at 19h45 on the second Wednesday of each month at Marist Brothers School, South Ridge Road, Durban. The Centre publishes a monthly magazine "Ndaba". Secretarial address: P O Box 5330, Durban, 4000, or telephone 031-255979 / 7011104 / 288213.

NATAL MIDLANDS CENTRE (Pietermaritzburg): Regular monthly meetings on the second Wednesday of each month starting at 19h45 are held at St Charles College, Harwin Rd. The Centre publishes a monthly newsletter, "Stardust". Secretarial address: P O Box 2106, Pietermaritzburg, 3200 or by phoning 0331-433646.

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

SECTIONS OF THE ASSA

These sections exist to co-ordinate the activities of special interest groups within the Society. Several of these sections co-ordinate constructive observing

programmes and more information on an observing section is given in the appropriate part of this handbook.

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

The objectives of the Computing Section were outlined in MNASSA. Vol 46 Nos. 5 & 6 June 1987 Page 66. Please refer to this write up for detailed information. Persons interested in the activities of the Computing Section are urged to contact the Director of the Societies Computing Section:

Mr Tony Hilton, P O Box 68846, Bryanston, 2021. Phone (w) (011) 53 8714
(h) (011) 465 2257.

Mr Hilton has compiled a comprehensive DATA BASE of all interested person's, equipment, available software etc. 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

| | d | h | | |
|---|---|---|---|---|
| Jan | 1 | 5 | Mars 4° S. of Moon | |
| | 2 | 1 | Jupiter 3° S. of Moon | |
| | 3 | 11 | Moon at perigee | |
| | 4 | 23 | Earth at perihelion | |
| | 5 | 14 | Saturn 0°·2 N. of Moon | Occn. |
| | 5 | 16 | FIRST QUARTER | |
| | 6 | 17 | Mercury greatest elong. W. (23°) | |
| | 9 | 15 | Aldebaran 0°·4 S. of Moon | |
| | 9 | 19 | Venus 4° N. of Neptune | |
| | 12 | 19 | FULL MOON | |
| | 16 | 13 | Venus in inferior conjunction | |
| | 18 | 23 | Moon at apogee | |
| | 20 | 1 | Neptune in conjunction with Sun | |
| | 20 | 22 | LAST QUARTER | |
| | 21 | 3 | Mars 0°·2 S. of Jupiter | |
| | 26 | 19 | Mercury 8° S. of Venus | |
| | 27 | 2 | Venus 3° N. of Moon | |
| | 27 | 3 | Mercury 5° S. of Moon | |
| | 28 | 8 | NEW MOON | |
| | 28 | 22 | Uranus in conjunction with Sun | |
| | 29 | 14 | Juno stationary | |
| | 29 | 19 | Jupiter 2° S. of Moon | |
| | 30 | 3 | Mars 1°·7S. of Moon | |
| | 30 | 16 | Moon at perigee | |
| Feb | 1 | 23 | Saturn 0°·6 N.of Moon | |
| | 2 | 13 | Mercury 2° S. of Neptune | |
| | 4 | 1 | FIRST QUARTER | |
| | 5 | 20 | Aldebaran 0°·2 S. of Moon | |
| | 5 | 20 | Venus stationary | |
| | 8 | 7 | Mercury 1°·4 S. of Uranus | |
| | 11 | 12 | FULL MOON | |
| | 14 | 14 | Pallas in conjunction with Sun | |
| | 15 | 17 | Moon at apogee | |
| | 19 | 17 | LAST QUARTER | |
| | 20 | 4 | Venus greatest brilliancy | |
| | 22 | 10 | Mercury in superior conjunction | |
| | 23 | 11 | Jupiter in conjunction with Sun | |
| | 23 | 19 | Venus 1°·6 N. of Moon | |
| | 24 | 8 | Neptune 3° S. of Moon | |
| | 25 | 0 | Uranus 3° S. of Moon | |
| | 26 | 19 | NEW MOON | |
| | 27 | 22 | Moon at perigee | |
| | 28 | 0 | Mars 0°·7 N. of Moon | |
| Mar | 1 | 11 | Saturn 1°·0 N. of Moon | |
| | 2 | 19 | Vesta 0°·1 S. of Moon | |
| | 5 | 2 | Aldebaran 0°·2 S. of Moon | |
| | 5 | 11 | FIRST QUARTER | |
| | 7 | 12 | Venus 4° N. of Neptune | |
| | 11 | 17 | Mercury 1°·2 N. of Mars | |
| | 12 | 18 | Pluto stationary | |
| | 13 | 7 | FULL MOON | Penumbral Eclipse |
| | 13 | 22 | Juno 0°·9 N. of Moon | |
| | 15 | 3 | Moon at apogee | |
| | 19 | 9 | Venus 3° N. of Uranus | |
| | 19 | 11 | Juno at opposition | |
| | 20 | 6 | Mercury greatest elong. E. (19°) | |
| | 20 | 22 | Equinox | |
| | 21 | 10 | LAST QUARTER | |
| | 23 | 19 | Neptune 3° S. of Moon | |
| | 24 | 12 | Uranus 3° S. of Moon | |
| | 24 | 21 | Venus 0°·09 S. of Moon | |
| | 26 | 14 | Jupiter 0°·8 S. of Moon | |
| | 27 | 17 | Mercury stationary | |
| | 27 | 21 | Venus greatest elong. W. (47°) | |
| | 28 | 5 | NEW MOON | |
| | 28 | 9 | Moon at perigee | |
| | 30 | 7 | Mercury 4° N of Mars | |
| | 30 | 22 | Vesta 1°·2 N. of Moon | |

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

# CONFIGURATIONS OF SUN, MOON AND PLANETS

| | d | h | |
|---|---|---|---|
| Jul | 16 | 17 | LAST QUARTER |
| | 17 | 5 | Mercury greatest elong. E. (27°) |
| | 17 | 7 | Saturn 2° N. of Moon |
| | 18 | 20 | Jupiter stationary |
| | 19 | 1 | Ceres 1°·1 S. of Moon |
| | 19 | 23 | Aldebaran 0°·3 S. of Moon |
| | 21 | 14 | Venus 4° N. of Moon |
| | 22 | 5 | Mars 5° N. of Moon |
| | 23 | 16 | NEW MOON |
| | 23 | 22 | Neptune at opposition |
| | 25 | 16 | Mercury 2° S. of Moon |
| | 25 | 23 | Regulus 0°·7 N. of Moon |
| | 26 | 15 | Pallas stationary |
| | 30 | 7 | Mercury stationary |
| | 30 | 14 | Moon at apogee |
| | 31 | 14 | FIRST QUARTER |
| Aug | 3 | 9 | Uranus at opposition |
| | 5 | 5 | Venus 0°·8 S. of Mars |
| | 7 | 3 | Neptune 2° S. of Moon |
| | 7 | 21 | Uranus 3° S. of Moon |
| | 8 | 4 | FULL MOON Penumbral Eclipse |
| | 8 | 20 | Venus 7° S. of Pollux |
| | 11 | 2 | Jupiter 0°·9 N. of Moon |
| | 11 | 14 | Moon at perigee |
| | 11 | 23 | Mars 6° S. of Pollux |
| | 13 | 14 | Saturn 2° N. of Moon |
| | 14 | 2 | Mercury in inferior conjunction |
| | 14 | 22 | LAST QUARTER |
| | 15 | 21 | Ceres 0°·9 S. of Moon |
| | 16 | 5 | Aldebaran 0°·2 S. of Moon |
| | 16 | 18 | Saturn stationary |
| | 18 | 21 | Pluto stationary |
| | 19 | 22 | Mars 4° N. of Moon |
| | 20 | 16 | Venus 3° N. of Moon |
| | 22 | 4 | NEW MOON |
| | 23 | 7 | Mercury stationary |
| | 26 | 1 | Mercury 3° S. of Venus |
| | 27 | 8 | Moon at apogee |
| | 30 | 7 | FIRST QUARTER |
| | 31 | 11 | Mercury greatest elong. W.(18°) |
| Sep | 3 | 12 | Neptune 2° S. of Moon |
| | 4 | 5 | Uranus 3° S. of Moon |
| | 6 | 12 | Venus 0°·8 N. of Regulus |
| | 6 | 13 | FULL MOON |
| | 7 | 6 | Jupiter 0°·5 N. of Moon |
| | 7 | 21 | Mercury 0°·8 N. of Regulus |
| | 8 | 8 | Moon at perigee |
| | 9 | 20 | Saturn 2° N. of Moon |
| | 11 | 2 | Mercury 0°·4 N. of Venus |
| | 12 | 10 | Aldebaran 0°·3 S. of Moon |
| | 12 | 13 | Ceres 0°·9 S. of Moon |
| | 13 | 4 | LAST QUARTER |
| | 16 | 5 | Jupiter at opposition |
| | 16 | 7 | Pallas at opposition |
| | 17 | 14 | Mars 2° N. of Moon |
| | 18 | 13 | Regulus 0°·6 N. of Moon Occn. |
| | 20 | 19 | NEW MOON |
| | 23 | 8 | Equinox |
| | 24 | 0 | Moon at apogee |
| | 25 | 22 | Mercury in superior conjunction |
| | 28 | 23 | FIRST QUARTER |
| | 30 | 21 | Neptune 2° S. of Moon |
| Oct | 1 | 14 | Uranus 3° S.of Moon |
| | 4 | 9 | Pallas 1°·0 S. of Moon |
| | 4 | 11 | Jupiter 0°·2 N. of Moon |
| | 5 | 22 | FULL MOON |
| | 6 | 15 | Moon at perigee |
| | 6 | 18 | Mars 0°·9 N. of Regulus |
| | 7 | 3 | Saturn 1°·8 N. of Moon |
| | 9 | 18 | Aldebaran 0°·4 S. of Moon |
| | 10 | 0 | Ceres 0°·9 S. of Moon |
| | 10 | 19 | Ceres stationary |
| | 11 | 13 | Neptune stationary |
| | 12 | 13 | LAST QUARTER |
| | 15 | 19 | Regulus 0°·5 N. of Moon |
| | 16 | 6 | Mars 1°·0 N. of Moon |
| | 19 | 3 | Uranus stationary |
| | 20 | 12 | NEW MOON |
| | 21 | 7 | Moon at apogee |
| | 21 | 20 | Mercury 7° S. of Moon |
| | 23 | 21 | Saturn at opposition |
| | 28 | 3 | Juno in conjunction with Sun |
| | 28 | 5 | Neptune 2° S. of Moon |
| | 28 | 14 | FIRST QUARTER |
| | 28 | 22 | Uranus 2° S. of Moon |
| | 30 | 6 | Venus in superior conjunction |
| | 31 | 18 | Jupiter 0°·2 N. of Moon Occn. |
| Nov | 3 | 11 | Saturn 1°·7 N. of Moon |
| | 4 | 3 | Moon at perigee |
| | 4 | 7 | FULL MOON |
| | 6 | 4 | Aldebaran 0°·6 S. of Moon |
| | 6 | 6 | Ceres 0°·3 S of Moon |
| | 7 | 1 | Pallas stationary |
| | 9 | 11 | Mercury 1°·9 N. of Antares |
| | 11 | 2 | LAST QUARTER |
| | 11 | 11 | Mercury greatest elong. E. (23°) |
| | 12 | 0 | Regulus 0°·3 N. of Moon |
| | 13 | 20 | Mars 0°·5 S. of Moon |
| | 14 | 3 | Jupiter stationary |
| | 17 | 8 | Moon at apogee |
| | 19 | 6 | NEW MOON |
| | 20 | 23 | Mercury 7° S. of Moon |
| | 21 | 16 | Mercury stationary |
| | 24 | 11 | Neptune 1°·9 S. of Moon |
| | 25 | 5 | Uranus 2° S. of Moon |
| | 27 | 2 | FIRST QUARTER |
| | 28 | 3 | Jupiter 0°·6 N. of Moon |
| | 29 | 0 | Ceres at opposition |
| | 30 | 10 | Pluto in conjunction with Sun |
| | 30 | 19 | Saturn 1°·8 N. of Moon |
| Dec | 1 | 17 | Mercury in inferior conjunction |
| | 2 | 14 | Moon at perigee |
| | 3 | 8 | Ceres 1°·2 N. of Moon |
| | 3 | 15 | Aldebaran 0°6 S. of Moon |
| | 3 | 17 | FULL MOON |
| | 9 | 8 | Regulus 0°·01 N. of Moon Occn. |
| | 10 | 20 | LAST QUARTER |
| | 11 | 8 | Mercury stationary |
| | 12 | 10 | Mars 1°·8 S. of Moon |
| | 14 | 19 | Moon at apogee |
| | 17 | 2 | Mercury 3° S. of Moon |
| | 19 | 1 | NEW MOON |
| | 20 | 6 | Mercury greatest elong. W. (22°) |
| | 21 | 18 | Neptune 1°·7 S. of Moon |
| | 22 | 4 | Solstice |
| | 22 | 8 | Mercury 7° N of Antares |
| | 22 | 13 | Uranus 1°.8 S. of Moon |
| | 23 | 1 | Vesta stationary |
| | 25 | 13 | Jupiter 1°·2 N.of Moon |
| | 26 | 13 | FIRST QUARTER |
| | 28 | 1 | Saturn 2° N. of Moon |
| | 30 | 18 | Saturn stationary |
| | 30 | 20 | Moon at perigee |
| | 31 | 1 | Aldebaran 0°·6 S of Moon |

# THE SUN

BASIC DATA:

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

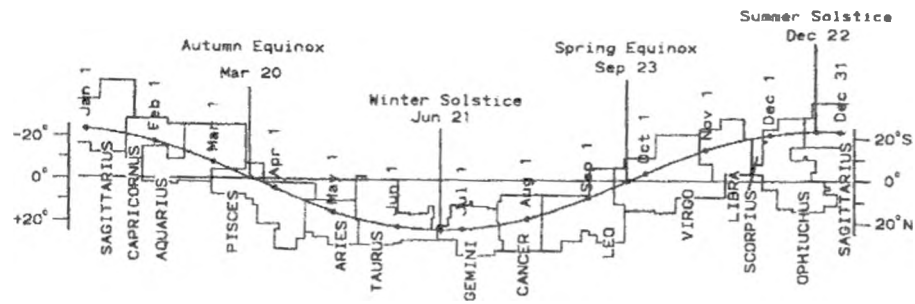
Mass: 1,99 x $10^{30}$kg (330 000 times Earth mass)

Surface Temperature: Approximately 6 000°C

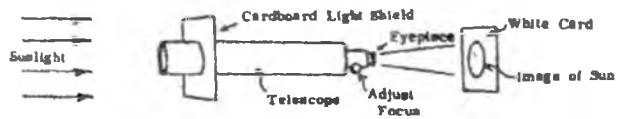
Temperature at centre: Approximately 10 million°C

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 1998 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° 2' | Apr 11 | 8°10' | Jul 20 | 20°44' | Oct 28 | -12°58' |
| 11 | -21 52 | 21 | 11 43 | 30 | 18 37 | Nov 7 | -16 9 |
| 21 | -20 0 | May 1 | 14 57 | Aug 9 | 15 58 | 17 | -18 52 |
| 31 | -17 30 | 11 | 17 46 | 19 | 12 55 | 27 | -21 3 |
| Feb 10 | -14 29 | 21 | 20 6 | 29 | 9 30 | Dec 7 | -22 33 |
| 20 | -11 4 | 31 | 21 51 | Sep 8 | 5 51 | 17 | -23 20 |
| Mar 2 | -7 22 | Jun 10 | 22 59 | 18 | 2 2 | 27 | -23 21 |
| 12 | -3 29 | 20 | 23 26 | 28 | -1 51 | | |
| 22 | 0 28 | 30 | 23 12 | Oct 8 | -5 43 | | |
| Apr 1 | 4 23 | Jul 10 | 22 17 | 18 | -9 28 | | |

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

A total eclipse of the Sun, on February 26, and a annular eclipse on August 21-22, take place during the year. Neither will be visible from Southern Africa.

SOLAR SECTION

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

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

A word of caution - NEVER observe the sun directly without adequate filtration as permanent eye damage can occur,and do not use the screw-in filters provided with some commercial telescopes, as they are inclined to shatter! Large instruments are not a prerequisite! Any telescope from 50mm, reflector or refractor can be used and provides an ideal opportunity for owners of small instruments to contribute immediately to Science. If one has no filter, then the only safe method is to project the image on to a white card. Image quality will be enhanced if the card is kept in the shade, or enclosed in a screen. Details of suitable filters are best sought from experienced solar observers or from the Director of the Solar Section.

Persons interested in observing the sun,or requiring information are invited to contact The Director of the Solar Section:

Jim Knight, 17 Mars Street, Atlasville, Boksburg, 1459 or tel. 011-9731380.

# The Moon

**BASIC DATA**

Diameter: 3 480 km (0,27 of Earth)
Mass: $7{,}35 \times 10^{22}$ x kg (1/81 of Earth)
Surface Gravity: 0,16 of Earth
Average distance from Earth: 384 000 km, Perigee ±357 000km, Apogee ±407 000km

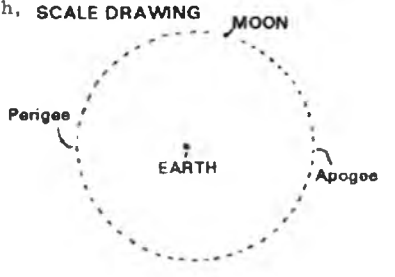
**THE SURFACE OF THE MOON**

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

**THE MOON'S ORBIT**

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

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




**ECLIPSES OF THE MOON**

The eclipse data is as follows:

| Penumbral Eclipse | d | h | m |
|---|---|---|---|
| Moon enters penumbra | Mar 13 | 4 | 14.2 |
| Middle of eclipse | 13 | 6 | 20.1 |
| Moon leaves penumbra | 13 | 8 | 25.9 |

| Contacts of Penumbra with Limb of Moon | Position Angles from the North Point |
|---|---|
| First | 156.1 to East |
| Last | 120.9 to West |

Penumbral magnitude of the eclipse: 0.735

| Penumbral Eclipse | d | h | m |
|---|---|---|---|
| Moon enters penumbra | Aug 8 | 3 | 31.8 |
| Middle of eclipse | 8 | 4 | 24.8 |
| Moon leaves penumbra | 8 | 5 | 18.2 |

| Contacts of Penumbra with Limb of Moon | Position Angles from the North Point |
|---|---|
| First | 150.0 to East |
| Last | 173.3 to West |

Penumbral magnitude of the eclipse: 0.146

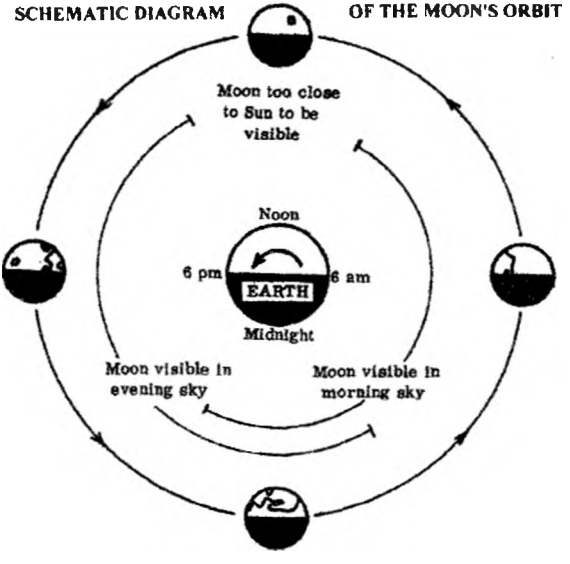
The penumbral eclipse of September 6 does not take place over Southern Africa.

## PHASES and VISIBILITY

### NEW MOON

| | d | h | m |
|---|---|---|---|
| Jan | 28 | 8 | 01 |
| Feb | 26 | 19 | 26 |
| Mar | 28 | 5 | 14 |
| Apr | 26 | 13 | 41 |
| May | 25 | 21 | 32 |
| Jun | 24 | 5 | 50 |
| Jul | 23 | 15 | 44 |
| Aug | 22 | 4 | 03 |
| Sep | 20 | 19 | 01 |
| Oct | 20 | 12 | 09 |
| Nov | 19 | 6 | 27 |
| Dec | 19 | 0 | 42 |

### SCHEMATIC DIAGRAM OF THE MOON'S ORBIT




### FIRST QUARTER

| | d | h | m |
|---|---|---|---|
| Jan | 5 | 16 | 18 |
| Feb | 4 | 0 | 53 |
| Mar | 5 | 10 | 41 |
| Apr | 3 | 22 | 18 |
| May | 3 | 12 | 04 |
| Jun | 2 | 3 | 45 |
| Jul | 1 | 20 | 43 |
| Jul | 31 | 14 | 05 |
| Aug | 30 | 7 | 06 |
| Sep | 28 | 23 | 11 |
| Oct | 28 | 13 | 46 |
| Nov | 27 | 2 | 23 |
| Dec | 26 | 12 | 46 |

### LAST QUARTER

| | d | h | m |
|---|---|---|---|
| Jan | 20 | 21 | 40 |
| Feb | 19 | 17 | 27 |
| Mar | 21 | 9 | 38 |
| Apr | 19 | 21 | 53 |
| May | 19 | 6 | 35 |
| Jun | 17 | 12 | 38 |
| Jul | 16 | 17 | 13 |
| Aug | 14 | 21 | 48 |
| Sep | 13 | 12 | 58 |
| Oct | 12 | 13 | 11 |
| Nov | 11 | 2 | 28 |
| Dec | 10 | 19 | 53 |

### FULL MOON

| | d | h | m |
|---|---|---|---|
| Jan | 12 | 19 | 24 |
| Feb | 11 | 12 | 23 |
| Mar | 13 | 6 | 34 |
| Apr | 12 | 0 | 23 |
| May | 11 | 16 | 29 |
| Jun | 10 | 6 | 18 |
| Jul | 9 | 18 | 01 |
| Aug | 8 | 4 | 10 |
| Sep | 6 | 13 | 21 |
| Oct | 5 | 22 | 12 |
| Nov | 4 | 7 | 18 |
| Dec | 3 | 17 | 19 |

### MOON at PERIGEE

| | d | h | | d | h | | d | h |
|---|---|---|---|---|---|---|---|---|
| Jan | 3 | 11 | May | 24 | 2 | Oct | 6 | 15 |
| | 30 | 16 | Jun | 20 | 19 | Nov | 4 | 3 |
| Feb | 27 | 22 | Jul | 16 | 16 | Dec | 2 | 14 |
| Mar | 28 | 9 | Aug | 11 | 14 | | 30 | 20 |
| Apr | 25 | 20 | Sep | 8 | 8 | | | |

### MOON at APOGEE

| | d | h | | d | h | | d | h |
|---|---|---|---|---|---|---|---|---|
| Jan | 18 | 23 | Jun | 5 | 2 | Oct | 21 | 7 |
| Feb | 15 | 17 | Jul | 2 | 19 | Nov | 17 | 8 |
| Mar | 15 | 3 | | 30 | 14 | Dec | 14 | 19 |
| Apr | 11 | 4 | Aug | 27 | 8 | | | |
| May | 8 | 11 | Sep | 24 | 0 | | | |

### 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 | 0.9 | 44 | Jul 7 | 7.8 | 152 | Jul 13 | 3.0 | 39 |
| Jan 10 | 8.1 | 321 | Jan 17 | 1.5 | 256 | Jul 20 | 7.5 | 325 | Jul 27 | 3.8 | 256 |
| Jan 24 | 9.2 | 143 | Jan 30 | 0.8 | 359 | Aug 3 | 8.2 | 147 | Aug 10 | 2.8 | 31 |
| Feb 6 | 8.8 | 315 | Feb 13 | 1.6 | 248 | Aug 16 | 8.1 | 319 | Aug 23 | 3.8 | 258 |
| Feb 21 | 9.8 | 137 | Feb 27 | 1.7 | 15 | Aug 31 | 8.6 | 139 | Sep 7 | 3.4 | 22 |
| Mar 5 | 9.6 | 311 | Mar 13 | 2.0 | 253 | Sep 13 | 8.9 | 313 | Sep 20 | 4.2 | 254 |
| Mar 21 | 9.9 | 132 | Mar 27 | 2.9 | 14 | Sep 28 | 8.6 | 129 | Oct 5 | 4.6 | 14 |
| Apr 2 | 9.8 | 310 | Apr 9 | 2.6 | 247 | Oct 11 | 9.2 | 310 | Oct 18 | 4.9 | 248 |
| Apr 17 | 9.2 | 131 | Apr 24 | 4.0 | 15 | Oct 26 | 8.1 | 118 | Nov 2 | 5.7 | 6 |
| Apr 30 | 9.3 | 312 | May 7 | 3.3 | 247 | Nov 8 | 8.3 | 308 | Nov 15 | 5.6 | 241 |
| May 14 | 8.2 | 140 | May 21 | 4.6 | 23 | Nov 22 | 7.1 | 138 | Dec 1 | 6.5 | 355 |
| May 28 | 8.3 | 316 | Jun 3 | 3.8 | 247 | Dec 7 | 7.7 | 304 | Dec 13 | 6.2 | 236 |
| Jun 10 | 7.7 | 150 | Jun 17 | 4.0 | 40 | Dec 17 | 6.7 | 172 | Dec 23 | 5.7 | 79 |
| Jun 24 | 7.5 | 323 | Jun 30 | 3.9 | 250 | Dec 28 | 6.8 | 3 | | | |

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.

# 1998 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 | 08 26 | 22 09 | 10 37 | 22 50 | 09 28 | 21 26 | 11 35 | 22 21 | 12 14 | 22 54 | 12 58 | |
| 2 | 09 31 | 22 52 | 11 43 | 23 30 | 10 36 | 22 09 | 12 36 | 23 14 | 13 02 | 23 51 | 13 31 | 00 28 |
| 3 | 10 37 | 23 32 | 12 48 | | 11 42 | 22 53 | 13 31 | | 13 44 | | 14 03 | 01 22 |
| 4 | 11 42 | | 13 52 | 00 12 | 12 46 | 23 39 | 14 20 | 00 08 | 14 23 | 00 47 | 14 35 | 02 15 |
| 5 | 12 47 | 00 11 | 14 53 | 00 55 | 13 46 | | 15 05 | 01 03 | 14 57 | 01 42 | 15 06 | 03 09 |
| 6 | 13 51 | 00 49 | 15 52 | 01 42 | 14 43 | 00 29 | 15 45 | 01 59 | 15 30 | 02 36 | 15 39 | 04 02 |
| 7 | 14 55 | 01 29 | 16 47 | 02 31 | 15 35 | 01 20 | 16 21 | 02 54 | 16 02 | 03 29 | 16 14 | 04 56 |
| 8 | 15 58 | 02 11 | 17 38 | 03 24 | 16 22 | 02 14 | 16 55 | 03 48 | 16 33 | 04 22 | 16 52 | 05 50 |
| 9 | 16 59 | 02 56 | 18 24 | 04 18 | 17 05 | 03 09 | 17 28 | 04 42 | 17 05 | 05 16 | 17 33 | 06 46 |
| 10 | 17 58 | 03 44 | 19 06 | 05 14 | 17 44 | 04 04 | 17 59 | 05 35 | 17 38 | 06 09 | 18 20 | 07 41 |
| 11 | 18 53 | 04 36 | 19 44 | 06 09 | 18 20 | 04 59 | 18 31 | 06 28 | 18 14 | 07 03 | 19 11 | 08 34 |
| 12 | 19 43 | 05 30 | 20 19 | 07 05 | 18 53 | 05 53 | 19 03 | 07 21 | 18 53 | 07 58 | 20 06 | 09 26 |
| 13 | 20 28 | 06 26 | 20 52 | 07 59 | 19 25 | 06 47 | 19 37 | 08 14 | 19 37 | 08 52 | 21 05 | 10 15 |
| 14 | 21 09 | 07 23 | 21 24 | 08 53 | 19 57 | 07 40 | 20 14 | 09 08 | 20 24 | 09 46 | 22 06 | 11 00 |
| 15 | 21 46 | 08 19 | 21 56 | 09 46 | 20 29 | 08 33 | 20 54 | 10 02 | 21 16 | 10 39 | 23 09 | 11 43 |
| 16 | 22 20 | 09 14 | 22 28 | 10 39 | 21 02 | 09 26 | 21 39 | 10 56 | 22 12 | 11 28 | | 12 23 |
| 17 | 22 52 | 10 08 | 23 02 | 11 32 | 21 37 | 10 19 | 22 27 | 11 49 | 23 11 | 12 16 | 00 13 | 13 01 |
| 18 | 23 24 | 11 01 | 23 38 | 12 26 | 22 15 | 11 13 | 23 21 | 12 41 | | 13 00 | 01 17 | 13 40 |
| 19 | 23 55 | 11 54 | | 13 20 | 22 56 | 12 07 | | 13 30 | 00 13 | 13 42 | 02 22 | 14 19 |
| 20 | | 12 48 | 00 17 | 14 15 | 23 42 | 13 01 | 00 18 | 14 17 | 01 16 | 14 22 | 03 29 | 15 00 |
| 21 | 00 28 | 13 41 | 01 02 | 15 10 | | 13 54 | 01 19 | 15 01 | 02 21 | 15 01 | 04 35 | 15 45 |
| 22 | 01 03 | 14 36 | 01 51 | 16 05 | 00 34 | 14 46 | 02 23 | 15 44 | 03 28 | 15 41 | 05 42 | 16 33 |
| 23 | 01 42 | 15 32 | 02 46 | 16 58 | 01 30 | 15 36 | 03 30 | 16 25 | 04 36 | 16 22 | 06 46 | 17 26 |
| 24 | 02 24 | 16 29 | 03 47 | 17 48 | 02 31 | 16 23 | 04 38 | 17 06 | 05 44 | 17 06 | 07 47 | 18 22 |
| 25 | 03 12 | 17 25 | 04 52 | 18 35 | 03 36 | 17 09 | 05 47 | 17 48 | 06 53 | 17 54 | 08 42 | 19 21 |
| 26 | 04 06 | 18 20 | 06 00 | 19 20 | 04 43 | 17 52 | 06 58 | 18 32 | 08 00 | 18 46 | 09 32 | 20 20 |
| 27 | 05 05 | 19 13 | 07 09 | 20 03 | 05 53 | 18 34 | 08 08 | 19 18 | 09 04 | 19 41 | 10 16 | 21 19 |
| 28 | 06 09 | 20 01 | 08 19 | 20 45 | 07 03 | 19 16 | 09 16 | 20 08 | 10 02 | 20 38 | 10 55 | 22 16 |
| 29 | 07 15 | 20 47 | | | 08 13 | 19 59 | 10 21 | 21 01 | 10 54 | 21 37 | 11 31 | 23 12 |
| 30 | 08 23 | 21 30 | | | 09 23 | 20 44 | 11 20 | 21 57 | 11 40 | 22 35 | 12 04 | |
| 31 | 09 30 | 22 10 | | | 10 31 | 21 32 | | | 12 21 | 23 32 | | |

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

# 1998 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 | 07 39 | 21 12 | 09 44 | 21 59 | 08 33 | 20 36 | 10 35 | 21 37 | 11 13 | 22 09 | 12 01 | 23 39 |
| 2 | 08 43 | 21 56 | 10 48 | 22 41 | 09 39 | 21 21 | 11 35 | 22 29 | 12 02 | 23 05 | 12 37 | |
| 3 | 09 47 | 22 38 | 11 51 | 23 24 | 10 44 | 22 06 | 12 30 | 23 24 | 12 46 | 24 00 | 13 10 | 00 31 |
| 4 | 10 50 | 23 19 | 12 53 | | 11 46 | 22 54 | 13 20 | | 13 25 | | 13 43 | 01 23 |
| 5 | 11 52 | 23 59 | 13 53 | 00 09 | 12 46 | 23 44 | 14 06 | 00 18 | 14 02 | 00 54 | 14 16 | 02 15 |
| 6 | 12 55 | | 14 51 | 00 57 | 13 42 | | 14 47 | 01 13 | 14 36 | 01 46 | 14 51 | 03 06 |
| 7 | 13 57 | 00 41 | 15 46 | 01 47 | 14 34 | 00 36 | 15 25 | 02 06 | 15 09 | 02 38 | 15 27 | 03 59 |
| 8 | 14 59 | 01 24 | 16 37 | 02 39 | 15 22 | 01 29 | 16 00 | 02 59 | 15 42 | 03 29 | 16 06 | 04 52 |
| 9 | 15 59 | 02 10 | 17 24 | 03 33 | 16 06 | 02 23 | 16 34 | 03 51 | 16 16 | 04 21 | 16 49 | 05 46 |
| 10 | 16 57 | 02 59 | 18 07 | 04 28 | 16 46 | 03 17 | 17 07 | 04 43 | 16 51 | 05 13 | 17 35 | 06 40 |
| 11 | 17 52 | 03 51 | 18 47 | 05 22 | 17 24 | 04 11 | 17 41 | 05 34 | 17 28 | 06 05 | 18 26 | 07 34 |
| 12 | 18 43 | 04 46 | 19 24 | 06 16 | 17 59 | 05 03 | 18 15 | 06 26 | 18 08 | 06 59 | 19 21 | 08 25 |
| 13 | 19 29 | 05 41 | 19 58 | 07 09 | 18 33 | 05 56 | 18 50 | 07 18 | 18 52 | 07 52 | 20 19 | 09 15 |
| 14 | 20 11 | 06 37 | 20 32 | 08 01 | 19 06 | 06 47 | 19 28 | 08 10 | 19 40 | 08 46 | 21 19 | 10 02 |
| 15 | 20 49 | 07 31 | 21 05 | 08 53 | 19 39 | 07 39 | 20 09 | 09 03 | 20 31 | 09 38 | 22 20 | 10 46 |
| 16 | 21 25 | 08 25 | 21 39 | 09 44 | 20 14 | 08 30 | 20 54 | 09 56 | 21 27 | 10 28 | 23 22 | 11 28 |
| 17 | 21 59 | 09 18 | 22 14 | 10 36 | 20 50 | 09 22 | 21 43 | 10 49 | 22 25 | 11 16 | | 12 08 |
| 18 | 22 32 | 10 09 | 22 51 | 11 28 | 21 29 | 10 14 | 22 36 | 11 40 | 23 25 | 12 02 | 00 24 | 12 48 |
| 19 | 23 05 | 11 01 | 23 32 | 12 21 | 22 11 | 11 07 | 23 33 | 12 30 | | 12 45 | 01 28 | 13 29 |
| 20 | 23 40 | 11 52 | | 13 15 | 22 58 | 12 01 | | 13 18 | 00 27 | 13 27 | 02 32 | 14 12 |
| 21 | | 12 45 | 00 17 | 14 10 | 23 49 | 12 53 | 00 32 | 14 04 | 01 30 | 14 08 | 03 37 | 14 58 |
| 22 | 00 16 | 13 38 | 01 07 | 15 04 | | 13 46 | 01 35 | 14 48 | 02 34 | 14 50 | 04 42 | 15 48 |
| 23 | 00 55 | 14 33 | 02 02 | 15 57 | 00 45 | 14 36 | 02 39 | 15 31 | 03 40 | 15 33 | 05 45 | 16 42 |
| 24 | 01 39 | 15 29 | 03 01 | 16 49 | 01 45 | 15 25 | 03 46 | 16 14 | 04 47 | 16 19 | 06 46 | 17 38 |
| 25 | 02 28 | 16 25 | 04 05 | 17 38 | 02 48 | 16 12 | 04 53 | 16 58 | 05 54 | 17 08 | 07 41 | 18 36 |
| 26 | 03 21 | 17 20 | 05 11 | 18 24 | 03 54 | 16 57 | 06 01 | 17 44 | 07 00 | 18 01 | 08 32 | 19 35 |
| 27 | 04 20 | 18 13 | 06 18 | 19 09 | 05 01 | 17 41 | 07 09 | 18 32 | 08 02 | 18 56 | 09 17 | 20 32 |
| 28 | 05 23 | 19 03 | 07 26 | 19 53 | 06 09 | 18 25 | 08 16 | 19 23 | 09 01 | 19 54 | 09 58 | 21 28 |
| 29 | 06 27 | 19 50 | | | 07 17 | 19 10 | 09 20 | 20 17 | 09 54 | 20 52 | 10 35 | 22 22 |
| 30 | 07 33 | 20 35 | | | 08 25 | 19 57 | 10 19 | 21 12 | 10 41 | 21 49 | 11 10 | 23 15 |
| 31 | 08 39 | 21 18 | | | 09 31 | 20 46 | | | 11 23 | 22 45 | | |

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

# 1998 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 | 07 56 | 20 59 | 09 44 | 22 03 | 08 30 | 20 43 | 10 17 | 21 57 | 10 54 | 22 29 | 11 51 | 23 48 |
| 2 | 08 55 | 21 47 | 10 43 | 22 50 | 09 31 | 21 32 | 11 15 | 22 51 | 11 44 | 23 23 | 12 31 | |
| 3 | 09 54 | 22 34 | 11 41 | 23 37 | 10 31 | 22 22 | 12 10 | 23 44 | 12 31 | | 13 08 | 00 37 |
| 4 | 10 53 | 23 20 | 12 39 | | 11 30 | 23 13 | 13 01 | | 13 14 | 00 15 | 13 45 | 01 24 |
| 5 | 11 50 | | 13 36 | 00 26 | 12 27 | | 13 49 | 00 38 | 13 54 | 01 05 | 14 22 | 02 12 |
| 6 | 12 48 | 00 05 | 14 32 | 01 16 | 13 23 | 00 04 | 14 33 | 01 30 | 14 32 | 01 54 | 15 00 | 02 59 |
| 7 | 13 46 | 00 51 | 15 26 | 02 08 | 14 15 | 00 57 | 15 14 | 02 20 | 15 09 | 02 42 | 15 40 | 03 48 |
| 8 | 14 44 | 01 39 | 16 18 | 03 00 | 15 04 | 01 49 | 15 54 | 03 09 | 15 46 | 03 29 | 16 23 | 04 38 |
| 9 | 15 41 | 02 28 | 17 07 | 03 53 | 15 50 | 02 42 | 16 31 | 03 58 | 16 23 | 04 17 | 17 08 | 05 29 |
| 10 | 16 38 | 03 19 | 17 52 | 04 46 | 16 34 | 03 33 | 17 08 | 04 45 | 17 02 | 05 04 | 17 56 | 06 21 |
| 11 | 17 32 | 04 12 | 18 35 | 05 37 | 17 14 | 04 23 | 17 46 | 05 32 | 17 43 | 05 53 | 18 48 | 07 13 |
| 12 | 18 24 | 05 06 | 19 16 | 06 28 | 17 53 | 05 12 | 18 23 | 06 20 | 18 26 | 06 43 | 19 42 | 08 06 |
| 13 | 19 12 | 06 00 | 19 54 | 07 17 | 18 31 | 06 01 | 19 03 | 07 08 | 19 12 | 07 34 | 20 38 | 08 57 |
| 14 | 19 57 | 06 53 | 20 32 | 08 05 | 19 08 | 06 48 | 19 44 | 07 57 | 20 01 | 08 26 | 21 34 | 09 46 |
| 15 | 20 39 | 07 45 | 21 09 | 08 52 | 19 46 | 07 36 | 20 28 | 08 47 | 20 53 | 09 18 | 22 31 | 10 34 |
| 16 | 21 18 | 08 35 | 21 46 | 09 40 | 20 24 | 08 23 | 21 14 | 09 38 | 21 47 | 10 09 | 23 29 | 11 20 |
| 17 | 21 56 | 09 24 | 22 25 | 10 28 | 21 04 | 09 11 | 22 04 | 10 29 | 22 42 | 10 59 | | 12 05 |
| 18 | 22 34 | 10 11 | 23 06 | 11 16 | 21 46 | 10 00 | 22 57 | 11 20 | 23 39 | 11 47 | 00 26 | 12 50 |
| 19 | 23 11 | 10 58 | 23 50 | 12 06 | 22 30 | 10 51 | 23 52 | 12 11 | | 12 35 | 01 24 | 13 36 |
| 20 | 23 49 | 11 46 | | 12 58 | 23 18 | 11 42 | | 13 02 | 00 36 | 13 21 | 02 24 | 14 24 |
| 21 | | 12 35 | 00 37 | 13 51 | | 12 34 | 00 49 | 13 51 | 01 35 | 14 07 | 03 24 | 15 14 |
| 22 | 00 29 | 13 25 | 01 28 | 14 45 | 00 10 | 13 26 | 01 47 | 14 39 | 02 34 | 14 54 | 04 25 | 16 07 |
| 23 | 01 12 | 14 16 | 02 22 | 15 39 | 01 05 | 14 19 | 02 47 | 15 27 | 03 35 | 15 42 | 05 26 | 17 03 |
| 24 | 01 58 | 15 10 | 03 21 | 16 32 | 02 03 | 15 10 | 03 48 | 16 16 | 04 36 | 16 33 | 06 25 | 18 00 |
| 25 | 02 48 | 16 05 | 04 21 | 17 25 | 03 02 | 16 01 | 04 50 | 17 05 | 05 39 | 17 26 | 07 22 | 18 57 |
| 26 | 03 42 | 17 00 | 05 23 | 18 16 | 04 04 | 16 51 | 05 53 | 17 55 | 06 41 | 18 21 | 08 14 | 19 53 |
| 27 | 04 40 | 17 55 | 06 26 | 19 06 | 05 06 | 17 40 | 06 56 | 18 48 | 07 42 | 19 18 | 09 02 | 20 47 |
| 28 | 05 40 | 18 49 | 07 28 | 19 55 | 06 09 | 18 30 | 07 59 | 19 42 | 08 41 | 20 15 | 09 46 | 21 39 |
| 29 | 06 42 | 19 40 | | | 07 12 | 19 20 | 09 01 | 20 38 | 09 35 | 21 11 | 10 27 | 22 29 |
| 30 | 07 43 | 20 29 | | | 08 15 | 20 11 | 09 59 | 21 34 | 10 24 | 22 06 | 11 06 | 23 18 |
| 31 | 08 44 | 21 17 | | | 09 17 | 21 03 | | | 11 10 | 22 58 | | |

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

# 1998 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 | 07 57 | 21 20 | 09 56 | 22 13 | 08 45 | 20 51 | 10 42 | 21 56 | 11 20 | 22 28 | 12 11 | 23 54 |
| 2 | 09 00 | 22 06 | 10 59 | 22 57 | 09 49 | 21 37 | 11 41 | 22 49 | 12 09 | 23 23 | 12 47 | |
| 3 | 10 02 | 22 49 | 12 00 | 23 41 | 10 52 | 22 24 | 12 36 | 23 43 | 12 53 | | 13 22 | 00 46 |
| 4 | 11 03 | 23 32 | 13 01 | | 11 54 | 23 13 | 13 27 | | 13 34 | 00 17 | 13 56 | 01 36 |
| 5 | 12 04 | | 14 00 | 00 27 | 12 53 | | 14 13 | 00 37 | 14 12 | 01 10 | 14 31 | 02 26 |
| 6 | 13 05 | 00 14 | 14 57 | 01 16 | 13 48 | 00 03 | 14 55 | 01 31 | 14 47 | 02 01 | 15 06 | 03 17 |
| 7 | 14 06 | 00 57 | 15 52 | 02 06 | 14 41 | 00 55 | 15 34 | 02 23 | 15 22 | 02 52 | 15 44 | 04 08 |
| 8 | 15 06 | 01 41 | 16 43 | 02 59 | 15 29 | 01 48 | 16 11 | 03 15 | 15 56 | 03 42 | 16 24 | 05 00 |
| 9 | 16 06 | 02 29 | 17 31 | 03 52 | 16 14 | 02 42 | 16 46 | 04 06 | 16 31 | 04 32 | 17 07 | 05 53 |
| 10 | 17 03 | 03 18 | 18 15 | 04 46 | 16 55 | 03 35 | 17 20 | 04 56 | 17 07 | 05 23 | 17 55 | 06 46 |
| 11 | 17 58 | 04 11 | 18 56 | 05 40 | 17 33 | 04 27 | 17 55 | 05 46 | 17 45 | 06 14 | 18 46 | 07 40 |
| 12 | 18 49 | 05 05 | 19 34 | 06 33 | 18 09 | 05 19 | 18 30 | 06 36 | 18 26 | 07 06 | 19 41 | 08 32 |
| 13 | 19 36 | 06 00 | 20 10 | 07 24 | 18 45 | 06 10 | 19 07 | 07 27 | 19 11 | 07 59 | 20 38 | 09 22 |
| 14 | 20 19 | 06 55 | 20 44 | 08 15 | 19 19 | 07 00 | 19 46 | 08 19 | 19 59 | 08 52 | 21 37 | 10 09 |
| 15 | 20 58 | 07 48 | 21 19 | 09 05 | 19 54 | 07 50 | 20 28 | 09 10 | 20 51 | 09 44 | 22 36 | 10 54 |
| 16 | 21 35 | 08 41 | 21 54 | 09 55 | 20 29 | 08 40 | 21 13 | 10 03 | 21 46 | 10 34 | 23 37 | 11 38 |
| 17 | 22 11 | 09 32 | 22 30 | 10 46 | 21 07 | 09 31 | 22 02 | 10 55 | 22 43 | 11 23 | | 12 20 |
| 18 | 22 45 | 10 22 | 23 08 | 11 37 | 21 47 | 10 22 | 22 55 | 11 46 | 23 42 | 12 10 | 00 38 | 13 01 |
| 19 | 23 19 | 11 12 | 23 50 | 12 29 | 22 30 | 11 15 | 23 51 | 12 37 | | 12 54 | 01 39 | 13 44 |
| 20 | 23 55 | 12 03 | | 13 22 | 23 17 | 12 07 | | 13 25 | 00 42 | 13 37 | 02 42 | 14 29 |
| 21 | | 12 54 | 00 36 | 14 16 | | 13 00 | 00 50 | 14 12 | 01 44 | 14 20 | 03 45 | 15 16 |
| 22 | 00 33 | 13 46 | 01 26 | 15 10 | 00 08 | 13 52 | 01 52 | 14 58 | 02 47 | 15 04 | 04 49 | 16 07 |
| 23 | 01 13 | 14 40 | 02 21 | 16 04 | 01 04 | 14 43 | 02 55 | 15 42 | 03 51 | 15 49 | 05 52 | 17 01 |
| 24 | 01 58 | 15 35 | 03 20 | 16 56 | 02 03 | 15 33 | 03 59 | 16 27 | 04 56 | 16 36 | 06 52 | 17 58 |
| 25 | 02 47 | 16 31 | 04 23 | 17 46 | 03 05 | 16 21 | 05 05 | 17 13 | 06 02 | 17 26 | 07 48 | 18 56 |
| 26 | 03 41 | 17 26 | 05 28 | 18 34 | 04 10 | 17 08 | 06 11 | 18 00 | 07 06 | 18 20 | 08 39 | 19 53 |
| 27 | 04 39 | 18 20 | 06 34 | 19 21 | 05 15 | 17 54 | 07 18 | 18 50 | 08 09 | 19 16 | 09 25 | 20 50 |
| 28 | 05 41 | 19 11 | 07 39 | 20 06 | 06 22 | 18 39 | 08 23 | 19 42 | 09 07 | 20 13 | 10 07 | 21 44 |
| 29 | 06 45 | 19 59 | | | 07 28 | 19 26 | 09 26 | 20 36 | 10 00 | 21 11 | 10 45 | 22 37 |
| 30 | 07 49 | 20 46 | | | 08 34 | 20 14 | 10 25 | 21 32 | 10 48 | 22 07 | 11 21 | 23 28 |
| 31 | 08 53 | 21 30 | | | 09 39 | 21 04 | | | 11 31 | 23 02 | | |

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

# 1998 TIMES OF MOON RISE AND SET WINDHOEK

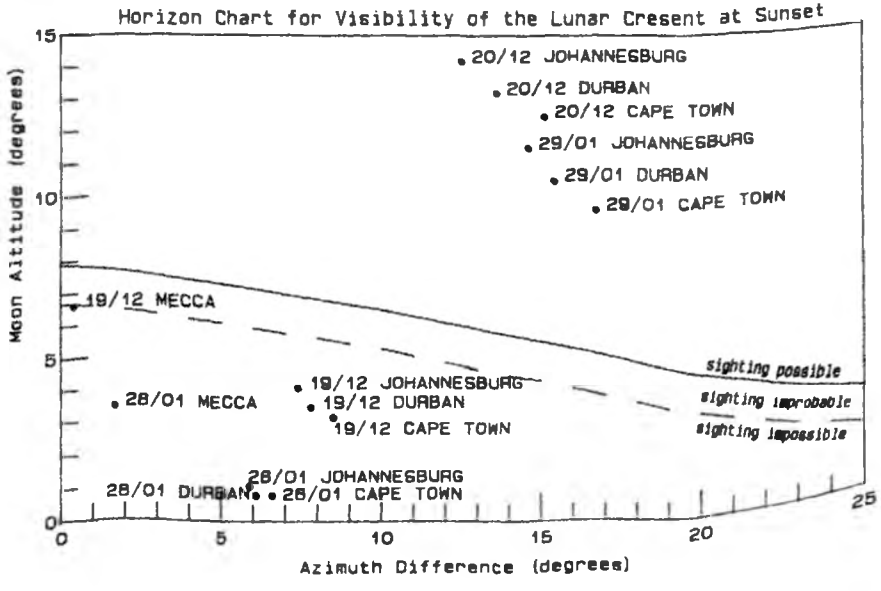
| | JANUARY | | FEBRUARY | | MARCH | | APRIL | | MAY | | JUNE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| 1 | 08 48 | 22 01 | 10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

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

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 charts.

| OCCASION | DATE | CAPE TOWN | | JOHANNESBURG | | DURBAN | | MECCA | |
|---|---|---|---|---|---|---|---|---|---|
| | d m | Alt° | DAzm° | Alt° | DAzm° | Alt° | DAzm° | Alt° | DAzm° |
| SHAWWALL | 28 01 | 0.8 | 6.6 | 1.1 | 5.9 | 0.8 | 6.1 | 3.5 | 1.7 |
| | 29 01 | 9.6 | 16.7 | 11.5 | 14.6 | 10.5 | 15.4 | 16.7 | 1.1 |
| RAMADAAN | 19 12 | 3.2 | 8.5 | 4.1 | 7.4 | 3.5 | 7.8 | 6.6 | 0.4 |
| | 20 12 | 12.5 | 15.1 | 14.2 | 12.5 | 13.2 | 13.6 | 16.7 | 5.1 |



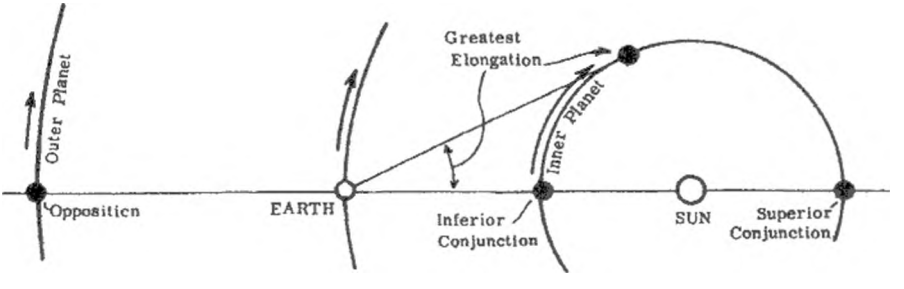
# THE PLANETS

## BASIC DATA

| | Dist from Sun $10^6$ km | Period of Revolution years | Mass (Earth = 1) | Equatorial Diameter $10^3$ km | Rotation Period | Inclination of Equator to orbit | No. of known satellites |
|---|---|---|---|---|---|---|---|
| Mercury | 58 | 0.24 | 0.055 | 4.98 | 58.65d | 0° | 0 |
| Venus | 108 | 0.62 | 0.815 | 12.10 | 243d R | 178° | 0 |
| Earth | 150 | 1.00 | 1.000 | 12.76 | 23h56m | 23°27′ | 1 |
| Mars | 228 | 1.88 | 0.107 | 6.79 | 24h37m | 23°59′ | 2 |
| Jupiter | 778 | 11.9 | 318.867 | 142.80 | 09h51m | 03°04′ | 16 |
| Saturn | 1 426 | 29.5 | 95.142 | 120.00 | 10h14m | 26°44′ | 18 |
| Uranus | 2 868 | 84.0 | 14.559 | 52.00 | 17.2h | 97°52′ | 15 |
| Neptune | 4 494 | 164.8 | 17.207 | 48.40 | 17.8h | 29°34′ | 8 |
| Pluto | 5 896 | 247.6 | 0.002 | 3.00 | 6.39d | 118°? | 1 |

## GENERAL

Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Their apparent brightness is measured in magnitudes. A planet of magnitude 1.0, that of the brightest stars, will be 100 times brighter than one of magnitude 6.0, the limit of visibility to the naked eye in the total absence of artificial lighting. Unlike the distant stars, the relative positions of the planets do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the starry background are complicated as they result from a combination of their own motion and the Earth's motion. Their brightnesses also vary considerably, as both their distances from the Earth and the visible portions of their sunlit hemispheres change. Since the period of a planet increases with increasing distance from the Sun, so we find that the inner planets - Mercury and Venus - appear to "overtake" the Earth in their orbits, while the Earth in turn "overtakes" the outer planets - Mars, Jupiter and Saturn. The terms given in astronomy to the various Sun-Earth-Planet configurations are illustrated in the accompanying diagram. Dates of such configurations occuring during the year are listed chronologically in the DIARY OF PHENOMENA and are also mentioned in the text below.




## OBSERVING THE PLANETS

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

**MERCURY**

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

January 1 (at mag.-0.1) to February 10 (at mag.-0.8),
April 15 (at mag.+2.8) to June 3 (at mag.-1.4),
August 22 (at mag.+2.2) to September 16 (at mag.-1.4) and
December 7 (at mag.+1.8) to December 31 (at mag.-0.4)

The best conditions for viewing will occur from the end of April until mid May when Mercury will be found in Pices.

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

March 4 (at mag.-1.4) to March 30 (at mag.+2.3),
June 18 (at mag.-1.3) to August 6 (at mag.+2.7), and
October 9 (at mag.-0.7) to November 26 (at mag.+1.8)

The best conditions for viewing will be in July, when Mercury will be found first in Cancer and later in Leo.

| | d h | d h | d h | d h |
|---|---|---|---|---|
| Superior Conjunction | | Feb 22 10 | Jun 10 9 | Sep 25 22 |
| Greatest Elongation East | | Mar 20 6 (19°) | Jul 17 5 (27°) | Nov 11 11 (23°) |
| Stationary | | Mar 27 17 | Jul 30 7 | Nov 21 16 |
| Inferior Conjunction | | Apr 6 19 | Aug 14 2 | Dec 1 17 |
| Stationary | | Apr 19 4 | Aug 23 7 | Dec 11 8 |
| Greatest Elongation West | Jan 6 17 (23°) | May 4 19 (27°) | Aug 31 11 (18°) | Dec 20 6 (22°) |

**VENUS**

Venus will be in the evening sky from the beginning of the year (at mag.-4.5) until the middle of the second week of January (at mag.-4.3).

It will become a morning sky object from the third week of January (at mag. -4.1), reaching greatest brilliancy (at mag.-4.6) on February 20. It remains in the morning sky until late September (at mag. -3.9).

It returns to the evening sky from mid December (at mag. -3.9) .

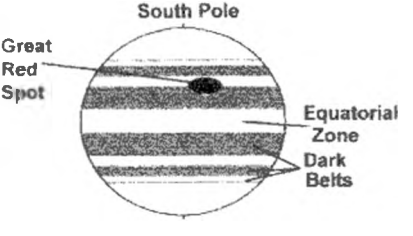
| | d h |
|---|---|
| Inferior Conjunction | Jan 16 13 |
| Stationary | Feb 5 20 |
| Greatest Elongation West | Mar 27 21 (47°) |
| Venus superior conjunction | Oct 30 6 |

**MARS**

Mars, visible (at mag.+1.2) in the evening sky, begins the year in the constellation of Capricornis, passing to Aquarius in the last week of January (at mag.+1.2), into Pisces at the end of February where, after the first week of March, it becomes too close to the sun to be seen. It reappears in the morning sky, in Gemini, in the second week of July (at mag. +1.6) and for the rest of the year it will be a morning sky object. It passes to Cancer in mid August (at mag.+1.7), into Leo in mid September and into Virgo in mid November (at mag.+1.5) where it remains for the rest of the year.

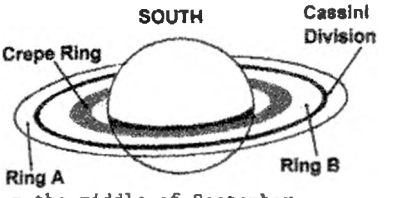
**JUPITER**

Jupiter (at mag.-2.1) begins the year in the evening sky, in Capricornus passing in the last week of January into Aquarius, where it will be visible for the first week of February, (at mag.-2.0) after which it will be too close to the Sun to be seen. It re-appears in the morning sky in the second week of March (at mag.-2.0). It passes to Pisces, in early June (at mag.-2.3), where by the middle of the month it will be visible for more than half the night. The planet passes back into Aquarius in late August



(at mag.-2.9) where it remains for the rest of the year. From the middle of September it will be visible all night and after mid December (at mag.-2.4) becomes an evening sky object.

**SATURN**



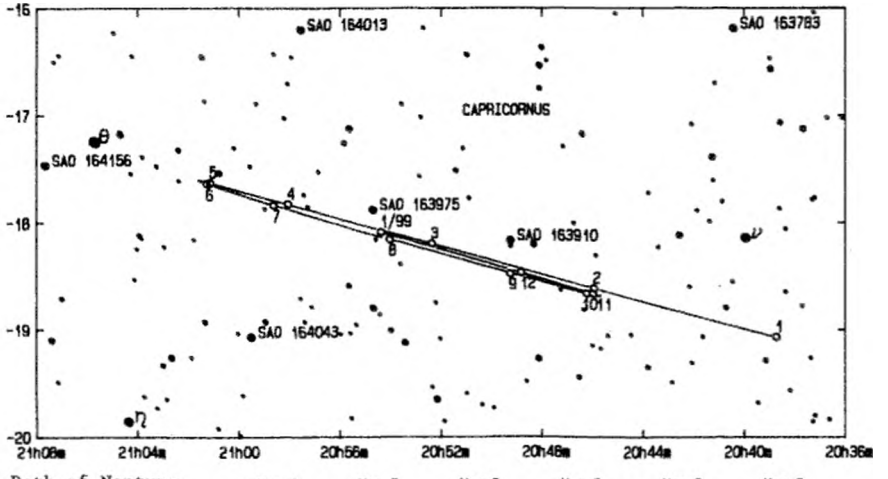

Saturn, found in Pisces, will be in the evening sky from January (at mag.+0.7) to late March (at mag.+0.6) when it becomes too close to the Sun to be seen. It will reappear in the morning sky at the beginning of May (at mag.+0.6). It passes into Cetus in the second half of July (at mag.+0.5) and back into Pices (at mag.+0.1) from the middle of September, where it remains for the rest of the year. It will be an all night object by the third week of October (at mag. -0.6).

**URANUS AND NEPTUNE**

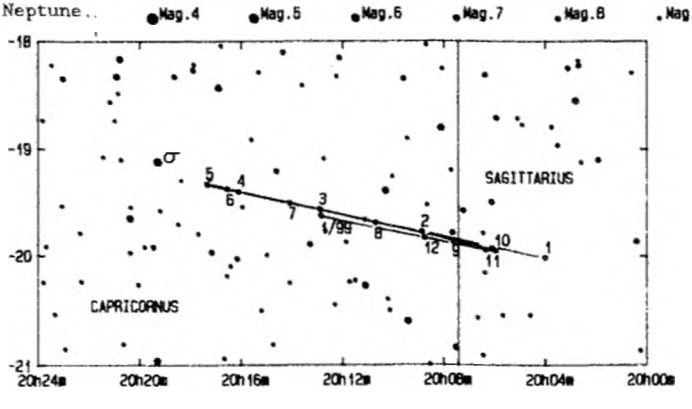
Uranus, visible with optical aid, found throughout the year in Capricornus, will set during the evening twilight until the fourth week of January. It will reappear in the morning sky in mid February. At opposition on August 3, it will be at magnitude 5.6.

Neptune, visible with optical aid, will set during the evening twilight for the first half of January. The planet will be found in the morning sky also in Capricornus, from mid February. At opposition on July 23, it will be at magnitude +7.9.

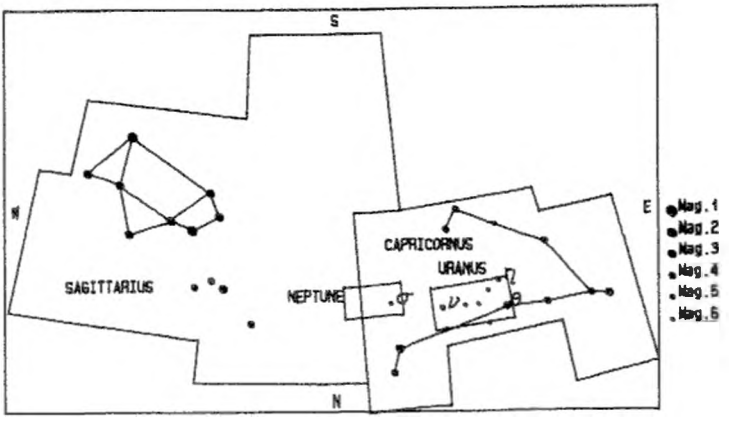
The Path of Uranus.




The Path of Neptune..



Sky Chart for the Paths of Uranus and Neptune




**PLUTO**

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

**EVENTS OF INTEREST**

Evening Sky:

| | | |
|---|---|---|
| 1 Jan | - 10 Jan | Jupiter, Mars, Saturn and Venus visible. |
| 11 Jan | - 10 Feb | Jupiter, Mars and Saturn visible. |
| 21 Jan | | Jupiter and Mars in conjunction. |
| 11 Feb | - 3 Mar | Mars and Saturn visible. |
| 4 Mar | - 9 Mar | Mars, Mercury and Saturn visible. |
| 10 Mar | - 27 Mar | Mercury and Saturn visible. |
| 11 Mar | | Mars and Mercury in conjunction. The planets will set approximately half an hour after sunset. |
| 9 Oct | - 22 Oct | Jupiter and Mercury visible. |
| 23 Oct | - 26 Nov | Jupiter, Mercury, and Saturn visible. |
| 27 Nov | - 9 Dec | Jupiter and Saturn visible. |
| 10 Dec | - 31 Dec | Jupiter, Saturn and Venus visible. |

Morning Sky:

| | | |
|---|---|---|
| 22 Jan | - 10 Feb | Mercury and Venus visible. |
| 26 Jan | | Mercury and Venus in conjunction |
| 9 Mar | - 14 Apr | Jupiter and Venus visible. |
| 15 Apr | - 30 Apr | Jupiter, Mercury and Venus visible. |
| 23 Apr | | Jupiter and Venus in conjunction. |
| 1 May | - 3 Jun | Jupiter, Mercury, Saturn and Venus visible. |
| 12 May | | Mercury and Saturn in conjunction. |
| 29 May | | Saturn and Venus in conjunction. |
| 4 Jun | - 9 Jul | Jupiter, Saturn and Venus visible. |
| 10 Jul | - 21 Aug | Jupiter, Mars, Saturn and Venus visible. |
| 5 Aug | | Mars and Venus in conjunction. |
| 22 Aug | - 16 Sep | Jupiter, Mars, Mercury, Saturn and Venus visible. |
| 26 Aug | | Mercury and Venus in conjunction. |
| 11 Sep | | Mercury and Venus in conjunction. |
| 17 Sep | - 22 Sep | Mars, Saturn and Venus visible. |
| 23 Sep | - 23 Oct | Mars and Saturn visible. |
| 7 Dec | - 31 Dec | Mercury and Mars visible. |

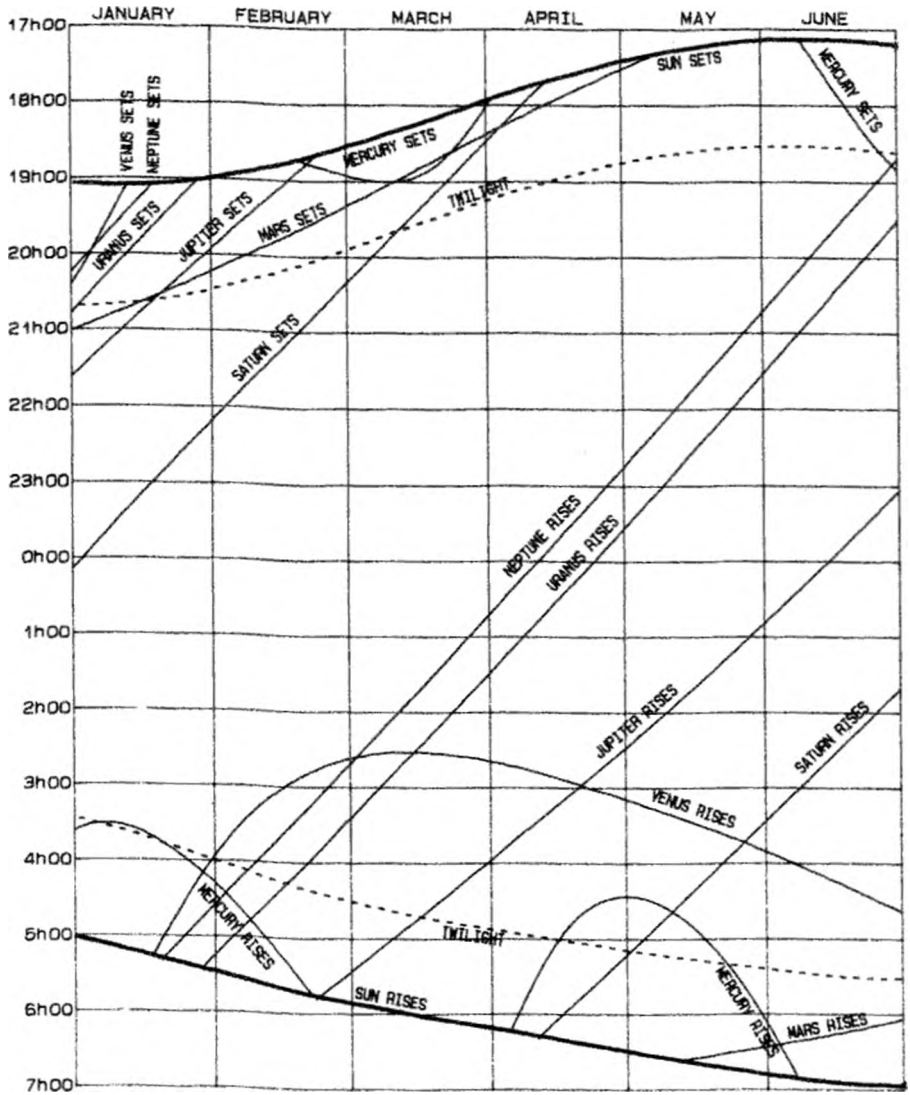
APPARENT PLACES:

| | Mercury | | Venus | | Mars | | Jupiter | |
|---|---|---|---|---|---|---|---|---|
| | RA | DEC | RA | DEC | RA | DEC | RA | DEC |
| | h m | ° ′ | h m | ° ′ | h m | ° ′ | h m | ° ′ |
| Jan 1 | 17 10.8 | -20 24 | 20 20.8 | -17 24 | 20 54.2 | -18 39 | 21 39.6 | -14 55 |
| Jan 11 | 17 51.1 | -22 20 | 20 2.2 | -15 46 | 21 25.7 | -16 18 | 21 47.9 | -14 13 |
| Jan 21 | 18 48.5 | -23 16 | 19 36.4 | -14 55 | 21 56.5 | -13 40 | 21 56.6 | -13 27 |
| Jan 31 | 19 52.7 | -22 19 | 19 18.8 | -14 52 | 22 26.6 | -10 48 | 22 5.6 | -12 39 |
| Feb 10 | 20 59.8 | -19 9 | 19 17.5 | -15 18 | 22 56.1 | -7 47 | 22 14.7 | -11 49 |
| Feb 20 | 22 8.3 | -13 38 | 19 31.5 | -15 48 | 23 25.0 | -4 39 | 22 23.8 | -10 58 |
| Mar 2 | 23 17.5 | -5 53 | 19 56.7 | -15 56 | 23 53.5 | -1 29 | 22 32.9 | -10 5 |
| Mar 12 | 0 23.0 | 3 5 | 20 29.3 | -15 27 | 0 21.8 | 1 41 | 22 42.0 | -9 13 |
| Mar 22 | 1 7.3 | 9 59 | 21 6.4 | -14 12 | 0 49.9 | 4 47 | 22 50.8 | -8 20 |
| Apr 1 | 1 10.5 | 11 4 | 21 46.1 | -12 12 | 1 18.0 | 7 48 | 22 59.5 | -7 28 |
| Apr 11 | 0 46.7 | 6 42 | 22 27.0 | -9 28 | 1 46.2 | 10 39 | 23 7.8 | -6 38 |
| Apr 21 | 0 37.8 | 2 54 | 23 8.5 | -6 8 | 2 14.7 | 13 19 | 23 15.7 | -5 50 |
| May 1 | 0 56.5 | 3 7 | 23 50.4 | -2 21 | 2 43.4 | 15 45 | 23 23.1 | -5 5 |
| May 11 | 1 35.4 | 6 38 | 0 32.5 | 1 42 | 3 12.5 | 17 55 | 23 30.0 | -4 23 |
| May 21 | 2 29.8 | 12 13 | 1 15.3 | 5 52 | 3 41.8 | 19 47 | 23 36.3 | -3 45 |
| May 31 | 3 41.0 | 18 38 | 1 59.1 | 9 58 | 4 11.4 | 21 20 | 23 41.8 | -3 12 |
| Jun 10 | 5 10.0 | 23 44 | 2 44.2 | 13 48 | 4 41.3 | 22 33 | 23 46.5 | -2 44 |
| Jun 20 | 6 43.9 | 24 55 | 3 31.0 | 17 10 | 5 11.2 | 23 24 | 23 50.2 | -2 23 |
| Jun 30 | 8 3.4 | 22 12 | 4 19.7 | 19 53 | 5 41.1 | 23 54 | 23 53.0 | -2 8 |
| Jul 10 | 9 2.9 | 17 28 | 5 10.1 | 21 47 | 6 10.7 | 24 2 | 23 54.6 | -2 1 |
| Jul 20 | 9 41.8 | 12 29 | 6 1.9 | 22 43 | 6 40.0 | 23 50 | 23 55.0 | -2 1 |
| Jul 30 | 9 56.7 | 8 53 | 6 54.3 | 22 35 | 7 8.9 | 23 18 | 23 54.3 | -2 9 |
| Aug 9 | 9 42.4 | 8 38 | 7 46.4 | 21 23 | 7 37.1 | 22 27 | 23 52.3 | -2 25 |
| Aug 19 | 9 14.8 | 12 1 | 8 37.7 | 19 8 | 8 4.7 | 21 20 | 23 49.3 | -2 47 |
| Aug 29 | 9 19.3 | 14 42 | 9 27.5 | 15 59 | 8 31.6 | 19 58 | 23 45.4 | -3 15 |
| Sep 8 | 10 9.7 | 12 43 | 10 15.7 | 12 5 | 8 57.6 | 18 22 | 23 40.9 | -3 45 |
| Sep 18 | 11 18.9 | 6 23 | 11 2.7 | 7 37 | 9 22.9 | 16 36 | 23 36.0 | -4 17 |
| Sep 28 | 12 25.5 | -1 25 | 11 48.7 | 2 47 | 9 47.5 | 14 40 | 23 31.2 | -4 48 |
| Oct 8 | 13 26.9 | -8 55 | 12 34.4 | -2 12 | 10 11.4 | 12 37 | 23 26.8 | -5 16 |
| Oct 18 | 14 25.5 | -15 27 | 13 20.5 | -7 9 | 10 34.6 | 10 29 | 23 23.2 | -5 37 |
| Oct 28 | 15 22.9 | -20 37 | 14 7.6 | -11 51 | 10 57.3 | 8 17 | 23 20.5 | -5 52 |
| Nov 7 | 16 17.5 | -24 3 | 14 56.3 | -16 5 | 11 19.3 | 6 3 | 23 19.0 | -5 59 |
| Nov 17 | 16 58.7 | -25 10 | 15 47.0 | -19 38 | 11 40.8 | 3 50 | 23 18.8 | -5 58 |
| Nov 27 | 16 54.5 | -23 0 | 16 39.6 | -22 16 | 12 1.8 | 1 38 | 23 19.8 | -5 49 |
| Dec 7 | 16 5.7 | -18 20 | 17 33.8 | -23 48 | 12 22.2 | -0 31 | 23 22.0 | -5 32 |
| Dec 17 | 16 8.7 | -18 26 | 18 28.8 | -24 9 | 12 42.1 | -2 34 | 23 25.4 | -5 8 |
| Dec 27 | 16 53.5 | -21 16 | 19 23.5 | -23 15 | 13 1.4 | -4 31 | 23 29.8 | -4 38 |

| | Saturn | | Uranus | | Neptune | | Pluto | |
|---|---|---|---|---|---|---|---|---|
| | RA | DEC | RA | DEC | RA | DEC | RA | DEC |
| | h m | ° ′ | h m | ° ′ | h m | ° ′ | h m | ° ′ |
| Jan 1 | 0 54.5 | 3 7 | 20 38.7 | -19 4 | 20 4.0 | -20 1 | 16 27.8 | -9 42 |
| Jan 11 | 0 55.8 | 3 18 | 20 41.0 | -18 56 | 20 5.5 | -19 56 | 16 29.1 | -9 44 |
| Jan 21 | 0 57.8 | 3 33 | 20 43.3 | -18 47 | 20 7.1 | -19 52 | 16 30.2 | -9 44 |
| Jan 31 | 1 0.3 | 3 51 | 20 45.7 | -18 38 | 20 8.7 | -19 47 | 16 31.2 | -9 44 |
| Feb 10 | 1 3.3 | 4 12 | 20 48.1 | -18 29 | 20 10.2 | -19 42 | 16 32.0 | -9 42 |
| Feb 20 | 1 6.8 | 4 35 | 20 50.4 | -18 20 | 20 11.7 | -19 38 | 16 32.6 | -9 41 |
| Mar 2 | 1 10.7 | 5 1 | 20 52.6 | -18 11 | 20 13.0 | -19 34 | 16 32.9 | -9 38 |
| Mar 12 | 1 14.8 | 5 28 | 20 54.6 | -18 3 | 20 14.2 | -19 30 | 16 33.1 | -9 35 |
| Mar 22 | 1 19.3 | 5 55 | 20 56.4 | -17 56 | 20 15.3 | -19 27 | 16 33.0 | -9 32 |
| Apr 1 | 1 23.9 | 6 24 | 20 58.0 | -17 49 | 20 16.1 | -19 24 | 16 32.7 | -9 28 |
| Apr 11 | 1 28.6 | 6 52 | 20 59.4 | -17 44 | 20 16.7 | -19 22 | 16 32.1 | -9 24 |
| Apr 21 | 1 33.3 | 7 20 | 21 0.4 | -17 40 | 20 17.2 | -19 21 | 16 31.4 | -9 21 |
| May 1 | 1 38.0 | 7 47 | 21 1.1 | -17 38 | 20 17.4 | -19 20 | 16 30.6 | -9 17 |
| May 11 | 1 42.7 | 8 13 | 21 1.5 | -17 36 | 20 17.3 | -19 20 | 16 29.6 | -9 14 |
| May 21 | 1 47.1 | 8 37 | 21 1.6 | -17 37 | 20 17.1 | -19 21 | 16 28.6 | -9 12 |
| May 31 | 1 51.3 | 8 59 | 21 1.3 | -17 38 | 20 16.6 | -19 22 | 16 27.5 | -9 10 |
| Jun 10 | 1 55.2 | 9 19 | 21 0.7 | -17 41 | 20 16.0 | -19 24 | 16 26.5 | -9 8 |
| Jun 20 | 1 58.8 | 9 37 | 20 59.9 | -17 45 | 20 15.1 | -19 27 | 16 25.4 | -9 8 |
| Jun 30 | 2 1.9 | 9 51 | 20 58.7 | -17 50 | 20 14.2 | -19 30 | 16 24.5 | -9 9 |
| Jul 10 | 2 4.5 | 10 3 | 20 57.4 | -17 56 | 20 13.1 | -19 34 | 16 23.7 | -9 10 |
| Jul 20 | 2 6.6 | 10 12 | 20 55.9 | -18 2 | 20 12.0 | -19 37 | 16 23.0 | -9 12 |
| Jul 30 | 2 8.1 | 10 17 | 20 54.4 | -18 8 | 20 10.9 | -19 41 | 16 22.5 | -9 15 |
| Aug 9 | 2 8.9 | 10 18 | 20 52.7 | -18 15 | 20 9.8 | -19 44 | 16 22.2 | -9 19 |
| Aug 19 | 2 9.1 | 10 17 | 20 51.2 | -18 21 | 20 8.8 | -19 48 | 16 22.1 | -9 24 |
| Aug 29 | 2 8.6 | 10 11 | 20 49.7 | -18 27 | 20 7.9 | -19 51 | 16 22.2 | -9 29 |
| Sep 8 | 2 7.5 | 10 3 | 20 48.4 | -18 32 | 20 7.1 | -19 53 | 16 22.5 | -9 35 |
| Sep 18 | 2 5.8 | 9 51 | 20 47.3 | -18 36 | 20 6.5 | -19 55 | 16 23.1 | -9 41 |
| Sep 28 | 2 3.5 | 9 38 | 20 46.4 | -18 39 | 20 6.1 | -19 57 | 16 23.8 | -9 47 |
| Oct 8 | 2 0.9 | 9 22 | 20 45.9 | -18 41 | 20 5.9 | -19 57 | 16 24.8 | -9 54 |
| Oct 18 | 1 57.9 | 9 6 | 20 45.7 | -18 42 | 20 5.9 | -19 58 | 16 25.9 | -10 0 |
| Oct 28 | 1 54.9 | 8 49 | 20 45.8 | -18 41 | 20 6.2 | -19 57 | 16 27.1 | -10 6 |
| Nov 7 | 1 51.9 | 8 34 | 20 46.3 | -18 39 | 20 6.7 | -19 56 | 16 28.5 | -10 12 |
| Nov 17 | 1 49.2 | 8 20 | 20 47.1 | -18 35 | 20 7.4 | -19 54 | 16 30.0 | -10 17 |
| Nov 27 | 1 46.8 | 8 8 | 20 48.3 | -18 30 | 20 8.3 | -19 51 | 16 31.5 | -10 22 |
| Dec 7 | 1 45.0 | 8 0 | 20 49.7 | -18 24 | 20 9.4 | -19 48 | 16 33.0 | -10 26 |
| Dec 17 | 1 43.7 | 7 56 | 20 51.4 | -18 17 | 20 10.7 | -19 44 | 16 34.5 | -10 30 |
| Dec 27 | 1 43.1 | 7 55 | 20 53.3 | -18 10 | 20 12.1 | -19 40 | 16 36.0 | -10 32 |

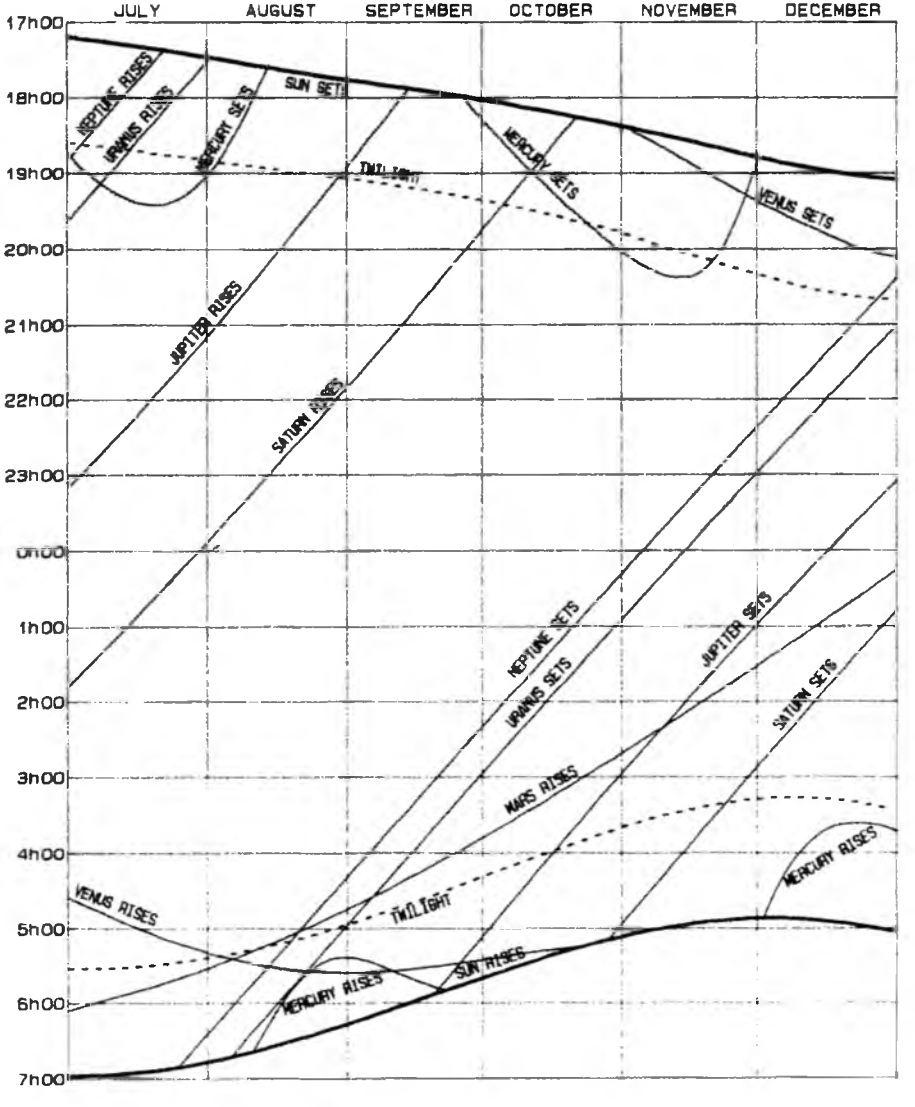
TIMES OF RISING AND SETTING

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



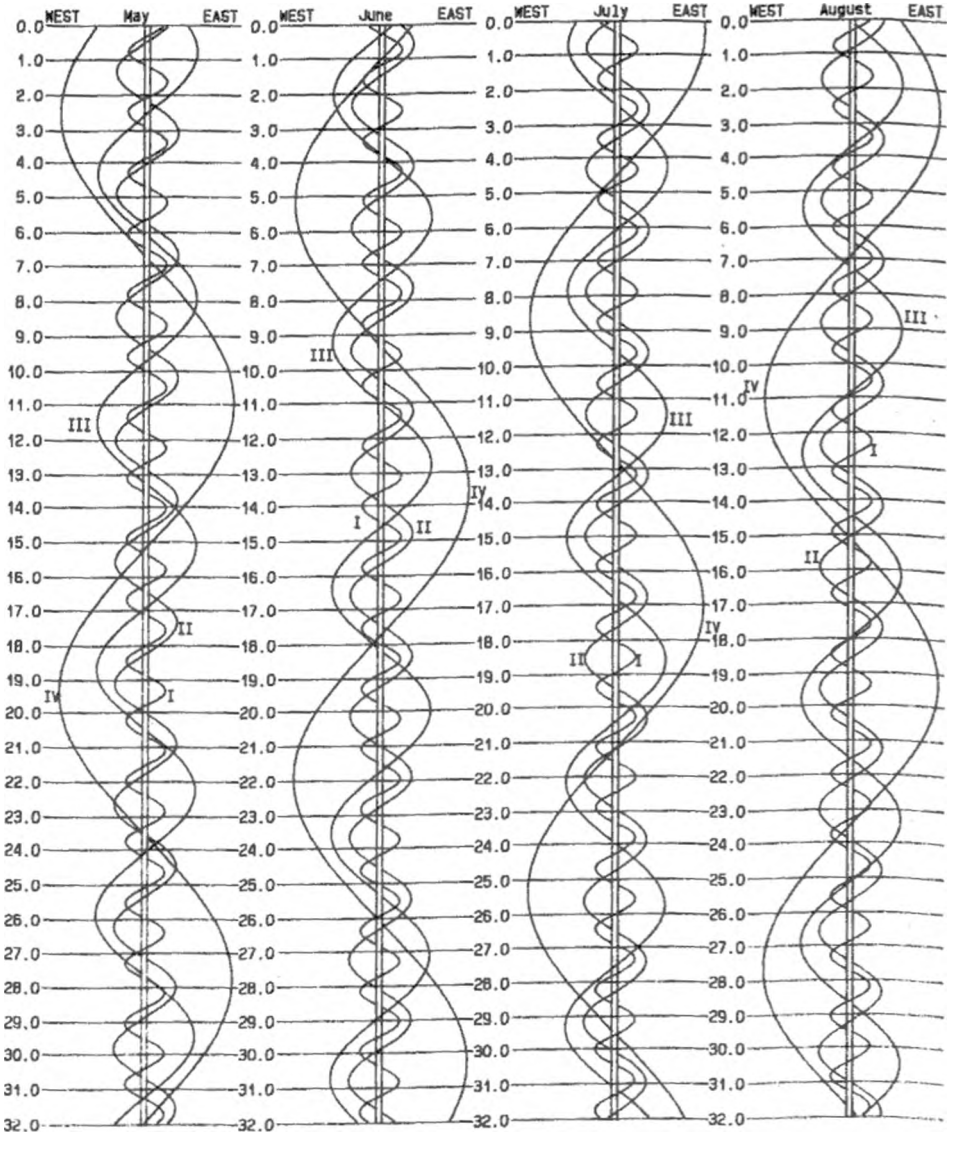
CORRECTION FOR PLACES NOT ON THE 30° E MERIDIAN
Approximate longitude corrections from the 30° East meridian are:

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

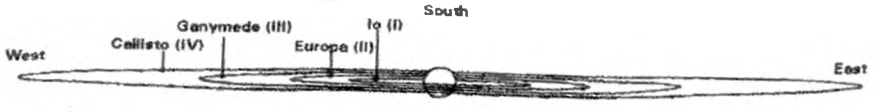


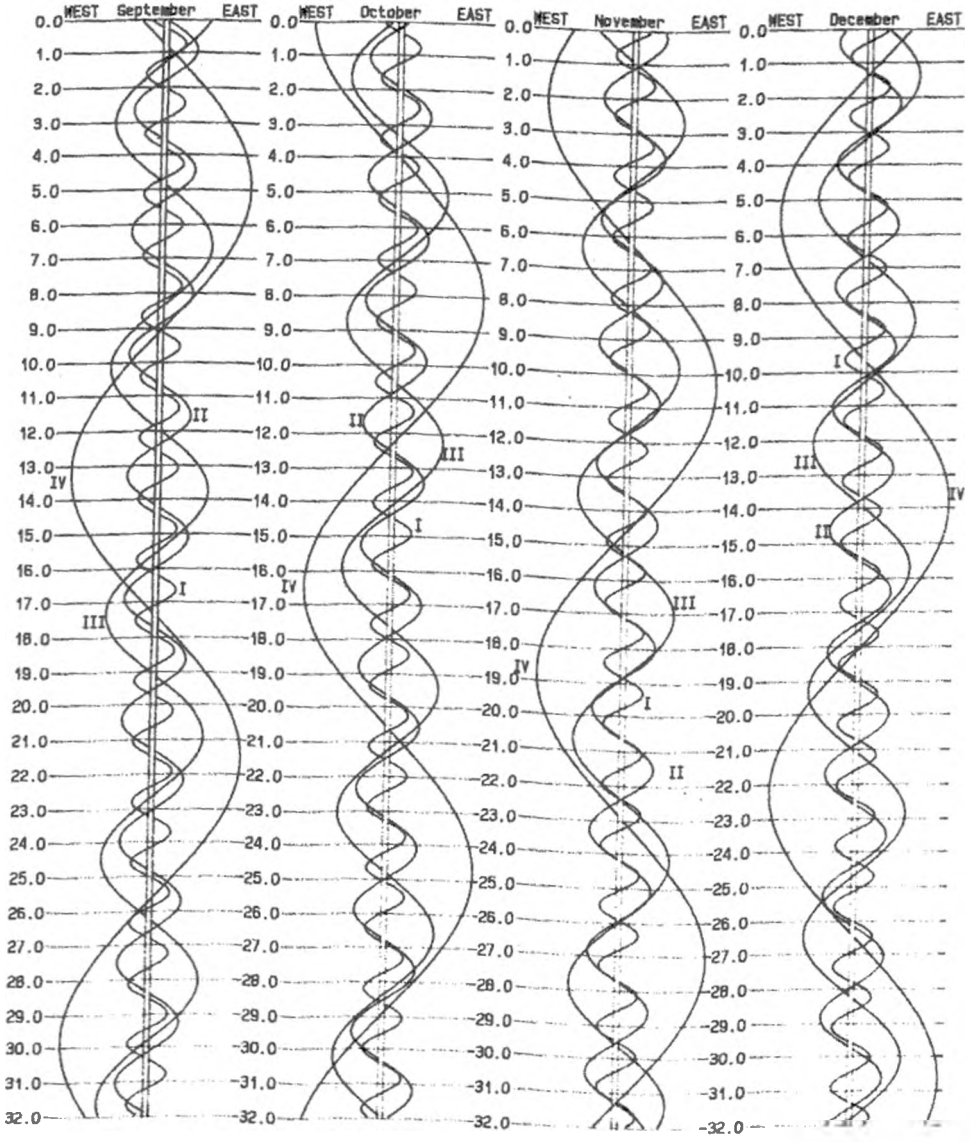
# THE MOONS OF JUPITER

One of the most popular sights for an observer with a small telescope is Jupiter and its moons. Four of the sixteen - Io, Europa, Ganymede and Callisto - are generally clearly visible - they would just be visible to the naked eye were it not for the glare from the mother planet. As the diagram on the next page indicates, the system is seen almost edge-on so the moons always lie close to a straight line extending from the planet's equator. As they orbit, so they appear to oscillate from one side to the other, alternately passing in front and behind the planet. This motion is represented in the following diagrams which show how their positions along such a straight line change during the 8 months when Jupiter is



prominent. For each month, time increases downward; the disk of Jupiter is stretched to make the central column, and horizontal lines representing midnight (0am SAST), are shown for every day of the month. The wavy lines show how the moons appear to ossilate from each side of the planet to the other.



When the moons pass in front and behind the planet, transits, occultations and eclipses occur. Details of such phenomena, occurring between the end of astronomical twilight in the evening and its commencement in the morning when the planet is above the horizon in Southern Africa, are given in the table below.

EXPLANATION OF THE TABLE.

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

| d | h | m | | d | h | m | | d | h | m | | d | h | m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Apr 23 | 04 | 47 | I.Tr.E. | Jun 12 | 03 | 03 | II.Tr.E. | Jul 13 | 02 | 51 | III.Tr.I. | Aug 05 | 23 | 10 | II.Ec.D. |
| | 05 | 09 | II.Tr.I. | | 14 | 05 | 29 III.Sh.I. | | 05 | 58 | III.Tr.E. | | 06 | 03 | 48 II.Oc.R. |
| | 05 | 59 | II.Sh.E. | | | 06 | 38 I.Ec.D. | | 23 | 59 | II.Sh.E. | | | 23 | 29 III.Ec.D. |
| 25 | 04 | 57 | III.Sh.E. | | 15 | 03 | 47 I.Sh.I. | | 14 | 02 | 30 II.Tr.E. | | 07 | 02 | 50 III.Ec.R. |
| | 05 | 28 | III.Tr.I. | | | 05 | 11 I.Tr.I. | | 15 | 05 | 51 I.Sh.I. | | | 03 | 27 III.Oc.D. |
| 28 | 04 | 57 | IV.Tr.I. | | | 06 | 03 I.Sh.E. | | 16 | 03 | 11 I.Ec.D. | | | 06 | 01 I.Sh.I. |
| 30 | 04 | 31 | I.Tr.I. | | 16 | 04 | 46 I.Oc.R. | | 17 | 00 | 19 I.Sh.I. | | | 22 | 52 II.Tr.E. |
| | 05 | 44 | I.Sh.E. | | 17 | 01 | 46 IV.Sh.I. | | | 01 | 35 I.Tr.I. | | 08 | 03 | 22 I.Ec.D. |
| | 05 | 47 | II.Sh.I. | | | 01 | 53 I.Tr.E. | | | 02 | 35 I.Sh.E. | | 09 | 00 | 30 I.Sh.I. |
| May 02 | 05 | 08 | II.Oc.R. | | | 05 | 01 II.Ec.D. | | | 03 | 48 I.Tr.E. | | | 01 | 25 I.Tr.I. |
| | 05 | 26 | III.Sh.I. | | | 05 | 12 IV.Sh.E. | | 18 | 01 | 09 I.Oc.R. | | | 02 | 45 I.Sh.E. |
| 06 | 04 | 23 | IV.Ec.D. | | 18 | 04 | 20 III.Oc.R. | | 19 | 04 | 40 II.Ec.D. | | | 03 | 39 I.Tr.E. |
| 07 | 05 | 22 | I.Sh.I. | | 19 | 02 | 54 II.Sh.E. | | 20 | 01 | 31 III.Sh.I. | | 10 | 00 | 58 I.Oc.R. |
| 08 | 06 | 04 | I.Oc.R. | | | 02 | 57 II.Tr.I. | | | 04 | 54 III.Sh.E. | | | 22 | 05 I.Tr.E. |
| 13 | 04 | 14 | III.Oc.D. | | | 05 | 40 II.Tr.E. | | | 06 | 34 III.Tr.I. | | 13 | 01 | 47 II.Ec.D. |
| 15 | 04 | 16 | IV.Tr.E. | | 22 | 05 | 41 I.Sh.I. | | | 23 | 50 II.Sh.I. | | | 06 | 08 II.Oc.R. |
| | 04 | 33 | I.Ec.D. | | 23 | 03 | 01 I.Ec.D. | | 21 | 02 | 17 II.Tr.I. | | 14 | 03 | 29 III.Ec.D. |
| - 16 | 04 | 00 | I.Sh.E. | | | 06 | 39 I.Oc.R. | | | 02 | 35 II.Sh.E. | | | 22 | 33 II.Tr.I. |
| | 05 | 12 | I.Tr.E. | | 24 | 01 | 33 I.Tr.I. | | | 04 | 57 II.Tr.E. | | | 23 | 39 II.Sh.E. |
| | 05 | 25 | II.Ec.D. | | | 02 | 25 I.Sh.E. | | 23 | 05 | 05 I.Ec.D. | | 15 | 01 | 11 II.Tr.E. |
| 18 | 05 | 39 | II.Tr.E. | | | 03 | 47 I.Tr.E. | | | 23 | 24 III.Oc.R. | | | 05 | 16 I.Ec.D. |
| 20 | 03 | 21 | III.Ec.D. | | 25 | 02 | 50 III.Ec.R. | | 24 | 02 | 13 I.Sh.I. | | 16 | 02 | 24 I.Sh.I. |
| 22 | 06 | 27 | I.Ec.D. | | | 05 | 07 III.Oc.D. | | | 03 | 24 I.Tr.I. | | | 03 | 11 I.Tr.I. |
| 23 | 03 | 38 | I.Sh.I. | | 26 | 02 | 32 IV.Oc.R. | | | 04 | 29 I.Sh.E. | | | 04 | 40 I.Sh.E. |
| | 04 | 55 | I.Tr.I. | | | 02 | 43 II.Sh.I. | | | 05 | 37 I.Tr.E. | | | 05 | 25 I.Tr.E. |
| | 05 | 53 | I.Sh.E. | | | 05 | 30 II.Sh.E. | | | 23 | 34 I.Ec.D. | | | 23 | 45 I.Ec.D. |
| 24 | 04 | 30 | I.Oc.R. | | | 05 | 33 II.Tr.I. | | 25 | 02 | 57 I.Oc.R. | | 17 | 02 | 44 I.Oc.R. |
| 25 | 02 | 57 | II.Sh.I. | | 28 | 02 | 21 II.Oc.R. | | 26 | 00 | 05 I.Tr.E. | | | 21 | 38 I.Tr.I. |
| | 05 | 38 | II.Tr.I. | | 30 | 04 | 55 I.Ec.D. | | 27 | 05 | 32 III.Sh.I. | | | 23 | 08 I.Sh.E. |
| | 05 | 46 | II.Sh.E. | Jul | 01 | 02 | 03 I.Sh.I. | | 28 | 02 | 26 II.Sh.I. | | | 23 | 43 III.Tr.E. |
| 30 | 05 | 31 | I.Sh.I. | | | 03 | 25 I.Tr.I. | | | 04 | 42 II.Tr.I. | | | 23 | 51 I.Tr.E. |
| 31 | 02 | 50 | I.Ec.D. | | | 04 | 19 I.Sh.E. | | | 05 | 11 II.Sh.E. | | 20 | 04 | 24 II.Ec.D. |
| | 02 | 57 | III.Tr.I. | | | 05 | 39 I.Tr.E. | | | 23 | 35 IV.Ec.D. | | 21 | 23 | 31 II.Sh.I. |
| | 06 | 15 | III.Tr.E. | | 02 | 03 | 00 I.Oc.R. | | 29 | 02 | 40 IV.Ec.R. | | 22 | 00 | 50 II.Tr.I. |
| | 06 | 26 | I.Oc.R. | | | 03 | 24 III.Ec.D. | | 30 | 01 | 26 II.Oc.R. | | | 02 | 15 II.Sh.E. |
| Jun 01 | 03 | 35 | I.Tr.E. | | 03 | 05 | 20 II.Sh.I. | | | 22 | 50 III.Ec.R. | | | 03 | 27 II.Tr.E. |
| | 05 | 34 | II.Sh.I. | | 05 | 04 | 52 II.Oc.R. | | | 23 | 55 III.Oc.D. | | 23 | 03 | 01 IV.Sh.I. |
| 03 | 05 | 16 | II.Oc.R. | | 06 | 02 | 12 III.Tr.E. | | 31 | 02 | 58 III.Oc.R. | | | 04 | 19 I.Sh.I. |
| 07 | 04 | 44 | I.Ec.D. | | 08 | 03 | 57 I.Sh.I. | | | 04 | 07 I.Sh.I. | | | 04 | 56 I.Tr.I. |
| | 04 | 55 | III.Sh.E. | | | 05 | 17 I.Tr.I. | | | 05 | 12 I.Tr.I. | | | 05 | 42 IV.Sh.E. |
| 08 | 03 | 16 | I.Tr.I. | | | 06 | 12 I.Sh.E. | | | 06 | 23 I.Sh.E. | | | 21 | 35 II.Oc.R. |
| | 04 | 09 | I.Sh.E. | | 09 | 01 | 17 I.Ec.D. | Aug | 01 | 01 | 28 I.Ec.D. | | 24 | 01 | 39 I.Ec.D. |
| | 05 | 30 | I.Tr.E. | | | 04 | 51 I.Oc.R. | | | 04 | 45 I.Oc.R. | | | 04 | 28 I.Oc.R. |
| 09 | 02 | 51 | I.Oc.R. | | 10 | 00 | 41 I.Sh.E. | | | 23 | 39 I.Tr.I. | | | 21 | 37 III.Sh.I. |
| | 06 | 14 | IV.Oc.D. | | | 01 | 58 I.Tr.E. | | 02 | 00 | 51 I.Sh.E. | | | 22 | 47 I.Sh.I. |
| 10 | 02 | 26 | II.Ec.D. | | 12 | 02 | 04 II.Ec.D. | | | 01 | 52 I.Tr.E. | | | 23 | 22 I.Tr.I. |
| | 05 | 11 | II.Ec.R. | | | 05 | 20 IV.Ec.D. | | | 23 | 12 I.Oc.R. | | 25 | 00 | 03 III.Tr.I. |
| | 05 | 12 | II.Oc.D. | | 13 | 00 | 55 III.Sh.E. | | 04 | 05 | 02 II.Sh.I. | | | 00 | 56 III.Sh.E. |

| d | h | m | |
|---|---|---|---|
| Aug 25 | 01 | 03 | I.Sh.E. |
| | 01 | 36 | I.Tr.E. |
| | 03 | 04 | III.Tr.E. |
| | 22 | 54 | I.Oc.R. |
| 29 | 02 | 07 | II.Sh.I. |
| | 03 | 05 | II.Tr.I. |
| | 04 | 50 | II.Sh.E. |
| | 05 | 43 | II.Tr.E. |
| 30 | 23 | 51 | II.Oc.R. |
| 31 | 03 | 34 | I.Ec.D. |
| Sep 01 | 00 | 42 | I.Sh.I. |
| | 01 | 07 | I.Tr.I. |
| | 01 | 38 | III.Sh.I. |
| | 02 | 57 | I.Sh.E. |
| | 03 | 20 | I.Tr.E. |
| | 03 | 21 | III.Tr.I. |
| | 04 | 56 | III.Sh.E. |
| | 22 | 02 | I.Ec.D. |
| 02 | 00 | 38 | I.Oc.R. |
| | 21 | 26 | I.Sh.E. |
| | 21 | 46 | I.Tr.E. |
| 05 | 04 | 43 | II.Sh.I. |
| | 05 | 19 | II.Tr.I. |
| 06 | 22 | 56 | II.Ec.D. |
| 07 | 02 | 07 | II.Oc.R. |
| | 05 | 28 | I.Ec.D. |
| 08 | 02 | 37 | I.Sh.I. |
| | 02 | 50 | I.Tr.I. |
| | 04 | 52 | I.Sh.E. |
| | 05 | 04 | I.Tr.E. |
| | 05 | 39 | III.Sh.I. |
| | 20 | 43 | II.Sh.E. |
| | 21 | 03 | II.Tr.E. |
| | 21 | 23 | IV.Sh.I. |
| | 23 | 49 | IV.Sh.E. |
| | 23 | 57 | I.Ec.D. |
| 09 | 02 | 22 | I.Oc.R. |
| | 21 | 06 | I.Sh.I. |
| | 21 | 16 | I.Tr.I. |
| | 23 | 21 | I.Sh.E. |
| | 23 | 30 | I.Tr.E. |
| 10 | 20 | 48 | I.Oc.R. |
| 11 | 23 | 12 | III.Oc.R. |
| 14 | 01 | 34 | II.Ec.D. |
| | 04 | 22 | II.Oc.R. |
| 15 | 04 | 32 | I.Sh.I. |
| | 04 | 34 | I.Tr.I. |
| | 20 | 36 | II.Sh.I. |
| | 20 | 39 | II.Tr.I. |
| | 23 | 17 | II.Tr.E. |
| | 23 | 18 | II.Sh.E. |
| 16 | 01 | 51 | I.Ec.D. |
| | 04 | 06 | I.Ec.R. |
| | 23 | 00 | I.Tr.I. |
| | 23 | 01 | I.Sh.I. |
| 17 | 01 | 14 | I.Tr.E. |
| | 01 | 16 | I.Sh.E. |
| | 20 | 18 | I.Oc.D. |
| | 22 | 34 | I.Ec.R. |
| 18 | 19 | 40 | I.Tr.E. |
| | 19 | 45 | I.Sh.E. |
| | 23 | 23 | III.Oc.D. |
| 19 | 02 | 52 | III.Ec.R. |

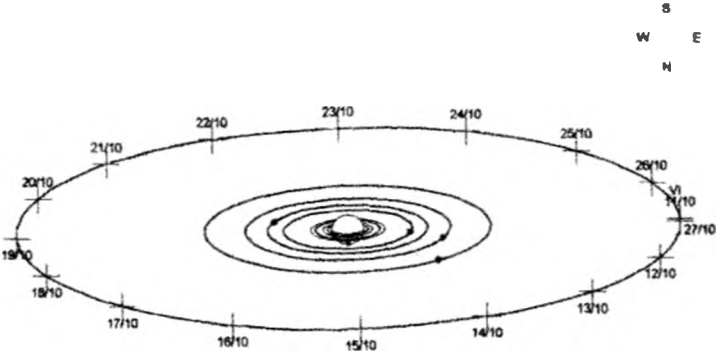
| d | h | m | |
|---|---|---|---|
| Sep 21 | 03 | 57 | II.Oc.D. |
| | 22 | 22 | 52 | II.Tr.I. |
| | 23 | 11 | II.Sh.I. |
| 23 | 01 | 30 | II.Tr.E. |
| | 01 | 53 | II.Sh.E. |
| | 03 | 35 | I.Oc.D. |
| 24 | 00 | 44 | I.Tr.I. |
| | 00 | 56 | I.Sh.I. |
| | 02 | 58 | I.Tr.E. |
| | 03 | 11 | I.Sh.E. |
| | 20 | 14 | II.Ec.R. |
| | 22 | 01 | I.Oc.D. |
| 25 | 00 | 29 | I.Ec.R. |
| | 19 | 10 | I.Tr.I. |
| | 19 | 25 | I.Sh.I. |
| | 21 | 24 | I.Tr.E. |
| | 21 | 40 | I.Sh.E. |
| 26 | 02 | 38 | III.Oc.D. |
| | 18 | 57 | I.Ec.R. |
| 29 | 19 | 29 | III.Tr.E. |
| | 20 | 59 | III.Sh.E. |
| 30 | 01 | 06 | II.Tr.I. |
| | 01 | 47 | II.Sh.I. |
| | 03 | 44 | II.Tr.E. |
| Oct 01 | 02 | 28 | I.Tr.I. |
| | 02 | 51 | I.Sh.I. |
| | 19 | 21 | II.Oc.D. |
| | 22 | 52 | II.Ec.R. |
| | 23 | 45 | I.Oc.D. |
| 02 | 02 | 23 | I.Ec.R. |
| | 20 | 54 | I.Tr.I. |
| | 21 | 20 | I.Sh.I. |
| | 23 | 08 | I.Tr.E. |
| | 23 | 35 | I.Sh.E. |
| 03 | 20 | 52 | I.Ec.R. |
| | 21 | 08 | IV.Oc.D. |
| | 22 | 11 | IV.Oc.R. |
| 04 | 00 | 51 | IV.Ec.D. |
| | 03 | 00 | IV.Ec.R. |
| 06 | 19 | 41 | III.Tr.I. |
| | 21 | 48 | III.Sh.I. |
| | 22 | 50 | III.Tr.E. |
| 07 | 01 | 01 | III.Sh.E. |
| | 03 | 20 | II.Tr.I. |
| 08 | 21 | 38 | II.Oc.D. |
| 09 | 01 | 30 | I.Oc.D. |
| | 01 | 31 | II.Ec.R. |
| | 22 | 39 | I.Tr.I. |
| | 23 | 16 | I.Sh.I. |
| 10 | 00 | 54 | I.Tr.E. |
| | 01 | 30 | I.Sh.E. |
| | 19 | 07 | II.Tr.E. |
| | 19 | 56 | I.Oc.D. |
| | 20 | 22 | II.Sh.E. |
| | 22 | 47 | I.Ec.R. |
| 11 | 19 | 20 | I.Tr.E. |
| | 19 | 59 | I.Sh.E. |
| 13 | 23 | 02 | III.Tr.I. |
| 14 | 01 | 50 | III.Sh.I. |
| | 02 | 12 | III.Tr.E. |
| 15 | 23 | 56 | II.Oc.D. |
| 17 | 00 | 25 | I.Tr.I. |
| | 01 | 11 | I.Sh.I. |

| d | h | m | |
|---|---|---|---|
| Oct 17 | 02 | 40 | I.Tr.E. |
| | 18 | 54 | III.Ec.R. |
| | 20 | 17 | II.Sh.I. |
| | 21 | 25 | II.Tr.E. |
| | 21 | 42 | I.Oc.D. |
| | 22 | 57 | II.Sh.E. |
| 18 | 00 | 42 | I.Ec.R. |
| | 18 | 52 | I.Tr.I. |
| | 19 | 40 | I.Sh.I. |
| | 21 | 07 | I.Tr.E. |
| | 21 | 55 | I.Sh.E. |
| 19 | 19 | 11 | I.Ec.R. |
| 20 | 19 | 14 | IV.Ec.D. |
| | 21 | 04 | IV.Ec.R. |
| 21 | 02 | 27 | III.Tr.I. |
| 23 | 02 | 17 | II.Oc.D. |
| 24 | 02 | 12 | I.Tr.I. |
| | 19 | 15 | III.Oc.R. |
| | 19 | 45 | III.Ec.D. |
| | 21 | 04 | II.Tr.I. |
| | 22 | 53 | II.Sh.I. |
| | 22 | 56 | III.Ec.R. |
| | 23 | 28 | I.Oc.D. |
| | 23 | 44 | II.Tr.E. |
| 25 | 01 | 33 | II.Sh.E. |
| | 20 | 39 | I.Tr.I. |
| | 21 | 36 | I.Sh.I. |
| | 22 | 54 | I.Tr.E. |
| | 23 | 51 | I.Sh.E. |
| 26 | 20 | 07 | II.Ec.R. |
| | 21 | 06 | I.Ec.R. |
| 28 | 19 | 02 | IV.Tr.I. |
| | 20 | 52 | IV.Tr.E. |
| 31 | 19 | 35 | III.Oc.D. |
| | 22 | 48 | III.Oc.R. |
| | 23 | 25 | II.Tr.I. |
| | 23 | 48 | III.Ec.D. |
| Nov 01 | 01 | 16 | I.Oc.D. |
| | 01 | 28 | II.Sh.I. |
| | 22 | 28 | I.Tr.I. |
| | 23 | 32 | I.Sh.I. |
| 02 | 00 | 43 | I.Tr.E. |
| | 01 | 46 | I.Sh.E. |
| | 19 | 43 | I.Oc.D. |
| | 22 | 45 | II.Ec.R. |
| | 23 | 01 | I.Ec.R. |
| 03 | 19 | 10 | I.Tr.E. |
| | 20 | 15 | I.Sh.E. |
| 07 | 23 | 11 | III.Oc.D. |
| 09 | 00 | 18 | I.Tr.I. |
| | 20 | 19 | II.Oc.D. |
| | 21 | 33 | I.Oc.D. |
| 10 | 00 | 56 | I.Ec.R. |
| | 19 | 57 | I.Sh.I. |
| | 21 | 00 | I.Tr.E. |
| | 22 | 11 | I.Sh.E. |
| 11 | 19 | 25 | I.Ec.R. |
| | 20 | 02 | II.Sh.E. |
| | 21 | 08 | III.Sh.E. |
| 14 | 23 | 19 | IV.Sh.I. |
| 15 | 00 | 07 | IV.Sh.E. |
| 16 | 22 | 48 | II.Oc.D. |
| | 23 | 24 | I.Oc.D. |

| d | h | m | |
|---|---|---|---|
| Nov 17 | 20 | 37 | I.Tr.I. |
| | 21 | 53 | I.Sh.I. |
| | 22 | 52 | I.Tr.E. |
| 18 | 00 | 07 | I.Sh.E. |
| | 19 | 58 | II.Sh.I. |
| | 20 | 09 | III.Tr.E. |
| | 20 | 10 | II.Tr.E. |
| | 21 | 20 | I.Ec.R. |
| | 22 | 03 | III.Sh.I. |
| | 22 | 38 | II.Sh.E. |
| 22 | 19 | 22 | IV.Oc.D. |
| | 21 | 53 | IV.Oc.R. |
| 24 | 22 | 29 | I.Tr.I. |
| | 23 | 49 | I.Sh.I. |
| 25 | 19 | 44 | I.Oc.D. |
| | 19 | 58 | II.Tr.I. |
| | 20 | 43 | III.Tr.I. |
| | 22 | 34 | II.Sh.I. |
| | 22 | 40 | II.Tr.E. |
| | 23 | 15 | I.Ec.R. |
| 26 | 00 | 00 | III.Tr.E. |
| | 20 | 32 | I.Sh.E. |
| 27 | 20 | 02 | II.Ec.R. |
| Dec 02 | 21 | 37 | I.Oc.D. |
| | 22 | 31 | II.Tr.I. |
| 03 | 20 | 14 | I.Sh.I. |
| | 21 | 08 | I.Tr.E. |
| | 22 | 28 | I.Sh.E. |
| 04 | 19 | 39 | I.Ec.R. |
| | 19 | 57 | II.Oc.R. |
| | 19 | 59 | II.Ec.D. |
| | 22 | 41 | II.Ec.R. |
| 06 | 19 | 59 | III.Ec.D. |
| | 23 | 04 | III.Ec.R. |
| 10 | 20 | 48 | I.Tr.I. |
| | 22 | 10 | I.Sh.I. |
| | 23 | 03 | I.Tr.E. |
| 11 | 19 | 51 | II.Oc.D. |
| | 21 | 35 | I.Ec.R. |
| | 22 | 36 | II.Oc.R. |
| | 22 | 38 | II.Ec.D. |
| 13 | 19 | 43 | II.Sh.E. |
| | 21 | 45 | III.Oc.R. |
| 17 | 22 | 08 | IV.Tr.I. |
| | 22 | 44 | I.Tr.I. |
| 18 | 19 | 57 | I.Oc.D. |
| | 22 | 31 | II.Oc.D. |
| 19 | 19 | 29 | I.Tr.E. |
| | 20 | 49 | I.Sh.E. |
| 20 | 19 | 41 | II.Sh.I. |
| | 19 | 43 | II.Tr.E. |
| | 22 | 20 | II.Sh.E. |
| | 22 | 34 | III.Oc.D. |
| 24 | 21 | 19 | III.Sh.E. |
| 25 | 21 | 54 | I.Oc.D. |
| 26 | 20 | 31 | I.Sh.I. |
| | 21 | 27 | I.Tr.E. |
| 27 | 19 | 40 | II.Tr.I. |
| | 19 | 55 | I.Ec.R. |
| | 22 | 18 | II.Sh.I. |
| 29 | 19 | 56 | II.Ec.R. |
| 31 | 20 | 18 | III.Tr.E. |

# THE MOONS OF SATURN

Saturn's moons are considerably fainter than the 4 Galilean moons of Jupiter. The diagram shows the orbits of 4 of Saturn's moons at opposition on October 23. 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 | 4 | 16.5 | Jan | 8 | 11.5 |
| Jan | 12 | 10.9 | Jan | 16 | 15.7 | | 20 | 15.9 | | 24 | 11.1 |
| | 28 | 10.5 | Feb | 1 | 15.5 | Feb | 5 | 15.7 | Feb | 9 | 10.9 |
| Feb | 13 | 10.6 | | 17 | 15.6 | | 21 | 15.8 | | 25 | 11.1 |
| Mar | 1 | 10.9 | Mar | 5 | 16.0 | Mar | 9 | 16.2 | Mar | 13 | 11.5 |
| | 17 | 11.5 | | 21 | 16.7 | | 25 | 16.7 | | 29 | 12.0 |
| Apr | 2 | 12.2 | Apr | 6 | 17.4 | Apr | 10 | 17.3 | Apr | 14 | 12.6 |
| | 18 | 13.0 | | 22 | 18.2 | | 26 | 17.9 | | 30 | 13.3 |
| May | 4 | 13.8 | May | 8 | 19.0 | May | 12 | 18.5 | May | 16 | 13.9 |
| | 20 | 14.5 | | 24 | 19.6 | | 28 | 19.0 | Jun | 1 | 14.3 |
| Jun | 5 | 15.1 | Jun | 9 | 20.1 | Jun | 13 | 19.2 | | 17 | 14.5 |
| | 21 | 15.4 | | 25 | 20.3 | | 29 | 19.2 | Jul | 3 | 14.5 |
| Jul | 7 | 15.3 | Jul | 11 | 20.1 | Jul | 15 | 18.9 | | 19 | 14.1 |
| | 23 | 14.9 | | 27 | 19.6 | | 31 | 18.2 | Aug | 4 | 13.3 |
| Aug | 8 | 14.1 | Aug | 12 | 18.6 | Aug | 16 | 17.1 | | 20 | 12.1 |
| | 24 | 12.7 | | 28 | 17.1 | Sep | 1 | 15.6 | Sep | 5 | 10.4 |
| Sep | 9 | 10.9 | Sep | 13 | 15.2 | | 17 | 13.6 | | 21 | 08.4 |
| | 25 | 08.7 | | 29 | 12.9 | Oct | 3 | 11.3 | Oct | 7 | 06.0 |
| Oct | 11 | 06.2 | Oct | 15 | 10.4 | | 19 | 08.8 | | 23 | 03.4 |
| | 27 | 03.5 | | 31 | 07.7 | Nov | 4 | 06.3 | Nov | 8 | 00.9 |
| Nov | 12 | 00.9 | Nov | 16 | 05.2 | | 20 | 03.9 | | 23 | 22.5 |
| | 27 | 22.5 | Dec | 2 | 02.9 | Dec | 6 | 01.8 | Dec | 9 | 20.5 |
| Dec | 13 | 20.5 | | 18 | 01.0 | | 22 | 00.0 | | 25 | 18.8 |
| | 29 | 19.0 | | | | | | | | | |

## 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 1998, 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 | PERIHELION DATE | PREDICTED MAXIMUM MAGNITUDE |
|---|---|---|
| Hale-Bopp | 1997 April 1 | 6 |
| Mueller | 1997 October 11 | 11 |
| Hartley 2 | 1997 December 22 | 8 |
| Tempel-Tuttle | 1998 February 28 | 10 |
| Meunier-Dupouy | 1998 March 10 | 10 |
| Giacobini-Zinner | 1998 November 21 | 9 |

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: tpcooper@ilink.nis.za**

**METEORS**

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

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

| SHOWER | MAX DATE | SHOWER DURATION | RADIANT RA 2000.0 | RADIANT DEC ° | ZHR | VEL km/s | REC.WATCH BEGIN SAST | REC.WATCH END SAST | OBSERVING CONDITIONS 1998 |
|---|---|---|---|---|---|---|---|---|---|
| α Crucids | Jan19 | Jan06-Jan28 | 12h48 | -63 | <5 | 50 | 00h00 | 03h30 | Poor |
| α Centaurids | Feb 8 | Jan28-Feb23 | 14h00 | -40 | 5 | 60 | 22h00 | 03h30 | Unfavourable |
| Pyxids | Mar 6 | Mar03-Mar09 | 09h00 | -35 | <5 | ? | 20h00 | 03h30 | Poor |
| γ Normids | Mar 14 | Feb25-Mar22 | 16h36 | -51 | 5 | 56 | 00h00 | 04h30 | Unfavourable |
| δ Pavonids | Apr 6 | Mar11-Apr16 | 20h32 | -63 | 5 | 59 | 02h00 | 04h30 | Good |
| April Lyrids | Apr 22 | Apr16-Apr24 | 18h05 | +34 | 15 | 49 | 03h00 | 05h00 | Good |
| π Puppids | Apr 23 | Apr16-Apr25 | 07h20 | -45 | <5 | 18 | 19h00 | 22h00 | Favourable |
| α Scorpiids | May 3 | Apr11-May12 | 16h00 | -27 | 5 | 35 | 21h00 | 04h00 | Favourable |
| η Aquarids | May 5 | Apr21-May12 | 22h24 | -02 | 60 | 65 | 04h00 | 05h30 | Good |
| χ Scorpiids | Jun 5 | May27-Jun20 | 16h32 | -14 | 5 | 21 | 21h00 | 04h30 | Poor |
| Sagittarids | Jun 11 | Jun08-Jun16 | 20h16 | -35 | <5 | 52 | 03h30 | 05h30 | Unfavourable |
| θ Ophiuchids | Jun 13 | Jun08-Jun16 | 17h48 | -20 | 5 | 27 | 20h00 | 05h30 | Unfavourable |
| June Lyrids | Jun 16 | Jun11-Jun21 | 18h32 | +35 | 5 | 31 | 23h30 | 02h00 | Poor |
| Cetids | Jun 28 | Jun26-Jun29 | 02h00 | -15 | <5 | ? | 03h00 | 05h30 | Favourable |
| Capricornids | Jul 26 | Jul10-Aug05 | 21h00 | -15 | 8 | ? | 20h30 | 05h30 | Favourable |
| Piscis Australids | Jul 28 | Jul19-Aug17 | 22h40 | -30 | 8 | 35 | 21h30 | 05h00 | Good |
| South δ Aquarids | Jul 29 | Jul21-Aug29 | 22h36 | -16 | 30 | 42 | 22h00 | 05h00 | Good |
| α Capricornids | Jul 30 | Jul15-Aug25 | 20h28 | -10 | 10 | 25 | 20h00 | 04h00 | Good |
| 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 | Unfavourable |
| North ι Aquarids | Aug 20 | Jul15-Sep20 | 21h48 | -06 | 10 | 36 | 20h00 | 05h00 | New moon |
| Orionids | Oct 21 | Oct02-Nov07 | 06h20 | +16 | 30 | 68 | 02h00 | 04h00 | New moon |
| Southern Taurids | Nov 3 | Sep15-Dec01 | 03h20 | +14 | 10 | 29 | 21h30 | 03h30 | Full moon |
| Northern Taurids | Nov 13 | Sep19-Dec01 | 04h00 | +23 | 5 | 31 | 21h30 | 03h30 | Good |
| Leonids | Nov 17 | Nov14-Nov20 | 10h08 | +22 | 50+ | 70 | 03h00 | 04h00 | Favourable |
| Dec. Phoenicids | Dec 5 | Dec03-Dec05 | 01h12 | -53 | 5 | 22 | 20h30 | 01h00 | Unfavourable |
| Geminids | Dec 14 | Dec04-Dec16 | 07h28 | +33 | 50 | 36 | 23h30 | 03h00 | Good |
| Velids | Dec 29 | Dec05-Jan07 | 09h56 | -51 | 5 | 40 | 22h30 | 03h30 | Poor |

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

# The Stars

## CONSTELLATIONS

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

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

## STAR NAMES

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

## STELLAR MAGNITUDES AND STELLAR DISTANCES

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

Distances are often expressed in units of light years - the distance light would travel in a year (equal to $9{,}5 \times 10^{12}$km).

## DOUBLE STARS

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

## STAR CLUSTERS

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

## NEBULAE

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

## THE STAR CHARTS

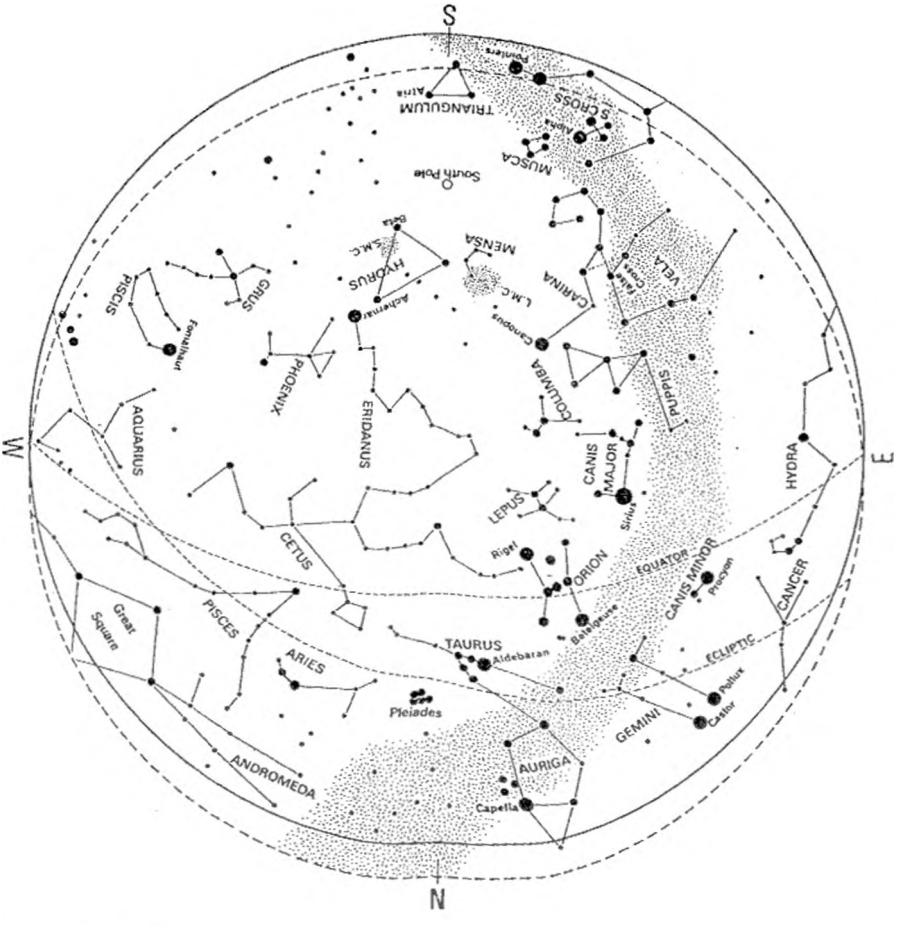
The star charts in this section show the night sky for each of the four seasons of the year. These seasonal charts depict stars down to magnitude 3.5 which is approximately what will be visible to the naked eye in city areas. Charts of 3 of the most interesting regions in the sky (showing stars down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

## THE SUMMER SKY

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

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

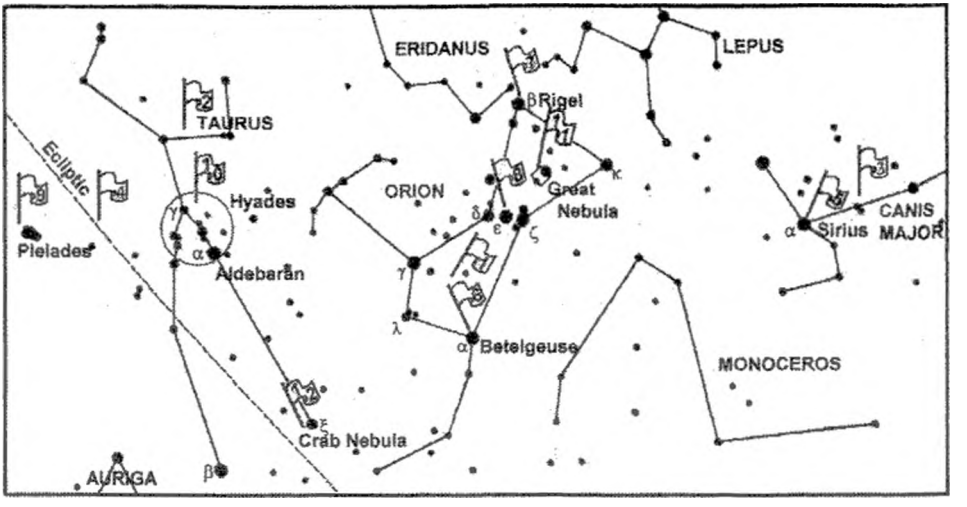
Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.




Courtesy of the

PLANETARIUM  SA MUSEUM

THE ORION REGION




(1) The constellation of Orion. The figure of the legendary hunter of Greek mythology is unfortunately upside down when seen from Southern Africa. The faint stars by λ represent the head, α and γ the shoulders, δ - ε - η the belt, and β and κ the legs. Orion forms part of the "great hunting scene" in which he faces the onslaught of (2) Taurus, the bull. Only the forepart of the bull is depicted and, like Orion, it is upside down, α and 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.

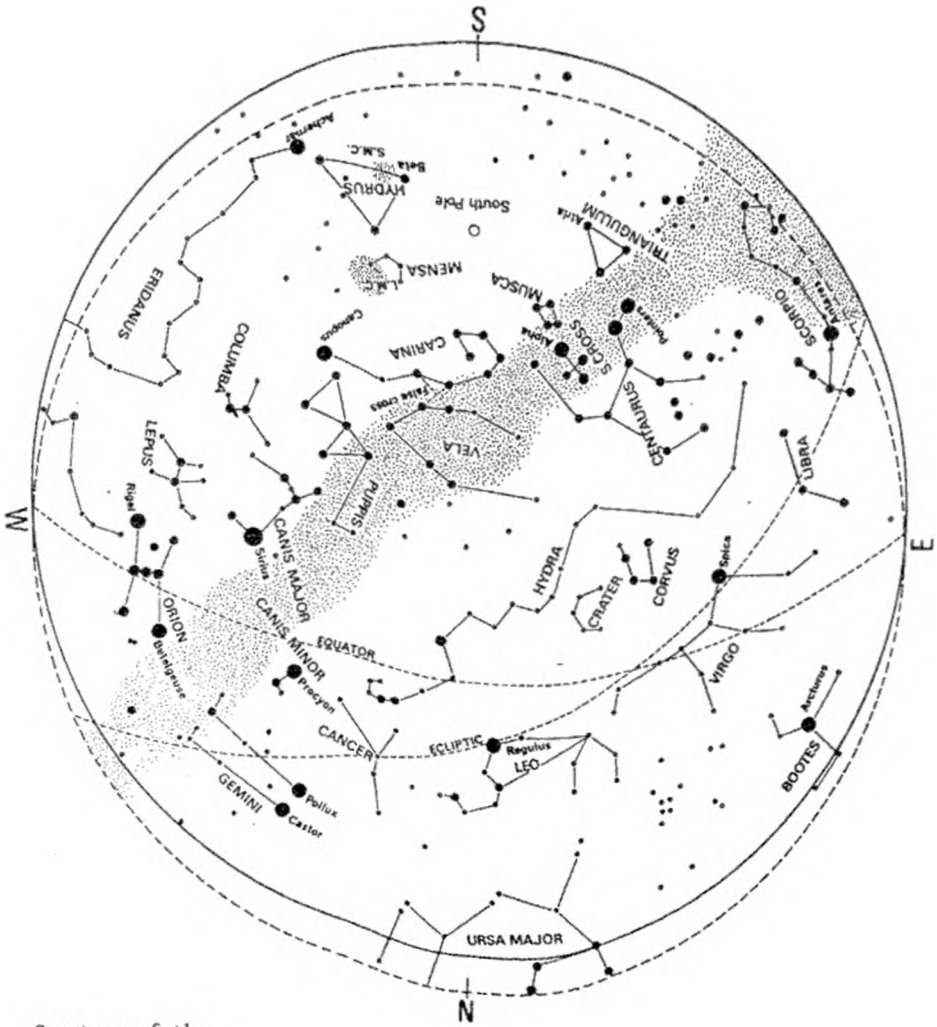
(12) The Crab Nebula, close to ξ Taurii, is the remnant of a supernova recorded by the Chinese in 1054, requires a moderate sized telescope for observation. In its heart is located the extraordinary pulsar which emits a double flash of light 30 times every second. The current belief is that it is a rapidly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

THE AUTUMN SKY

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

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

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

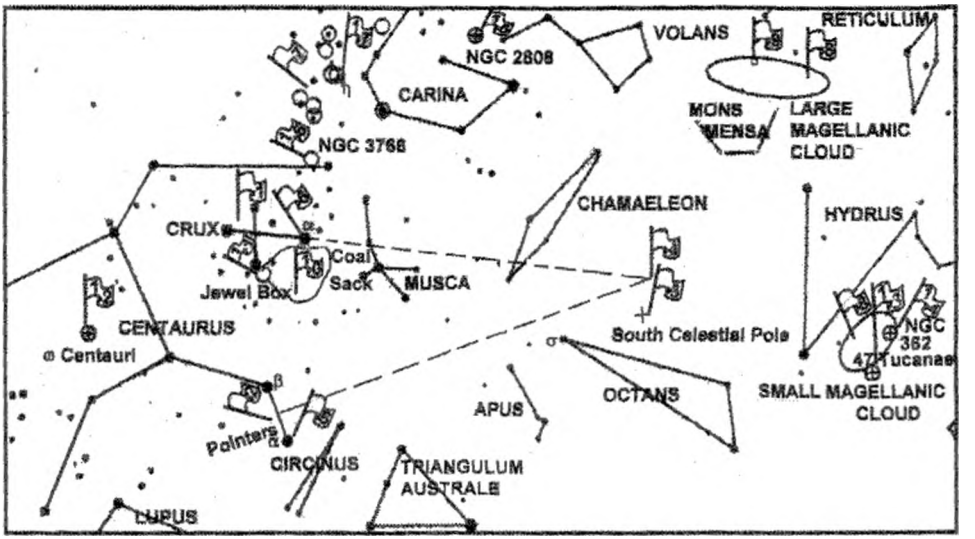



Courtesy of the

PLANETARIUM

SA MUSEUM

THE SOUTHERN CROSS REGION



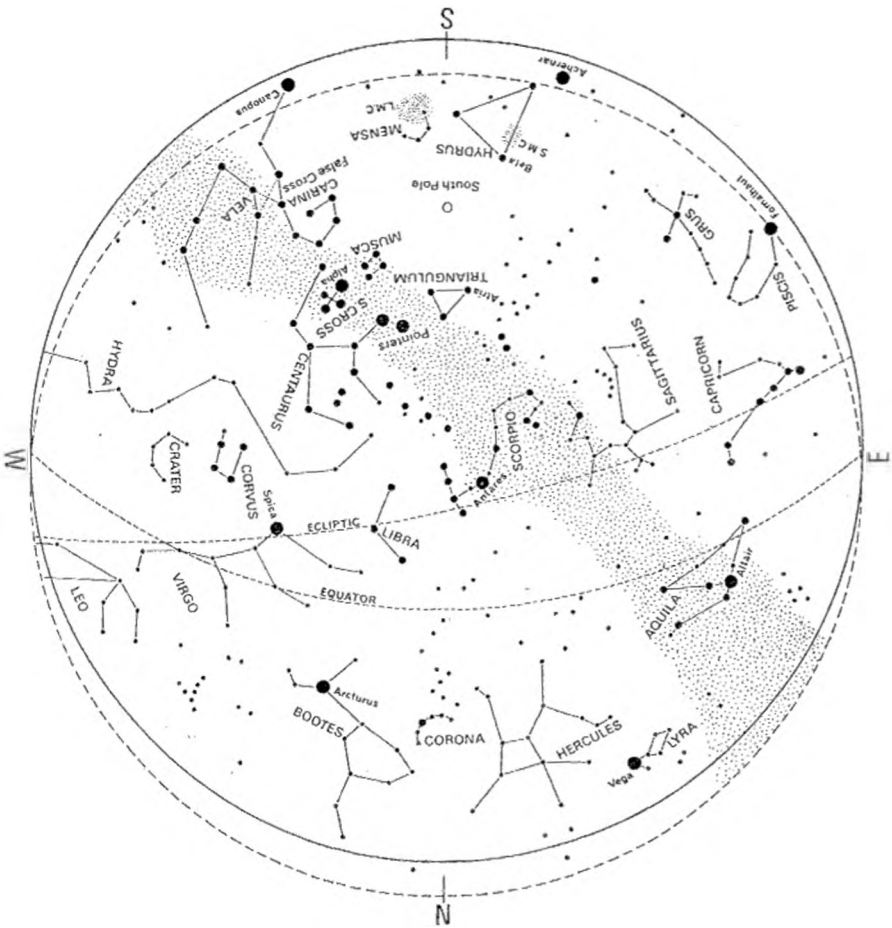

(1) Crux, the Southern Cross, is one of the most compact patterns of bright stars to be found in the sky. It lies on the border of that region of the sky which never sets as seen from Southern Africa.
(2) The two "Pointer" stars lie close to the Cross. (A similar pattern to the Southern Cross - called the False Cross, 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 seconds of arc).
(7) The region indicated is one of the brightest section of the entire Milky Way with many star clusters.
(8) The Large and Small Magellanic Clouds are the nearest of the external galaxies (see also next section). They can be seen with the naked eye provided the sky is reasonably dark.
(9) The Great Looped Nebula - possibly the remnant of a supernova explosion - in the Large Magellanic Cloud. (Naked eye or binoculars).
(10) The "Coal Sack" - a dark mass of gas and dust obscuring a part of the Milky Way. (Naked eye or binoculars).
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).
(12) ω Centauri and (13) 47 Tucanae are perhaps the best known globular cluster. Binoculars will show their fuzzy appearance. (14) NGC 362 and (15) NGC 2808 are fainter globular clusters.
(16) NGC 3766 - a fine galactic cluster. (Binoculars or small telescope).
(17) The η Carinae nebula - site of a slow supernova that brightened to magnitude -0.8 in 1843 and is now of magnitude 6.4.

THE WINTER SKY

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

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

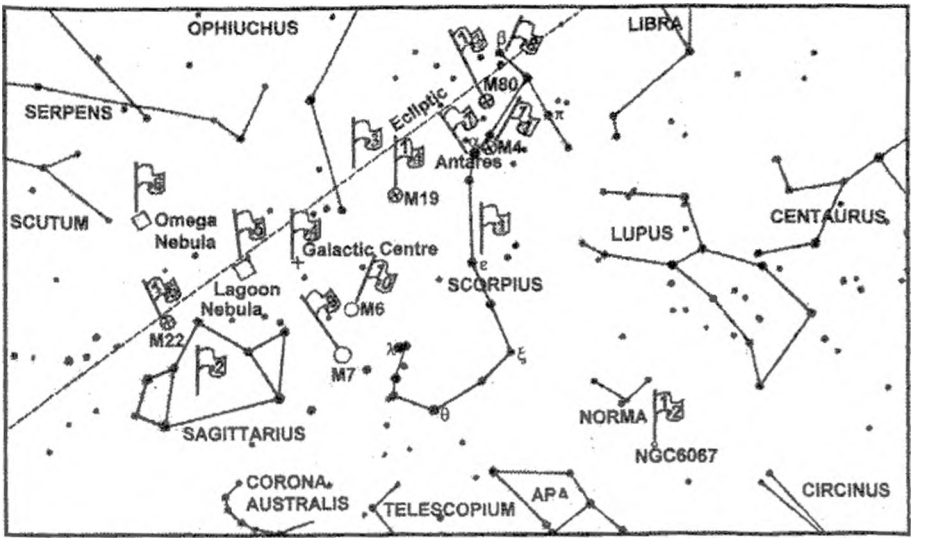
Correct times for places elsewhere may be found by subtracting 4 minutes for each degree of longitude east of Cape Town or adding 4 min for each degree of longitude west of Cape Town.




Courtesy of the

PLANETARIUM  SA MUSEUM

THE SCORPIUS REGION



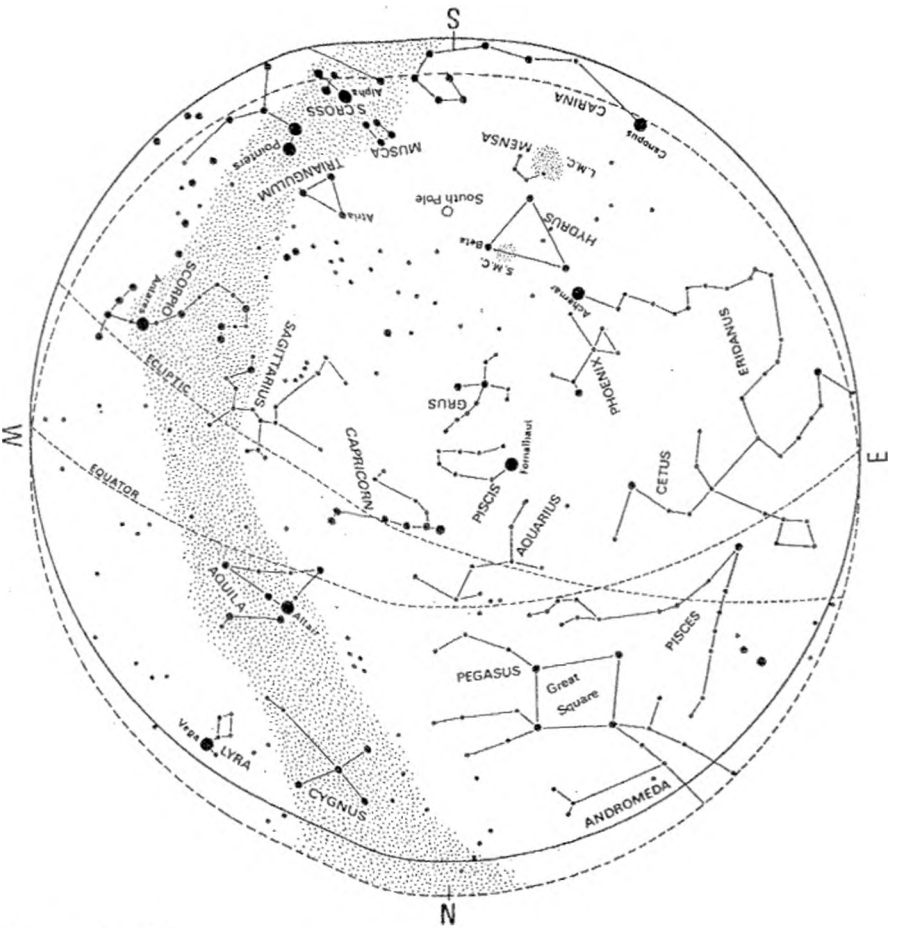

(1) The constellation of Scorpius. The creature is depicted with α in the centre of the body and β and π the claws. The distinctive tail ε - ζ - θ curls round to the sting.
(2) Sagittarius - the figure of the centaur archer is very difficult to make out. A more easily recognisable asterism is the 'teapot'.
(3) A section of the Ecliptic. Like Taurus, Scorpius and Sagittarius are constellations of the Zodiac.
(4) The direction of the centre of our Galaxy - the Milky Way is that part of our Galaxy visible to us. Unfortunately the central nucleus is obscured by foreground gaseous and dusty matter - both dark and luminous - hence the irregular shape of the Milky Way in this region, see the chart opposite. Luminous nebulae include (5) the Lagoon nebula and (6) the Omega nebula. These are best seen with the aid of binoculars.
(7) Antares - a distant red giant, several hundred times the diameter of our Sun - is so named because its red colour rivals that of the planet Mars.
(8)β Scorpii can be resolved as a double star (separation 16 sec of arc) with a small telescope. In fact the brighter component is in itself a triple star, and the fainter component a double star!
This region includes a number of galactic clusters including (9)M7, (10)M6, (11)M4 and (12) NGC 6067. (Use binoculars or a small telescope). Further from the plane of the Milky Way are some globular clusters: (13) M80 (14) M19 (15) M22.

THE SPRING SKY

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

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

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




Courtesy of the

PLANETARIUM

SA MUSEUM

**VARIABLE STAR OBSERVING**

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

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

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

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

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

Mr. J. Hers, P.O. Box 48, Sedgefield, 6573, Telephone 044-343-1736.

They will then be sent charts of a few easy objects and data on stars which may be observed with the equipment at their disposal.

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

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

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

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

Typical examples include:

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

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

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

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

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

**NOVA SEARCHING**

On rare occasions a star may undergo a nova outburst, its light increasing tremendously. The result is that a "new" star appears where previously no star was visible to the naked eye, or even with a small telescope. The light of the nova may fluctuate for a time, then gradually fades over a period of days, weeks or months.

Even observers having no telescopes can perform a useful task in keeping a watch for such novae in an allocated area of the sky. A good knowledge of the constellations is a recommendation, since part of the procedure is to scan the whole sky for bright novae before the more detailed search in the allocated area is begun. However, anyone can be given training in star recognition.

**DEEP SKY SECTION**

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

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

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

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

# TOTAL LUNAR OCCULTATIONS

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

An occultation occurs when the disk of the Moon moves in front of a star. Timings of occultations, to a precision of one-tenth of a second if possible are very valuable for studies of the Moon's shape and motion. Since only very modest equipment is required, amateurs can make important contributions in this field. Persons interested in making and reporting occultation observations are urged to contact the Director of the Society's Occultation Section:
Mr. M.D. Overbeek, P.O. Box 212, Edenvale, 1610 Tel: (011) 453 6918

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

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

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

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

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

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

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

EXPLANATIONS OF ABBREVIATIONS USED IN THE TABLES:

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

Observers who want to observe occultations of stars fainter than the ones listed, can contact Mr Overbeek 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 | I.C. | Mag. | Ph | ELG | UT | a. | b. | P.A. | UT | a. | b. | P.A. | UT | a. | b. | P.A. |
| M D | | | | ° | h m | m | m | ° | h m | m | m | ° | h m | m | m | ° |
| JAN 2 | 3280 | 7.4 | DD | 52 | | | | | | | | | 17 16.4 | | | 6 |
| JAN 3 | 3431 | 6.6 | DD | 66 | 19 6.3 | | | 6 | | | | | | | | |
| JAN 5 | SATURN | 0.7 | DD | 88 | | | | | | | | | 10 21.4 | 0.0 | 2.0 | 24 |
| JAN 5 | SATURN | 0.7 | RB | 88 | | | | | 11 10.5 | -0.5 | -0.5 | 260 | 11 3.7 | -0.8 | -1.8 | 293 |
| JAN 7 | 454 | 5.8 | DD | 121 | 23 23.3 | -0.2 | -0.8 | 138 | | | | | | | | |
| JAN 19 | 1821 | 2.9 | DB | 251 | | | | | 1 43.0 | -1.5 | -2.9 | 148 | 1 29.7 | -2.5 | -1.7 | 119 |
| JAN 19 | 1821 | 2.9 | RD | 252 | | | | | 3 11.0 | -3.2 | -0.2 | 275 | 3 11.1 | -2.5 | -1.8 | 306 |
| JAN 19 | 1921 | 5.9 | RD | 261 | | | | | | | | | 23 37.6 | | | 232 |
| JAN 21 | 2133 | 5.6 | RD | 283 | | | | | 23 42.6 | -0.3 | -1.1 | 277 | 23 32.4 | -0.1 | -1.5 | 302 |
| JAN 22 | 2137 | 6.4 | RD | 283 | 0 13.0 | 0.3 | -3.0 | 340 | | | | | | | | |
| FEB 2 | 269 | 7.3 | DD | 74 | | | | | 18 16.8 | -1.6 | 0.5 | 99 | 18 27.8 | -1.3 | 1.1 | 77 |
| FEB 6 | 832 | 4.7 | DD | 125 | | | | | 18 39.9 | | | 151 | 18 28.4 | -3.2 | -1.3 | 116 |
| FEB 6 | 836 | 5.5 | DD | 126 | | | | | | | | | 19 38.9 | -2.5 | -2.7 | 139 |
| FEB 7 | 1006 | 6.9 | DD | 139 | 22 38.7 | -2.7 | 3.5 | 40 | | | | | | | | |
| MAR 1 | 219 | 5.1 | DD | 43 | 18 38.4 | | | 156 | | | | | | | | |
| MAR 2 | 352 | 7.3 | DD | 56 | | | | | | | | | 17 10.6 | -1.4 | 1.2 | 72 |
| MAR 2 | 354 | 5.5 | DD | 56 | | | | | 17 37.0 | -1.1 | 2.6 | 34 | | | | |
| MAR 2 | 360 | 6.8 | DD | 56 | 18 5.6 | -1.1 | 1.0 | 92 | 18 23.7 | -0.8 | 1.3 | 72 | 18 39.3 | -0.7 | 2.0 | 46 |
| MAR 4 | 636 | 6.9 | DD | 82 | | | | | 18 12.2 | | | 156 | 18 2.0 | -1.9 | -0.6 | 115 |
| MAR 4 | 650 | 5.7 | DD | 83 | 19 40.8 | -0.9 | -0.6 | 134 | 19 49.7 | -0.8 | 0.5 | 102 | 19 58.9 | -0.9 | 1.1 | 75 |
| MAR 5 | 787 | 7.5 | DD | 95 | | | | | 17 42.8 | -2.5 | 0.1 | 99 | 17 54.8 | -2.7 | 1.0 | 75 |
| MAR 6 | 947 | 5.2 | DD | 108 | 18 40.1 | -2.3 | -0.5 | 115 | 19 2.5 | -2.4 | 0.5 | 91 | 19 18.7 | -2.8 | 1.7 | 63 |
| MAR 8 | 1207 | 5.8 | DD | 130 | | | | | | | | | 17 36.3 | -2.8 | -3.2 | 143 |
| MAR 9 | 1323 | 6.3 | DD | 141 | | | | | 17 0.1 | | | 178 | | | | |
| MAR 9 | 1336 | 5.2 | DD | 143 | 20 40.4 | -2.4 | -0.4 | 103 | 21 11.4 | -3.4 | 1.8 | 67 | | | | |
| MAR 11 | 1547 | 3.9 | DD | 165 | 19 28.3 | -1.4 | -2.8 | 148 | 19 27.4 | -2.1 | -1.8 | 121 | 19 23.5 | -2.8 | -0.7 | 96 |
| MAR 15 | 1950 | 5.8 | RD | 209 | 20 22.2 | -0.7 | -1.4 | 276 | 20 17.5 | -0.9 | -1.9 | 302 | 20 0.5 | -0.5 | -2.8 | 329 |
| MAR 17 | 2072 | 6.7 | DD | 222 | | | | | 1 23.3 | | | 198 | | | | |
| MAR 20 | 2433 | 6.5 | RD | 255 | 0 52.6 | -1.0 | -2.4 | 310 | | | | | | | | |
| MAR 24 | 3015 | 5.3 | RD | 304 | 2 2.7 | 0.1 | -2.6 | 310 | | | | | | | | |
| MAR 26 | 3322 | 6.4 | RD | 332 | 3 44.7 | -0.2 | -1.7 | 289 | | | | | | | | |
| APR 2 | 904 | 7.1 | DD | 78 | | | | | 19 50.9 | 0.3 | -1.9 | 152 | 19 44.6 | -0.5 | -0.2 | 114 |
| APR 6 | 1413 | 6.7 | DD | 126 | | | | | | | | | 22 33.3 | -0.3 | -1.7 | 148 |
| APR 10 | 1821 | 2.9 | DD | 169 | 23 2.5 | -0.8 | -3.5 | 167 | 23 1.3 | -2.1 | -1.1 | 124 | 23 5.2 | -3.0 | 0.4 | 91 |
| APR 11 | 1821 | 2.9 | RB | 170 | 0 3.0 | -2.9 | 2.2 | 251 | 0 30.0 | -1.6 | -0.1 | 292 | 0 25.6 | -1.2 | -2.1 | 325 |
| APR 18 | 2680 | 5.8 | RD | 250 | | | | | 3 3.9 | -2.8 | 2.1 | 236 | 3 22.4 | -3.0 | 0.3 | 267 |
| APR 18 | 2686 | 5.2 | RD | 250 | 3 39.8 | -2.5 | -0.5 | 281 | 3 56.6 | -3.1 | -2.3 | 310 | | | | |
| APR 19 | 2826 | 4.0 | RD | 260 | 0 37.9 | -1.2 | -0.8 | 262 | 0 40.1 | -1.4 | -2.0 | 296 | 0 11.6 | | | 347 |
| APR 19 | 2828 | 6.0 | RD | 260 | | | | | | | | | 0 35.0 | -2.6 | 2.7 | 219 |
| APR 21 | 3112 | 6.2 | RD | 286 | 2 45.1 | -1.1 | -4.2 | 316 | | | | | | | | |
| APR 23 | VENUS | -4.2 | DB | 315 | | | | | 6 59.4 | | | 132 | 6 54.0 | -3.7 | -0.5 | 96 |
| APR 23 | VENUS | -4.2 | RD | 315 | | | | | 7 28.1 | | | 168 | 8 10.5 | -1.2 | 3.5 | 202 |
| APR 29 | 832 | 4.7 | DD | 45 | | | | | | | | | 17 46.9 | 0.0 | -1.2 | 137 |
| MAY 1 | 1130 | 7.2 | DD | 70 | 17 19.3 | | | 28 | | | | | | | | |
| MAY 2 | 1260 | 7.0 | DD | 83 | 18 50.1 | | | 47 | | | | | | | | |
| MAY 2 | 1262 | 6.2 | DD | 83 | 19 24.9 | -2.1 | 2.3 | 64 | | | | | | | | |
| MAY 3 | 1371 | 6.4 | DD | 93 | | | | | 16 6.0 | | | 42 | | | | |
| MAY 4 | 1476 | 7.0 | DD | 105 | 17 26.9 | -2.3 | -1.1 | 115 | 17 50.6 | -3.4 | 0.7 | 81 | | | | |
| MAY 13 | 2372 | 4.4 | RD | 198 | 3 23.4 | -1.2 | 1.5 | 260 | 3 41.4 | -0.9 | 0.5 | 280 | 3 42.9 | -1.2 | -1.1 | 309 |
| MAY 14 | 2495 | 6.0 | RD | 208 | 0 36.2 | -2.0 | -4.1 | 331 | | | | | | | | |

| | | | | | CAPE TOWN E 18.5 S 33.9 | | | | JOHANNESBURG E 28.1 S 26.2 | | | | HARARE E 31.0 S 17.8 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | I.C. | Mag. | Ph | ELG | UT | a. | b. | P.A. | UT | a. | b. | P.A. | UT | a. | b. | P.A. |
| M D | | | | ° | h m | m | m | ° | h m | m | m | ° | h m | m | m | ° |
| MAY 15 | 2640 | 6.1 | RD | 220 | 2 22.8 | -2.4 | 0.5 | 268 | 2 46.6 | -2.5 | -0.5 | 291 | 2 37.5 | | | 331 |
| MAY 15 | 2647 | 6.4 | RD | 221 | 3 32.9 | -2.5 | -1.5 | 311 | | | | | | | | |
| MAY 15 | 2653 | 6.4 | RD | 221 | 4 30.3 | -1.5 | 1.2 | 265 | | | | | | | | |
| MAY 15 | 2764 | 6.3 | RD | 229 | | | | | 19 50.4 | -0.9 | 1.4 | 219 | 19 55.5 | -0.4 | -0.2 | 256 |
| MAY 16 | 2787 | 6.4 | RD | 231 | | | | | | | | | 0 30.9 | -3.0 | 1.5 | 241 |
| MAY 18 | 3066 | 6.0 | RD | 255 | 0 46.6 | | | 329 | | | | | | | | |
| MAY 20 | 3353 | 3.8 | RD | 282 | 3 5.2 | | | 189 | 3 37.4 | -1.6 | 2.1 | 215 | | | | |
| MAY 20 | 3360 | 6.3 | RD | 283 | 4 48.5 | -1.7 | 1.3 | 229 | | | | | | | | |
| MAY 27 | 913 | 5.2 | DD | 25 | 15 59.9 | -1.4 | 1.7 | 66 | | | | | | | | |
| MAY 29 | 1203 | 7.1 | DD | 51 | 16 34.6 | -2.3 | 1.8 | 66 | | | | | | | | |
| MAY 30 | 1337 | 5.6 | DD | 64 | 18 26.8 | -0.9 | -0.1 | 123 | 18 40.2 | -1.1 | 1.1 | 85 | 19 7.3 | | | 29 |
| MAY 30 | 1336 | 5.2 | DD | 64 | | | | | 18 46.2 | -0.1 | -1.4 | 149 | 18 41.1 | -0.6 | -0.2 | 114 |
| JUN 2 | 1644 | 4.1 | DD | 97 | | | | | 16 2.1 | -2.9 | -0.8 | 101 | 16 15.1 | -5.1 | 2.1 | 65 |
| JUN 3 | 1749 | 6.1 | DD | 109 | 18 8.5 | -2.4 | -0.9 | 111 | 18 40.7 | -4.2 | 2.6 | 66 | | | | |
| JUN 4 | 1864 | 6.8 | DD | 121 | | | | | 22 17.6 | -0.5 | -3.7 | 170 | 22 3.7 | -1.0 | -1.0 | 129 |
| JUN 5 | 1976 | 6.9 | DD | 133 | 23 49.7 | -0.8 | -0.6 | 135 | 23 56.0 | -0.6 | 0.4 | 106 | 24 4.3 | -0.3 | 1.4 | 74 |
| JUN 6 | 1978 | 6.6 | DD | 133 | 0 30.7 | -0.6 | -1.4 | 151 | | | | | | | | |
| JUN 13 | 3019 | 5.9 | RD | 225 | | | | | 22 4.8 | -1.8 | 2.1 | 216 | 22 18.9 | -2.0 | 0.3 | 252 |
| JUN 17 | 3461 | 6.4 | RD | 265 | 1 28.3 | -1.4 | -1.0 | 269 | 1 35.2 | -2.5 | -2.2 | 292 | | | | |
| JUN 18 | 55 | 6.4 | RD | 279 | | | | | 2 54.6 | | | 181 | 3 23.2 | -1.5 | 2.3 | 212 |
| JUN 20 | 327 | 4.5 | RD | 305 | | | | | 1 16.4 | -0.2 | 0.1 | 242 | 1 15.3 | -0.5 | -0.6 | 270 |
| JUN 27 | 1396 | 7.1 | DD | 44 | 16 50.9 | -1.3 | 0.5 | 104 | 17 15.4 | -1.7 | 2.7 | 60 | | | | |
| JUN 28 | 1487 | 1.3 | DD | 53 | 10 10.4 | -0.9 | -1.6 | 105 | 10 11.1 | -1.3 | -0.9 | 88 | 10 14.1 | -1.7 | 0.8 | 61 |
| JUN 28 | 1487 | 1.3 | RB | 53 | 11 25.8 | -1.5 | -1.5 | 285 | 11 29.4 | -1.9 | -2.0 | 306 | 11 13.0 | -1.8 | -3.6 | 334 |
| JUN 29 | 1609 | 4.7 | DD | 67 | 16 41.7 | -1.1 | -2.0 | 153 | 16 47.6 | -1.9 | -0.4 | 114 | 16 57.2 | -2.8 | 1.3 | 79 |
| JUL 2 | 1923 | 7.1 | DD | 101 | 17 39.8 | -2.4 | -0.7 | 108 | 18 15.7 | -4.2 | 3.6 | 60 | | | | |
| JUL 3 | 2035 | 7.1 | DD | 113 | 20 16.1 | -1.8 | -1.0 | 129 | 20 32.8 | -1.8 | 0.7 | 94 | 20 52.9 | -1.9 | 3.5 | 55 |
| JUL 3 | 2043 | 6.6 | DD | 114 | 23 6.9 | | | 171 | 22 59.9 | -0.5 | -0.7 | 134 | | | | |
| JUL 4 | 2133 | 5.6 | DD | 122 | 17 11.0 | -1.4 | -2.5 | 138 | 17 16.4 | -2.7 | -0.9 | 101 | 17 29.1 | -4.9 | 2.4 | 62 |
| JUL 6 | 2279 | 6.2 | DD | 137 | 0 42.3 | -0.5 | 1.3 | 86 | | | | | | | | |
| JUL 14 | 3412 | 4.4 | RD | 236 | 0 10.4 | -1.6 | -0.1 | 251 | 0 28.1 | -2.5 | -0.4 | 268 | 0 26.2 | -4.0 | -3.0 | 300 |
| JUL 25 | 1466m | 5.2 | DD | 26 | 16 33.5 | -0.9 | 1.0 | 94 | 16 59.5 | | | 43 | | | | |
| JUL 30 | 2005 | 7.0 | DD | 83 | 21 20.9 | -0.3 | 2.8 | 59 | | | | | | | | |
| JUL 31 | 2089 | 6.8 | DD | 93 | | | | | | | | | 17 50.7 | -1.5 | -4.6 | 164 |
| AUG 3 | 2460 | 6.1 | DD | 126 | 16 42.3 | -1.3 | -2.3 | 126 | 16 48.9 | -2.5 | -0.5 | 89 | 17 5.2 | -4.2 | 3.2 | 50 |
| AUG 3 | 2485 | 7.4 | DD | 129 | 22 37.2 | -1.7 | -0.6 | 127 | 22 49.6 | -1.1 | 0.3 | 107 | 22 57.4 | -0.7 | 0.9 | 82 |
| AUG 4 | 2495 | 6.0 | DD | 129 | 0 13.8 | -0.5 | 1.1 | 90 | 0 25.1 | 0.0 | 1.3 | 75 | | | | |
| AUG 5 | 2640 | 6.1 | DD | 142 | 1 5.2 | -0.9 | 0.0 | 123 | 1 12.1 | -0.3 | 0.3 | 109 | | | | |
| AUG 5 | 2647 | 6.4 | DD | 142 | 1 55.2 | -0.1 | 1.1 | 87 | | | | | | | | |
| AUG 5 | 2764 | 6.3 | DD | 150 | 17 33.8 | -1.3 | -1.2 | 96 | 17 47.7 | -2.3 | 0.8 | 61 | | | | |
| AUG 5 | 2787 | 6.4 | DD | 153 | | | | | 23 9.4 | | | 140 | 23 7.4 | -2.0 | -0.2 | 106 |
| AUG 9 | 3353 | 3.8 | RD | 204 | 21 16.3 | | | 333 | | | | | | | | |
| AUG 10 | 3379 | 6.4 | RD | 207 | 2 56.1 | -0.7 | 2.9 | 204 | 3 23.0 | -0.6 | 2.5 | 212 | | | | |
| AUG 10 | 3383 | 6.5 | RD | 208 | 3 59.7 | -1.3 | 0.9 | 275 | | | | | | | | |
| AUG 14 | 401 | 6.3 | RD | 260 | | | | | 1 34.9 | | | 174 | 2 5.4 | -1.3 | 2.5 | 207 |
| AUG 17 | 832 | 4.7 | RD | 299 | | | | | | | | | 1 7.1 | -0.4 | 0.2 | 245 |
| AUG 17 | 836 | 5.5 | RD | 299 | | | | | | | | | 1 35.0 | -0.1 | 1.6 | 214 |
| AUG 26 | 1950 | 5.8 | DD | 51 | | | | | 16 14.9 | -1.5 | -1.3 | 135 | 16 14.9 | -1.9 | 0.0 | 102 |
| SEP 2 | 2865 | 5.9 | DD | 133 | | | | | 21 42.1 | | | 158 | 21 30.0 | -2.4 | -0.6 | 112 |
| SEP 2 | 2865 | 5.9 | RD | 133 | | | | | 21 52.4 | | | 173 | | | | |

| | | | | | CAPE TOWN E 18.5 S 33.9 | | | | JOHANNESBURG E 28.1 S 26.2 | | | | HARARE E 31.0 S 17.8 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE M D | I.C. | Mag. | Ph | ELG ° | 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. ° |
| SEP 12 | 650 | 5.7 | RD | 258 | 2 59.4 | -1.2 | 2.1 | 205 | 3 31.8 | -2.1 | 2.1 | 219 | | | | |
| SEP 14 | 947 | 5.2 | RD | 282 | | | | | | | | | 0 25.7 | -0.3 | 0.9 | 228 |
| SEP 18 | 1487 | 1.3 | DB | 335 | 11 14.1 | -2.3 | 1.4 | 80 | | | | | | | | |
| SEP 18 | 1487 | 1.3 | RD | 335 | 12 18.3 | -0.5 | -1.3 | 331 | | | | | | | | |
| SEP 24 | 2133 | 5.6 | DD | 44 | 18 4.2 | -0.8 | 0.1 | 119 | 18 13.2 | -0.3 | 0.7 | 96 | 18 23.2 | 0.0 | 1.6 | 65 |
| SEP 25 | 2240 | 6.8 | DD | 55 | | | | | 16 35.0 | -1.7 | 4.6 | 45 | | | | |
| SEP 26 | 2372 | 4.4 | DD | 66 | | | | | 17 5.0 | -2.0 | -0.5 | 117 | 17 12.1 | -1.8 | 0.8 | 87 |
| SEP 27 | 2508 | 6.3 | DD | 78 | | | | | | | | | 19 23.1 | | | 154 |
| SEP 28 | 2640 | 6.1 | DD | 89 | 17 29.0 | -2.3 | 1.7 | 66 | 18 8.7 | -1.5 | 3.7 | 40 | | | | |
| SEP 28 | 2649 | 6.6 | DD | 89 | 19 3.4 | -1.9 | 0.3 | 104 | 19 24.8 | -1.4 | 1.0 | 87 | 19 39.4 | -0.8 | 1.7 | 63 |
| SEP 28 | 2653 | 6.4 | DD | 89 | 19 38.6 | -1.2 | 1.9 | 67 | 20 3.7 | -0.5 | 2.4 | 51 | 20 31.0 | | | 15 |
| SEP 28 | 2658 | 5.4 | DD | 90 | 21 25.6 | | | 153 | 21 27.2 | -0.8 | -0.6 | 130 | 21 27.5 | -0.3 | 0.2 | 103 |
| SEP 29 | 2787 | 6.4 | DD | 99 | | | | | | | | | 16 18.0 | -3.0 | 1.7 | 60 |
| SEP 29 | 2794 | 6.7 | DD | 100 | | | | | | | | | 17 32.7 | -3.4 | -1.8 | 120 |
| OCT 3 | 3379 | 6.4 | DD | 153 | 21 52.9 | -2.3 | 0.4 | 90 | 22 18.9 | -2.0 | 0.9 | 83 | 22 33.9 | -1.6 | 1.4 | 64 |
| OCT 3 | 3383 | 6.5 | DD | 154 | 23 3.0 | -0.7 | 2.8 | 23 | 23 31.9 | -0.2 | 3.4 | 14 | | | | |
| OCT 11 | 913 | 5.2 | RD | 254 | 3 40.2 | -2.3 | 0.7 | 248 | | | | | | | | |
| OCT 15 | 1434 | 5.6 | RD | 302 | 3 21.2 | | | 347 | | | | | | | | |
| OCT 24 | 2460 | 6.1 | DD | 47 | | | | | 18 8.7 | | | 8 | | | | |
| OCT 25 | 2596 | 7.3 | DD | 59 | | | | | | | | | 19 19.5 | -1.2 | -2.1 | 143 |
| OCT 26 | 2745 | 6.9 | DD | 70 | 18 19.5 | -0.5 | 4.0 | 29 | 18 59.0 | | | 358 | | | | |
| OCT 26 | 2755 | 6.6 | DD | 71 | 19 49.6 | -0.6 | 1.4 | 80 | 20 4.1 | -0.1 | 1.4 | 69 | | | | |
| OCT 28 | 3019 | 5.9 | DD | 93 | 17 44.2 | -2.2 | 1.1 | 74 | 18 14.9 | -1.8 | 1.8 | 61 | 18 37.9 | -1.1 | 2.7 | 39 |
| OCT 28 | 3029 | 6.9 | DD | 95 | 20 44.2 | -1.1 | 1.2 | 87 | 21 1.3 | -0.6 | 1.2 | 79 | 21 13.6 | -0.2 | 1.5 | 59 |
| OCT 31 | JUPITER | -2.8 | DD | 129 | 14 24.0 | -0.4 | -0.7 | 80 | 14 28.8 | -0.8 | 0.5 | 52 | 14 45.0 | -0.8 | 3.4 | 14 |
| OCT 31 | JUPITER | -2.8 | RB | 130 | 15 26.1 | -0.9 | -0.1 | 243 | 15 34.3 | -1.5 | -0.7 | 266 | 15 27.0 | -2.1 | -2.9 | 302 |
| OCT 31 | 3461 | 6.4 | DD | 133 | 20 47.6 | -0.7 | 3.3 | 14 | 21 20.0 | -0.1 | 4.1 | 5 | | | | |
| OCT 31 | 3472 | 7.1 | DD | 134 | 22 44.9 | -1.4 | 1.0 | 90 | 23 4.4 | -0.9 | 1.1 | 81 | 23 17.2 | -0.6 | 1.4 | 62 |
| NOV 1 | 55 | 6.4 | DD | 147 | 20 40.4 | -3.0 | -1.0 | 110 | 21 4.5 | -2.9 | -0.2 | 103 | 21 14.8 | -2.4 | 0.7 | 81 |
| NOV 3 | 219 | 5.1 | DD | 162 | 0 43.4 | -0.7 | 3.2 | 14 | | | | | | | | |
| NOV 6 | 684 | 6.2 | RD | 207 | 1 43.9 | -2.2 | -1.2 | 312 | | | | | | | | |
| NOV 23 | 2865 | 5.9 | DD | 52 | 20 11.3 | 0.0 | 1.1 | 86 | | | | | | | | |
| NOV 26 | 3253 | 5.4 | DD | 86 | | | | | 17 0.9 | -3.8 | -1.7 | 118 | 17 6.6 | -2.9 | 0.3 | 91 |
| NOV 26 | 3255 | 7.4 | DD | 87 | | | | | 18 16.5 | -1.4 | 2.0 | 54 | 18 39.0 | -0.8 | 2.6 | 34 |
| NOV 27 | 3412 | 4.4 | DD | 102 | 22 58.4 | -0.2 | 1.5 | 66 | | | | | | | | |
| DEC 4 | 915 | 4.7 | RD | 199 | 23 6.1 | -2.1 | -0.1 | 263 | 23 27.5 | -2.5 | -0.2 | 278 | 23 29.3 | -2.8 | -1.4 | 303 |
| DEC 6 | 1217 | 6.1 | RD | 225 | 22 23.1 | -1.2 | -0.9 | 265 | 22 30.3 | -1.8 | -1.0 | 278 | 22 25.1 | -2.2 | -1.8 | 301 |
| DEC 9 | 1487 | 1.3 | DB | 254 | | | | | 7 28.5 | | | 176 | 7 13.6 | -0.4 | -0.9 | 133 |
| DEC 9 | 1487 | 1.3 | RD | 254 | | | | | 7 58.1 | | | 230 | | | | |
| DEC 28 | 362 | 6.5 | DD | 121 | | | | | 18 39.8 | -1.3 | 2.7 | 23 | 19 18.8 | | | 348 |
| DEC 30 | 650 | 5.7 | DD | 147 | | | | | | | | | 16 56.0 | -2.2 | -1.3 | 107 |
| DEC 30 | 684 | 6.2 | DD | 150 | 23 2.4 | -1.8 | 3.1 | 26 | | | | | | | | |

# GRAZING OCCULTATIONS

When a star moves tangentially to the limb of the Moon, and is occulted for a very short period only - a few minutes, or even seconds - a grazing occultation is said to occur. Because the limb, as seen from the Earth, is in fact the outline of numerous mountains and valleys, there may be several disappearances and reappearances, which are not only fascinating to observe, but which may be accurately timed to yield valuable data on the relative positions of star and Moon, as well as on the shape of the Moon. Some of this data cannot readily be obtained in any other way.

The maps on the following pages have been prepared by the Hydrographic Dept., Tokyo to show the tracks of stars brighter than 7.5 magnitude which will graze the limb of the Moon when it is at a favourable elongation from the Sun and at least 10° above the observer's horizon (2° in the case of bright stars). Each track starts in the west at some arbitrary time given in the key and ends beyond the area of interest, except where the Moon is at a low altitude, the bright limb or sunlight interferes.

The tracks as shown on the maps are approximate only. Since the observer's location is very critical, successful observations call for very accurate predictions. Such predictions, which include graphical representations of the probable profile of the Moon, are computed annually for a number of centres in Southern Africa. By plotting the predicted graze track on a reliable survey map (e.g.South African 1:50 000 series) it is usually possible to select a convenient site from where the graze may be observed. Ideally a team of observers would be stationed at intervals along a line running at right angles to the graze track - say,along a main road - each with his own telescope and timing equipment. Each observer will see a different sequence of events, the combined results forming an accurate picture of the limb of the Moon.

The equipment needed is similar to that used for ordinary or "total" occultations, but must, of course, be portable. A 75 mm refractor is ideal for average events, but instruments with a larger aperture have often shown their superiority under difficult conditions. Timing is best carried out with a portable tape recorder and a small FM radio tuned to a pre-arranged transmission.

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

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

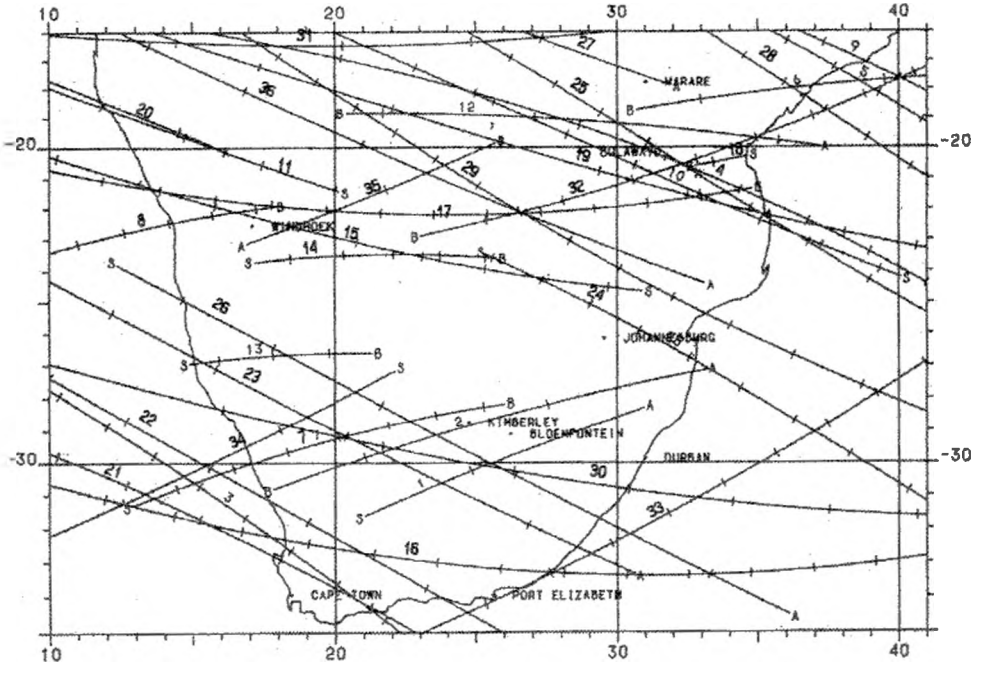
Mr.M.D. Overbeek, P.O. Box 212, Edenvale, 1610. Tel: (011) 453 6918

EXPLANATION OF THE COLUMN HEADINGS IN THE TABLES:

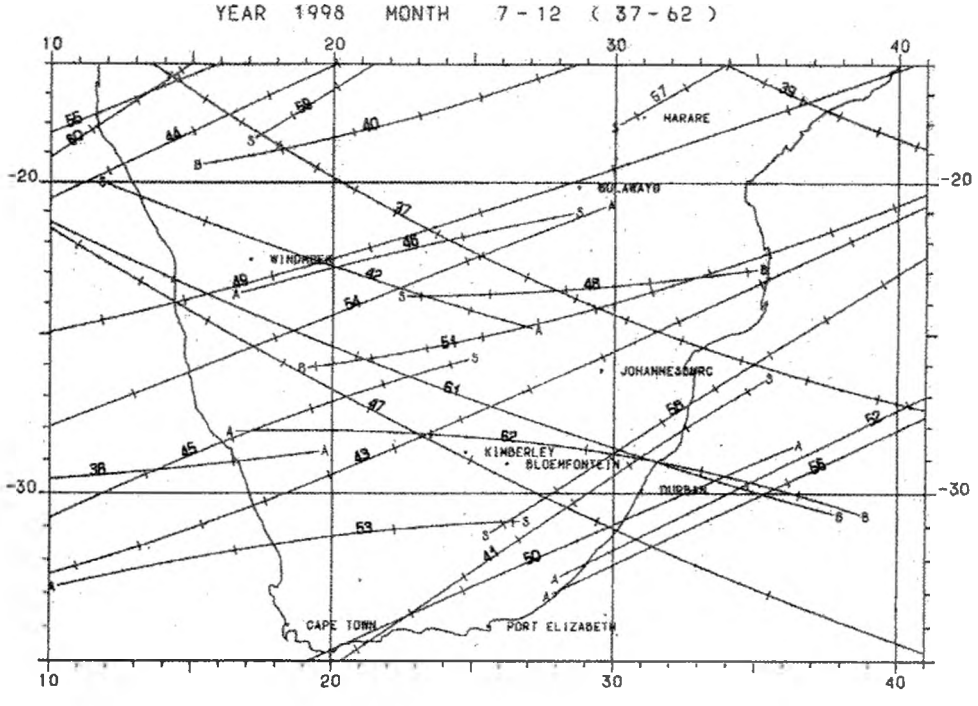
| | |
|---|---|
| SEQ | : Sequential number in the year. The same number is attached to the corresponding track on the map. |
| NZC NO | : Zodiacal Catalogue number of the star. |
| MAG | : Magnitude of the star. |
| MON, DAY, H, M, S | : Month, day, hour, minute and second in SAST for the west end of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

The map gives the graze tracks or the limits of occultations. Along each track on the map tick marks are given for the points corresponding to the multiples of five minutes of every hour, while the prediction for the west end of each track is shown 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 1998 MONTH 1 - 6 ( 1 - 36 )




| SEQ | NZC NO | MAG | MON | DAY | H | M | S | SUNLIT(%) | LIMIT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3137 | 6.65 | 1 | 1 | 20 | 12 | 17.89 | 11.15 | N | (S) | (A) |
| 2 | 3431 | 6.60 | 1 | 3 | 21 | 26 | 40.73 | 29.72 | N | (B) | (A) |
| 3 | 1821 | 2.91 | 1 | 19 | 3 | 48 | 56.90 | -65.92 | S | ( ) | ( ) |
| 4 | 1921 | 5.94 | 1 | 20 | 1 | 6 | 36.38 | -57.40 | S | ( ) | ( ) |
| 5 | 1924 | 5.76 | 1 | 20 | 2 | 28 | 19.07 | -57.12 | S | ( ) | ( ) |
| 6 | 109 | 6.51 | 2 | 1 | 20 | 2 | 41.69 | 25.31 | N | (B) | ( ) |
| 7 | 832 | 4.73 | 2 | 6 | 20 | 16 | 16.83 | 79.02 | S | (S) | (B) |
| 8 | 836 | 5.50 | 2 | 6 | 21 | 2 | 0.67 | 79.21 | S | ( ) | (B) |
| 9 | 2089 | 6.78 | 2 | 18 | 0 | 23 | 29.47 | -65.63 | S | ( ) | ( ) |
| 10 | 2485 | 7.42 | 2 | 21 | 4 | 5 | 21.91 | -35.02 | S | ( ) | (S) |
| 11 | 2640 | 6.08 | 2 | 22 | 5 | 52 | 8.91 | -24.77 | S | ( ) | (S) |
| 12 | 354 | 5.53 | 3 | 2 | 20 | 3 | 35.15 | 21.65 | N | (B) | (A) |
| 13 | 636 | 6.86 | 3 | 4 | 19 | 52 | 11.40 | 43.05 | S | (S) | (B) |
| 14 | 1207 | 5.79 | 3 | 8 | 19 | 36 | 47.33 | 82.62 | S | (S) | (B) |
| 15 | 2731 | 6.46 | 3 | 22 | 4 | 54 | 33.27 | -41.04 | S | ( ) | (S) |
| 16 | 2680 | 5.76 | 4 | 18 | 3 | 46 | 7.46 | -67.54 | S | ( ) | ( ) |
| 17 | 2685 | 6.98 | 4 | 18 | 4 | 25 | 30.07 | -67.37 | S | ( ) | (B) |
| 18 | 2686 | 5.17 | 4 | 18 | 5 | 38 | 0.74 | -67.43 | N | (B) | (S) |
| 19 | 2828 | 6.02 | 4 | 19 | 1 | 51 | 44.43 | -57 99 | S | ( ) | ( ) |
| 20 | 1006 | 6.88 | 4 | 30 | 21 | 37 | 23.10 | 23.44 | N | ( ) | (A) |
| 21 | 1130 | 7.18 | 5 | 1 | 19 | 14 | 22.64 | 32.55 | N | ( ) | ( ) |
| 22 | 1260 | 7.04 | 5 | 2 | 20 | 54 | 55.88 | 43.14 | N | ( ) | ( ) |
| 23 | 1262 | 6.18 | 5 | 2 | 21 | 41 | 34.32 | 43.34 | N | ( ) | (A) |
| 24 | 1371 | 6.40 | 5 | 3 | 18 | 14 | 21.94 | 52.52 | N | (S) | ( ) |
| 25 | 1476 | 7.04 | 5 | 4 | 20 | 10 | 2.01 | 62.78 | N | ( ) | ( ) |
| 26 | 1203 | 7.13 | 5 | 29 | 18 | 55 | 58.26 | 18.11 | N | (S) | (A) |
| 27 | 1337 | 5.64 | 5 | 30 | 21 | 9 | 35.40 | 27.39 | N | ( ) | (A) |
| 28 | 1644 | 4.13 | 6 | 2 | 18 | 45 | 12.40 | 55.81 | N | ( ) | ( ) |
| 29 | 1749 | 6.13 | 6 | 3 | 20 | 25 | 8.75 | 65.78 | N | ( ) | ( ) |
| 30 | 3019 | 5.91 | 6 | 13 | 23 | 25 | 48.82 | -84.88 | S | ( ) | ( ) |
| 31 | 3313 | 6.78 | 6 | 16 | 1 | 27 | 8.33 | -65.47 | S | ( ) | ( ) |
| 32 | 3461 | 6.40 | 6 | 17 | 3 | 1 | 4.74 | -53.88 | N | (B) | ( ) |
| 33 | 3465 | 6.50 | 6 | 17 | 4 | 30 | 22.83 | -53.37 | N | ( ) | ( ) |
| 34 | 475 | 7.42 | 6 | 21 | 6 | 43 | 8.28 | -11.19 | N | ( ) | (S) |
| 35 | 627 | 6.84 | 6 | 22 | 6 | 23 | 8.57 | -5.00 | S | (A) | (S) |
| 36 | 1396 | 7.06 | 6 | 27 | 19 | 18 | 23.55 | 13.78 | N | ( ) | (A) |




| SEQ | NZC NO | MAG | MON | DAY | H | M | S | SUNLIT(%) | LIMIT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | 1923 | 7.07 | 7 | 2 | 19 | 47 | 34.08 | 59.01 | N | ( ) | ( ) |
| 38 | 2047 | 6.69 | 7 | 4 | 1 | 42 | 6.11 | 69.60 | S | ( ) | (A) |
| 39 | 2133 | 5.63 | 7 | 4 | 20 | 4 | 42.53 | 76.75 | N | ( ) | ( ) |
| 40 | 3412 | 4.40 | 7 | 14 | 1 | 30 | 5.62 | -78.11 | N | (B) | ( ) |
| 41 | 3430 | 5.71 | 7 | 14 | 5 | 23 | 24.74 | -77.12 | N | ( ) | (S) |
| 42 | 1466m | 5.18 | 7 | 25 | 19 | 2 | 4.94 | 4.56 | N | (S) | (A) |
| 43 | 2865 | 5.87 | 9 | 2 | 23 | 7 | 52.45 | 83.90 | S | ( ) | ( ) |
| 44 | 800 | 7.50 | 9 | 13 | 4 | 16 | 54.44 | -49.24 | N | ( ) | ( ) |
| 45 | 971 | 7.30 | 9 | 14 | 5 | 30 | 12.36 | -37.92 | N | ( ) | (S) |
| 46 | 1354 | 7.27 | 9 | 17 | 5 | 30 | 33.42 | -11.52 | N | (A) | (S) |
| 47 | 1487 | 1.34 | 9 | 18 | 13 | 27 | 37.52 | -4.92 | N | ( ) | ( ) |
| 48 | 2240 | 6.83 | 9 | 25 | 18 | 48 | 58.18 | 20.59 | N | (S) | (B) |
| 49 | 2508 | 6.29 | 9 | 27 | 21 | 6 | 38.82 | 38.81 | S | ( ) | ( ) |
| 50 | 2658 | 5.40 | 9 | 28 | 23 | 35 | 52.85 | 49.49 | S | ( ) | (A) |
| 51 | 2794 | 6.70 | 9 | 29 | 19 | 34 | 19.07 | 58.55 | S | (B) | ( ) |
| 52 | 895 | 5.89 | 10 | 11 | 0 | 31 | 17.39 | -65.87 | N | (A) | ( ) |
| 53 | 1434 | 5.62 | 10 | 15 | 4 | 56 | 23.89 | -23.51 | N | (A) | (S) |
| 54 | 2596 | 7.28 | 10 | 25 | 21 | 16 | 31.71 | 23.70 | S | ( ) | (A) |
| 55 | 2758 | 7.03 | 10 | 26 | 23 | 7 | 16.43 | 33.14 | S | ( ) | ( ) |
| 56 | 995 | 4.06 | 11 | 7 | 22 | 51 | 53.37 | -81.00 | N | (A) | ( ) |
| 57 | 3108 | 5.50 | 11 | 25 | 18 | 28 | 22.04 | 35.74 | S | (S) | ( ) |
| 58 | 3253 | 5.40 | 11 | 26 | 19 | 13 | 51.62 | 46.68 | S | (S) | ( ) |
| 59 | 3388 | 5.56 | 11 | 27 | 19 | 36 | 2.05 | 57.89 | S | (S) | ( ) |
| 60 | 3537 | 6.85 | 11 | 28 | 21 | 25 | 25.52 | 69.48 | S | ( ) | ( ) |
| 61 | 1487 | 1.34 | 12 | 9 | 9 | 30 | 20.89 | -64.81 | S | ( ) | (B) |
| 62 | 1684 | 7.04 | 12 | 11 | 2 | 11 | 8.84 | -46.92 | N | (A) | (B) |

# 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 "alt" are the approximate azimuths and altitudes as seen from Bloemfontein.

OCCULTATIONS OF STARS BY MINOR PLANETS

| Date | SAST | STAR | Mag. | RA (2000.0) | Dec | Planet | Mag. | Dur | Az | Alt |
|---|---|---|---|---|---|---|---|---|---|---|
| d | h m | | | h m s | ° ′ | | | s | | ° |
| Jan 5 | 02 34 | +25 01410 | 10.0 | 07 24 59 | +25 54 | 123 Brunhild | 11.8 | 5 | NW | 20 |
| Jan 16 | 23 38 | -03 06408 | 10.7 | 08 32 02 | -03 35 | 957 Camelia | 13.7 | 7 | NE | 40 |
| Feb 14 | 20 29 | FK5 227 | 1.9 | 05 59 32 | +44 57 | 1116 Catriona | 13.7 | 4 | N | 10 |
| Feb 15 | 03 55 | PPM 179066 | 9.9 | 13 31 10 | -02 16 | 394 Arduina | 15.1 | 14 | NE | 70 |
| Feb 16 | 02 25 | PPM 231608 | 9.5 | 16 22 21 | -13 49 | 485 Genua | 14.0 | 3 | NE | 20 |
| Feb 16 | 22 48 | PPM 224632 | 8.8 | 11 35 22 | -16 06 | 478 Tergeste | 12.5 | 10 | NE | 30 |
| Feb 17 | 03 51 | ACRS546497 | 9.4 | 18 04 14 | -24 15 | 514 Armida | 15.1 | 3 | NE | 20 |
| Feb 22 | 04 27 | PPM 198002 | 9.6 | 14 52 49 | -07 07 | 326 Tamara | 13.2 | 10 | NE | 75 |
| Feb 25 | 23 14 | TAC+09 03359 | 10.4 | 09 09 14 | +09 01 | 426 Hippo | 12.2 | 11 | N | 30 |
| Mar 20 | 19 54 | PPM 71836 | 10.2 | 06 36 06 | +31 48 | 562 Salome | 15.8 | 3 | N | 15 |
| Mar 30 | 23 30 | PPM 705352 | 9.5 | 10 49 50 | -08 54 | 584 Semiramis | 13.1 | 5 | NW | 80 |
| Apr 2 | 19 09 | PPM 96205 | 10.1 | 06 34 48 | +24 09 | 27 Euterpe | 11.1 | 6 | N | 25 |
| May 19 | 20 36 | PPM 717603 | 9.8 | 14 52 38 | -11 52 | 742 Edisona | 14.2 | 4 | NE | 30 |
| Jun 12 | 04 52 | PPM 237176 | 6.7 | 20 16 23 | -12 20 | 1127 Mimi | 15.5 | 10 | NW | 50 |
| Jun 16 | 01 45 | PPM 200662 | 9.6 | 17 26 43 | -07 07 | 18 Melpomene | 9.6 | 12 | NW | 45 |
| Jun 27 | 23 04 | PPM 236753 | 7.8 | 19 58 12 | -15 58 | 248 Lameia | 13.4 | 7 | E | 35 |
| Jun 28 | 21 58 | FK5 737 | 5.0 | 19 36 53 | -07 02 | 226 Weringia | 12.5 | 5 | NE | 25 |
| Jul 10 | 01 05 | 0593 00038 | 10.7 | 23 55 38 | +07 28 | 2 Pallas | 9.9 | 74 | NE | 15 |
| Jul 29 | 22 17 | PPM 719911 | 9.9 | 18 57 17 | -15 42 | 624 Ute | 13.6 | 7 | NE | 85 |
| Aug 11 | 23 36 | TAC-07 08489 | 10.6 | 16 26 59 | -07 26 | 6 Hebe | 10.2 | 18 | NW | 25 |
| Aug 24 | 21 34 | TAC-04 15107 | 10.8 | 21 49 15 | -04 40 | 678 Fredegund | 11.7 | 5 | NE | 40 |
| Aug 27 | 03 13 | PPM 237981 | 9.5 | 20 20 01 | -18 26 | Uranus | 5.7 | 2509 | NW | 20 |
| Aug 28 | 05 41 | 1281 01170 | 11.4 | 05 03 49 | +15 43 | 52 Europa | 11.9 | 12 | NE | 35 |
| Sep 23 | 04 32 | TAC+1901423 | 11.1 | 06 02 54 | +19 49 | 65 Cybele | 13.3 | 17 | NE | 25 |
| Sep 30 | 02 42 | PPM 121053 | 8.7 | 05 31 33 | +15 19 | 52 Europa | 11.5 | 27 | NE | 25 |
| Oct 2 | 23 02 | PPM 209269 | 9.8 | 00 46 09 | -12 49 | 286 Iclea | 13.5 | 7 | E | 70 |
| Oct 14 | 04 05 | TAC+04 01219 | 11.4 | 02 45 42 | +04 38 | 197 Arete | 12.7 | 4 | NW | 35 |
| Nov 2 | 02 25 | PPM98371 | 8.9 | 08 07 51 | +22 47 | 447 Valentine | 14.4 | 8 | NE | 15 |
| Nov 20 | 00 02 | PPM208277 | 9.5 | 00 03 12 | -15 35 | 521 Brixia | 12.1 | 12 | NW | 30 |
| Nov 23 | 22 08 | PPM 144585 | 11.1 | 01 25 03 | +06 41 | 119 Althaea | 12.1 | 15 | N | 40 |
| Dec 12 | 22 43 | TAC+18 01099 | 10.5 | 05 48 21 | +18 54 | 65 Cybele | 12.0 | 15 | NE | 25 |

SIDEREAL TIME ON THE 30° MERIDIAN

| | At 0 hrs | At 21 hrs | | At 0 hrs | At 21 hrs | | At 0 hrs | At 21 hrs |
|---|---|---|---|---|---|---|---|---|
| | h m | h m | | h m | h m | | h m | h m |
| Jan 1 | 6 41 | 3 45 | May 11 | 15 14 | 12 17 | Sep 18 | 23 47 | 20 50 |
| 11 | 7 21 | 4 24 | 21 | 15 53 | 12 57 | 28 | 0 26 | 21 29 |
| 21 | 8 0 | 5 4 | 31 | 16 33 | 13 36 | Oct 8 | 1 5 | 22 9 |
| 31 | 8 40 | 5 43 | Jun 10 | 17 12 | 14 16 | 18 | 1 45 | 22 48 |
| Feb 10 | 9 19 | 6 23 | 20 | 17 52 | 14 55 | 28 | 2 24 | 23 28 |
| 20 | 9 59 | 7 2 | 30 | 18 31 | 15 35 | Nov 7 | 3 4 | 0 7 |
| Mar 2 | 10 38 | 7 41 | Jul 10 | 19 11 | 16 14 | 17 | 3 43 | 0 47 |
| 12 | 11 17 | 8 21 | 20 | 19 50 | 16 53 | 27 | 4 22 | 1 26 |
| 22 | 11 57 | 9 0 | 30 | 20 29 | 17 33 | Dec 7 | 5 2 | 2 5 |
| Apr 1 | 12 36 | 9 40 | Aug 9 | 21 9 | 18 12 | 17 | 5 41 | 2 45 |
| 11 | 13 16 | 10 19 | 19 | 21 48 | 18 52 | 27 | 6 21 | 3 24 |
| 21 | 13 55 | 10 59 | 29 | 22 28 | 19 31 | 31 | 6 37 | 3 40 |
| May 1 | 14 35 | 11 38 | Sep 8 | 23 7 | 20 11 | | | |

CORRECTION FOR PLACES NOT ON THE 30° MERIDIAN

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

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

TELESCOPE SETTING

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

A LIST OF BRIGHT STARS FOR CHECKING TELESCOPE CIRCLES (1998.5)

| Star | R.A. h m | Dec. ° ′ | Mag. | Sp. | Star | R.A. h m | Dec. ° ′ | Mag. | Sp. |
|---|---|---|---|---|---|---|---|---|---|
| ACHERNAR | 1 37.6 | -57 14 | 0.6 | B5 | PROCYON | 7 39.2 | 5 14 | 0.5 | F5 |
| ALDEBARAN | 4 35.8 | 16 30 | 1.1 | K5 | REGULUS | 10 8.3 | 11 59 | 1.3 | B8 |
| RIGEL | 5 14.4 | -8 12 | 0.3 | B8 | SPICA | 13 25.1 | -11 9 | 1.2 | B2 |
| BETELGEUSE | 5 55.1 | 7 24 | 0.4 | M0 | ARCTURUS | 14 15.6 | 19 12 | 0.2 | K0 |
| CANOPUS | 6 23.9 | -52 42 | -0.9 | F0 | ANTARES | 16 29.3 | -26 26 | 1.2 | M1 |
| SIRIUS | 6 45.1 | -16 43 | -1.6 | A0 | ALTAIR | 19 50.7 | 8 52 | 0.9 | A5 |

## JULIAN DATE AT 1400 HOURS - SAST 1998

| | JAN. 2450 | FEB. 2450 | MAR. 2450 | APR. 2450 | MAY 2450 | JUN. 2450 | JUL. 245 | AUG. 2451 | SEP. 2451 | OCT. 2451 | NOV. 2451 | DEC. 2451 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 815 | 846 | 874 | 905 | 935 | 966 | 996 | 027 | 058 | 088 | 119 | 149 |
| 2 | 816 | 847 | 875 | 906 | 936 | 967 | 997 | 028 | 059 | 089 | 120 | 150 |
| 3 | 817 | 848 | 876 | 907 | 937 | 968 | 998 | 029 | 060 | 090 | 121 | 151 |
| 4 | 818 | 849 | 877 | 908 | 938 | 969 | 999 | 030 | 061 | 091 | 122 | 152 |
| 5 | 819 | 850 | 878 | 909 | 939 | 970 | 1000 | 031 | 062 | 092 | 123 | 153 |
| 6 | 820 | 851 | 879 | 910 | 940 | 971 | 1001 | 032 | 063 | 093 | 124 | 154 |
| 7 | 821 | 852 | 880 | 911 | 941 | 972 | 1002 | 033 | 064 | 094 | 125 | 155 |
| 8 | 822 | 853 | 881 | 912 | 942 | 973 | 1003 | 034 | 065 | 095 | 126 | 156 |
| 9 | 823 | 854 | 882 | 913 | 943 | 974 | 1004 | 035 | 066 | 096 | 127 | 157 |
| 10 | 824 | 855 | 883 | 914 | 944 | 975 | 1005 | 036 | 067 | 097 | 128 | 158 |
| 11 | 825 | 856 | 884 | 915 | 945 | 976 | 1006 | 037 | 068 | 098 | 129 | 159 |
| 12 | 826 | 857 | 885 | 916 | 946 | 977 | 1007 | 038 | 069 | 099 | 130 | 160 |
| 13 | 827 | 858 | 886 | 917 | 947 | 978 | 1008 | 039 | 070 | 100 | 131 | 161 |
| 14 | 828 | 859 | 887 | 918 | 948 | 979 | 1009 | 040 | 071 | 101 | 132 | 162 |
| 15 | 829 | 860 | 888 | 919 | 949 | 980 | 1010 | 041 | 072 | 102 | 133 | 163 |
| 16 | 830 | 861 | 889 | 920 | 950 | 981 | 1011 | 042 | 073 | 103 | 134 | 164 |
| 17 | 831 | 862 | 890 | 921 | 951 | 982 | 1012 | 043 | 074 | 104 | 135 | 165 |
| 18 | 832 | 863 | 891 | 922 | 952 | 983 | 1013 | 044 | 075 | 105 | 136 | 166 |
| 19 | 833 | 864 | 892 | 923 | 953 | 984 | 1014 | 045 | 076 | 106 | 137 | 167 |
| 20 | 834 | 865 | 893 | 924 | 954 | 985 | 1015 | 046 | 077 | 107 | 138 | 168 |
| 21 | 835 | 866 | 894 | 925 | 955 | 986 | 1016 | 047 | 078 | 108 | 139 | 169 |
| 22 | 836 | 867 | 895 | 926 | 956 | 987 | 1017 | 048 | 079 | 109 | 140 | 170 |
| 23 | 837 | 868 | 896 | 927 | 957 | 988 | 1018 | 049 | 080 | 110 | 141 | 171 |
| 24 | 838 | 869 | 897 | 928 | 958 | 989 | 1019 | 050 | 081 | 111 | 142 | 172 |
| 25 | 839 | 870 | 898 | 929 | 959 | 990 | 1020 | 051 | 082 | 112 | 143 | 173 |
| 26 | 840 | 871 | 899 | 930 | 960 | 991 | 1021 | 052 | 083 | 113 | 144 | 174 |
| 27 | 841 | 872 | 900 | 931 | 961 | 992 | 1022 | 053 | 084 | 114 | 145 | 175 |
| 28 | 842 | 873 | 901 | 932 | 962 | 993 | 1023 | 054 | 085 | 115 | 146 | 176 |
| 29 | 843 | | 902 | 933 | 963 | 994 | 1024 | 055 | 086 | 116 | 147 | 177 |
| 30 | 844 | | 903 | 934 | 964 | 995 | 1025 | 056 | 087 | 117 | 148 | 178 |
| 31 | 845 | | 904 | | 965 | | 1026 | 057 | | 118 | | 179 |

### 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 | | |

# ASSA OFFICE BEARERS

**COUNCIL**

| | | | |
|---|---|---|---|
| President: | Dr R.S. Stobie | Hon. Treasurer: | Mr C. Gray |
| Vice-Presidents: | Dr D. Smits | Hon. Secretary: | Mr B. Skinner |
| | Mr M.D. Overbeek | Business Manager: | Mr C.R.G. Turk |
| | Mr A. Hilton | Membership Secretary: | Mrs A. Joubert |
| Members: | Dr D.M. Kilkenny | | |
| | Mr T.W.E. Budge | | |
| | Mr T.P.Cooper | | |
| | Mr P.van Blommestein | | |

**Honarary Auditor:** Mr R.G. Glass (Zeller Karro)

**PUBLICATIONS**

Editor of MNASSA: Mr A. Slotegraaf Assistant Editor of MNASSA: Dr I. S. Glass
Editor of Handbook: Miss P. Booth

**BLOEMFONTEIN CENTRE**

| | |
|---|---|
| Chairman: | Mr B. van Zyl |
| Vice-Chairman: | Mr H. Calitz |
| Secretary | Miss G. Erasmus |
| Treasurer: | Miss E. Pienaar |
| Committee: | Mr D. van Yaarsveld |
| | Mrs D. van Yaarsveld |
| Council Rep.: | Mr C. de Koning |

**CAPE CENTRE**

| | |
|---|---|
| Chairman: | Mr A.B. Mahomed |
| Vice-Chairman: | Mr A. Gray |
| Secretary | Mr S. Klein |
| Treasurer: | Mr C. Forder |
| Curator of Instruments: | Mr R. Sessions |
| Council Rep.: | Miss P. Booth |
| Commitee: | Mr B. Wagener |
| | Mz G. Quick |
| | Mr G. Bosch |

**JOHANNESBURG CENTRE**

| | |
|---|---|
| Chairman: | Mr E. Finlay |
| Vice Chairman: | Mr E. Dembsky |
| Secretary: | Mr C. Volschenk |
| Treasurer: | Mr G. Corbett |
| Librarian: | Mr J. Maher |
| Curator of Instruments: | Mr B. Fraser |
| Editor of Canopus: | Mr B. Fraser |
| and: | Mz V. Fraser |
| Commitee: | Mr C. Steward |
| | Mz M. Chitters |
| | Mr B. Payne |
| | Mr G. Penberthy |

**NATAL CENTRE**

| | |
|---|---|
| Chairman: | Mr S. Thomson |
| Vice-Chairman: | Mr P. Cramb |
| Secretary and Treasurer: | Mr D. Sargeant |
| Librarian: | Mz P. Cramb |
| Council Rep.: | Mr P. Cramb |
| Instruments: | Mr R. Suberg |
| Observatory Director: | Mr R. Field |
| PRO: | Mr S. Aspinal |
| Project Co-ordinator: | Mr D. Teague |

**NATAL MIDLANDS CENTRE**

| | |
|---|---|
| Chairman: | Mr J. Watson |
| Vice Chairman, Newsletter and Instruments: | Mr R. Roth |
| Secretary: | Miss L. Hearmon |
| Treasurer: | Mr P. Hawkins |
| Council Rep, PRO, Librarian: | Miss K. Hampson |

**PRETORIA CENTRE**

| | |
|---|---|
| Chairman: | Mr L. Barendse |
| Vice-Chairman and Council Rep: | Mr M. Poll |
| Secretary: | Mr M. Haslam |
| Treasurer and Editor: | Mrs M. Barendse |
| Curator of Instruments: | Mr S. Liebner |
| Librarian: | Mr P. Prinsloo |
| Director Observations: | Mr T. Cooper |
| Committee: | Mr F. le Roux |
| | Mr N. Young |
| | Mr G. Vrey |
| | Mr B. Swart |
| | Mr C. Barnard |
| | Mr T. Viljoen |
| | Mz B. Cunow |

**HARARE CENTRE**

| | |
|---|---|
| Chairman: | |
| Vice-Chairman: | |
| Secretary: | |
| Treasurer: | |
| Committee: | |
| Council Rep: | Mr M. Begbie |

PAST PRESIDENTS

1922-23 S S Hough
1923-24 R T A Innes
1924-25 J K E Halm
1925-26 W Reid
1926-27 H Spencer Jones
1927-28 A W Roberts
1928-29 A W Long
1929-30 H E Wood
1930-31 D Cameron-Swan
1931-32 H L Alden
1932-33 H Spencer Jones
1933-34 D G McIntyre
1934-35 J K E Halm
1935-36 J Jackson
1936-37 H E Houghton
1937-38 J S Paraskevopoulos
1938-39 T Mackenzie
1939-40 R A Rossiter
1940-41 E B Ford
1941-42 H Knox Shaw
1942-43 A F I Forbes
1943-44 W H van den Bos
1944-45 A W J Cousins
1945-46 R H Stoy
1946-47 W P Hirst
1947-48 J Jackson
1948-49 A E H Bleksley
1949-50 W S Finsen
1950-51 H E Krumm
1951-52 A D Thackeray
1952-53 J C Bentley
1953-54 D S Evans
1954-55 P Kirchhoff
1955-56 W H van den Bos
1956-57 S C Venter
1957-58 M W Feast
1958-59 H Haffner
1959-60 P Smits
1960-61 G G Cillie
1961-62 M D Overbeek
1962-63 A J Wesselink
1963-64 A G F Morrisby
1964-65 H C Lagerweij
1965-66 A Menzies
1966-67 G R Atkins
1967-68 J Hers
1968-69 J C Bennett
1969-70 J Churms
1970-71 W C Bentley
1971-72 A H Jarrett
1972-73 K H Sterling
1973-74 G A Harding
1974-75 C Papadopoulos
1975-76 P A T Wild
1976-77 S S Booysen
1977-78 B Warner
1978-79 R F Hurly
1979-80 M W Feast
1980-81 M A Gray
1981-82 E E Baart
1982-83 J V Vincent
1983-84 A P Fairall
1984-85 J S Bondietti
1985-86 G D Nicolson
1986-87 C R G Turk
1987-88 J H Spencer Jones
1988-89 J P G Cramb
1989-90 I S Glass
1990-91 J da S. Campos
1991-92 T Lloyd Evans
1992-93 M G Soltynski
1993-94 W F Wargau
1994-95 B D Fraser
1995-96 B C Raubenheimer
1996-97 A Hilton

HONORARY SECRETARIES

1922 H W Schonegevel
1922-23 T Mackenzie
1923 C L O'Brien Dutten
1923-30 H E Houghton
1930-31 S Skewes
1931-34 H Horrocks
1934-35 H W Schonegevel
1935-65 A Menzies
1965-80 T W Russo
1981-82 Mrs M Fitzgerald
1983-91 H E Krumm
1992- B Skinner

HONORARY TREASURERS

1922 J F Skjellerup
1922-23 A F I Forbes
1923-37 W H Smith
1937-40 Miss J R Robinson
1940-42 J B G Turner
1942-50 H E Krumm
1950-87 F N G Orpen
1987-89 Mrs E C Olsen
1989-93 D Duprez
1994- C Gray

HONORARY MEMBERS

Mr W C Bentley
Dr A W J Cousins
Mr J da S. Campos
Dr D S Evans
Prof Ch Fehrenbach
Mr J Hers
Dr G Heyman
Mr H C Krumm
Mr M D Overbeek

GILL MEDALLISTS

1956 H Knox Shaw
1957 W P Hirst
1958 J Jackson
1960 W H van den Bos
1963 A W J Cousins
1965 R H Stoy
1967 W S Finsen
1970 J C Bennett
1976 A D Thackeray
1981 C Papadopoulos
1983 M W Feast
1984 M D Overbeek
1988 D S Evans
1992 B Warner
1997 G Nicholson

McINTYRE AWARDS

1971 D S Evans, T J Deeming, Mrs B K Evans & S Goldfarb
1983 B Warner

LONG SERVICE AWARDS

1984 J Churms
1988 R F Hurly
1993 H E Krumm

# The Johannesburg Planetarium

University of the Witwatersrand, Yale Road, Milner Park
P O Box 31149, Braamfontein, 2017 Tel: (011)716-3199 Fax: (011)339-2926

## Your Venue for

* Informative Public Shows
* Educational School Shows
* Astronomy Courses
* Corporate Launches
* Music Concerts