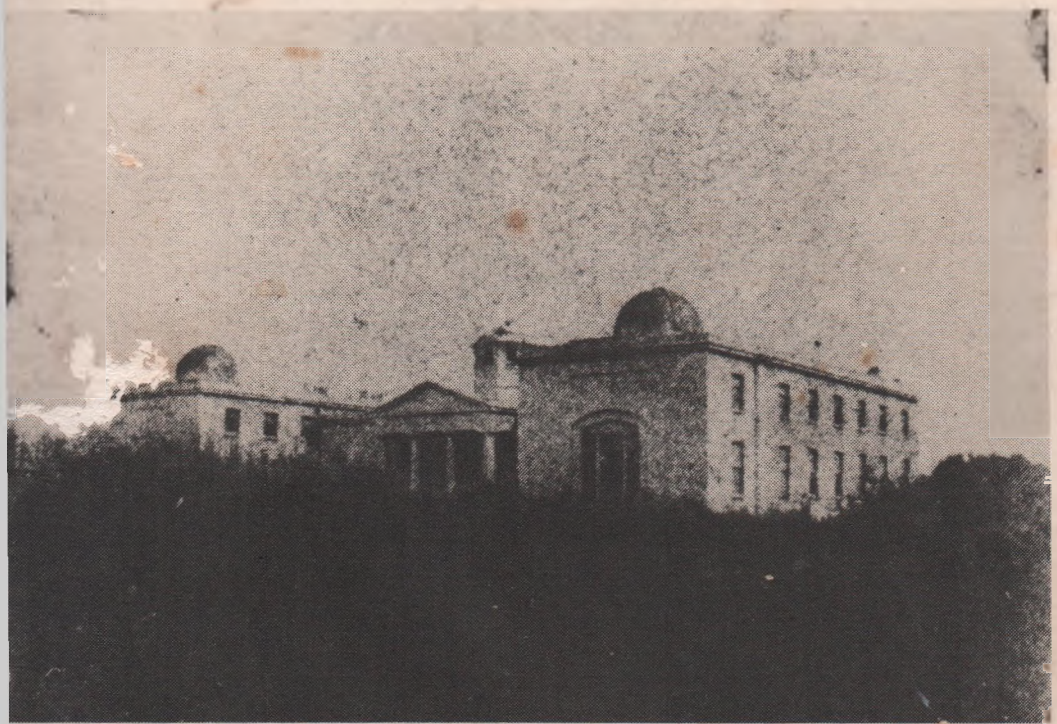
# ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

# 1987



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## PREDICTED PERIHELION PASSAGES OF COMETS, 1987

| Periodic comet | Perihelion date | Revolution period years | Perihelion distance au |
|---|---|---|---|
| Forbes | Jan. 2 | 6·3 | 1·47 |
| Jackson-Neujmin | May 22 | 8·4 | 1·44 |
| du Toit-Hartley | June 11 | 5·2 | 1·20 |
| Grigg-Skjellerup | June 18 | 5·1 | 0·99 |
| Encke | July 17 | 3·3 | 0·33 |
| Klemola | July 22 | 10·9 | 1·77 |
| West-Kohoutek-Ikemura | July 29 | 6·4 | 1·57 |
| Gehrels 1* | July–Aug. | 14·5 | 2·93 |
| Denning-Fujikawa | Aug. 2 | 8·6 | 0·76 |
| Comas Solá | Aug. 18 | 8·8 | 1·83 |
| Schwassmann-Wachmann | Aug. 30 | 6·4 | 2·07 |
| Wild 3* | Aug. 31 | 6·9 | 2·29 |
| Brooks 2 | Oct. 16 | 6·9 | 1·84 |
| Reinmuth 2 | Oct. 25 | 6·7 | 1·94 |
| Kohoutek | Oct. 30 | 6·6 | 1·77 |
| Harrington | Oct. 30 | 6·8 | 1·60 |
| Borrelly | Dec. 18 | 6·9 | 1·36 |

* Periodic comet of only one appearance

### MINOR PLANET OCCULTATIONS

A number of A.S.S.A. members and professional observatories form part of a worldwide network which observes the above events. The observations are very useful to astronomers who study the Solar System.

Often an amateur is located on or near an occultation path, and the observation which he or she can make may be of considerable value. The equipment requirements are modest. A 50mm telescope and means to record the times of multiple events will suffice in most instances. The timing equipment can comprise a portable tape recorder and a radio tuned to a continuous time signal such as ZUO or WWV. If a continuous time signal cannot be received reliably, then an assistant can read off time intervals of, say, ten seconds from a quartz watch synchronised with the SABC "six pips" time signal. The commentary of the observer and timekeeper is thus recorded for later analysis.

If you are in touch with one of the A.S.S.A. Centres and would like to participate, then you are invited to contact one of the conveners listed below. If you do not live near a Centre, then please contact M.D. Overbeek, PO Box 212, Edenvale, 1610. Further updated information may also be obtained from him at 011 535 447.

| | |
|---|---|
| CAPE TOWN | Cliff Turk, 20 Nerina Avenue, Pinelands, 7405. |
| PIETERMARITZBURG | Mrs C S Lake, Budleigh Road, Winterskloof, 3240 |
| BULAWAYO | Arthur G.F. Morrisby, Dept. of Surveyor General, PO Box 1580, Bulawaya, Zimbabwe. |
| BLOEMFONTEIN | Mr J van Ellinckhuyzen, 30 Mellville Drive, Brandwag, Bloemfontein, 9301 |
| WITWATERSRAND | M.D. Overbeek, PO Box 212, Edenvale, 1610. |
| HARARE | R.W. Fleet, PO Box 1335, Harare, Zimbabwe. |
| DURBAN | R.K. Field, 303 Wakesleigh Road, Bellair, 4094. |
| PRETORIA | J.C. Bennett, 90 Malan Street, Riveria, Pretoria, 0084. |
| PORT ELIZABETH | V. Hirsh, PO Box 13115, Port Elizabeth, 6013. |

# ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA 1987

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

This photograph, taken circa 1843 by Charles Piazzi Smyth, of the Royal Observatory, Cape of Good Hope, is the earliest known of any observatory, It is one of many interesting illustrations in "Charles Piazzi Smyth" by Brian Warner, published by Balkims, Cape Town & Rotterdam, 1983.

## CONTENTS



### NOTE

All times are SAST unless otherwise stated.

This hand book is produced for the Astronomical Society of Southern Africa. The data it contains has been adapted for Southern Africa from data obtained from Royal Greenwich Observatory, Herstmonceux, from the International Lunar Occultation Centre, Tokyo, The Royal Astronomical Society of Canada, the Hydrographer of the South African Navy

All correspondence concerning this booklet should be addressed to the Handbook Editor, Astronomical Society of Southern Africa, 8 Glebe Road, Rondebosch, 7700, from whon further copies are available at R4,00 per copy.

Although every care has been taken in the compilation of the Handbook, it is sold and distributed on the explicit understanding that neither the Society or any of its members accepts any responsibility for errors therein.

Dit spyt ons dat as gevolg van beperkte fondse en produksie fasiliteite dit nie moontlik is om die handboek in Afrikaans te laat druk nie.

R F HURLY
Editor

# ASTRONOMY IN SOUTHERN AFRICA

As one of the few parts of the Earth having both access to the rich southern skies and a suitable climate, Southern Africa holds a favoured position in astronomy. Consequently, it has seen the establishment of a number of professional observatories engaged in research while many individuals have become enthusiastic amateur astronomers. Planetaria and visiting nights at observatories convey to the general public much of what goes on in this field.

**Observatories**

The South African Astronomical Observatory (SAAO) was established in 1972, as a joint venture between the Council for Scientific and Industrial Research (CSIR) of SA and the Science Research Council of the UK, combining the facilities of the former Royal and Republic Observatories, and is directed by Prof M W Feast. On the closure of the Radcliffe Observatory in 1974, the CSIR acquired the 1.9-m telescope, and moved it to Sutherland in the Karoo, where there are also 1.0-m, 0.75-m and 0.5-m telescopes. The headquarters are in Cape Town, where also a limited amount of observing continues. 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.

The 0.67-m visual refractor at the former Republic Observatory, Johannesburg is maintained by the National Institute for Telecommunications Research (NITR) of the CSIR. The 0.25-m Franklin-Adams Camera at the Broederstroom Observatory, Hartbeespoort is maintained by the Dept of National Education.

Boyden Observatory, situated at Mazelspoort, 25 km from Bloemfontein, is owned by the Institute and Dept of Astronomy of the University of the Orange Free State, and directed by Prof A H Jarrett. Observing facilities include a 1.52-m and two 0.41-m telescopes, as well as the 0.25-m Metcalf camera, a 0.33-m refractor and a 0.20-m solar installation. The main research areas include flare stars, short period variable stars, and atomic emissions from nebulae, the Sun and interplanetary space.

The Radio Astronomy Observatory at Hartebeesthoek, near Krugersdorp, is operated by the NITR. The director is Dr G D Nicolson. The telescope, a 26-m dish, is used for observations of extragalactic radio objects such as quasars and X-ray sources. The Rhodes University Radio Astronomy Group, led by Prof E E Baart, use this telescope, currently in a survey of the whole southern sky at 13 cm.

In addition to the professional observatories mentioned above, South Africa and Zimbabwe have numerous private observatories, built and operated by amateur astronomers.

**Observatories Open to the Public**

SAAO headquarters in Observatory are open to visitors on the second saturday of each month, and in addition from January to March on the fourth saturday, 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.

Visiting nights at Boyden Observatory are generally held around the time of first quarter, and numbers are restricted to 20 persons on each occasion. Enquiries should be made to the Observatory.

**Planetaria**

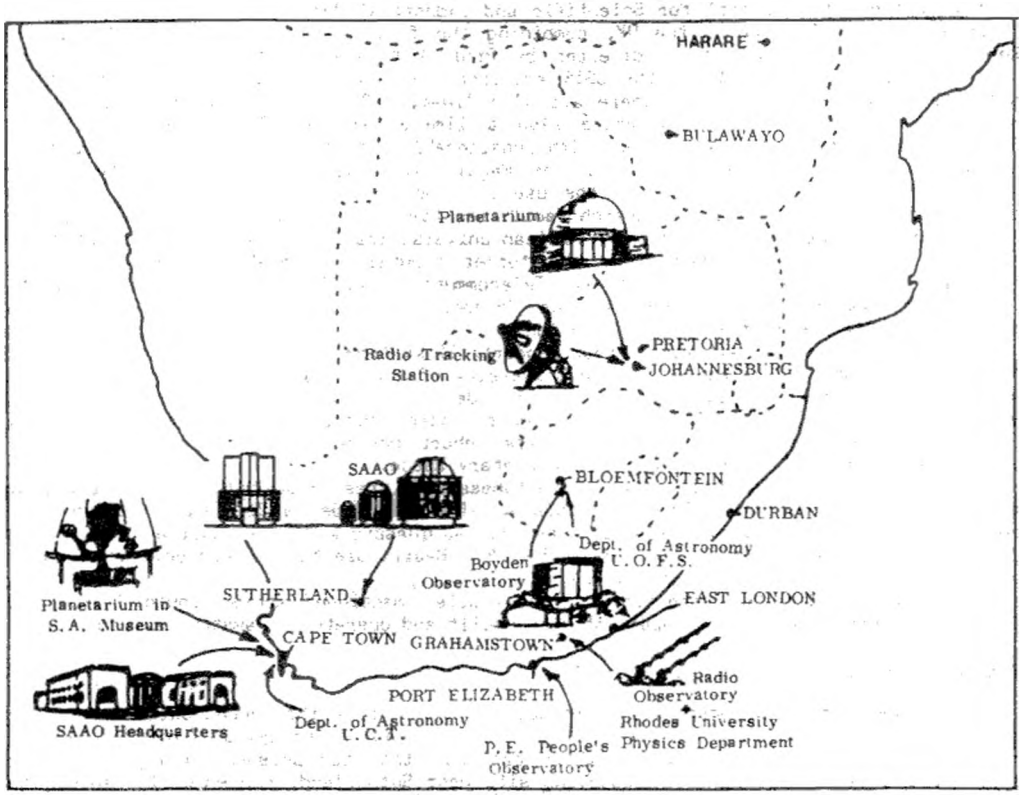
A planetarium is situated in the grounds of the University of the Witwatersrand (entrance in Yale Road, alongside M1). It is equipped with a Zeiss projector and seats over 400 persons.

A small planetarium with a Spitz projector and seating approximately 70, is located within the South African Museum, Cape Town. Shows are given on Saturday and Sunday at 15h00, and at additional times on public holidays. A new planetarium with a Minolta projector and seating 140 is presently under construction at the Museum, and it is expected to be in use by mid-1987.

# ASTRONOMY IN SOUTHERN AFRICA

**Universities**

Several universities undertake research in astronomy and offer teaching courses. The chair of astronomy at UCT is occupied by Brian Warner, whose department use the SAAO observing facilities at Sutherland. Prof G F R Ellis of the Dept of Applied Mathematics, UCT heads a group carrying out research in theoretical cosmology. The University of OFS has an Institute (created in 1981) and a Dept of Astronomy. Both are incorporated with the Boyden Observatory, and headed by Prof A H Jarrett. 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.




**The Astronomical Society of Southern Africa**

The Astronomical Society of Southern Africa is a body consisting of both amateur and professional astronomers. Membership is open to all interested persons, regardless of knowledge or experience. In addition to this Handbook, the Society issues the Monthly Notes of the Astronomical Society of Southern Africa (MNASSA). Members also receive the popular monthly magazine Sky and Telescope published in the USA, which provides information on professional and amateur activities, together with news of space research and other related subjects. The Society's annual subscription is R50.00 and there is an entrance fee of R10.00. A prospectus and application form may be obtained from the Honorary Secretary, Astronomical Society of S A, c/o S A Astronomical Observatory, P O Box 9, Observatory 7935, Cape.

# ASTRONOMY IN SOUTH AFRICA

## LOCAL CENTRES OF THE SOCIETY

Autonomous local centres of the Society hold regular meetings in Cape Town, Durban, Johannesburg, Bloemfontein, Pietermaritzburg, Pretoria and Harare. Visitors are very welcome at meetings and may, if they wish, join a Centre without becoming a full member of the Society. Centre members do not receive society publications, nor "Sky and Telescope".

CAPE CENTRE (Cape Town): Formal meetings are held on the second Wednesday of the month (except January and December) when professional and prominent local amateur astronomers present lectures on the latest topics in Astronomy. Informal meetings are held on most other Wednesdays except during January and December. At these observing sessions discussion groups are held. Two or three out-of-town weekend observing sessions are held each year in the Cedarberg Mountain area under exceptionally dark skies. The Centre publishes a quarterly journal, the "Cape Observer", which gives information on meetings, current notes on the Centre's activities and information on objects to observe. More information can be obtained by contacting Dr Peter Mack at the South African Astronomical Observatory, P O Box 9, Observatory, 7935, telephone: 47 0025 office hours. Meetings are held at the S.A.A.O., Observatory Road, Observatory.

TRANSVAAL CENTRE (Johannesburg): General meetings are held on the second Wednesday of each month, excluding December, in the Sir Herbert Baker Building in the grounds of the Old Republic Observatory, 18A Gill Street, Observatory, Johannesburg at 20h00. These meetings consist of lectures, films or observing evenings. The Centre has two small observatories on the site. One contains the Jacobs telescope, a 30cm F8 Newtonian and in the Papadopoulos Dome is housed a combined instrument comprising a 18cm F16 refractor, a 15cm refractor, and a 30cm F16 Cassegrain reflector. Informal observing evenings are held every Friday night. The Centre publishes a monthly newsletter "Canopus", which carries information on meetings and the Centre's activities. Secretarial address: G J Jacobs, Private Bag X7, Parkview, 2122. Telephone: (011) 646 5959.

NATAL CENTRE (Durban): Regular monthly meetings are held on the third Wednesday of each month in St Thomas Church Hall at 19h45. The Natal Centre publishes a monthly booklet "NDABA" which contains news and views and current information on astronomical and related topics. Secretarial address: P O Box 5330, Durban, 4000. Telephone: (w) (031) 42 3684 or (h) 84 4751.

NATAL MIDLANDS CENTRE (Pietermaritzburg): Meetings are held on the third Thursday of the month (except January) at the PMB Music College, Havelock Road at 19h45. Information on meetings and membership is available from the Secretary, P O Box 2106, Pietermaritzburg, 3200 or by phoning (0331) 33 646 or 33 710.

BLOEMFONTEIN CENTRE: Meetings are held every fourth Friday of the month. For further information contact Mr F C Neser, telephone (051) 22 1142, 108 Japie Neser Street, Uitsig, Bloemfontein.

PRETORIA CENTRE: Meetings are held on the fourth Wednesday of each month (except December) at 20h00, the venue being either the Main Academic Building of the University of South Africa, or the Christian Brothers' College, Silverton Road. The Centre's observatory containing a 30cm reflecting telescope is situated on the latter site. For further information contact the Honorary Secretary, Dr C Verburgh, P O Box 11399, Brooklyn, Pretoria, 0011. Telephone: (012) 433 531.

HARARE CENTRE: The centre holds a meeting on the last Wednesday of each month (except December). These are usually held at 17h30 at the Queen Victoria Museum and usually consist of lectures, films or general discussions. Informal observing sessions are ablso held at the homes of some members. The address of the Harare Centre is P O Box UA 428, Union Avenue, Harare, Zimbabwe.

## OBSERVING SECTIONS OF THE SOCIETY:

These sections exist to co-ordinate constructive observing programmes. Mention of the type of observations and equipment involved are made in the appropriate parts of this handbook together with the names and addresses of the directors. In addition to the sections listed below is a newly formed computing section. The director is Mr A S Hilton, P O Box 68846, Bryanston, 2021.

# DIARY OF PHENOMENA, 1987
## CONFIGURATIONS OF SUN, MOON AND PLANETS

| | d | h | |
|---|---|---|---|
| Jan. | 3 | 14 | Juno in conjunction with Sun |
| | | 21 | Jupiter 1°3N of Moon |
| | 5 | 01 | Earth at perihelion |
| | 5 | 14 | Mars 1°4N of Moon |
| | 7 | 01 | FIRST QUARTER |
| | 12 | 19 | Mercury in superior conjunction |
| | 13 | 07 | Moon at apogee |
| | 15 | 05 | FULL MOON |
| | 15 | 23 | Venus greatest elong. W.(47°) |
| | 15 | 23 | Venus 8°N of Antares |
| | 23 | 01 | LAST QUARTER |
| | 24 | 22 | Venus 1°8N of Saturn |
| | 25 | 16 | Antares 0°4S |
| | 26 | 07 | Saturn 6°N of Moon |
| | 26 | 09 | Venus 8°N of Moon |
| | 26 | 18 | Uranus 5°N of Moon |
| | 27 | 12 | Neptune 6°N of Moon |
| | 28 | 13 | Moon at perigee |
| | 29 | 16 | NEW MOON |
| | 31 | 19 | Venus 3°N of Uranus |
| Feb. | 1 | 16 | Jupiter 0°7N of Moon |
| | 3 | 13 | Mars 0°3S of Moon |
| | 5 | 18 | FIRST QUARTER |
| | 9 | 18 | Moon at apogee |
| | 11 | 15 | Venus 1°3N of Neptune |
| | 12 | 07 | Mercury greatest elong.E (18°) |
| | 12 | 23 | FULL MOON |
| | 16 | 13 | Pluto stationary |
| | 18 | 04 | Mercury stationary |
| | 18 | 14 | Spica 1°1S of Moon |
| | 21 | 11 | LAST QUARTER |
| | 22 | 00 | Antares 0°2S of Moon |
| | 22 | 18 | Saturn 6°N of Moon |
| | 23 | 04 | Uranus 5°N of Moon |
| | 23 | 22 | Neptune 6°N of Moon |
| | 24 | 21 | Venus 7°N of Moon |
| | 25 | 18 | Moon at perigee |
| | 27 | 20 | Mercury in inferior conjunction |
| | 28 | 03 | NEW MOON |
| Mar. | 1 | 14 | Jupiter 0°005S of Moon |
| | 4 | 13 | Mars 1°9S of Moon |
| | 7 | 14 | FIRST QUARTER |
| | 9 | 12 | Moon at apogee |
| | 12 | 03 | Mercury stationary |
| | 15 | 15 | FULL MOON |
| | 17 | 20 | Spica 1°0S of Moon |
| | 21 | 05 | Antares 0°1S of Moon |
| | 21 | 06 | Equinox |
| | 22 | 01 | Saturn 7°N of Moon |
| | 22 | 10 | Uranus 5°N of Moon |
| | 22 | 18 | LAST QUARTER |
| | 23 | 05 | Neptune 6°N of Moon |
| | 24 | 21 | Moon at perigee |
| | 26 | 14 | Venus 3°N of Moon |
| | 26 | 23 | Mercury greatest elong.W (28°) |
| | 27 | 03 | Jupiter in conjunction with Sun |
| | 27 | 10 | Mercury 1°6N of Moon |
| | 29 | 15 | NEW MOON Eclipse |
| | 31 | 08 | Saturn stationary |
| | 31 | 13 | Pallas stationary |
| Apr. | 1 | 06 | Uranus stationary |
| | 2 | 11 | Mars 3°S of Moon |
| | 6 | 09 | Moon at apogee |
| | 6 | 10 | FIRST QUARTER |

| | d | h | |
|---|---|---|---|
| Apr. | 10 | 01 | Neptune Stationary |
| | 14 | 04 | Spica 1°0S of Moon Occ$^n$ |
| | 14 | 04 | FULL MOON Penumbral Eclipse |
| | 17 | 11 | Antares 0°1S of Moon Occ$^n$ |
| | 18 | 07 | Saturn 7°N of Moon |
| | 18 | 16 | Uranus 5°N of Moon |
| | 18 | 19 | Moon at perigee |
| | 19 | 10 | Neptune 6°N of Moon |
| | 19 | 14 | Mercury 1°4S of Jupiter |
| | 21 | 00 | LAST QUARTER |
| | 21 | 14 | Mars 6°N of Aldebaran |
| | 25 | 14 | Venus 1°0S of Moon Occ$^n$ |
| | 26 | 08 | Jupiter 1°4S of Moon |
| | 28 | 04 | NEW MOON |
| | 29 | 12 | Pluto at opposition |
| | 30 | 19 | Ceres stationary |
| May | 1 | 07 | Mars 4°S of Moon |
| | 4 | 04 | Moon at apogee |
| | 5 | 00 | Venus 0°6S of Jupiter |
| | 6 | 04 | FIRST QUARTER |
| | 7 | 12 | Mercury in superior conjunction |
| | 11 | 13 | Spica 1°0S of Moon Occ$^n$ |
| | 13 | 05 | Pallas at opposition |
| | 13 | 15 | FULL MOON |
| | 14 | 19 | Antares 0°2S of Moon Occ$^n$ |
| | 15 | 13 | Saturn 6°N of Moon |
| | 15 | 22 | Uranus 5°N of Moon |
| | 16 | 01 | Moon at perigee |
| | 16 | 16 | Neptune 6°N of Moon |
| | 19 | 00 | Mercury 7°N of Aldebaran |
| | 20 | 06 | LAST QUARTER |
| | 24 | 02 | Jupiter 2°S of Moon |
| | 25 | 18 | Venus 4°S of Moon |
| | 27 | 17 | NEW MOON |
| May | 28 | 06 | Vesta in conjunction with Sun |
| | 29 | 15 | Mercury 3°S of Moon |
| | 30 | 04 | Mars 4°S of Moon |
| | 31 | 20 | Moon at apogee |
| June | 4 | 21 | FIRST QUARTER |
| | 7 | 12 | Mercury greatest elong.E (24°) |
| | 7 | 23 | Spica 0°9S of Moon Occ$^n$ |
| | 09 | 07 | Saturn at opposition |
| | 11 | 05 | Antares 0°2S of Moon Occ$^n$ |
| | 11 | 19 | Saturn 6°N of Moon |
| | 11 | 23 | FULL MOON |
| | 12 | 06 | Uranus 5°N of Moon |
| | 13 | 01 | Neptune 6°N of Moon |
| | 13 | 03 | Moon at perigee |
| | 16 | 12 | Uranus at opposition |
| | 18 | 13 | LAST QUARTER |
| | 19 | 18 | Venus 5°N of Aldebaran |
| | 20 | 13 | Ceres at opposition |
| | 20 | 18 | Jupiter 3°S of Moon |
| | 20 | 19 | Mercury stationary |
| | 22 | 00 | Solstice |
| | 24 | 22 | Venus 5°S of Moon |
| | 26 | 08 | NEW MOON |
| | 27 | 11 | Mars 6°S of Pollux |
| | 27 | 23 | Mars 4°S of Moon |
| | 28 | 06 | Moon at apogee |
| | 28 | 23 | Neptune at opposition |
| July | 4 | 03 | Earth at aphelion |
| | 4 | 06 | Mercury in inferior conjunction |
| | 4 | 11 | FIRST QUARTER |
| | 5 | 08 | Spica 0°6S of Moon Occ$^n$ |
| | 8 | 14 | Juno stationary |

# DIARY OF PHENOMENA, 1987
## CONFIGURATIONS OF SUN, MOON AND PLANETS

| | d | h | | |
|---|---|---|---|---|
| July | 8 | 16 | Antares 0°1S of Moon | Occ$^{n}$ |
| | 9 | 03 | Saturn 6°N of Moon | |
| | 9 | 15 | Uranus 5°N of Moon | |
| | 10 | 10 | Neptune 6°N of Moon | |
| | 11 | 06 | FULL MOON | |
| | 11 | 12 | Moon at perigee | |
| | 12 | 03 | Mercury 5°S of Venus | |
| | 12 | 21 | Pallas stationary | |
| | 15 | 08 | Mercury stationary | |
| | 17 | 22 | LAST QUARTER | |
| | 18 | 07 | Jupiter 4°S of Moon | |
| | 24 | 02 | Mercury 8°S of Moon | |
| | 24 | 06 | Pluto stationary | |
| | 25 | 10 | Moon at apogee | |
| | 25 | 12 | Mercury greatest elong.W (20°) | |
| | 25 | 23 | NEW MOON | |
| Aug. | 1 | 13 | Spica 0°3S of Moon | |
| | 2 | 21 | FIRST QUARTER | |
| | 3 | 17 | Mercury 7°S of Pollux | |
| | 5 | 01 | Antares 0°1N of Moon | Occ$^{n}$ |
| | 5 | 11 | Saturn 6°N of Moon | |
| | 5 | 22 | Ceres 0°7N of Moon | Occ$^{n}$ |
| | 6 | 00 | Uranus 5°N of Moon | |
| | 6 | 20 | Neptune 6°N of Moon | |
| | 8 | 21 | Moon at perigee | |
| | 9 | 12 | FULL MOON | |
| | 10 | 16 | Ceres stationary | |
| | 14 | 18 | Jupiter 4°S of Moon | |
| | 16 | 10 | LAST QUARTER | |
| | 19 | 17 | Saturn stationary | |
| | 20 | 08 | Mercury in superior conjunction | |
| | 20 | 10 | Jupiter stationary | |
| | 21 | 16 | Moon at apogee | |
| | 23 | 08 | Venus in superior conjunction | |
| | 23 | 21 | Juno at opposition | |
| | 24 | 14 | NEW MOON | |
| | 25 | 10 | Mars in conjunction with Sun | |
| | 28 | 21 | Spica 0°2S of Moon | Occ$^{n}$ |
| Sept. | 1 | 06 | FIRST QUARTER | |
| | 1 | 08 | Antares 0°3N of Moon | Occ$^{n}$ |
| | 1 | 16 | Uranus stationary | |
| | 1 | 18 | Saturn 6°N of Moon | |
| | 2 | 07 | Uranus 5°N of Moon | |
| | 2 | 08 | Ceres 0°4N of Moon | Occ$^{n}$ |
| | 3 | 03 | Neptune 6°N of Moon | |
| | 6 | 05 | Moon at perigee | |
| | 7 | 20 | FULL MOON | |
| | 11 | 02 | Jupiter 4°S of Moon | |
| | 15 | 02 | LAST QUARTER | |
| | 17 | 09 | Neptune stationary | |
| | 18 | 05 | Moon at apogee | |
| | 23 | 05 | NEW MOON | Eclipse |
| | 23 | 15 | Mercury 0°5N of Spica | |
| | 23 | 16 | Equinox | |
| | 25 | 03 | Spica 0°1S of Moon | Occ$^{n}$ |
| | 25 | 07 | Mercury 0°3N of Moon | Occ$^{n}$ |
| | 28 | 14 | Antares 0°3N of Moon | Occ$^{n}$ |
| | 29 | 02 | Saturn 6°N of Moon | |
| | 29 | 14 | Uranus 5°N of Moon | |
| | 29 | 22 | Ceres 0°2N of Moon | Occ$^{n}$ |
| | 30 | 10 | Neptune 6°N of Moon | |
| | 30 | 13 | FIRST QUARTER | |
| Oct. | 4 | 03 | Moon at perigee | |
| | 4 | 12 | Mercury greatest along.E (26°) | |
| | 4 | 22 | Venus 3°N of Spica | |

| | d | h | | |
|---|---|---|---|---|
| Oct. | 6 | 07 | Juno stationary | |
| | 7 | 06 | FULL MOON | Penumbral Eclipse |
| | 8 | 07 | Jupiter 4°S of Moon | |
| | 14 | 20 | LAST QUARTER | |
| | 15 | 23 | Moon at apogee | |
| | 16 | 22 | Mercury stationary | |
| | 18 | 17 | Jupiter at opposition | |
| | 20 | 03 | Mercury 3°S of Venus | |
| | 21 | 06 | Mars 1°7N of Moon | |
| | 22 | 19 | NEW MOON | |
| | 24 | 05 | Venus 4°N of Moon | |
| | 25 | 20 | Antares 0°2N of Moon | Occ$^{n}$ |
| | 26 | 11 | Saturn 6°N of Moon | |
| | 26 | 21 | Uranus 5°N of Moon | |
| | 27 | 16 | Neptune 6°N of Moon | |
| | 27 | 17 | Ceres 0°6S of Moon | Occ$^{n}$ |
| | 28 | 10 | Mercury in inferior conjunction | |
| | 30 | 19 | FIRST QUARTER | |
| | 30 | 05 | Moon at perigee | |
| Nov. | 2 | 23 | Pluto in conjunction with Sun | |
| | 4 | 09 | Jupiter 4°S of Moon | |
| | 5 | 19 | FULL MOON | |
| | 6 | 01 | Mercury stationary | |
| | 11 | 06 | Venus 4°N of Antares | |
| | 12 | 18 | Mars 3°N of Spica | |
| | 12 | 20 | Moon at apogee | |
| | 13 | 11 | Mercury greatest elong.W (19°) | |
| | 13 | 17 | LAST QUARTER | |
| | 19 | 19 | Spica 0°1S of Moon | Occ$^{n}$ |
| | 19 | 03 | Mars 3°N of Moon | |
| | 20 | 03 | Mercury 6°N of Moon | |
| | 20 | 18 | Venus 2°S of Saturn | |
| | 21 | 09 | NEW MOON | |
| | 22 | 23 | Saturn 6°N of Moon | |
| | 23 | 03 | Venus 4°N of Moon | |
| | 23 | 06 | Uranus 5°N of Moon | |
| | 24 | 00 | Neptune 6°N of Moon | |
| | 24 | 12 | Venus 0°8S of Uranus | |
| | 24 | 15 | Ceres 0°6S of Moon | Occ$^{n}$ |
| | 24 | 17 | Moon at perigee | |
| | 27 | 18 | Juno 1°0N of Moon | Occ$^{n}$ |
| | 28 | 03 | FIRST QUARTER | |
| Dec. | 1 | 12 | Jupiter 4°S of Moon | |
| | 3 | 12 | Venus 2°S of Neptune | |
| | 5 | 10 | FULL MOON | |
| | 8 | 00 | Vesta stationary | |
| | 10 | 16 | Moon at apogee | |
| | 13 | 14 | LAST QUARTER | |
| | 16 | 05 | Jupiter stationary | |
| | 16 | 05 | Saturn in conjunction with Sun | |
| | 16 | 05 | Spica 0°1N of Moon | Occ$^{n}$ |
| | 17 | 23 | Mars 5°N of Moon | |
| | 19 | 11 | Uranus in conjunction with Sun | |
| | 19 | 14 | Antares 0°2N of Moon | Occ$^{n}$ |
| | 20 | 20 | NEW MOON | |
| | 22 | 12 | Solstice | |
| | 22 | 13 | Moon at perigee | |
| | 23 | 00 | Venus 2°N of Moon | |
| | 23 | 10 | Mercury in superior conjunction | |
| | 27 | 12 | FIRST QUARTER | |
| | 28 | 17 | Jupiter 4°S of Moon | |
| | 29 | 08 | Pallas in conjunction with Sun | |
| | 30 | 01 | Neptune in conjunction with Sun | |

# THE SUN 1987

Basic Data

Diameter: 1 392 000 km (1 09 times Earth diameter)

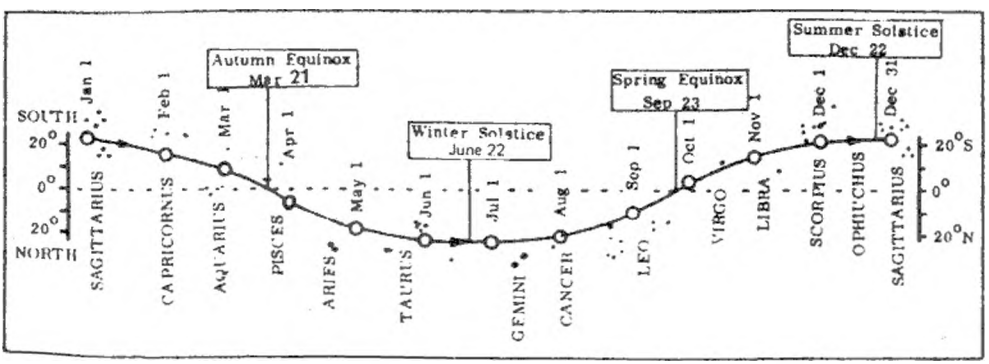
Mass: $1{,}99 \times 10^{30}$ kg (330 000 times Earth mass)

Surface Temperature: Approximately 6 000°C

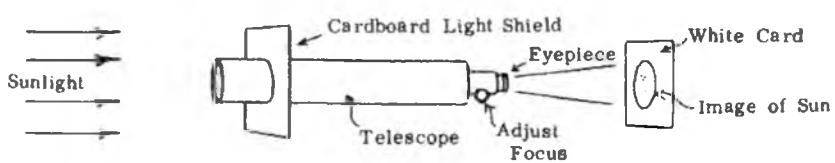
Temperature at centre: Approximately 10 million°C

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

The Earth's orbit round the Sun is not quite circular. In 1987 we will be closest to the Sun on January 5 (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.




SUN'S DECLINATION

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 23°04'S | Apr | 1 | 4°15'N | Jul | 10 | 22°20'N | Oct | 8 | 5°36'S |
| | 11 | 21°55'S | | 11 | 8°02'N | | 20 | 20°48'N | | 18 | 9°20'S |
| | 21 | 20°04'S | | 21 | 11°36'N | | 30 | 18°42'N | | 28 | 12°52'S |
| | 31 | 17°38'S | May | 1 | 14°31'N | Aug | 9 | 16°04'N | Nov | 7 | 16°03'S |
| Feb | 10 | 14°38'S | | 11 | 17°41'N | | 19 | 13°01'N | | 17 | 18°48'S |
| | 20 | 11°11'S | | 21 | 20°02'N | | 29 | 9°38'N | | 27 | 20°59'S |
| Mar | 2 | 7°30'S | | 31 | 21°49'N | Sep | 8 | 5°59'N | Dec | 7 | 22°31'S |
| | 12 | 3°37'S | Jun | 10 | 22°57'N | | 18 | 2°10'N | | 17 | 23°20'S |
| | 22 | 0°20'N | | 22 | 23°27'N | | 28 | 1°43'S | | 26 | 23°24'S |
| | | | | 30 | 22°12'N | | | | | 31 | 23°09'S |

# The Sun 1987

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

| | | CAPE TOWN | | DURBAN | | BLOEMFONTEIN | | JOHANNESBURG | | HARARE | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | sunrise | sunset | sunrise | sunset | sunrise | sunset | sunrise | sunset | sunrise | sunset |
| Jan | 1 | 05h38m | 20h01m | 04h58m | 19h01m | 05h21m | 19h18m | 05h18m | 19h04m | 05h24m | 18h35m |
| | 11 | 05 46 | 20 02 | 05 06 | 19 02 | 05 29 | 19 18 | 05 25 | 19 05 | 05 29 | 18 37 |
| | 21 | 05 55 | 19 59 | 05 14 | 19 00 | 05 37 | 19 17 | 05 33 | 19 04 | 05 37 | 18 38 |
| Feb | 1 | 06 07 | 19 52 | 05 24 | 18 55 | 05 46 | 19 13 | 05 42 | 19 00 | 05 42 | 18 36 |
| | 11 | 06 17 | 19 44 | 05 32 | 18 48 | 05 54 | 19 06 | 05 49 | 18 55 | 05 47 | 18 32 |
| | 21 | 06 26 | 19 33 | 05 41 | 18 39 | 06 02 | 18 57 | 05 54 | 18 47 | 05 52 | 18 27 |
| Mar | 1 | 06 33 | 19 23 | 05 46 | 18 30 | 06 08 | 18 48 | 06 00 | 18 39 | 05 55 | 18 21 |
| | 11 | 06 41 | 19 11 | 05 53 | 18 19 | 06 13 | 18 38 | 06 04 | 18 29 | 05 57 | 18 15 |
| | 21 | 06 49 | 18 58 | 05 59 | 18 06 | 06 18 | 18 27 | 06 11 | 18 19 | 06 00 | 18 06 |
| Apr | 1 | 06 58 | 18 41 | 06 06 | 17 53 | 06 25 | 18 13 | 06 17 | 18 06 | 06 02 | 17 57 |
| | 11 | 07 04 | 18 30 | 06 11 | 17 43 | 06 30 | 18 03 | 06 21 | 17 56 | 06 04 | 17 50 |
| | 21 | 07 13 | 18 17 | 06 17 | 17 31 | 06 35 | 17 52 | 06 25 | 17 47 | 06 07 | 17 43 |
| May | 1 | 07 20 | 18 06 | 06 24 | 17 22 | 06 42 | 17 44 | 06 31 | 17 38 | 06 10 | 17 37 |
| | 11 | 07 28 | 17 57 | 06 31 | 17 14 | 06 49 | 17 36 | 06 37 | 17 31 | 06 13 | 17 32 |
| | 21 | 07 34 | 17 50 | 06 36 | 17 06 | 06 54 | 17 30 | 06 41 | 17 26 | 06 16 | 17 29 |
| Jun | 1 | 07 43 | 17 45 | 06 43 | 17 04 | 07 01 | 17 27 | 06 47 | 17 23 | 06 20 | 17 28 |
| | 11 | 07 48 | 17 44 | 06 48 | 17 03 | 07 05 | 17 26 | 06 52 | 17 22 | 06 23 | 17 27 |
| | 21 | 07 51 | 17 44 | 06 51 | 17 04 | 07 06 | 17 27 | 06 55 | 17 24 | 06 26 | 17 29 |
| Jul | 1 | 07 53 | 17 48 | 06 53 | 17 07 | 07 10 | 17 30 | 06 57 | 17 27 | 06 27 | 17 32 |
| | 11 | 07 51 | 17 52 | 06 51 | 17 11 | 07 06 | 17 34 | 06 55 | 17 30 | 06 27 | 17 35 |
| | 21 | 07 47 | 17 58 | 06 48 | 17 16 | 07 05 | 17 39 | 06 53 | 17 35 | 06 26 | 17 40 |
| Aug | 1 | 07 39 | 18 06 | 06 42 | 17 22 | 07 00 | 17 45 | 06 48 | 17 41 | 06 23 | 17 42 |
| | 11 | 07 30 | 18 13 | 06 34 | 17 29 | 06 53 | 17 51 | 06 41 | 17 46 | 06 18 | 17 46 |
| | 21 | 07 19 | 18 20 | 06 24 | 17 35 | 06 42 | 17 55 | 06 32 | 17 50 | 06 11 | 17 48 |
| Sep | 1 | 07 06 | 18 27 | 06 12 | 17 40 | 06 31 | 18 01 | 06 21 | 17 54 | 06 04 | 17 49 |
| | 11 | 06 52 | 18 34 | 06 00 | 17 46 | 06 19 | 18 06 | 06 11 | 17 59 | 05 55 | 17 51 |
| | 21 | 06 38 | 18 41 | 05 48 | 17 51 | 06 07 | 18 10 | 05 59 | 18 03 | 05 46 | 17 52 |
| Oct | 1 | 06 25 | 18 48 | 05 37 | 17 57 | 05 57 | 18 16 | 05 50 | 18 08 | 05 39 | 17 54 |
| | 11 | 06 12 | 18 55 | 05 25 | 18 03 | 05 45 | 18 22 | 05 39 | 18 12 | 05 30 | 17 57 |
| | 21 | 05 58 | 19 04 | 05 12 | 18 09 | 05 33 | 18 27 | 05 27 | 18 17 | 05 23 | 17 59 |
| Nov | 1 | 05 46 | 19 13 | 05 02 | 18 17 | 05 24 | 18 35 | 05 19 | 18 24 | 05 16 | 18 03 |
| | 11 | 05 38 | 19 23 | 04 55 | 18 26 | 05 17 | 18 44 | 05 13 | 18 32 | 05 14 | 18 08 |
| | 21 | 05 31 | 19 33 | 04 49 | 18 34 | 05 12 | 18 52 | 05 06 | 18 39 | 05 11 | 18 13 |
| Dec | 1 | 05 29 | 19 43 | 04 48 | 18 42 | 05 11 | 19 00 | 05 07 | 18 46 | 05 12 | 18 19 |
| | 11 | 05 28 | 19 50 | 04 48 | 18 50 | 05 11 | 19 07 | 05 08 | 18 53 | 05 14 | 18 25 |
| | 21 | 05 32 | 19 57 | 04 52 | 18 57 | 05 15 | 19 14 | 05 12 | 19 00 | 05 18 | 18 31 |

## Eclipses of the Sun

The Annular-Total eclipse of the Sun on March 29 will be seen only on a line from parts of South America to a point on the West Coast of Africa on the equator, and on to the Horn of Africa. It will be seen only as a very minor partial eclipse over Southern Africa from about 11h45 to 14h45.

The Annular eclipse of the Sun on September 23 will not be seen from Southern Africa.

## Solar Observing Section

Mr R.G.B. Anderson of 217 7th Avenue, Bezuidenhout Valley, Johannesburg 2094, is the director of this newly formed section. Interested persons should contact him for details.

# THE MOON 1987

## BASIC DATA

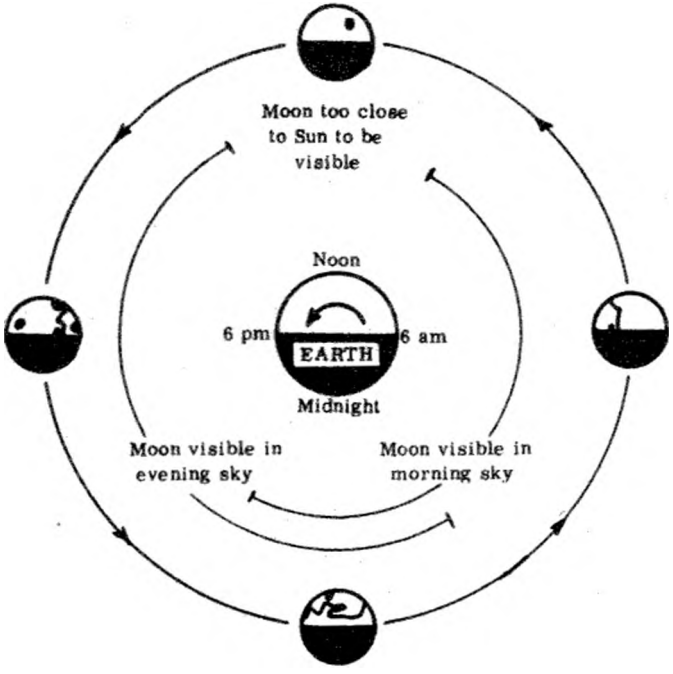
| | |
|---|---|
| Diameter: | 3 480 km (0,27 of Earth) |
| Mass: | 7,35 x $10^{22}$ x kg (1/81 of Earth) |
| Surface Gravity: | 0,16 of Earth |
| Average distance from Earth: | 384 000 km |

## PHASES AND VISIBILITY

### NEW MOON

| | d | h | m |
|---|---|---|---|
| Jan | 29 | 15 | 44 |
| Feb | 28 | 02 | 51 |
| Mar | 29 | 14 | 46 |
| Apr | 28 | 03 | 34 |
| May | 27 | 17 | 13 |
| Jun | 26 | 07 | 37 |
| Jul | 25 | 22 | 37 |
| Aug | 24 | 13 | 59 |
| Sep | 23 | 05 | 08 |
| Oct | 22 | 19 | 28 |
| Nov | 21 | 08 | 33 |
| Dec | 20 | 20 | 25 |

## SCHEMATIC DIAGRAM OF MOON'S ORBIT




### FIRST QUARTER

| | d | h | m |
|---|---|---|---|
| Jan | 7 | 00 | 34 |
| Feb | 5 | 18 | 21 |
| Mar | 7 | 13 | 58 |
| Apr | 6 | 09 | 48 |
| May | 6 | 04 | 26 |
| Jun | 4 | 20 | 53 |
| Jul | 4 | 10 | 34 |
| Aug | 2 | 21 | 24 |
| Sep | 1 | 05 | 48 |
| Sep | 30 | 12 | 39 |
| Oct | 29 | 19 | 10 |
| Nov | 28 | 02 | 37 |
| Dec | 27 | 12 | 01 |

### LAST QUARTER

| | d | h | m |
|---|---|---|---|
| Jan | 23 | 00 | 45 |
| Feb | 21 | 10 | 56 |
| Mar | 22 | 18 | 22 |
| Apr | 21 | 00 | 15 |
| May | 20 | 06 | 02 |
| Jun | 18 | 13 | 02 |
| Jul | 17 | 22 | 17 |
| Aug | 16 | 10 | 25 |
| Sep | 15 | 01 | 44 |
| Oct | 14 | 20 | 06 |
| Nov | 13 | 16 | 38 |
| Dec | 13 | 13 | 41 |

### FULL MOON

| | d | h | m |
|---|---|---|---|
| Jan | 14 | 04 | 30 |
| Feb | 13 | 22 | 58 |
| Mar | 15 | 15 | 13 |
| Apr | 14 | 04 | 31 |
| May | 13 | 14 | 50 |
| Jun | 11 | 22 | 49 |
| Jul | 11 | 05 | 33 |
| Aug | 9 | 12 | 17 |
| Sep | 7 | 20 | 13 |
| Oct | 7 | 06 | 12 |
| Nov | 5 | 18 | 46 |
| Dec | 5 | 10 | 01 |

# THE MOON'S ORBIT

Dates of Apogee, when the Moon is furthest from the Earth (approximately 407 000km) and date of Perigee, when the Moon is closest to the Earth (approximately 357 000km) are given below.

| Moon at Perigee | | | | Moon at Apogee | | | |
|---|---|---|---|---|---|---|---|
| | d | h | | | d | h | |
| Jan. | 28 | 11 | Aug. | 8 | 21 | Jan. 13 | 07 |
| Feb. | 25 | 18 | Sep. | 6 | 05 | Feb. 9 | 18 |
| Mar. | 24 | 21 | Oct. | 4 | 03 | Mar. 9 | 12 |
| Apr. | 18 | 19 | Oct. | 30 | 05 | Apr. 6 | 09 |
| May | 16 | 01 | Nov. | 24 | 17 | May 4 | 04 |
| June | 13 | 01 | Dec. | 22 | 13 | May 31 | 20 |
| July | 11 | 12 | | | | Jun 28 | 06 |
| | | | | | | Jul 25 | 10 |
| | | | | | | Aug 21 | 16 |
| | | | | | | Sep 18 | 05 |
| | | | | | | Oct. 15 | 23 |
| | | | | | | Nov. 12 | 20 |
| | | | | | | Dec. 10 | 16 |

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. It occasionally passes in front of bright stars (details given in Occultation section - page 35) and close to visible planets (details given in Diary pages 4 and 5).

## TIMES OF MOONRISE AND MOONSET

Times for Bloemfontein, Cape Town, Durban, Johannesburg and Port Elizabeth can be obtained from the tables on pages 11 to 16.

## THE SURFACE OF THE MOON

In common with the inner planets of our solar system, the Moon's surface suffered bombardment by numerous minor bodies during a period 4,5 to 3,0 billion years ago. This had produced the heavily cratered topography now visible. Some particularly large impacts caused large circular depressions, which were flooded by molten lava from the Moon's interior. These are the maria basins which appear smoother and darker than the rest of the surface (the Latin words mare and maria come from older times when they 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 of so deep.

## LUNAR ECLIPSES

There will be two penumbral eclipses of the moon in 1987. In a penumbral eclipse the full shadow of the earth does not reach the moon and its surface is thus only dimmed.

On April 14 the moon enters the half-shadow at 2h20m and leaves it at 6h18m. On October 7 the times are respectively 03h53m and 08h10m.

## MAP OF THE MOON'S NEAR SIDE


## LIBRATIONS

Jan 14, Feb 10, Mar 10
Apr 6, Mar 3, May 30
Jun 26, Jul 24, Aug 20
Sep 16, Oct 14, Nov 9
Dec 7

Jan 1, Jan 28, Feb 24
Mar 23, Apr 30, May 17
Jun 13, Jul 11, Aug 7
Sep 3, Sep 30, Oct 27
Nov 23, Dec 21

Jan 6, Feb 3, Mar 3
Mar 31, Apr 26, May 23
Jun 19, Jul 17, Aug 15
Sep 12, Oct 10, Nov 6
Dec 4, Dec 29

Jan 1, Jan 28, Feb 24
Mar 23, Apr 20, May 17
Jun 13, Jul 11, Aug 7
Sep 3, Sep 30, Oct 27
Nov 23, Dec 21

1 9 8 7

TIMES OF MOON RISE AND MOON SET - JOHANNESBURG

| | JANUARY | | FEBRUARY | | MARCH | | APRIL | | MAY | | JUNE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| 1 | 06h24m | 20h45m | 08h33m | 31h14m | 07h15m | 19h41m | 08h56m | 19h52m | 09h38m | 19h57m | 10h46m | 21h26m |
| 2 | 07 36 | 21 32 | 09 34 | 21 46 | 08 15 | 20 13 | 09 55 | 20 32 | 10 33 | 20 49 | 11 23 | 22 21 |
| 3 | 08 45 | 22 11 | 10 32 | 22 17 | 09 14 | 20 46 | 10 53 | 21 17 | 11 24 | 21 43 | 11 56 | 23 15 |
| 4 | 09 50 | 22 46 | 11 29 | 22 50 | 10 12 | 21 20 | 11 50 | 22 06 | 12 09 | 22 39 | 12 27 | - |
| 5 | 10 50 | 23 18 | 12 25 | 23 24 | 11 10 | 21 58 | 12 43 | 22 58 | 12 49 | 23 35 | 12 56 | 00 09 |
| 6 | 11 47 | 23 48 | 13 22 | - | 12 08 | 22 39 | 13 31 | 23 53 | 13 25 | - | 13 26 | 01 03 |
| 7 | 12 43 | - | 14 19 | 00 02 | 13 05 | 23 25 | 14 14 | - | 13 57 | 00 30 | 13 56 | 01 58 |
| 8 | 13 38 | 00 19 | 15 14 | 00 45 | 14 00 | - | 14 52 | 00 50 | 14 28 | 01 25 | 14 30 | 02 57 |
| 9 | 14 33 | 00 51 | 16 07 | 01 32 | 14 51 | 00 15 | 15 27 | 01 46 | 14 58 | 02 20 | 15 09 | 04 00 |
| 10 | 15 30 | 01 26 | 16 56 | 02 23 | 15 37 | 01 08 | 15 59 | 02 42 | 15 28 | 03 16 | 15 56 | 05 07 |
| 11 | 16 25 | 02 05 | 17 41 | 03 18 | 16 18 | 02 04 | 16 30 | 03 37 | 16 01 | 04 14 | 16 51 | 06 18 |
| 12 | 17 20 | 02 49 | 18 21 | 04 14 | 16 55 | 03 01 | 17 00 | 04 33 | 16 37 | 05 15 | 17 55 | 07 29 |
| 13 | 18 12 | 03 37 | 18 56 | 05 11 | 17 29 | 03 58 | 17 32 | 05 31 | 17 20 | 06 21 | 19 05 | 08 36 |
| 14 | 19 00 | 04 30 | 19 29 | 06 07 | 18 00 | 04 54 | 18 06 | 06 30 | 18 10 | 07 30 | 20 18 | 09 34 |
| 15 | 19 43 | 05 25 | 19 59 | 07 02 | 18 31 | 05 49 | 18 44 | 07 33 | 19 08 | 08 41 | 21 28 | 10 23 |
| 16 | 20 21 | 06 22 | 20 29 | 07 57 | 19 01 | 06 45 | 19 28 | 08 39 | 20 14 | 09 49 | 22 34 | 11 05 |
| 17 | 20 55 | 07 18 | 20 59 | 08 53 | 19 33 | 07 43 | 20 20 | 09 48 | 21 24 | 10 51 | 23 36 | 11 42 |
| 18 | 21 27 | 08 13 | 21 31 | 09 50 | 20 07 | 08 42 | 21 20 | 10 56 | 22 33 | 11 43 | - | 12 14 |
| 19 | 21 57 | 09 07 | 22 06 | 10 49 | 20 47 | 09 45 | 22 25 | 12 00 | 23 40 | 12 28 | 00 35 | 12 49 |
| 20 | 22 26 | 10 02 | 22 47 | 11 52 | 21 32 | 10 51 | 23 34 | 12 57 | - | 13 06 | 01 33 | 13 17 |
| 21 | 22 57 | 10 57 | 23 35 | 12 58 | 22 26 | 11 58 | - | 13 46 | 00 42 | 13 40 | 02 30 | 13 50 |
| 22 | 23 30 | 11 55 | - | 14 05 | 23 26 | 13 04 | 00 41 | 14 28 | 01 42 | 14 12 | 03 27 | 14 25 |
| 23 | - | 12 56 | 00 31 | 15 11 | - | 14 05 | 01 46 | 15 05 | 02 40 | 14 43 | 04 25 | 15 04 |
| 24 | 00 07 | 14 01 | 01 36 | 16 12 | 00 33 | 15 00 | 02 48 | 15 38 | 03 37 | 15 15 | 05 23 | 15 48 |
| 25 | 00 51 | 15 10 | 02 45 | 17 06 | 01 42 | 15 47 | 03 48 | 16 10 | 04 34 | 15 48 | 06 19 | 16 36 |
| 26 | 01 44 | 16 20 | 03 57 | 17 52 | 02 50 | 16 28 | 04 46 | 16 41 | 05 32 | 16 25 | 07 12 | 17 29 |
| 27 | 02 46 | 17 27 | 05 06 | 18 32 | 03 55 | 17 04 | 05 44 | 17 14 | 06 31 | 17 05 | 08 01 | 18 24 |
| 28 | 03 55 | 18 27 | 06 12 | 19 08 | 04 58 | 17 38 | 06 42 | 17 48 | 07 29 | 17 51 | 08 44 | 19 20 |
| 29 | 05 08 | 19 18 | | | 05 58 | 18 10 | 07 42 | 18 27 | 08 25 | 18 41 | 09 23 | 20 15 |
| 30 | 06 20 | 20 02 | | | 06 58 | 18 42 | 08 41 | 19 10 | 09 17 | 19 35 | 09 57 | 21 09 |
| 31 | 07 29 | 20 40 | | | 07 56 | 19 16 | | | 10 04 | 20 30 | | |

# 1987

## TIMES OF MOON RISE AND MOON SET - JOHANNESBURG

| | JULY | | AUGUST | | SEPTEMBER | | OCTOBER | | NOVEMBER | | DECEMBER | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| 1 | 10h28m | 22h02m | 10h26m | 23h33m | 11h05m | 00h32m | 12h04m | 01h35m | 14h21m | 02h31m | 15h14m | 02h11m |
| 2 | 10 57 | 22 55 | 10 59 | - | 12 02 | 01 39 | 13 13 | 02 28 | 15 20 | 03 05 | 16 14 | 02 44 |
| 3 | 11 26 | 23 48 | 11 37 | 00 33 | 13 07 | 02 43 | 14 22 | 03 15 | 16 22 | 03 37 | 17 15 | 03 20 |
| 4 | 11 55 | - | 12 21 | 01 37 | 14 18 | 03 43 | 15 28 | 03 55 | 17 23 | 04 11 | 18 16 | 04 00 |
| 5 | 12 26 | 00 44 | 13 14 | 02 44 | 15 30 | 04 35 | 16 33 | 04 32 | 18 25 | 04 45 | 19 16 | 04 45 |
| 6 | 13 02 | 01 43 | 14 17 | 03 53 | 16 40 | 05 21 | 17 35 | 05 06 | 19 27 | 05 23 | 20 12 | 05 35 |
| 7 | 13 43 | 02 46 | 15 27 | 04 58 | 17 47 | 06 01 | 18 37 | 05 40 | 20 29 | 06 06 | 21 03 | 06 29 |
| 8 | 14 33 | 03 54 | 16 41 | 05 56 | 18 52 | 06 37 | 19 39 | 06 14 | 21 28 | 06 53 | 21 48 | 07 25 |
| 9 | 15 32 | 05 05 | 17 54 | 06 47 | 19 54 | 07 11 | 20 42 | 06 50 | 22 22 | 07 44 | 22 27 | 08 21 |
| 10 | 16 41 | 06 14 | 19 03 | 07 30 | 20 56 | 07 45 | 21 44 | 07 30 | 23 10 | 08 39 | 23 02 | 09 17 |
| 11 | 17 54 | 07 17 | 20 09 | 08 08 | 21 58 | 08 19 | 22 44 | 08 14 | 23 53 | 09 35 | 23 33 | 10 11 |
| 12 | 19 08 | 08 12 | 21 11 | 08 43 | 22 59 | 08 57 | 23 40 | 09 03 | - | 10 31 | - | 11 03 |
| 13 | 20 18 | 08 58 | 22 12 | 09 16 | 23 58 | 09 37 | - | 09 55 | 00 30 | 11 26 | 00 02 | 11 55 |
| 14 | 21 24 | 09 38 | 23 12 | 09 49 | - | 10 23 | 00 32 | 10 50 | 01 03 | 12 20 | 00 30 | 12 48 |
| 15 | 22 26 | 10 13 | - | 10 24 | 00 56 | 11 12 | 01 17 | 11 46 | 01 34 | 13 13 | 00 58 | 13 42 |
| 16 | 23 26 | 10 46 | 00 11 | 11 01 | 01 50 | 12 05 | 01 57 | 12 42 | 02 02 | 14 06 | 01 28 | 14 38 |
| 17 | - | 11 18 | 01 11 | 11 43 | 02 38 | 13 00 | 02 33 | 13 37 | 02 31 | 15 00 | 02 02 | 15 40 |
| 18 | 00 24 | 11 51 | 02 08 | 12 29 | 03 21 | 13 56 | 03 05 | 14 31 | 03 01 | 15 56 | 02 41 | 16 45 |
| 19 | 01 22 | 12 25 | 03 04 | 13 19 | 04 00 | 14 52 | 03 35 | 15 24 | 03 33 | 16 56 | 03 27 | 17 53 |
| 20 | 02 20 | 13 03 | 03 55 | 14 13 | 04 34 | 15 46 | 04 04 | 16 18 | 04 09 | 18 00 | 04 23 | 19 02 |
| 21 | 03 18 | 13 46 | 04 42 | 15 08 | 05 05 | 16 40 | 04 33 | 17 13 | 04 52 | 19 07 | 05 27 | 20 06 |
| 22 | 04 14 | 14 33 | 05 23 | 16 04 | 05 34 | 17 33 | 05 03 | 18 11 | 05 42 | 20 15 | 06 37 | 21 02 |
| 23 | 05 08 | 15 24 | 06 00 | 16 59 | 06 03 | 18 27 | 05 37 | 19 12 | 06 40 | 21 21 | 07 50 | 21 50 |
| 24 | 05 58 | 16 19 | 06 33 | 17 53 | 06 32 | 19 23 | 06 15 | 20 16 | 07 46 | 22 20 | 09 00 | 22 31 |
| 25 | 06 43 | 17 14 | 07 03 | 18 46 | 07 03 | 20 21 | 06 59 | 21 23 | 08 55 | 23 11 | 10 06 | 23 07 |
| 26 | 07 23 | 18 10 | 07 32 | 19 39 | 07 37 | 21 22 | 07 51 | 22 28 | 10 05 | 23 54 | 11 09 | 23 41 |
| 27 | 07 58 | 19 04 | 08 00 | 20 33 | 08 16 | 22 25 | 08 51 | 23 30 | 11 11 | - | 12 10 | - |
| 28 | 08 30 | 19 58 | 08 29 | 21 28 | 09 02 | 23 31 | 09 56 | - | 12 14 | 00 32 | 13 09 | 00 13 |
| 29 | 09 00 | 20 50 | 09 01 | 22 26 | 09 56 | - | 11 04 | 00 25 | 13 15 | 01 07 | 14 08 | 00 46 |
| 30 | 09 28 | 21 43 | 09 36 | 23 28 | 10 57 | 00 35 | 12 12 | 01 13 | 14 15 | 01 39 | 15 08 | 01 21 |
| 31 | 09 57 | 22 37 | 10 17 | - | | | 13 17 | 01 54 | | | 16 08 | 01 59 |

1 9 8 7

TIMES OF MOON RISE AND MOON 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 |
| 1 | 06h43m | 21h44m | 09h09m | 21h56m | 07h53m | 20h20m | 09h51m | 20h15m | 10h42m | 20h14m | 11h45m | 21h48m |
| 2 | 07 59 | 22 26 | 10 14 | 22 23 | 08 58 | 20 48 | 10 54 | 20 52 | 11 38 | 21 05 | 12 18 | 22 47 |
| 3 | 09 13 | 23 01 | 11 17 | 22 50 | 10 02 | 21 16 | 11 56 | 21 34 | 12 27 | 22 01 | 12 47 | 23 45 |
| 4 | 10 23 | 23 30 | 12 19 | 23 18 | 11 05 | 21 46 | 12 54 | 22 22 | 13 10 | 22 59 | 13 14 | - |
| 5 | 11 28 | 23 57 | 13 20 | 23 48 | 12 08 | 22 19 | 13 47 | 23 15 | 13 47 | 23 58 | 13 39 | 00 43 |
| 6 | 12 30 | - | 14 21 | - | 13 09 | 22 57 | 14 34 | - | 14 19 | - | 14 04 | 01 42 |
| 7 | 13 30 | 00 23 | 15 20 | 00 23 | 14 08 | 23 41 | 15 14 | 00 12 | 14 47 | 00 57 | 14 30 | 02 42 |
| 8 | 14 30 | 00 49 | 16 18 | 01 02 | 15 04 | - | 15 49 | 01 11 | 15 13 | 01 57 | 15 00 | 03 46 |
| 9 | 15 29 | 01 18 | 17 11 | 01 48 | 15 54 | 00 31 | 16 19 | 02 11 | 15 39 | 02 56 | 15 34 | 04 54 |
| 10 | 16 29 | 01 49 | 17 59 | 02 40 | 16 38 | 01 25 | 16 47 | 03 11 | 16 05 | 03 57 | 16 16 | 06 06 |
| 11 | 17 28 | 02 25 | 18 41 | 03 36 | 17 17 | 02 24 | 17 13 | 04 11 | 06 32 | 05 00 | 17 08 | 07 21 |
| 12 | 18 24 | 03 06 | 19 18 | 04 35 | 17 50 | 03 24 | 17 39 | 05 12 | 17 04 | 06 07 | 18 11 | 08 34 |
| 13 | 19 16 | 03 54 | 19 49 | 05 36 | 18 19 | 04 25 | 18 06 | 06 14 | 17 42 | 07 18 | 19 23 | 09 40 |
| 14 | 20 02 | 04 47 | 2- 18 | 06 36 | 18 46 | 05 25 | 18 35 | 07 19 | 18 28 | 08 31 | 20 39 | 10 35 |
| 15 | 20 42 | 05 44 | 20 44 | 07 36 | 19 12 | 06 25 | 19 09 | 08 27 | 19 25 | 09 45 | 21 54 | 11 20 |
| 16 | 21 17 | 06 44 | 21 09 | 08 35 | 19 38 | 07 26 | 19 49 | 09 38 | 20 30 | 10 54 | 23 05 | 11 57 |
| 17 | 21 47 | 07 44 | 21 35 | 09 35 | 20 05 | 08 29 | 20 37 | 10 51 | 21 42 | 11 54 | - | 12 28 |
| 18 | 22 14 | 08 43 | 22 02 | 10 37 | 20 35 | 09 33 | 21 36 | 12 01 | 22 56 | 12 43 | 00 12 | 12 56 |
| 19 | 22 40 | 09 42 | 22 33 | 11 41 | 21 10 | 10 41 | 22 42 | 13 05 | - | 13 23 | 01 16 | 13 25 |
| 20 | 23 05 | 10 41 | 23 09 | 12 49 | 21 51 | 11 51 | 23 53 | 13 59 | 00 07 | 13 56 | 02 18 | 13 49 |
| 21 | 23 21 | 11 41 | 23 53 | 13 59 | 22 42 | 13 01 | - | 14 44 | 01 15 | 14 25 | 03 20 | 14 17 |
| 22 | 23 59 | 12 43 | - | 15 09 | 23 42 | 14 09 | 01 05 | 15 21 | 02 20 | 14 52 | 04 22 | 14 48 |
| 23 | - | 13 49 | 00 48 | 16 16 | - | 15 09 | 02 15 | 15 53 | 03 22 | 15 18 | 05 24 | 15 24 |
| 24 | 00 32 | 14 59 | 01 52 | 17 16 | 00 50 | 16 01 | 03 22 | 16 22 | 04 24 | 15 45 | 06 25 | 16 05 |
| 25 | 01 12 | 16 12 | 03 04 | 18 06 | 02 02 | 16 44 | 04 27 | 16 48 | 05 26 | 16 14 | 07 23 | 16 53 |
| 26 | 02 01 | 17 24 | 04 19 | 18 47 | 03 15 | 17 20 | 05 30 | 17 15 | 06 29 | 16 47 | 08 16 | 17 46 |
| 27 | 03 02 | 18 31 | 05 34 | 19 22 | 04 26 | 17 51 | 06 33 | 17 43 | 07 31 | 17 25 | 09 03 | 18 42 |
| 28 | 04 13 | 19 28 | 06 45 | 19 52 | 05 34 | 18 19 | 07 36 | 18 14 | 08 32 | 18 08 | 09 44 | 19 41 |
| 29 | 05 29 | 20 15 | | | 06 39 | 18 47 | 08 39 | 18 48 | 09 29 | 18 57 | 10 19 | 20 40 |
| 30 | 06 46 | 20 54 | | | 07 43 | 19 14 | 09 42 | 19 28 | 10 21 | 19 52 | 10 49 | 21 38 |
| 31 | 07 59 | 21 27 | | | 08 47 | 19 43 | | | 11 06 | 20 49 | | |

# 1987

## TIMES OF MOON RISE AND MOON SET CAPE TOWN

FOR PORT ELIZABETH SUBTRACT 28 MINUTES

| | JULY | | AUGUST | | SEPTEMBER | | OCTOBER | | NOVEMBER | | DECEMBER | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | set | Rise | set | Rise | set | Rise | set | Rise | set | Rise | set |
| 1 | $11^h16^m$ | $22^h35^m$ | $10^h59^m$ | h m | $11^h23^m$ | $01^h35^m$ | $12^h22^m$ | $02^h38^m$ | $14^h56^m$ | $03^h18^m$ | $16^h03^m$ | $02^h45^m$ |
| 2 | 11 41 | 23 32 | 11 27 | 00 23 | 12 18 | 02 43 | 13 35 | 03 28 | 16 01 | 03 47 | 17 07 | 03 14 |
| 3 | 12 05 | - | 12 00 | 01 28 | 13 24 | 03 48 | 14 48 | 04 10 | 17 08 | 04 15 | 18 13 | 03 45 |
| 4 | 12 30 | 00 31 | 12 41 | 02 37 | 14 37 | 04 45 | 16 00 | 04 46 | 18 14 | 04 43 | 19 17 | 04 21 |
| 5 | 12 57 | 01 31 | 13 31 | 03 48 | 15 53 | 05 34 | 17 10 | 05 17 | 19 20 | 05 13 | 20 19 | 05 03 |
| 6 | 13 28 | 02 35 | 14 33 | 04 58 | 17 09 | 06 14 | 18 18 | 05 46 | 20 27 | 05 47 | 21 16 | 05 51 |
| 7 | 14 05 | 03 43 | 15 45 | 06 02 | 18 21 | 06 49 | 19 25 | 06 15 | 21 31 | 06 25 | 22 06 | 06 45 |
| 8 | 14 51 | 04 55 | 17 02 | 06 57 | 19 32 | 07 20 | 20 32 | 06 44 | 22 32 | 07 10 | 22 48 | 07 43 |
| 9 | 15 49 | 06 09 | 18 20 | 07 43 | 20 40 | 07 49 | 21 39 | 07 16 | 23 26 | 08 00 | 23 24 | 08 42 |
| 10 | 16 57 | 07 19 | 19 35 | 08 21 | 21 46 | 08 17 | 22 45 | 07 52 | - | 08 56 | 23 55 | 09 41 |
| 11 | 18 13 | 08 20 | 20 46 | 08 53 | 22 53 | 08 47 | 23 47 | 08 32 | 00 13 | 09 54 | - | 10 39 |
| 12 | 19 31 | 09 11 | 21 53 | 09 23 | 23 58 | 09 20 | - | 09 19 | 00 52 | 10 53 | 00 22 | 11 36 |
| 13 | 20 47 | 09 52 | 23 00 | 09 51 | - | 09 57 | 00 45 | 10 11 | 01 26 | 11 52 | 00 46 | 12 32 |
| 14 | 21 58 | 10 26 | - | 10 19 | 01 01 | 10 40 | 01 35 | 11 08 | 01 55 | 12 50 | 01 10 | 13 29 |
| 15 | 23 05 | 10 56 | 00 44 | 10 50 | 02 00 | 11 28 | 02 18 | 12 06 | 02 21 | 13 47 | 01 34 | 14 27 |
| 16 | - | 11 24 | 01 08 | 11 23 | 02 54 | 12 21 | 02 55 | 13 05 | 02 46 | 14 44 | 02 00 | 15 29 |
| 17 | 00 10 | 11 51 | 02 11 | 12 02 | 03 41 | 13 18 | 03 27 | 14 04 | 03 10 | 15 43 | 02 29 | 16 35 |
| 18 | 01 13 | 12 20 | 03 12 | 12 45 | 04 22 | 14 18 | 03 55 | 15 02 | 03 35 | 16 45 | 03 04 | 17 45 |
| 19 | 02 15 | 12 50 | 04 08 | 13 35 | 04 56 | 15 17 | 04 20 | 16 00 | 04 03 | 17 49 | 03 46 | 18 57 |
| 20 | 03 18 | 13 24 | 04 59 | 14 30 | 05 26 | 16 15 | 04 45 | 16 58 | 04 34 | 18 58 | 04 39 | 20 07 |
| 21 | 04 19 | 14 04 | 05 44 | 15 27 | 05 53 | 17 13 | 05 09 | 17 59 | 05 13 | 20 09 | 05 43 | 21 09 |
| 22 | 05 18 | 14 49 | 06 22 | 16 27 | 06 18 | 18 11 | 05 35 | 19 01 | 06 00 | 21 20 | 06 55 | 22 02 |
| 23 | 06 13 | 15 40 | 06 55 | 17 26 | 06 42 | 19 10 | 06 04 | 20 07 | 06 57 | 22 25 | 08 12 | 22 45 |
| 24 | 07 02 | 16 36 | 07 24 | 18 24 | 07 07 | 20 10 | 06 38 | 21 16 | 08 03 | 23 22 | 09 27 | 23 21 |
| 25 | 07 44 | 17 35 | 07 50 | 19 21 | 07 33 | 21 12 | 07 19 | 22 26 | 09 15 | - | 10 38 | 23 53 |
| 26 | 08 21 | 18 33 | 08 14 | 20 19 | 08 03 | 22 19 | 08 08 | 23 33 | 10 28 | 00 09 | 11 47 | - |
| 27 | 08 52 | 19 32 | 08 38 | 21 17 | 08 38 | 23 27 | 09 07 | - | 11 40 | 00 48 | 12 50 | 00 21 |
| 28 | 09 20 | 20 30 | 09 03 | 22 17 | 09 20 | - | 10 14 | 00 34 | 12 48 | 01 21 | 13 56 | 00 48 |
| 29 | 09 45 | 21 27 | 09 30 | 23 20 | 10 12 | 00 35 | 11 25 | 01 27 | 13 54 | 01 50 | 15 01 | 01 16 |
| 30 | 10 09 | 22 24 | 10 01 | - | 11 13 | 01 40 | 12 37 | 02 10 | 14 58 | 02 18 | 16 05 | 01 47 |
| 31 | 10 03 | 23 22 | 10 38 | 00 26 | | | 13 48 | 02 47 | | | 17 09 | 02 21 |

# 1987

## TIMES OF MOON RISE AND MOON 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 |
| 1 | 06h02m | 20h41m | 08h19m | 21h03m | 07h01m | 19h29m | 08h50m | 19h33m | 09h37m | 19h35m | 10h43m | 21h06m |
| 2 | 07 16 | 21 26 | 09 21 | 21 33 | 08 04 | 19 59 | 09 51 | 20 11 | 10 32 | 20 26 | 11 18 | 22 02 |
| 3 | 08 28 | 22 04 | 10 22 | 22 02 | 09 05 | 20 30 | 10 51 | 20 54 | 11 22 | 21 21 | 11 50 | 22 58 |
| 4 | 09 34 | 12 36 | 11 21 | 22 33 | 10 06 | 21 02 | 11 48 | 21 43 | 12 07 | 22 18 | 12 19 | 23 54 |
| 5 | 10 37 | 23 06 | 12 20 | 23 05 | 11 06 | 21 38 | 12 41 | 22 36 | 12 45 | 23 15 | 12 46 | - |
| 6 | 11 36 | 23 34 | 13 18 | 23 42 | 12 05 | 22 17 | 13 29 | 23 31 | 13 19 | - | 13 13 | 00 50 |
| 7 | 12 34 | - | 14 16 | - | 13 03 | 23 02 | 14 11 | - | 13 50 | 00 12 | 13 42 | 01 48 |
| 8 | 13 31 | 00 03 | 15 13 | 00 23 | 13 59 | 23 52 | 14 48 | 00 29 | 14 19 | 01 09 | 14 14 | 02 49 |
| 9 | 14 28 | 00 33 | 16 06 | 01 09 | 14 49 | - | 15 21 | 01 27 | 14 47 | 02 06 | 14 51 | 03 54 |
| 10 | 15 26 | 01 07 | 16 55 | 02 01 | 15 35 | 00 46 | 15 51 | 02 25 | 15 15 | 03 04 | 15 35 | 05 03 |
| 11 | 16 23 | 01 44 | 17 38 | 02 56 | 16 15 | 01 43 | 16 20 | 03 22 | 15 46 | 04 04 | 16 28 | 06 16 |
| 12 | 17 19 | 02 27 | 18 17 | 03 54 | 16 50 | 02 41 | 16 48 | 04 20 | 16 20 | 05 08 | 17 32 | 07 28 |
| 13 | 18 11 | 03 15 | 18 51 | 04 52 | 17 22 | 03 40 | 17 17 | 05 20 | 17 00 | 06 16 | 18 43 | 08 34 |
| 14 | 18 58 | 04 07 | 19 21 | 05 50 | 17 52 | 04 38 | 17 49 | 06 22 | 17 48 | 07 27 | 19 57 | 09 31 |
| 15 | 19 39 | 05 04 | 19 50 | 06 47 | 18 20 | 05 35 | 18 25 | 07 27 | 18 45 | 08 39 | 21 09 | 10 19 |
| 16 | 20 16 | 06 01 | 20 17 | 07 44 | 18 48 | 06 34 | 19 08 | 08 35 | 19 51 | 09 48 | 22 18 | 10 59 |
| 17 | 20 49 | 06 59 | 20 46 | 08 42 | 19 17 | 07 33 | 19 58 | 09 46 | 21 02 | 10 49 | 23 22 | 11 33 |
| 18 | 21 19 | 07 56 | 21 15 | 09 41 | 19 50 | 08 35 | 20 57 | 10 55 | 22 13 | 11 40 | - | 12 03 |
| 19 | 21 46 | 08 53 | 21 49 | 10 42 | 20 27 | 09 40 | 22 03 | 11 59 | 23 22 | 12 23 | 00 24 | 12 36 |
| 20 | 22 14 | 09 49 | 22 27 | 11 47 | 21 11 | 10 47 | 23 12 | 12 55 | - | 12 59 | 01 23 | 13 02 |
| 21 | 22 42 | 10 47 | 23 13 | 12 55 | 22 03 | 11 56 | - | 13 42 | 00 27 | 13 31 | 02 22 | 13 32 |
| 22 | 23 13 | 11 46 | - | 14 04 | 23 03 | 13 02 | 00 21 | 14 22 | 01 29 | 14 01 | 03 21 | 14 06 |
| 23 | 23 49 | 12 49 | 00 09 | 15 10 | - | 14 04 | 01 29 | 14 57 | 02 20 | 14 29 | 04 21 | 14 43 |
| 24 | - | 13 57 | 01 13 | 16 11 | 00 10 | 14 57 | 02 33 | 15 28 | 03 28 | 14 59 | 05 20 | 15 26 |
| 25 | 00 31 | 15 07 | 02 23 | 17 03 | 01 21 | 15 43 | 03 35 | 15 57 | 04 27 | 15 30 | 06 17 | 16 14 |
| 26 | 01 22 | 16 18 | 03 36 | 17 47 | 02 31 | 16 22 | 14 36 | 16 27 | 05 27 | 16 05 | 07 11 | 17 06 |
| 27 | 02 23 | 17 25 | 04 48 | 18 25 | 03 38 | 16 56 | 05 36 | 16 57 | 06 28 | 16 44 | 07 59 | 18 02 |
| 28 | 03 33 | 18 24 | 05 56 | 18 59 | 04 43 | 17 27 | 06 36 | 17 30 | 07 27 | 17 29 | 08 41 | 18 59 |
| 29 | 04 47 | 19 14 | | | 05 46 | 17 57 | 07 37 | 18 07 | 08 24 | 18 19 | 19 18 | 19 56 |
| 30 | 06 01 | 19 56 | | | 06 48 | 18 27 | 08 38 | 18 48 | 09 16 | 19 12 | 09 51 | 20 52 |
| 31 | 07 12 | 20 31 | | | 07 49 | 18 59 | | | 10 02 | 20 09 | | |

# 1987

## TIMES OF MOON RISE AND MOON SET DURBAN

FOR BLOEMFONTEIN ADD 19 MINUTES

| | JULY | | AUGUST | | SEPTEMBER | | OCTOBER | | NOVEMBER | | DECEMBER | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| 1 | 10h20m | 21h47m | 10h11m | 23h25m | 10h43m | 00h30m | 11h41m | 01h33m | 14h06m | 02h23m | 15h06m | 01h57m |
| 2 | 10 47 | 22 41 | 10 42 | - | 11 39 | 01 37 | 12 52 | 02 25 | 15 08 | 02 54 | 16 08 | 02 28 |
| 3 | 11 14 | 23 37 | 11 18 | 00 27 | 12 45 | 02 42 | 14 03 | 03 10 | 16 13 | 03 25 | 17 11 | 03 02 |
| 4 | 11 41 | - | 12 00 | 01 33 | 13 56 | 03 41 | 15 12 | 03 48 | 17 16 | 03 55 | 18 13 | 03 40 |
| 5 | 12 11 | 00 35 | 12 52 | 02 42 | 15 10 | 04 31 | 16 19 | 04 23 | 18 20 | 04 28 | 19 14 | 04 23 |
| 6 | 12 44 | 01 36 | 13 54 | 03 51 | 16 22 | 05 15 | 17 24 | 04 55 | 19 24 | 05 04 | 20 11 | 05 12 |
| 7 | 13 23 | 02 41 | 05 05 | 04 56 | 17 32 | 05 53 | 18 29 | 05 26 | 20 27 | 05 45 | 21 01 | 06 06 |
| 8 | 14 11 | 03 51 | 16 20 | 05 54 | 18 39 | 06 26 | 19 33 | 05 58 | 21 26 | 06 31 | 21 45 | 07 03 |
| 9 | 15 09 | 05 03 | 17 35 | 06 42 | 19 44 | 06 59 | 20 37 | 06 32 | 22 21 | 07 22 | 22 23 | 08 01 |
| 10 | 16 17 | 06 12 | 18 47 | 07 23 | 20 48 | 07 30 | 21 41 | 07 10 | 23 08 | 08 16 | 22 56 | 08 58 |
| 11 | 17 32 | 07 15 | 19 55 | 07 59 | 21 52 | 08 02 | 22 42 | 07 52 | 23 50 | 09 14 | 23 25 | 09 54 |
| 12 | 18 48 | 08 08 | 21 00 | 08 31 | 22 55 | 08 37 | 23 39 | 08 40 | - | 10 11 | 23 52 | 10 48 |
| 13 | 20 00 | 08 53 | 22 03 | 09 02 | 23 56 | 09 17 | - | 09 32 | 00 25 | 11 08 | - | 11 42 |
| 14 | 21 09 | 09 30 | 23 05 | 09 33 | - | 10 00 | 00 30 | 10 28 | 00 57 | 12 03 | 00 18 | 12 36 |
| 15 | 22 13 | 10 03 | - | 10 06 | 00 55 | 10 49 | 01 15 | 11 25 | 01 25 | 12 58 | 00 45 | 13 32 |
| 16 | 23 15 | 10 34 | 00 07 | 10 42 | 01 49 | 11 42 | 01 54 | 12 22 | 01 52 | 13 53 | 01 13 | 14 31 |
| 17 | - | 11 03 | 01 08 | 11 21 | 02 37 | 12 38 | 02 27 | 13 19 | 02 19 | 14 49 | 01 45 | 15 34 |
| 18 | 00 15 | 11 34 | 02 07 | 12 06 | 03 19 | 13 36 | 02 58 | 14 15 | 02 46 | 15 48 | 02 21 | 16 41 |
| 19 | 01 15 | 12 07 | 03 03 | 12 56 | 03 55 | 14 33 | 03 26 | 15 10 | 03 17 | 16 50 | 03 06 | 17 52 |
| 20 | 02 15 | 12 43 | 03 54 | 13 50 | 04 28 | 15 29 | 03 53 | 16 06 | 03 51 | 17 55 | 04 00 | 19 01 |
| 21 | 03 15 | 13 24 | 04 40 | 14 47 | 04 57 | 16 25 | 04 20 | 17 03 | 04 31 | 19 05 | 05 04 | 20 04 |
| 22 | 04 13 | 14 10 | 05 20 | 15 44 | 05 24 | 17 20 | 04 48 | 18 03 | 05 20 | 20 14 | 06 15 | 20 59 |
| 23 | 05 07 | 15 01 | 05 55 | 16 41 | 05 51 | 18 16 | 05 19 | 19 06 | 06 18 | 21 20 | 07 29 | 21 45 |
| 24 | 05 57 | 15 56 | 06 26 | 17 37 | 06 18 | 19 14 | 05 55 | 20 13 | 07 23 | 22 18 | 08 41 | 22 24 |
| 25 | 06 41 | 16 53 | 06 54 | 18 32 | 06 47 | 20 14 | 06 38 | 21 21 | 08 34 | 23 07 | 09 50 | 22 58 |
| 26 | 07 19 | 17 50 | 07 21 | 19 27 | 07 19 | 21 17 | 07 29 | 22 27 | 09 45 | 23 49 | 10 56 | 23 29 |
| 27 | 07 53 | 18 47 | 07 48 | 20 23 | 07 56 | 22 23 | 08 28 | 23 29 | 10 54 | - | 11 58 | 23 59 |
| 28 | 08 23 | 19 42 | 08 15 | 21 20 | 08 40 | 23 29 | 09 34 | - | 11 59 | 00 25 | 13 00 | - |
| 29 | 08 51 | 20 36 | 08 44 | 22 20 | 09 33 | - | 10 43 | 00 23 | 13 02 | 00 56 | 14 01 | 00 30 |
| 30 | 09 17 | 21 31 | 09 17 | 23 24 | 10 34 | 00 34 | 11 53 | 01 09 | 14 04 | 01 27 | 15 03 | 01 03 |
| 31 | 09 44 | 22 27 | 09 56 | - | | | 1300 | 01 48 | | | 16 05 | 01 39 |

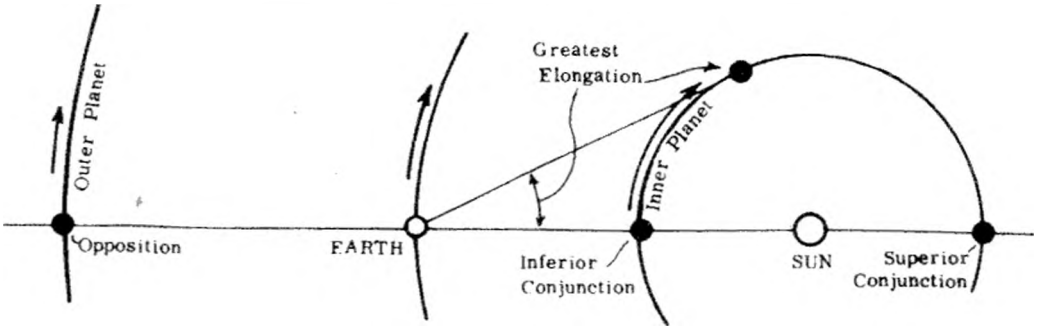
# THE PLANETS 1987

BASIC DATA

| | Dist from Sun $10^6$ km | Period of Revolution years | Mass (Earth = 1) | Diameter $10^3$ km | Rotation Period | Inclination of Equator to Orbit |
|---|---|---|---|---|---|---|
| Mercury | 58 | 0,24 | 0,056 | 4,98 | 59d | ? |
| Venus | 108 | 0,62 | 0,817 | 12,4 | 244 | ? |
| Earth | 150 | 1,00 | 1,000 | 12,8 | $23^h56^m$ | 23°27' |
| Mars | 228 | 1,88 | 0,108 | 6,76 | 24 37 | 23 59 |
| Jupiter | 778 | 11,9 | 318,0 | 142,7 | 09 51 | 03 04 |
| Saturn | 1 426 | 29,5 | 95,2 | 120,8 | 10 14 | 26 44 |
| Uranus | 2 868 | 84,0 | 14,6 | 47,1 | 10 49 | 27 53 |
| Neptune | 4 494 | 164,8 | 17,3 | 44,6 | 14 ? | 28 48 |
| Pluto | 5 896 | 247,6 | 0,9? | ? | 6d? | ? |

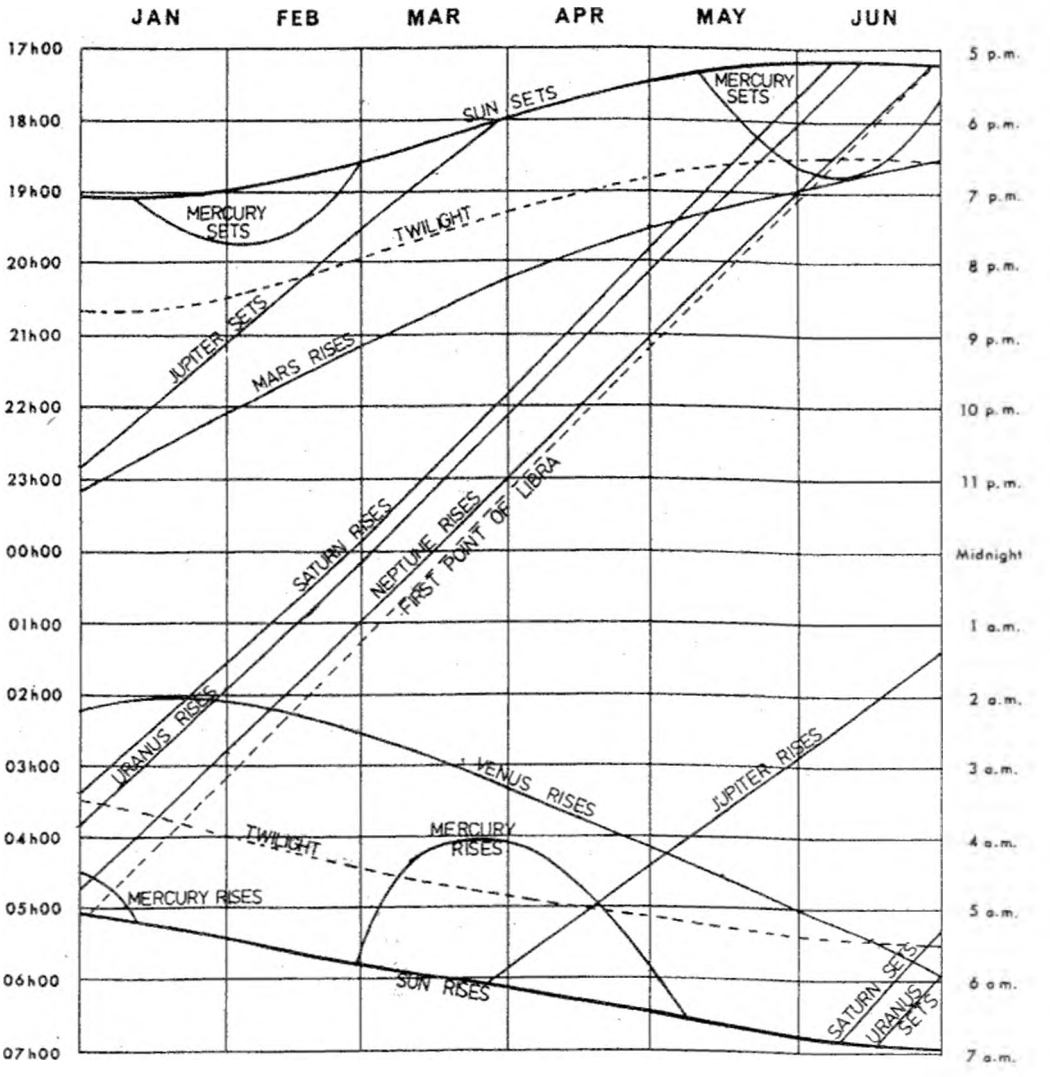
GENERAL

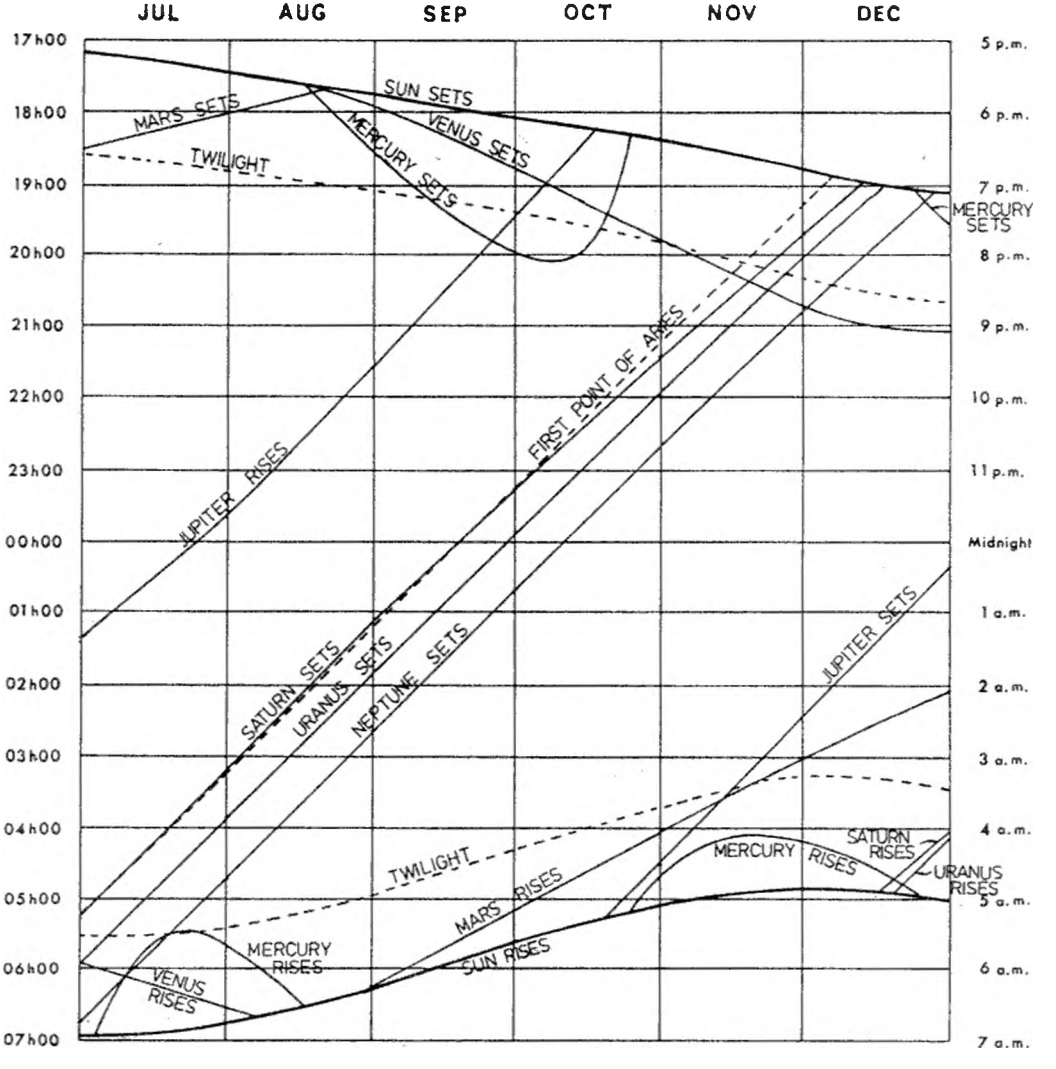
Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Unlike the distant stars, their relative positions do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the 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 in 1986 are listed chronologically in the Diary (pages 4 and 5) and are also mentioned in the text below.



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. Longitude corrections are given on page 44.




JUL
AUG
SEP
OCT
NOV
DEC
17h00
18h00
19h00
20h00
21h00
22h00
23h00
00h00
01h00
02h00
03h00
04h00
05h00
06h00
07h00
5 p.m.
6 p.m.
7 p.m.
8 p.m.
9 p.m.
10 p.m.
11 p.m.
Midnight
1 a.m.
2 a.m.
3 a.m.
4 a.m.
5 a.m.
6 a.m.
7 a.m.
SUN SETS
MARS SETS
VENUS SETS
MERCURY SETS
TWILIGHT
MERCURY SETS
FIRST POINT OF ARIES
JUPITER RISES
SATURN SETS
URANUS SETS
NEPTUNE SETS
JUPITER SETS
TWILIGHT
MERCURY RISES
SATURN RISES
URANUS RISES
MARS RISES
MERCURY RISES
VENUS RISES
SUN RISES

# The Planets 1987

## OBSERVING THE PLANETS

To the naked eye, planets appear as virtually pinpoint 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

Mercury will be seen in the early evening sky from about January 26 to February 21, May 15 to June 26, and August 30 to October 22.

It will be seen in the morning sky from March 6 to April 29, July 12 to August 12, November 3 to December 6. It will best be seen in late September and early October.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Superior conjunction | Jan | 12 | 19 | | May | 7 | 12 | | Aug 20 | 08 |
| Greatest elongation East | Feb | 12 | 07 | (18°) | Jun | 07 | 12 | (24°) | Oct 04 | 12 (26°) |
| Stationary | Feb | 18 | 04 | | Jun | 20 | 19 | | Oct 16 | 22 |
| Interior conjunction | Feb | 27 | 20 | | Jul | 04 | 06 | | Oct 28 | 10 |
| Stationary | Mar | 12 | 03 | | Jul | 15 | 08 | | Nov 06 | 01 |
| Greatest elongation West | Mar | 26 | 23 | (28°) | Jul | 25 | 12 | (20°) | Nov 13 | 11 (19°) |

On March 27 at 10 am, it will be 1°6 North of the sickle moon. On April 19 at 2 pm, it will be 1°4 South of Jupiter.

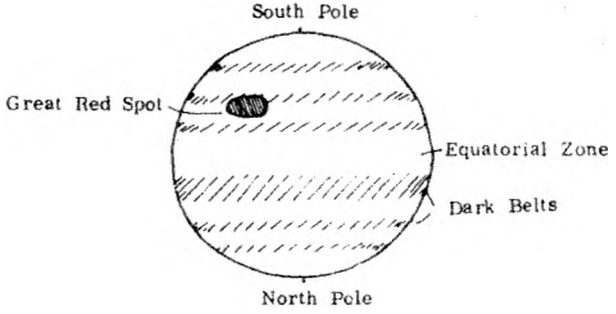
Mercury is the planet with the greatest magnitude changes from -1 in January fading to +4.5 on March 1, brightening to -2 on May 10 and fading to +5 on July 4, then brightening to -1.8 on August 18, fading to +4.7 on October 24 and ending the year at -1.0.

### Venus

Venus will be in the morning sky till mid-July and in the evening sky from the beginning of October for the rest of the year. It will be at its brightest in January (mag -4.6) but after falling to -3.9 in mid-April, remains more or less at constant brightness for the rest of the year.

### Mars

Mars will be seen in the evening sky until July and in the morning sky from mid-October. It will fade from 0.5 in January to 1.8 in July and will brighten to 1.6 at the end of the year.



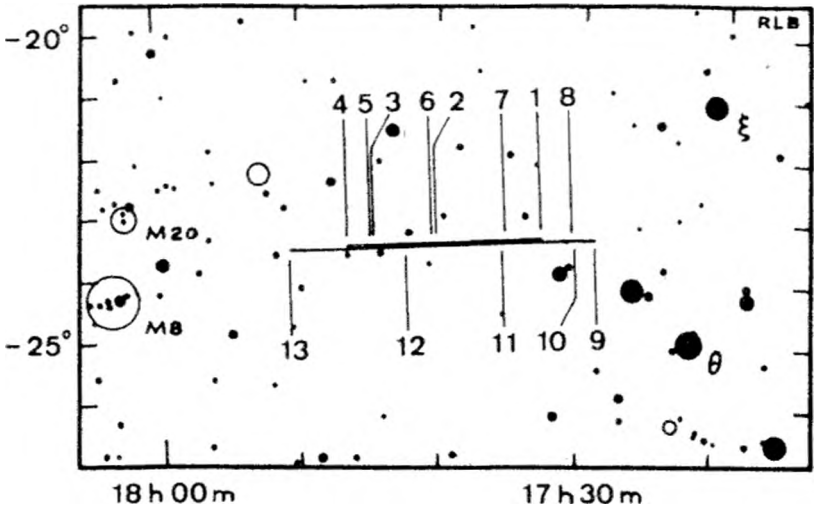

### Jupiter

Jupiter is in the evening sky until early March and from mid-April it will be in the morning sky. Jupiter will fade from -2.3 to -2.0 in April and brighten to -2.9 in October.


Saturn

Saturn will be in the morning sky and rises earlier each day. By late November it will be vanishing in the evening twilight. It will be at about mag. 0.5 in January brightening to 0.0 in the first half of June, and then fading back to about 0.5 for the rest of the year.

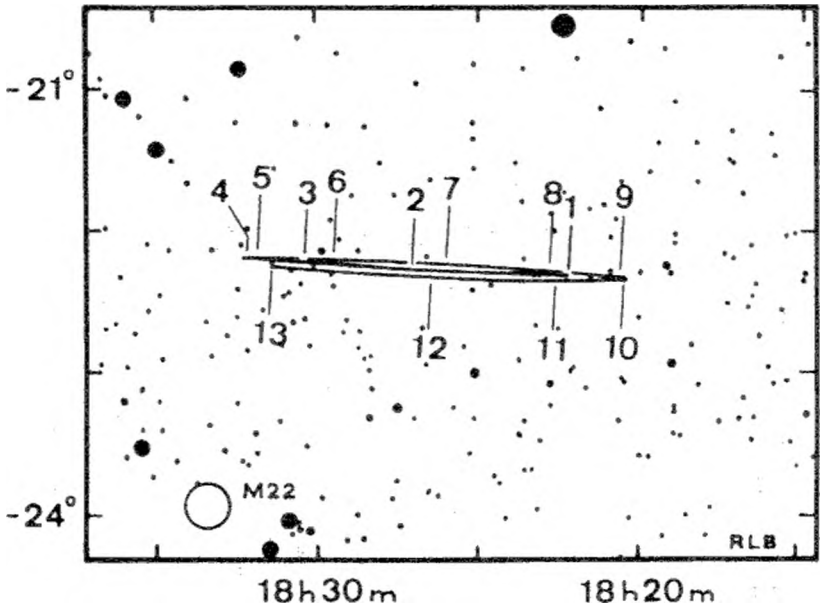
## PATH OF URANUS 1987




Uranus is visible before sunrise from mid-January in Ophiuchus in the pre-dawn sky. It moves into Sagittarius in early February and back into Ophuichus in late May where it remains till late November and then is lost in the evening twilight. Its magnitude varies from 5.8 to 5.5 Its diameter is about 3.5".

| | R A h m | Dec |
|---|---|---|
| Jan 1 | 17.32 | - 23° 24' |
| 16 | 17.36 | - 23° 27' |
| Feb 1 | 17.39 | - 23° 29' |
| 15 | 17.42 | - 23° 30' |
| Mar 1 | 17.44 | - 23° 31' |
| 16 | 17.45 | - 23° 32' |
| Apr 1 | 17.46 | - 23° 32' |
| 16 | 17.45 | - 23° 32' |
| May 1 | 17.44 | - 23° 32' |
| 16 | 17.42 | - 23° 32' |
| Jun 1 | 17.39 | - 23° 31' |
| 16 | 17.37 | - 23° 29' |
| Jul 1 | 17.34 | - 23° 28' |
| 16 | 17.32 | - 23° 27' |
| Aug 1 | 17.30 | - 23° 25' |
| 16 | 17.29 | - 23° 24' |
| Sep 1 | 17.28 | - 23° 24' |
| 16 | 17.29 | - 23° 24' |
| Oct 1 | 17.30 | - 23° 25' |
| 16 | 17.32 | - 23° 27' |
| Nov 1 | 17.35 | - 23° 29' |
| 16 | 17.38 | - 23° 30' |
| Dec 1 | 17.41 | - 23° 32' |
| 16 | 17.46 | - 23° 34' |

# PATH OF NEPTUNE 1987




## Neptune

Neptune at mag. 8 is very difficult to pick up even with binoculars. It will be above the horizon during darkness from mid-January until mid-December.

| | R A | | Dec | | R A | | Dec | | R A | | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | h m | | | | h m | | | | h m | | |
| Jan 1 | 18.25 | - | 22° 19' | May 1 | 18.34 | - | 22° 10' | Sep 1 | | | |
| Feb 1 | 18.29 | - | 22° 15' | Jun 1 | 18.32 | - | 22° 11' | Oct 1 | 18.23 | - | 22° 20' |
| Mar 1 | 18.34 | - | 22° 10' | Aug 1 | 18.25 | - | 22° 16' | Dec 1 | 18.29 | - | 22° 19' |
| | | | | | | | | Dec 31 | 18.34 | - | 22° 16' |

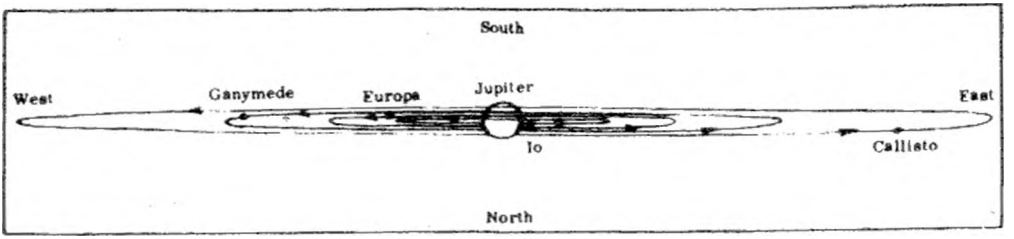
## Pluto

Pluto at magnitude 13.8 is at R A 14h 49m on January 1, 14h 51m on February 14, 14h 41m on July 29 and 14h 58m on December 31. Its declination varies from 10° 38' on January 1 to +1° 46' on June 9 to -0° 20' on December 31.

# THE MOONS OF JUPITER AND SATURN 1987

## MOONS OF JUPITER

One of the most popular sights for an observer with a small telescope is Jupiter and its Moons. Four of the fifteen - 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 below 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 diagrams on page 26 which cover the period when Jupiter is clearly visible in the evening sky. The horizontal lines show their relative configurations at 2am each day.

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 and just after midnight (and when the planet is above the horizon in Southern Africa) are given in the table below.

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

| d | h | m | | d | h | m | | d | h | m | | d | h | m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 1 | 22 | 30 | I Tr I | Jun | 6 | 36 | I Tr E | Jul | 5 | 33 | I Sh E | 29 | 2 | 29 | I Oc R |
| 9 | 21 | 40 | I Oc D | 20 | 3 | 54 | I Ou R | | 5 | 34 | II Sh I | 30 | 2 | 34 | II Sh E |
| 10 | 21 | 15 | I Tr E | 21 | 2 | 42 | II Tr E | 13 | 4 | 13 | I Oc R | | 3 | 00 | II Tr I |
| 17 | 21 | 01 | I Tr I | 26 | 5 | 07 | I Sh I | 14 | 2 | 29 | I Ec R | | 5 | 18 | II Tr E |
| 18 | 21 | 24 | I Ec R | | 5 | 35 | II Ec D | | 2 | 50 | I Oc D | Aug 1 | 3 | 01 | III Sh I |
| 26 | 20 | 44 | I Sh E | | 6 | 23 | I Tr I | | 4 | 52 | III Ec D | | 5 | 37 | III Sh E |
| | 21 | 26 | III Sh E | | 6 | 57 | III Sh I | | 5 | 10 | II Oc R | 4 | 3 | 32 | I Sh I |
| 27 | 21 | 00 | II Oc D | 28 | 2 | 48 | II Sh E | 15 | 0 | 06 | II Tr E | | 4 | 53 | I Tr I |
| Jun 1 | 4 | 44 | III Ec D | | 3 | 02 | II Tr I | 18 | 3 | 03 | III Tr E | | 5 | 42 | I Sh E |
| 3 | 3 | 07 | II Sh I | | 3 | 02 | I Tr E | 19 | 5 | 16 | I Sh I | 5 | 0 | 48 | I Ec D |
| 10 | 5 | 45 | II Sh I | | 5 | 25 | II Tr E | 20 | 2 | 31 | I Ec D | | 0 | 52 | III Oc R |
| | 6 | 50 | I Sh I | 30 | 2 | 21 | III Oc D | | 6 | 07 | I Oc R | | 4 | 32 | I Oc R |
| 11 | 4 | 02 | I Ec D | | 4 | 48 | III Oc R | 21 | 1 | 07 | I Tr I | 6 | 0 | 10 | I Sh E |
| 12 | 3 | 30 | I Sh E | Jul 4 | 4 | 14 | I Ec D | | 1 | 55 | I Sh E | | 1 | 29 | I Tr E |
| | 3 | 44 | III Tr I | 5 | 2 | 49 | I Tr I | | 2 | 36 | II Ec D | | 2 | 45 | II Sh I |
| | 4 | 39 | I Tr E | | 2 | 56 | II Sh I | | 3 | 16 | I Tr E | | 5 | 11 | II Sh E |
| | 5 | 13 | II Ou R | | 3 | 39 | I Sh E | | 5 | 03 | II Ec R | | 5 | 34 | II Tr I |
| | 6 | 18 | III Tr E | | 4 | 58 | I Tr E | | 5 | 26 | II Oc D | 8 | 2 | 04 | II Oc R |
| 18 | 5 | 57 | I Ec D | | 5 | 25 | II Sh E | 23 | 2 | 43 | II Tr E | 12 | 2 | 32 | III Oc D |
| 19 | 12 | 55 | III Sh I | | 5 | 45 | II Tr I | 25 | 1 | 37 | III Sh E | | 2 | 43 | I Ec D |
| | 3 | 01 | II Ec D | 6 | 2 | 17 | I Oc R | | 4 | 49 | III Tr I | | 4 | 39 | III Oc R |
| | 3 | 13 | I Sh I | 7 | 2 | 34 | II Oc R | 27 | 4 | 26 | I Ec D | | 6 | 13 | I Oc R |
| | 4 | 26 | I Tr I | | 3 | 33 | III Ec R | 28 | 1 | 38 | I Sh I | | 23 | 54 | I Sh I |
| | 5 | 23 | I Sh E | | 6 | 33 | III Oc D | | 3 | 01 | I Tr I | 13 | 1 | 12 | I Tr I |
| | 5 | 30 | II Ec R | 11 | 6 | 08 | I Ec D | | 3 | 48 | I Sh E | | 2 | 04 | I Sh E |
| | 5 | 31 | II Oc D | 12 | 3 | 22 | I Sh I | | 5 | 09 | I Tr E | | 3 | 20 | I Tr E |
| | 5 | 38 | III Sh E | | 4 | 44 | I Tr I | | 5 | 10 | II Ec D | | 5 | 22 | II Sh I |

| | d | h | m | | |
|---|---|---|---|---|---|
| Aug | 14 | 0 | 41 | I | Oc R |
| | | 23 | 37 | II | Ec D |
| | 15 | 2 | 03 | II | Ec R |
| | | 2 | 16 | II | Oc R |
| | 15 | 4 | 32 | II | Oc R |
| | 16 | 23 | 34 | II | Tr E |
| | 19 | 0 | 57 | III | Ec D |
| | | 3 | 34 | III | Ec R |
| | | 4 | 37 | I | Ec D |
| | 20 | 1 | 48 | I | Sh I |
| | | 3 | 02 | I | Tr I |
| | | 3 | 58 | I | Sh E |
| | | 5 | 10 | I | Tr E |
| | 21 | 2 | 31 | I | Oc R |
| | | 23 | 37 | I | Tr E |
| | 22 | 2 | 12 | II | Ec D |
| | | 4 | 38 | II | Ec R |
| | | 4 | 42 | II | Oc D |
| | 23 | 23 | 42 | II | Sh E |
| | | 23 | 47 | II | Tr I |
| | 24 | 2 | 01 | II | Tr E |
| | 26 | 4 | 59 | III | Ec D |
| | 27 | 3 | 41 | I | Sh I |
| | | 4 | 50 | I | Tr I |
| | 28 | 1 | 00 | I | Ec D |
| | | 4 | 19 | I | Oc R |
| | | 23 | 17 | I | Tr I |
| | 29 | 0 | 20 | I | Sh E |
| | | 1 | 25 | I | Tr E |
| | | 4 | 47 | II | Ec D |
| | | 22 | 46 | I | Oc R |
| | | 23 | 51 | III | Tr I |
| | 30 | 1 | 49 | III | Tr E |
| | | 23 | 54 | II | Sh I |
| | 31 | 2 | 12 | II | Tr I |
| | | 2 | 19 | II | Sh E |
| | | 4 | 26 | II | Tr E |
| Sep | 1 | 22 | 33 | II | Oc R |
| | | 5 | 35 | I | Sh I |
| | 4 | 2 | 54 | I | Ec D |
| | 5 | 0 | 03 | I | Sh I |
| | | 1 | 05 | I | Tr I |
| | | 2 | 14 | I | Sh E |
| | | 3 | 13 | I | Tr E |
| | | 23 | 05 | III | Sh I |
| | 6 | 0 | 34 | I | Oc R |
| | | 1 | 37 | III | Sh E |
| | | 3 | 24 | III | Tr I |
| | | 5 | 20 | III | Tr E |
| | 7 | 2 | 31 | II | Sh I |
| | | 4 | 34 | II | Tr I |
| | | 4 | 55 | II | Sh E |
| | 9 | 0 | 54 | II | Oc R |
| | 11 | 4 | 49 | I | Ec D |
| | 12 | 1 | 57 | I | Sh I |
| | | 2 | 51 | I | Tr I |
| | | 4 | 08 | I | Sh E |
| | | 4 | 59 | I | Tr E |
| | | 23 | 17 | I | Ec D |
| | 13 | 2 | 20 | I | Oc R |
| | | 3 | 05 | III | Sh I |
| | | 5 | 37 | III | Sh E |
| | | 22 | 37 | I | Sh E |
| | | 23 | 26 | I | Tr E |
| | 14 | 5 | 07 | II | Sh I |

| | d | h | m | | |
|---|---|---|---|---|---|
| Sep | 15 | 23 | 16 | II | Ec |
| | 16 | 3 | 13 | II | Oc R |
| | | 22 | 31 | III | Oc R |
| | 17 | 22 | 17 | II | Tr E |
| | 19 | 3 | 51 | I | Sh I |
| | | 4 | 37 | I | Tr I |
| | 20 | 4 | 05 | I | Oc R |
| | | 22 | 20 | I | Sh I |
| | | 23 | 03 | I | Tr I |
| | 21 | 0 | 31 | I | Sh E |
| | | 1 | 11 | I | Tr E |
| | | 22 | 31 | I | Oc R |
| | 23 | 1 | 52 | II | Ec D |
| | | 21 | 05 | III | Ec D |
| | | 23 | 36 | III | Ec R |
| | 23 | 23 | 56 | III | Oc D |
| | 24 | 1 | 53 | III | Oc R |
| | | 21 | 02 | II | Sh I |
| | | 22 | 21 | II | Tr I |
| | | 23 | 21 | II | Sh E |
| | 25 | 0 | 34 | II | Tr E |
| | 27 | 3 | 06 | I | Ec D |
| | 28 | 0 | 14 | I | Sh I |
| | | 0 | 47 | I | Tr I |
| | | 2 | 25 | I | Sh E |
| | | 2 | 56 | I | Tr E |
| | | 21 | 35 | I | Ec D |
| | 29 | 0 | 16 | I | Oc R |
| | | 21 | 22 | I | Tr E |
| | 30 | 4 | 28 | II | Ec D |
| Oct | 1 | 1 | 06 | III | Ec D |
| | | 5 | 12 | III | Oc R |
| | | 23 | 39 | II | Sh I |
| | 2 | 0 | 36 | II | Tr I |
| | | 2 | 03 | II | Sh E |
| | | 2 | 50 | II | Tr E |
| | 3 | 20 | 53 | II | Oc R |
| | 4 | 5 | 01 | I | Ec D |
| | 5 | 2 | 09 | I | Sh I |
| | | 2 | 31 | I | Tr I |
| | | 4 | 20 | I | Sh E |
| | | 4 | 40 | I | Tr E |
| | | 23 | 29 | I | Ec D |
| | 6 | 2 | 00 | I | Oc R |
| | | 20 | 37 | I | Sh I |
| | | 20 | 57 | I | Tr I |
| | | 22 | 48 | I | Sh E |
| | | 23 | 06 | I | Tr E |
| | 7 | 20 | 26 | I | Oc R |
| | 8 | 5 | 07 | III | Ec D |
| | 9 | 2 | 15 | II | Sh I |
| | | 2 | 50 | II | Tr I |
| | | 4 | 39 | II | Sh E |
| | | 5 | 05 | II | Tr E |
| | 10 | 20 | 23 | II | Ec D |
| | | 23 | 08 | II | Oc R |
| | 11 | 20 | 10 | III | Tr I |
| | | 21 | 39 | III | Sh E |
| | | 22 | 09 | III | Tr E |
| | 12 | 4 | 03 | I | Sh I |
| | | 4 | 15 | I | Tr I |
| | 13 | 1 | 24 | I | Ec D |
| | | 3 | 43 | I | Oc R |
| | | 22 | 32 | I | Sh I |
| | | 22 | 40 | I | Tr I |

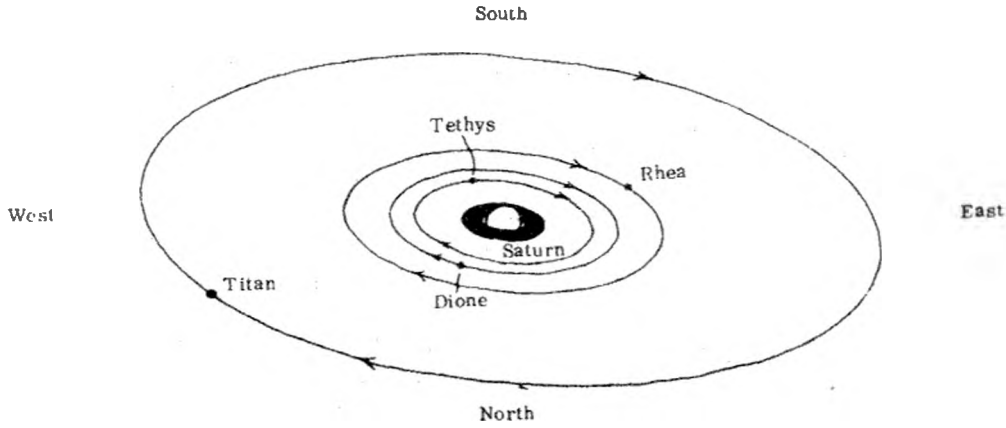
| | d | h | m | | |
|---|---|---|---|---|---|
| Oct | 14 | 0 | 43 | I | Sh E |
| | | 0 | 50 | I | Tr E |
| | | 19 | 53 | I | Ec D |
| | | 22 | 09 | I | Oc R |
| | 17 | 23 | 00 | II | Ec D |
| | 18 | 1 | 24 | II | Ec R |
| | | 23 | 13 | III | Sh I |
| | | 23 | 33 | III | Tr I |
| | 19 | 1 | 25 | III | Tr E |
| | | 1 | 40 | III | Sh E |
| | | 20 | 26 | II | Tr E |
| | | 20 | 33 | II | Sh E |
| | 20 | 3 | 17 | I | Oc D |
| | 21 | 0 | 24 | I | Tr I |
| | | 0 | 27 | I | Sh I |
| | | 2 | 33 | I | Tr E |
| | | 2 | 38 | I | Sh E |
| | | 21 | 43 | I | Oc D |
| | | 23 | 59 | I | Ec R |
| | 25 | 1 | 20 | II | Oc D |
| | | 4 | 00 | II | Ec R |
| | 26 | 2 | 37 | III | Tr I |
| | | 3 | 14 | III | Sh I |
| | | 4 | 41 | III | Tr E |
| | | 5 | 40 | III | Sh E |
| | | 20 | 23 | II | Tr I |
| | | 20 | 47 | II | Sh I |
| | | 22 | 40 | II | Tr E |
| | | 23 | 09 | II | Sh E |
| | 28 | 2 | 07 | I | Tr I |
| | | 2 | 22 | I | Sh I |
| | | 4 | 17 | I | Tr E |
| | | 23 | 27 | I | Oc D |
| | 29 | 1 | 54 | I | Ec R |
| | | 20 | 33 | I | Tr I |
| | | 20 | 51 | I | Sh I |
| | | 22 | 43 | I | Tr E |
| | | 23 | 02 | I | Sh E |
| | 30 | 20 | 22 | I | Ec R |
| Nov | 1 | 3 | 34 | II | Oc D |
| | 2 | 22 | 37 | II | Tr I |
| | | 23 | 22 | II | Sh I |
| | 3 | 0 | 55 | II | Tr E |
| | | 1 | 45 | II | Sh E |
| | 4 | 3 | 52 | I | Tr I |
| | 5 | 1 | 11 | I | Oc D |
| | | 3 | 48 | I | Ec R |
| | | 22 | 18 | I | Tr I |
| | | 22 | 46 | I | Sh I |
| | | 20 | 41 | III | Ec R |
| | 6 | 0 | 28 | I | Tr E |
| | | 0 | 57 | I | Sh E |
| | | 22 | 17 | I | Ec R |
| | 10 | 0 | 53 | II | Tr I |
| | | 2 | 00 | II | Sh I |
| | | 3 | 11 | II | Tr E |
| | 11 | 22 | 34 | II | Ec R |
| | 12 | 2 | 56 | I | Oc D |
| | | 22 | 46 | III | Oc D |
| | 13 | 0 | 03 | I | Tr I |
| | | 0 | 41 | I | Sh I |
| | | 1 | 01 | III | Oc R |
| | | 1 | 18 | III | Ec D |
| | 13 | 2 | 13 | I | Tr E |
| | | 2 | 52 | I | Sh E |

| | d | h | m | | |
|---|---|---|---|---|---|
| Nov | | 3 | 42 | III | Ec R |
| | | 21 | 22 | I | Oc D |
| | 14 | 0 | 12 | I | Ec R |
| | | 20 | 39 | I | Tr E |
| | | 21 | 21 | I | Sh E |
| | 17 | 3 | 10 | II | Tr I |
| | 18 | 21 | 16 | II | Oc D |
| | 19 | 1 | 12 | II | Ec R |
| | 20 | 1 | 47 | I | Tr I |
| | | 2 | 07 | III | Oc D |
| | | 2 | 37 | I | Sh I |
| | | 23 | 08 | I | Oc D |
| | 21 | 2 | 07 | I | Ec R |
| | | 21 | 06 | I | Sh I |
| | | 22 | 26 | I | Tr E |
| | | 23 | 36 | I | Sh E |
| | 22 | 20 | 36 | I | Ec R |
| | 25 | 23 | 37 | II | Oc D |
| | 26 | 3 | 50 | II | Ec R |
| | 27 | 20 | 31 | II | Sh I |
| | | 20 | 59 | II | Tr E |
| | | 22 | 51 | II | Sh E |
| | 28 | 00 | 55 | I | Oc D |
| | | 22 | 04 | I | Tr I |
| | | 23 | 01 | I | Sh I |
| | 29 | 0 | 14 | I | Tr E |
| | | 1 | 12 | I | Sh E |
| | | 22 | 31 | I | Ec R |
| | 30 | 21 | 45 | III | Tr E |
| | | 23 | 26 | III | Sh I |
| Dec | 1 | 1 | 47 | III | Sh E |
| | 4 | 21 | 07 | II | Tr I |
| | | 23 | 08 | II | Sh I |
| | | 23 | 22 | II | Tr E |
| | 5 | 1 | 27 | II | Sh E |
| | | 23 | 52 | I | Tr I |
| | 6 | 0 | 57 | I | Sh I |
| | | 21 | 10 | I | Oc D |
| | 7 | 0 | 26 | I | Ec R |
| | | 20 | 30 | I | Tr E |
| | | 21 | 36 | I | Sh E |
| | | 22 | 58 | III | Tr I |
| | 8 | 1 | 22 | III | Tr E |
| | 11 | 23 | 25 | II | Tr I |
| | 13 | 22 | 26 | II | Ec R |
| | | 23 | 00 | I | Oc D |
| | 14 | 21 | 22 | I | Sh I |
| | | 22 | 21 | I | Tr E |
| | | 23 | 32 | I | Sh E |
| | 15 | 20 | 51 | I | Ec R |
| | 18 | 21 | 29 | III | Ec D |
| | | 23 | 50 | III | Ec R |
| | 20 | 22 | 33 | II | Oc R |
| | | 22 | 44 | II | Ec D |
| | 21 | 0 | 51 | I | Oc D |
| | | 22 | 01 | I | Tr I |
| | | 23 | 18 | I | Sh I |
| | 22 | 0 | 13 | I | Tr E |
| | | 22 | 46 | I | Ec R |
| | 25 | 22 | 43 | III | Oc R |
| | 27 | 22 | 40 | II | Oc D |
| | 28 | 23 | 55 | I | Tr I |
| | 29 | 21 | 12 | I | Oc D |
| | | 22 | 33 | II | Sh E |
| | 30 | 21 | 53 | I | Sh E |

# THE MOONS OF JUPITER AND SATURN 1987

## SATURN'S MOONS

Saturn's moons are considerably fainter than the four Galilean moons of Jupiter. The diagram shows the orbits of four of Saturn's ten moons. The easiest to find is Titan (magnitude 8,5), according to the diagram and the information in the table below.

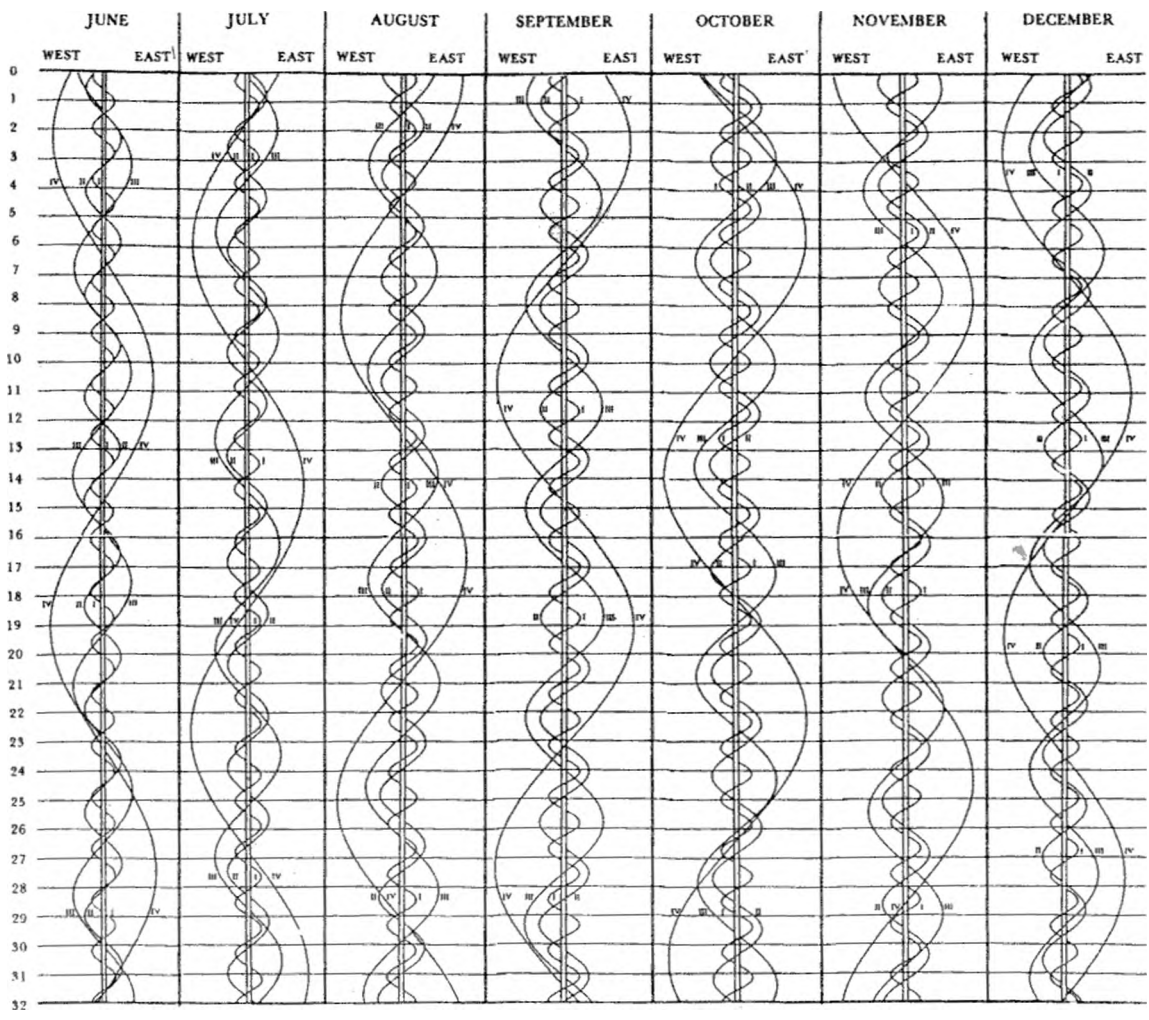



TITAN 1987

| Eastern Elongation | | Inferior Conjunction | | Western Elongation | | Superior Conjunction | |
|---|---|---|---|---|---|---|---|
| | SAST | | SAST | | SAST | | SAST |
| Jan 7 | 02.4 | Jan 11 | 00.3 | Jan 15 | 05.0 | Jan 3 | 06.6 |
| 23 | 02.9 | 27 | 00.9 | 31 | 05.6 | 19 | 07.2 |
| Feb 8 | 03.1 | Feb 12 | 01.2 | Feb 16 | 05.8 | Feb 4 | 07.6 |
| 24 | 03.0 | 28 | 01.0 | Mar 4 | 05.6 | 20 | 07.6 |
| Mar 12 | 02.4 | Mar 16 | 00.4 | 20 | 04.9 | Mar 8 | 07.1 |
| 28 | 01.4 | 31 | 23.3 | Apr 5 | 03.6 | 24 | 06.3 |
| Apr 12 | 23.9 | Apr 16 | 21.7 | 21 | 01.9 | Apr 9 | 04.9 |
| 28 | 22.0 | May 2 | 19.7 | May 6 | 23.7 | 25 | 03.1 |
| May 14 | 19.7 | 18 | 17.2 | 22 | 21.1 | May 11 | 00.8 |
| 30 | 17.2 | Jun 3 | 14.6 | Jun 7 | 18.3 | 26 | 22.3 |
| Jun 15 | 14.6 | 19 | 11.8 | 29 | 15.6 | Jun 11 | 19.6 |
| Jul 1 | 12.0 | Jul 5 | 09.2 | Jul 9 | 13.0 | 27 | 17.0 |
| 17 | 09.7 | 21 | 06.9 | 25 | 10.7 | Jul 13 | 14.5 |
| Aug 2 | 07.7 | Aug 6 | 04.9 | Aug 10 | 08.9 | 29 | 12.5 |
| 18 | 06.2 | 22 | 03.5 | 26 | 07.6 | Aug 14 | 10.8 |
| Sep 3 | 05.1 | Sep 7 | 02.5 | Sep 11 | 06.8 | 30 | 09.6 |
| 19 | 04.5 | 23 | 02.1 | 27 | 06.5 | Sep 15 | 08.9 |
| Oct 5 | 04.3 | Oct 9 | 02.1 | Oct 13 | 06.6 | Oct 1 | 08.6 |
| 21 | 04.4 | 25 | 02.4 | 29 | 07.1 | 17 | 08.8 |
| Nov 6 | 04.9 | Nov 10 | 03.1 | Nov 14 | 07.9 | Nov 2 | 09.2 |
| 22 | 05.6 | 26 | 03.9 | 30 | 08.9 | 18 | 09.9 |
| Dec 8 | 06.4 | Dec 12 | 04.9 | Dec 16 | 09.9 | Dec 4 | 10.7 |
| 24 | 07.2 | 28 | 05.9 | | | 20 | 11.6 |

## The Moons of Jupiter and Saturn 1987

## CHANGING CONFIGURATIONS OF JUPITER'S MOONS




The four bright moons of Jupiter always appear close to a straight line passing through the planets since, as shown in the drawing at the top, their orbits are seen nearby edge on. The main part of the diagram then shows how their positions along such a straight line change during the seven 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 2 am (0 hrs Universal time), are shown for every day of the month. The wavy lines show how the Moons appear to oscillate from each side of the planet to the other.

# COMETS AND METEORS

## COMETS

About a dozen comets are observed each year. Of these, five or six are new discoveries while the others have been observed during their previous returns around our Sun.
Comets are divided into two groups, depending on the length of their periods around the Sun: Short-period comets, which on the average have a 7 year period, an orbital inclination of about 13 degrees, small orbital eccentricities (between 0.2 and 0.9) and usually travel in a direct motion.
Long-period comets, i.e., those of a period greater than 200 years, have random orbital inclinations, about 0.9999 eccentricity and random motion.
A typical comet consists of a very small solid nucleous surrounded by a large envelope of gas and dust called the coma and in some instances they might develop two kinds of tail, dust and gas tails. As a comet approaches or moves away from the Sun its visual appearance changes drastically. Observers with modest equipment such as a good pair of binoculars (for bright comets) or a refractor with an objective not less than 7,5cm can contribute with valuable information, by reporting on their visual appearance. Another area in need of observers, is that of regularly and systematically conducting visual searches for new comets, namely in the southern celestial hemisphere; this activity is also well within the scope of the equipment mentioned. Occasionally, very bright comets are discovered with the naked-eye.
Interested members are asked to contact the Director of the Comet & Meteor Section, Mr. Jose' Campos, 19 Fiskaal Place, Woodhaven, Durban 4001.
A list of predicted perihelion passages of comets for the current year is printed elsewere in the Handbook.

## METEORS

Orbiting in the interplanetary space, METEOROIDS (usually about the size of a grain of sand), sometimes collide with the Earth's atmosphere and due to the direction of the Earth's motion around the Sun, these collisions are generally seen in greater numbers after local midnight, than in the early evening.
As the meteoroid enters the upper Earth's atmosphere, its rapid motion will heat it to incandescence by friction with the atmosphere's gaseous molecules, causing them to be ionized resulting in an emission of light; this is then called a METEOR (popularly known as a "shooting star") and they are desintegrated completely, long before they can reach the ground. There are two types of meteors, the sporadic ones and the showers; the direction in the sky where the shower appears to come from, is called the Radiant. Some showers are known to be caused by the debris of a comet; when our planet intersects a comet's orbit, such a shower may take place. A table of predicted meteor showers is given on the next page.
Occasionally an extremely bright meteor, i.e. those of visual magnitude greater than Venus (-4.0 mag.), is seen travelling across the sky and it may break up or even explode during its flight; such a very bright meteor is called a fireball and sometimes it may produce debris that reach the ground becoming then known as METEORITES and their masses can range from a few grams, up to several tons.
Interested persons are urged to contact the Director of Comet and Meteor Section, Mr. J. Campos, 19 Fiskaal Place, Woodhaven, Durban 4001. In the event of bright fireballs, please phone 031-423684 at any time.

## PREDICTED METEOR SHOWERS 1987

| Predicted Limits | Shower | Radiant R.A. (1950) | Radiant Dec. | Transit of Radiant SAST | Transit of Radiant Alt | Date at Maximum | Zenithal Hourly Rate | Recommended time of Watch Beginning: SAST | Beginning: Alt | Ending: SAST | Ending: Alt | Conditions at Maximum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feb 6-15 | Theta Centaurids | 14h20m | -44° | 05h05 | 76° | Feb 8 | ? | 01h00 | 40° | 04h00 | 70° | Good |
| Mar 13-18 | Corona Australids | 16h20 | -48 | 04h43 | 72 | Mar 16 | 5 | 01h00 | 44 | 04h30 | 71 | Unfavourable |
| Apr 19-24 | April Lyrids | 18h08 | +32 | 04h06 | 28 | Apr 22 | 15 | 03h00 | 26 | 05h00 | 26 | Unfavourable |
| May 1-12 | Eta Aquarids | 22h24 | 00 | 07h30 | 60 | May 5 | 30 | 04h00 | 31 | 05h00 | 43 | Favourable |
| Apr 20-Jul 30 | Sco-Sgn System | 18h00 | -30 | 00h29 | 90 | Jun 14 | ? | 21h00 | 45 | 04h00 | 44 | Unfavourable |
| Jun 10-21 | June Lyrids | 18h32 | +35 | 00h53 | 25 | Jun 16 | 8 | 23h30 | 22 | 01h30 | 24 | Unfavourable |
| Jun 17-26 | Ophiuchids | 17h20 | -20 | 23h22 | 80 | Jun 20 | 10 | 19h00 | 30 | 02h00 | 53 | Favourable |
| Jun 26-29 | Cedits (New) | 02h00 | -15 | 07h35 | 75 | Jun 28 | ? | 03h00 | 25 | 05h20 | 56 | Favourable |
| Jul 10-Aug 5 | Capricornids | 21h00 | -15 | 00h47 | 75 | Jul 26 | 8 | 20h30 | 30 | 05h15 | 25 | Very Good |
| Jul 15-Aug 15 | Delta Aquarids | 22h36 | (-17<br>( 00 | 02h07 | 77 | Jul 29 | (25<br>(10 | 22h00 | 33 | 05h00 | 47 | Very Good |
| Jul 15-Aug 20 | Pisces Australids | 22h40 | -30 | 02h03 | 89 | Jul 31 | 12 | 21h30 | 32 | 05h00 | 51 | Very Good |
| Jul 15-Aug 25 | Alpha Capricornids | 20h26 | -10 | 23h48 | 70 | Aug 2 | 10 | 20h00 | 33 | 04h00 | 29 | Very Good |
| Jul 15-Aug 24 | Iota Aquarids | (22h04<br>(22h32 | (- 6<br>(-15 | 01h33 | 75 | Aug 6 | 12 | 22h00 | 40 | 04h00 | 52 | Unfavourable |
| Oct 16-27 | Orionids | 06h24 | +15 | 04h23 | 45 | Oct 21 | 35 | 02h00 | 33 | 03h20 | 42 | Favourable |
| Oct 10-Dec 5 | Taurids | (03h44<br>(03h44 | (+14<br>(+22 | 00h26 | 38 | (Nov 6<br>(Nov 10 | ( 5<br>(10 | 23h30 | 36 | 01h00 | 37 | Unfavourable |
| Nov 14-20 | Leonids | 10h08 | +22 | 06h21 | 38 | Nov 17 | 10 | 03h00 | 18 | 03h30 | 23 | Poor |
| Dec 3- 5 | Phoenicids | 01h00 | -55 | 20h03 | 65 | Dec 4 | 5 | 20h30 | 64 | 01h00 | 33 | Unfavourable |
| Dec 7-15 | Geminids | 07h28 | +32 | 01h55 | 28 | Dec 14 | 55 | 23h30 | 19 | 03h00 | 26 | Unfavourable |
| Dec 5-Jan 7 | Velaids | 09h56 | -51 | 03h25 | 69 | Dec 29 | 15? | 00h30 | 51 | 03h30 | 69 | Favourable |

NOTE: The times and altitudes (in degrees) given, are for an observer stationed at E 30.5 S 29.5 (Durban). The Cetids are uncertain and confirmation on this Shower is requested.

COMET WILSON (19861)

DETAILS OF ORBITAL ELEMENTS FROM PROGRAM BY PETER MACK
TIME OF PERIHELION PASSAGE 1987 4 20.8587
ARGUMENT OF PERIHELION 238.2680
LONGITUDE OF ASCENDING NODE 110.9259
INCLINATION OF THE ORBIT 147.1395
PERIHELION DISTANCE (A.U.) 1.2001

| YEAR | MON | DAY | HOURS | RA (1950) | | | DEC (1950) | | | DELTA | R | MAG1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | 1 | 1 | 0.00 | 19 | 58 | 42 | -12 | 45 | 7 | 2.908 | 2.021 | 8.00 |
| 1987 | 1 | 11 | 0.00 | 20 | 3 | 26 | -14 | 13 | 1 | 2.864 | 1.913 | 7.84 |
| 1987 | 1 | 21 | 0.00 | 20 | 8 | 47 | -15 | 39 | 52 | 2.786 | 1.807 | 7.64 |
| 1987 | 1 | 31 | 0.00 | 20 | 14 | 37 | -17 | 9 | 51 | 2.671 | 1.703 | 7.41 |
| 1987 | 2 | 5 | 0.00 | 20 | 17 | 41 | -17 | 57 | 36 | 2.600 | 1.653 | 7.28 |
| 1987 | 2 | 10 | 0.00 | 20 | 20 | 49 | -18 | 48 | 11 | 2.520 | 1.604 | 7.14 |
| 1987 | 2 | 15 | 0.00 | 20 | 24 | 3 | -19 | 42 | 33 | 2.431 | 1.557 | 6.99 |
| 1987 | 2 | 20 | 0.00 | 20 | 27 | 23 | -20 | 41 | 49 | 2.333 | 1.511 | 6.83 |
| 1987 | 2 | 25 | 0.00 | 20 | 30 | 48 | -21 | 47 | 21 | 2.226 | 1.467 | 6.65 |
| 1987 | 3 | 2 | 0.00 | 20 | 34 | 21 | -23 | 0 | 54 | 2.111 | 1.426 | 6.47 |
| 1987 | 3 | 7 | 0.00 | 20 | 38 | 3 | -24 | 24 | 41 | 1.988 | 1.386 | 6.27 |
| 1987 | 3 | 12 | 0.00 | 20 | 41 | 58 | -26 | 1 | 35 | 1.857 | 1.350 | 6.06 |
| 1987 | 3 | 17 | 0.00 | 20 | 46 | 11 | -27 | 55 | 33 | 1.720 | 1.317 | 5.83 |
| 1987 | 3 | 22 | 0.00 | 20 | 50 | 52 | -30 | 11 | 59 | 1.578 | 1.287 | 5.59 |
| 1987 | 3 | 27 | 0.00 | 20 | 56 | 13 | -32 | 58 | 29 | 1.431 | 1.261 | 5.32 |
| 1987 | 4 | 1 | 0.00 | 21 | 2 | 39 | -36 | 26 | 5 | 1.282 | 1.239 | 5.04 |
| 1987 | 4 | 6 | 0.00 | 21 | 10 | 54 | -40 | 50 | 50 | 1.133 | 1.222 | 4.74 |
| 1987 | 4 | 11 | 0.00 | 21 | 22 | 29 | -46 | 35 | 59 | 0.989 | 1.210 | 4.41 |
| 1987 | 4 | 16 | 0.00 | 21 | 41 | 10 | -54 | 12 | 26 | 0.854 | 1.202 | 4.08 |
| 1987 | 4 | 21 | 0.00 | 22 | 18 | 47 | -64 | 6 | 39 | 0.739 | 1.200 | 3.76 |
| 1987 | 4 | 26 | 0.00 | 0 | 10 | 30 | -75 | 4 | 40 | 0.657 | 1.203 | 3.50 |
| 1987 | 5 | 1 | 0.00 | 4 | 56 | 40 | -75 | 19 | 46 | 0.623 | 1.211 | 3.40 |
| 1987 | 5 | 6 | 0.00 | 7 | 4 | 57 | -61 | 45 | 24 | 0.646 | 1.224 | 3.51 |
| 1987 | 5 | 11 | 0.00 | 7 | 46 | 15 | -47 | 52 | 12 | 0.720 | 1.241 | 3.78 |
| 1987 | 5 | 16 | 0.00 | 8 | 6 | 13 | -36 | 49 | 22 | 0.830 | 1.263 | 4.13 |
| 1987 | 5 | 21 | 0.00 | 8 | 18 | 27 | -28 | 34 | 30 | 0.963 | 1.289 | 4.51 |
| 1987 | 5 | 26 | 0.00 | 8 | 27 | 6 | -22 | 27 | 19 | 1.108 | 1.320 | 4.87 |
| 1987 | 5 | 31 | 0.00 | 8 | 33 | 51 | -17 | 50 | 51 | 1.260 | 1.353 | 5.21 |
| 1987 | 6 | 5 | 0.00 | 8 | 39 | 28 | -14 | 18 | 27 | 1.413 | 1.390 | 5.53 |
| 1987 | 6 | 10 | 0.00 | 8 | 44 | 22 | -11 | 31 | 59 | 1.566 | 1.429 | 5.82 |
| 1987 | 6 | 15 | 0.00 | 8 | 48 | 48 | -9 | 19 | 11 | 1.717 | 1.471 | 6.09 |
| 1987 | 6 | 20 | 0.00 | 8 | 52 | 54 | -7 | 31 | 42 | 1.863 | 1.515 | 6.34 |
| 1987 | 6 | 25 | 0.00 | 8 | 56 | 45 | -6 | 3 | 39 | 2.005 | 1.561 | 6.57 |
| 1987 | 6 | 30 | 0.00 | 9 | 0 | 26 | -4 | 50 | 49 | 2.141 | 1.609 | 6.79 |
| 1987 | 7 | 5 | 0.00 | 9 | 3 | 58 | -3 | 50 | 8 | 2.271 | 1.658 | 6.99 |
| 1987 | 7 | 10 | 0.00 | 9 | 7 | 23 | -2 | 59 | 17 | 2.394 | 1.708 | 7.17 |
| 1987 | 7 | 15 | 0.00 | 9 | 10 | 42 | -2 | 16 | 31 | 2.510 | 1.759 | 7.35 |
| 1987 | 7 | 20 | 0.00 | 9 | 13 | 55 | -1 | 40 | 27 | 2.619 | 1.811 | 7.51 |
| 1987 | 7 | 25 | 0.00 | 9 | 17 | 3 | -1 | 10 | 0 | 2.720 | 1.864 | 7.66 |
| 1987 | 7 | 30 | 0.00 | 9 | 20 | 6 | 0 | 44 | 16 | 2.814 | 1.918 | 7.80 |
| 1987 | 8 | 4 | 0.00 | 9 | 23 | 3 | 0 | 22 | 33 | 2.899 | 1.972 | 7.93 |
| 1987 | 8 | 14 | 0.00 | 9 | 28 | 37 | 0 | 11 | 15 | 3.046 | 2.081 | 8.17 |
| 1987 | 8 | 24 | 0.00 | 9 | 33 | 44 | 0 | 35 | 19 | 3.159 | 2.191 | 8.37 |
| 1987 | 9 | 3 | 0.00 | 9 | 38 | 16 | 0 | 52 | 42 | 3.240 | 2.302 | 8.54 |
| 1987 | 9 | 13 | 0.00 | 9 | 42 | 5 | 1 | 5 | 56 | 3.289 | 2.413 | 8.69 |
| 1987 | 9 | 23 | 0.00 | 9 | 45 | 4 | 1 | 17 | 18 | 3.308 | 2.524 | 8.81 |
| 1987 | 10 | 3 | 0.00 | 9 | 47 | 0 | 1 | 28 | 58 | 3.297 | 2.634 | 8.90 |
| 1987 | 10 | 13 | 0.00 | 9 | 47 | 40 | 1 | 43 | 10 | 3.261 | 2.745 | 8.98 |
| 1987 | 10 | 23 | 0.00 | 9 | 46 | 49 | 2 | 2 | 13 | 3.202 | 2.855 | 9.03 |

# 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 patters, or constellations, with various mythological characters and creatures, and most of the names they gave are still used today.

In all there are 88 consteliations, 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 a(Alpha),the next B(Beta) and so on through the Greek alphabet. Most of the brightest stars also have their own names - usually of arabic origin. For example, $\alpha$ Canis Majoris, otherwise known as Sirius, is the brightest star in the constellation Canis Major.

## STELLAR MAGNITUDES

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. A star of magnitude 1,0 (typical of the brightest stars in the night sky) would be exactly one hundred times more luminous than a star of magnitude 6,0 (about the limit of visibility to the naked eye). The maps in this section show stars down to magnitude 4,5.

## STELLAR DISTANCES

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 of 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.

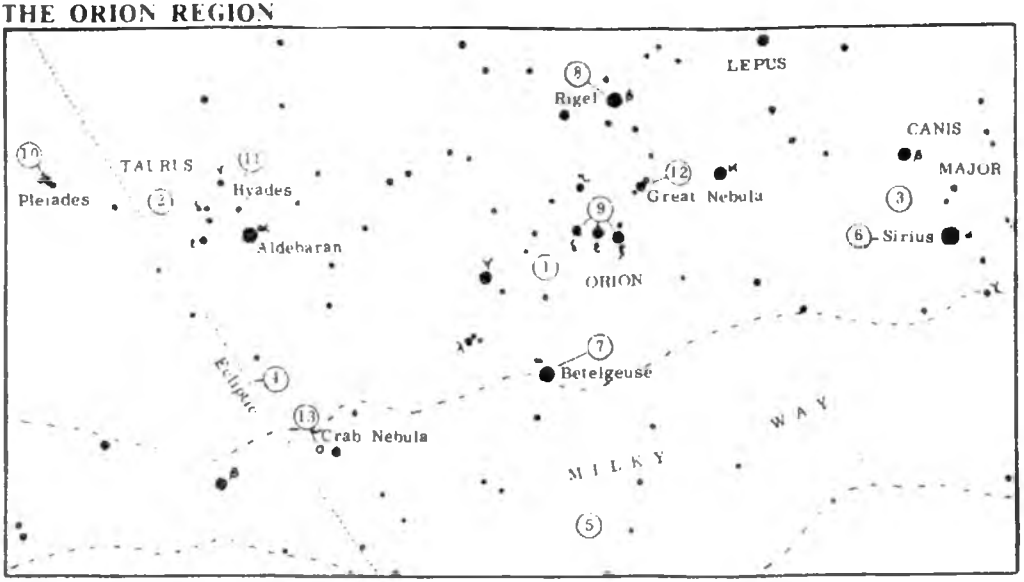
## NEBULAE

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).

## THREE POPULAR REGIONS

The dominating constellation of the summer skies is Orion, that of the winter skies is Scorpius, while the Southern Cross is conspicuous for most of the year. The regions around these constellations are also rich in interesting objects - visible either to the naked eye, or with the aid of binoculars or a small telescope - and are featured in the maps and text below. It may be necessary to rotate the maps to match the orientation of the constellations in the sky.

## 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, ι - ε - δ the belt, and β and κ the legs. Orion forms part of the "great hunting scene" in which he faces the onslaught of (2) Taurus, the bull. Only the forepart of the bull is depicted and, like Orion, it is upside down. α and ε are the eyes, γ the nose. Orion is accompanied by (3) Canis major, the large dog, and the small dog (off map) while Lepus, the hare, crouches at his feet.

(4) A section of the Ecliptic - a line encircling the entire sky and representing the plane of the Earth's orbit. As the Earth revolves around the Sun, the Sun appears to move along the ecliptic through the constellations of the Zodiac, of which Taurus is one.

(5) A portion of the Milky Way (looking out towards the edge of our Galaxy).

(6) Sirius - the brightest star in the night sky. It is somewhat brighter than our Sun and relatively close by - at a distance of 9 light years. It is a double star but the companion is a white dwarf (only slightly larger than the Earth, and with a mass comparable to our Sun ) and is only visible through a large telescope.

(7) Betelgeuse - most famous of the red giant stars. Its diameter is of the order of the size of the Earth's orbit and its luminosity is nearly 10 000 times that of our Sun. Its red colour should be obvious to the eye. It is 520 light years distant.

(8) Rigel, despite being physically smaller than Betelgeuse, is more luminous (higher surface temperature - bluish colour) and more distant.

(9) The stars in Orion's belt are distant hot blue stars.

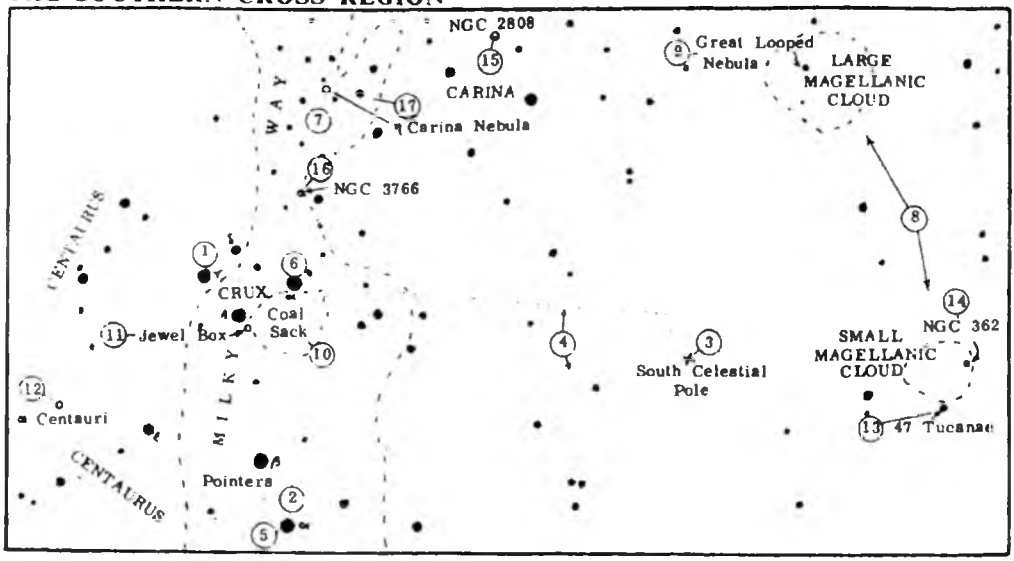
(10) The Pleiades or Seven Sisters form the best known nearby star cluster. Six or seven stars are visible to the naked eye, binoculars or a small telescope show more.

(11) The Hyades is another nearby galactic cluster, but Aldebaran is not a member (it lies closer to us).

(12) The Great Nebula in Orion, just visible to the naked eye, shows up as a fan shaped mass of luminous gas through binoculars or a telescope. A telescope will also show a tiny "Trapezium" of four stars in the centre.

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

## THE SOUTHERN CROSS REGION




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

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

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

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

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

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

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

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

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

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

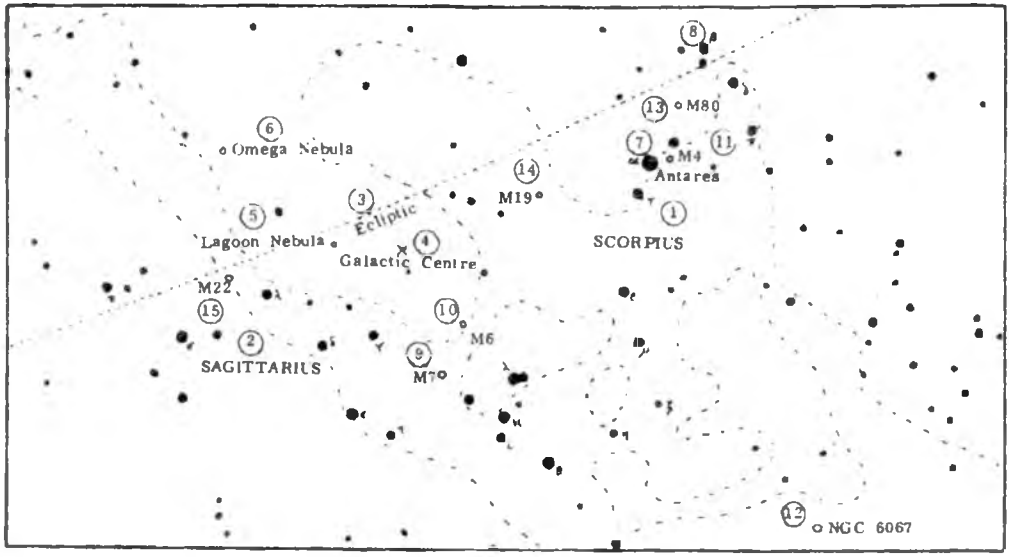
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).

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

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

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

## THE 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 λ

(2) Sagittarius - the figure of the centaur archer is very difficult to make out.

(3) A section of the Ecliptic. Like Taurus, Scorpius and Sagittarius are constellations of the Zodiac.

(4) The direction of the centre of our Galaxy - the Milky Way is that part of our Galaxy visible to us. Unfortunately the central nucleus is obscured by foreground gaseous and dusty matter - both dark and luminous - hence the irregular shape of the Milky Way in this region. Luminous nebulae include (5) the Lagoon nebula and (6) the Omega nebula. These are best seen with the aid of binoculars.

(7) Antares - a distant red giant, several hundred times the diameter of our Sun - is so named because its red colour rivals that of the planet Mars.

(8) δ Scorpii can be resolved as a double star (separation 16 sec of arc) with a small telescope. In fact the brighter component is in itself a triple star, and the fainter component a double star!

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

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

## 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.

Interested persons should contact the Director of the Nova Search Section, Mr. J.C. Bennett, 90 Malan Street, Riviera, Pretoria 0084.

## 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 lease 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 South Africa.

The Variable Star Section of the A.S.S.A. exists for the purpose of encouraging observers and of acting as a medium of 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 orbicing satellite observatories whenever outburst occurred of certain eruptive variables.

Visual estimates of magnituue are made by comparing the variable with two or more comparison stars, respectively brighter and fainter than the unknown variable. Suitable comparison stars are shown on special charts, which have been prepared for each variable, mainly by the two variable star organisations mentioned above. The use of these charts is essential for accurate, standardized observations, and intending new observers are therefore advised to obtain the necessary data by contacting the Director of the Variable Star Section, Mr J Hers, P O Box 48, Sedgefield 6573, Telephone (04455) 736. 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 07104 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 the 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:

| | | Approx. 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.

# ORDINARY OCCULTATIONS

This Section and that following concern a specialised branch of observational astronomy 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 A G F Morrisby, (c/o Dept of Surveyor General, P O Box 1580, Bulawayo, Zimbabwe).

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 | - 33°.933 |
| Johannesburg | - 28°.075 | - 26°.182 |

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

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

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

Explanations of Abbreviations used in 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 U T
a,b - parameters in minutes for predicting times other than at standard stations (explained above in text)
P.A. - The Position Angle on the Moon's limb measured eastward from the north point

# LUNAR OCCULTATIONS 1987 UT

| | | | | | | CAPE TOWN | | | | | JOHANNESBURG | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | E 18.5 | | S. 33.9 | | | 28.1 | | S 26.2 | | |
| | DATE | ZC | MAG | PHASE | ELG | TIME | | A | B | P | TIME | | A | B | P |
| M | D | | | | ° | h | m | m | m | ° | h | m | m | m | ° |
| JAN | 7 | 241 | 6.9 | D D | 100 | 18 | 49.1 | -1.3 | 2.1 | 30 | 19 | 20.3 | -1.3 | 2.6 | 29 |
| JAN | 7 | 240 | 5.6 | D D | 100 | 18 | 59.2 | - | - | -346 | | | | | |
| FEB | 1 | Jupiter | -1.7 | D D | 41 | 14 | 8.9 | -1.2 | 1.9 | 35 | 14 | 37.0 | -1.3 | 2.6 | 40 |
| FEB | 1 | Jupiter | -1.7 | R B | 42 | 15 | 25.5 | -1.6 | 1.6 | 240 | 15 | 52.4 | -1.2 | 2.1 | 237 |
| FEB | 3 | 201 | 7.5 | D D | 69 | 19 | 48.5 | -0.7 | 1.1 | 95 | | | | | |
| FEB | 4 | 313 | 7.5 | D D | 80 | 18 | 27.1 | -1.8 | 1.6 | 67 | 18 | 55.6 | -1.4 | 1.8 | 57 |
| FEB | 5 | 425 | 7.1 | D D | 91 | | | | | | 17 | 40.3 | -1.5 | 3.1 | 16 |
| FEB | 5 | 435 | 5.9 | D D | 91 | 19 | 29.8 | -1.8 | 1.0 | 95 | 19 | 53.6 | -1.3 | 1.3 | 79 |
| FEB | 6 | 536 | 5.4 | D D | 102 | | | | | | 17 | 19.2 | -2.9 | 0.7 | 76 |
| FEB | 6 | 537 | 3.8 | D D | 102 | | | | | | 17 | 30.1 | -4.2 | -1.7 | 123 |
| FEB | 6 | 539 | 4.4 | D D | 102 | | | | | | 17 | 52.6 | -2.4 | 1.8 | 47 |
| FEB | 6 | 541 | 4.0 | D D | 102 | | | | | | 18 | 08.9 | -2.8 | 0.8 | 81 |
| FEB | 6 | 546 | 7.0 | D D | 102 | 18 | 28.8 | | | -143 | 18 | 46.5 | -2.7 | -0.9 | 123 |
| FEB | 6 | 542 | 5.9 | D D | 102 | | | | | | 18 | 30.3 | -2.3 | 2.2 | 41 |
| FEB | 6 | 543 | 6.5 | D D | 102 | | | | | | 18 | 31.2 | -2.4 | 1.9 | 50 |
| FEB | 6 | 548 | 6.7 | D D | 102 | 18 | 34.3 | -2.5 | 0.8 | 78 | 19 | 06.4 | -2.3 | 1.5 | 67 |
| FEB | 6 | 553 | 6.8 | D D | 103 | | | | | | 19 | 39.3 | -1.6 | -1.7 | 137 |
| FEB | 6 | 557 | 6.6 | D D | 103 | | | | | | 20 | 18.7 | -0.9 | -1.1 | 134 |
| FEB | 6 | 562 | 6.6 | D D | 103 | | | | | | 20 | 50.9 | -0.4 | -0.9 | 134 |
| FEB | 8 | 810 | 1.8 | D D | 122 | | | | | | 14 | 39.5 | -0.6 | 0.2 | 57 |
| FEB | 8 | 810 | 1.8 | R B | 123 | 15 | 48.3 | -1.3 | -0.9 | 263 | 15 | 58.6 | -2.1 | 1.0 | 265 |
| FEB | 10 | 1119 | 5.7 | D D | 147 | 21 | 57.3 | | | 175 | 21 | 53.3 | -1.5 | -0.8 | 132 |
| FEB | 10 | 1122 | 3.9 | D D | 147 | 22 | 05.7 | -2.1 | 0.1 | 107 | 22 | 34.2 | -2.9 | 1.7 | 70 |
| FEB | 17 | 1770 | 5.9 | R D | 217 | 2 | 08.7 | -1.6 | -1.3 | 313 | 2 | 01.6 | -0.1 | -3.4 | 359 |
| FEB | 21 | 2235 | 6.2 | R D | 266 | | | | | | 0 | 40.3 | -2.5 | 0.3 | 248 |
| FEB | 23 | 2545 | 6.4 | R D | 292 | 0 | 34.9 | -0.1 | -0.9 | 267 | 0 | 26.0 | 0.1 | -1.5 | 301 |
| FEB | 23 | 2554 | 4.4 | R D | 292 | 2 | 04.9 | 0.3 | -2.7 | 327 | | | | | |
| MAR | 8 | 921 | 6.3 | D D | 104 | | | | | | 17 | 54.3 | -3.6 | 3.1 | 36 |
| MAR | 9 | 1081 | 6.2 | D D | 116 | 22 | 12.7 | 0.2 | -1.1 | 154 | | | | | |
| MAR | 10 | 1189 | 5.0 | D D | 125 | | | | | | 17 | 05.7 | -2.6 | -1.4 | 115 |
| MAR | 17 | 1945 | 5.4 | R D | 208 | 20 | 43.9 | -0.4 | -2.1 | 320 | 20 | 27.3 | 0.1 | -2.9 | 351 |
| MAR | 20 | 2349 | 3.1 | R D | 247 | 22 | 53.9 | -1.3 | -0.4 | 247 | 22 | 56.8 | -0.9 | -1.3 | 287 |
| MAR | 21 | 2366 | 1.2 | D B | 249 | 02 | 40.5 | | | 171 | 02 | 31.8 | -2.2 | -1.6 | 122 |
| MAR | 21 | 2366 | 1.2 | R D | 250 | 03 | 20.9 | | | 228 | 03 | 58.1 | -2.5 | 0.3 | 271 |
| APR | 3 | 731 | 5.9 | D D | 62 | 18 | 07.4 | -0.9 | 0.1 | 124 | 18 | 20.7 | -1.0 | 0.9 | 92 |
| APR | 5 | 1032 | 5.5 | D D | 85 | 19 | 42.0 | -1.4 | 0.9 | 97 | 20 | 09.8 | -2.3 | 2.9 | 52 |
| APR | 7 | 1274 | 5.7 | D D | 107 | | | | | | 21 | 29.8 | 0.1 | -1.1 | 149 |
| APR | 16 | 2299 | 6.4 | R D | 217 | 22 | 51.5 | -1.7 | -0.9 | 271 | 22 | 55.5 | -1.3 | -2.0 | 311 |
| APR | 18 | 2470 | 6.1 | R D | 232 | 13 | 9.5 | -2.2 | -0.4 | 275 | 01 | 52.1 | -2.3 | -2.0 | 310 |
| APR | 18 | 2617 | 4.7 | R D | 224 | | | | | | 20 | 51.4 | -1.2 | 0.9 | 224 |
| APR | 19 | 2645 | 6.0 | R D | 245 | 05 | 6.8 | | | 216 | 01 | 28.1 | -2.5 | 0.0 | 262 |
| APR | 19 | 2644 | 6.3 | R D | 245 | 01 | 6.1 | -1.3 | -2.2 | 303 | | | | | |
| APR | 19 | 2660 | 6.1 | R D | 247 | 03 | 46.5 | -2.3 | -0.2 | 277 | | | | | |
| MAY | 1 | 810 | 1.8 | D D | 42 | 17 | 30.2 | 0.4 | -1.2 | 151 | | | | | |
| MAY | 2 | 967 | 6.9 | D D | 53 | 17 | 10.5 | -2.6 | 2.4 | 54 | | | | | |
| MAY | 3 | 1103 | 5.9 | D D | 64 | 18 | 8.7 | | | 175 | 18 | 1.3 | -0.7 | -0.3 | 126 |
| MAY | 4 | 1232 | 6.7 | D D | 76 | 18 | 47.2 | -2.4 | 1.8 | 74 | | | | | |
| MAY | 4 | 1233 | 5.8 | D D | 76 | 19 | 11.9 | -0.4 | -0.6 | 142 | 19 | 18.6 | -1.0 | 0.5 | 102 |
| MAY | 8 | 1645 | 6.6 | D D | 121 | 20 | 7.0 | -0.9 | -1.8 | 155 | 20 | 12.1 | -2.0 | -0.4 | 113 |
| MAY | 8 | 1648 | 7.0 | D D | 121 | 21 | 10.3 | -2.3 | 0.9 | 92 | | | | | |
| MAY | 9 | 1746 | 7.1 | D D | 133 | 20 | 10.2 | -2.4 | -0.4 | 104 | | | | | |
| MAY | 15 | 2545 | 6.4 | R D | 212 | 19 | 26.1 | -0.2 | -1.0 | 271 | | | | | |
| MAY | 15 | 2554 | 4.4 | R D | 212 | 20 | 53.3 | 0.3 | -2.9 | 331 | 19 | 16.6 | 0.1 | -1.7 | 306 |
| MAY | 17 | 2784 | 3.4 | R D | 230 | 03 | 12.3 | -1.8 | 1.6 | 241 | 03 | 39.9 | -1.7 | -1.2 | 253 |
| MAY | 19 | 3089 | 5.3 | R D | 255 | | | | | | 05 | 07.3 | -1.7 | 2.4 | 208 |
| MAY | 19 | 3092 | 6.2 | R D | 256 | 1 | 39.3 | -1.9 | -2.8 | 298 | | | | | |
| MAY | 31 | 1181 | 6.8 | D D | 45 | | | | | | 17 | 09.4 | | -0.9 | 144 |
| JUN | 4 | 1603 | 7.1 | D D | 90 | 18 | 14.7 | -2.9 | 0.8 | 88 | | | | | |
| JUNE | 6 | 1814 | 7.1 | D D | 115 | 23 | 13.1 | -0.4 | -1.6 | 159 | | | | | |
| JUNE | 7 | 1911 | 7.1 | D D | 124 | | | | | | 16 | 12.8 | -2.1 | -1.2 | 101 |

| DATE | | ZC | MAG | PHASE | ELG | CAPE TOWN TIME | | A | B | P | JOHANNESBURG TIME | | A | B | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | D | | | | ° | h | m | m | m | ° | h | m | m | m | ° |
| JUNE | 7 | 1917 | 7.0 | D D | 126 | | | | | | 20 | 17.9 | | | 192 |
| JUNE | 16 | 3197 | 6.5 | R D | 239 | 02 | 29.6 | -0.6 | 3.5 | 188 | 03 | 01.0 | -0.6 | 3.2 | 194 |
| JUNE | 17 | 3461 | 6.4 | R D | 264 | 23 | 39.4 | | | 310 | | | | | |
| JUNE | 18 | 35 | 6.4 | | | | | | | | 23 | 57.4 | -0.7 | -0.8 | 265 |
| JUL | 5 | 1986 | 7.0 | D D | 108 | 19 | 29.3 | -0.8 | -3.2 | 169 | 19 | 27.7 | -1.7 | -1.0 | 127 |
| JULY | 5 | 2002 | 6.8 | D D | 110 | 23 | 30.9 | | 2.1 | 261 | | | | | |
| JULY | 7 | 2227 | 5.8 | D D | 132 | 16 | 35.1 | -0.8 | -1.9 | 128 | 16 | 37.6 | -2.2 | -0.6 | 89 |
| JULY | 7 | 2235 | 6.2 | D D | 132 | 17 | 19.7 | -1.8 | -0.9 | 93 | | | | | |
| JULY | 7 | 2237 | 5.1 | D D | 133 | | | | | | 18 | 44.1 | -1.2 | -3.5 | 160 |
| JULY | 7 | 2257 | 6.7 | D D | 135 | 22 | 52.7 | -1.0 | 2.9 | 55 | | | | | |
| JULY | 8 | 2270 | 5.4 | D D | 136 | 01 | 27.5 | 0.8 | 3.2 | 39 | | | | | |
| JULY | 9 | 2554 | 4.4 | D D | 159 | 16 | 23.0 | -0.7 | -0.5 | 70 | | | | | |
| JULY | 13 | 3256 | 6.2 | R D | 218 | 20 | 07.8 | -0.5 | 0.3 | 228 | 20 | 12.0 | -0.7 | -0.5 | 261 |
| JULY | 13 | 3275 | 6.1 | R D | 220 | 23 | 52.6 | | | | | | | | |
| JULY | 14 | 3275 | 6.1 | R D | 221 | | | | | | 0 | 16.2 | -2.3 | 0.6 | 252 |
| JULY | 15 | 3430 | 5.7 | R D | 237 | 05 | 11.5 | -1.6 | 1.3 | 261 | | | | | |
| JULY | 31 | 1836 | 6.3 | D D | 66 | | | | | | 19 | 01.6 | | | 180 |
| AUG | 3 | 2183 | 5.7 | D D | 102 | | | | | | 03 | 18.4 | -1.3 | -4.9 | 172 |
| AUG | 5 | 2366 | 1.2 | D D | 118 | 00 | 24.7 | | | 158 | | | | | |
| AUG | 5 | 2366 | 1.2 | R B | 118 | 0 | 46.8 | | | 206 | | | | | |
| AUG | 5 | 2505 | 5.4 | D D | 128 | 18 | 46.2 | -2.1 | -1.0 | 105 | 19 | 08.5 | -2.5 | 0.9 | 75 |
| AUG | 18 | 731 | 5.9 | R D | 290 | | | | | | | | -0.8 | 0.7 | 226 |
| AUG | 29 | 2029 | 5.1 | D D | 61 | 15 | 50.2 | -1.0 | -1.2 | 147 | 18 | 53.5 | -0.7 | -0.2 | 120 |
| AUG | 31 | 2286 | 5.4 | D D | 85 | 18 | 15.0 | -1.9 | 3.9 | 49 | | | | | |
| AUG | 31 | 2295 | 7.0 | D D | 86 | 20 | 32.4 | -0.3 | 2.7 | 54 | 20 | 54.9 | | | 30 |
| SEPT | 2 | 2617 | 4.7 | D D | 112 | 19 | 58.0 | -1.7 | 1.3 | 74 | 20 | 24.0 | -1.1 | 1.7 | 61 |
| SEPT | 3 | 2644 | 6.3 | D D | 114 | 0 | 12.6 | -0.6 | | 127 | | | | | |
| SEPT | 11 | 399 | 5.7 | R D | 235 | 23 | 40.6 | -1.6 | -0.5 | 259 | 23 | 56.9 | -2.3 | -0.1 | 259 |
| SEPT | 15 | 824 | 6.2 | R D | 271 | 02 | 23.3 | -1.8 | -0.8 | 265 | 02 | 40.0 | -2.6 | -0.4 | 268 |
| SEPT | 26 | 2115 | 7.1 | D D | 43 | 18 | 19.1 | -0.5 | 0.8 | 101 | | | | | |
| SEPT | 28 | 2366 | 1.2 | D D | 64 | 10 | 12.5 | 0.3 | -2.3 | 145 | 09 | 59.7 | -0.6 | -1.4 | 110 |
| SEPT | 28 | 2366 | 1.2 | R B | 65 | 11 | 06.0 | -1.3 | -0.8 | 260 | 11 | 07.6 | -1.0 | -1.7 | 298 |
| SEPT | 28 | 2405 | 6.4 | D D | 69 | | | | | | 19 | 00.8 | | | 159 |
| SEPT | 29 | 2583 | 5.8 | D D | 83 | 22 | 35.3 | 0.5 | 1.5 | 60 | | | | | |
| SEPT | 30 | 2743 | 7.4 | D D | 95 | 19 | 16.2 | -1.1 | 2.2 | 51 | 19 | 41.3 | -0.4 | 2.3 | 43 |
| OCT | 3 | 3081 | 6.7 | D D | 124 | 00 | 08.4 | -0.6 | 0.9 | 101 | 00 | 18.0 | -0.2 | 0.7 | 97 |
| OCT | 3 | 3217 | 7.2 | D D | 136 | 21 | 12.8 | -0.7 | 2.5 | 24 | 21 | 38.0 | -0.5 | 2.4 | 27 |
| OCT | 4 | 3237 | 4.4 | D D | 138 | 01 | 47.9 | 0.1 | 1.5 | 57 | | | | | |
| OCT | 11 | 616 | 5.6 | R D | 228 | 01 | 15.7 | -1.6 | 1.1 | 220 | 01 | 45.8 | -2.3 | 1.7 | 225 |
| OCT | 15 | 1189 | 5.0 | R D | 274 | 02 | 16.1 | -2.1 | -2.3 | 316 | 02 | 18.6 | -2.7 | -3.2 | 331 |
| OCT | 25 | 2366 | 1.2 | D D | 39 | 18 | 37.1 | -0.4 | 0.5 | 111 | 18 | 42.8 | | 0.5 | 102 |
| OCT | 25 | 2366 | 1.2 | R B | 39 | 19 | 29.7 | 0.4 | 1.4 | 252 | | | | | |
| OCT | 27 | 2712 | 7.5 | D D | 66 | 20 | 53.6 | | | 138 | | | | | |
| OCT | 29 | 3031 | 5.9 | D D | 92 | 21 | 44.2 | 0.2 | 2.1 | 34 | 21 | 56.7 | 0.5 | 1.9 | 32 |
| OCT | 30 | 3171 | 3.8 | D D | 105 | 20 | 44.9 | | | 347 | 21 | 03.8 | | | 351 |
| OCT | 30 | 3190 | 3.0 | D D | 107 | 23 | 41.3 | -0.2 | 0.9 | 100 | | | | | |
| OCT | 31 | 3324 | 7.2 | D D | 120 | 23 | 25.6 | -0.4 | 1.5 | 71 | 23 | 39.2 | -0.1 | 1.4 | 65 |
| NOV | 7 | 569 | 5.4 | R D | 198 | 02 | 58.1 | -1.2 | 0.8 | 282 | | | | | |
| NOV | 9 | 850 | 6.0 | R D | 220 | 00 | 00.5 | -2.2 | -0.2 | 259 | 00 | 24.3 | -2.9 | 0.0 | 267 |
| NOV | 10 | 1018 | 5.5 | R D | 232 | 01 | 45.8 | -2.6 | 0.2 | 254 | 02 | 14.1 | -2.8 | 0.1 | 275 |
| NOV | 23 | 2643 | 6.7 | D D | 34 | 15 | 36.1 | 0.9 | 2.6 | 27 | | | | | |
| NOV | 25 | 2991 | 6.2 | D D | 62 | 20 | 49.1 | 0.7 | 2.2 | 21 | | | | | |
| NOV | 27 | 3268 | 5.6 | D D | 86 | | | | | | 17 | 56.5 | -1.5 | 1.7 | 57 |
| NOV | 28 | 3405 | 7.0 | D D | 100 | 19 | 17.2 | -1.5 | 1.7 | 58 | 19 | 53.4 | -1.3 | 1.7 | 61 |
| NOV | 30 | 98 | 6.2 | D D | 125 | | | | | | 18 | 30.6 | -3.4 | 0.1 | 91 |
| NOV | 30 | 105 | 4.6 | D D | 126 | | | | | | 20 | 48.5 | | | 341 |
| DEC | 7 | 1081 | 6.2 | R D | 210 | 21 | 45.2 | -1.7 | -1.4 | 252 | 21 | 54.4 | -2.4 | -1.4 | 290 |
| DEC | 19 | 2366 | 1.2 | D B | 342 | 12 | 11.5 | -1.5 | 1.0 | 270 | 12 | 33.7 | -0.8 | 1.7 | 68 |
| DEC | 19 | 2366 | 1.2 | R D | 343 | 13 | 22.4 | -1.0 | 0.6 | 261 | 13 | 34.3 | -0.9 | | 296 |
| DEC | 22 | 3078 | 4.9 | D D | 42 | 18 | 12.4 | -0.8 | 1.0 | 96 | 18 | 24.6 | -0.4 | 0.8 | 94 |
| DEC | 24 | 3190 | 3.0 | D D | 50 | 09 | 17.8 | -0.6 | 0.3 | 49 | 09 | 38.3 | -1.2 | 3.8 | 7 |
| DEC | 24 | 3190 | 3.0 | R B | 51 | 10 | 17.9 | -0.9 | -1.0 | 268 | 10 | 14.0 | -1.5 | -3.8 | 306 |
| DEC | 26 | 3500 | 7.3 | D D | 82 | 18 | 41.6 | | | 349 | 19 | 06.1 | | | 349 |
| DEC | 31 | 731 | 5.9 | D D | 153 | | | | | | 17 | 29.1 | -2.9 | -2.3 | 120 |

# G R A Z I N G  O C C U L T A T I O N S

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 these data cannot readily be obtained in any other way.

The maps on the following pages have been prepared by 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 letters "A", "B" or "S" are given. "A" denotes that the Moon is at a low altitude, "B" that the bright limb interferes, and "S" that sunlight interferes. The tick marks along the tracks denote 5 minute intervals (at whole minutes), give the approximate time of the graze at places along the tracks.

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 radio receiver tuned to ZUO or other time signal station.

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:
M.D. Overbeek, P.O. Box 212, Edenvale, 1610. Tel: (011) 535 447.

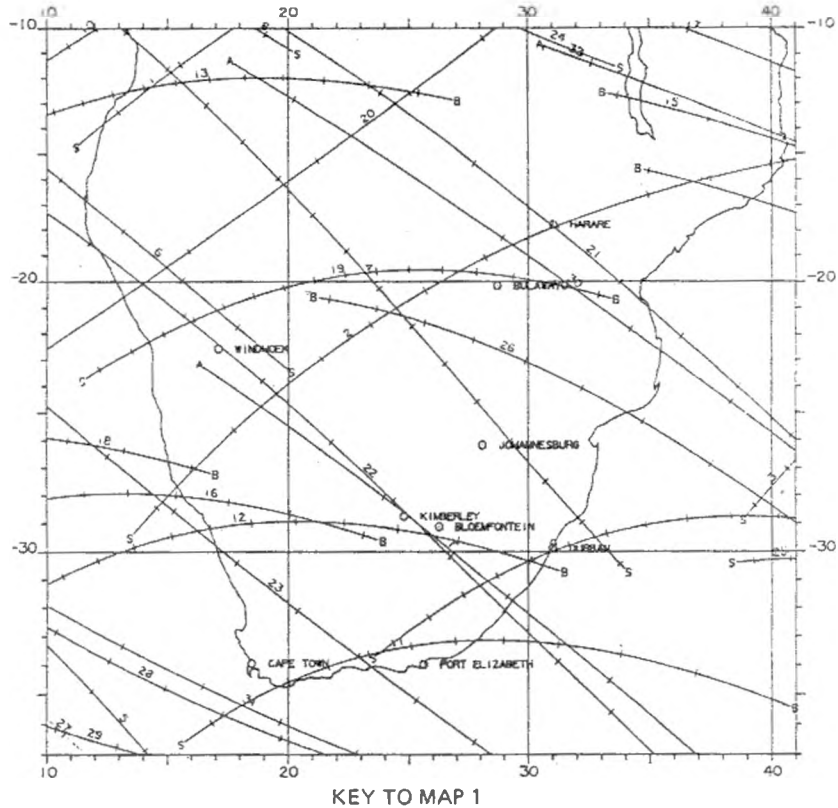
EXPLANATION OF COLUMN HEADINGS IN TABLES:

| | | |
|---|---|---|
| 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 UT for the west end of the track. |
| SUNLIT (%) | : | Percent of the Moon sunlit (a minus sign indicates a waning Moon). |
| Limit | : | Whether the track is the north (N) the south (S) limits of the occultation. |
| - | | (A) denotes that the Moon is at a low altitude. |
| | | (B) denotes that the star is occultated at bright limb. |
| | | S) denotes that the daylight interferes. |

The map gives the graze tracks or the limits of occultations. Along each track on the map, tick marks are 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 on the computer list, 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.

# GRAZING OCCULTATIONS 1987

YEAR 1987 MONTH 1-3 ( 1-32 )

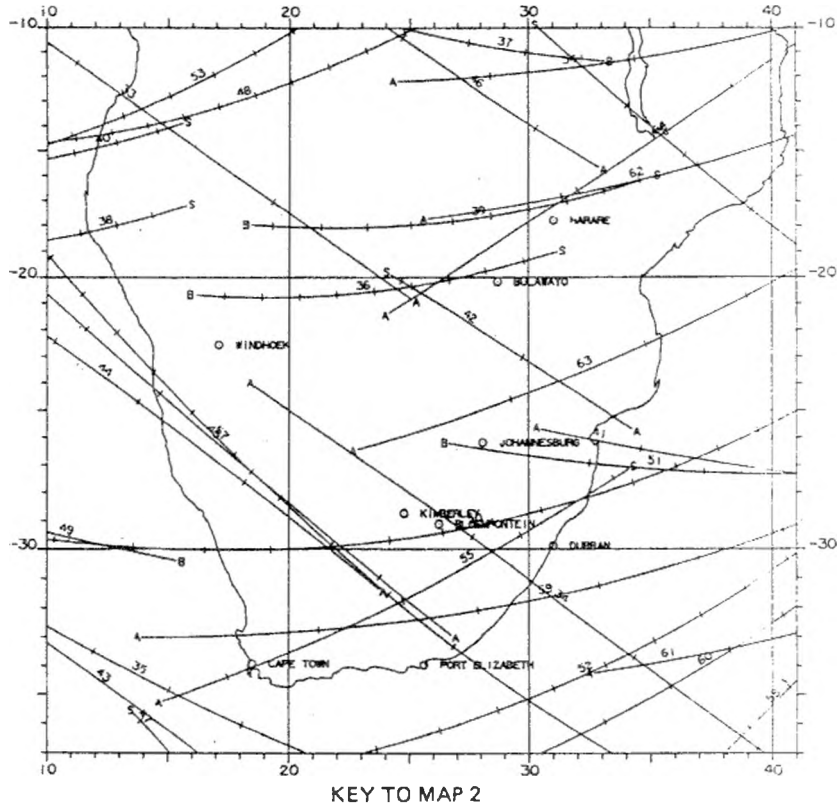



## KEY TO MAP 1

| SEQ | NZC NO | MAG | MON | DAY | UT H | M | S | SUNLIT(%) | LIMIT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3288 | 5.92 | 1 | 3 | 18 | 11 | 33.37 | 17.79 | S | (S) | ( ) |
| 2 | 4 | 6.28 | 1 | 5 | 18 | 36 | 44.48 | 37.73 | S | (S) | ( ) |
| 3 | 104 | 5.82 | 1 | 6 | 16 | 53 | 37.12 | 47.44 | S | (S) | ( ) |
| 4 | 1911 | 7.06 | 1 | 22 | 1 | 24 | 21.31 | -58.94 | S | ( ) | (S) |
| 5 | 2021 | 6.69 | 1 | 23 | 1 | 11 | 4.66 | -48.42 | S | ( ) | ( ) |
| 6 | 2299 | 6.42 | 1 | 25 | 3 | 28 | 59.35 | -25.74 | S | ( ) | (S) |
| 7 | 2449 | 7.48 | 1 | 26 | 1 | 35 | 16.93 | -16.86 | S | (A) | ( ) |
| 8 | 2645 | 6.04 | 1 | 27 | 4 | 9 | 33.82 | -8.21 | S | ( ) | (S) |
| 9 | 537 | 3.81 | 2 | 6 | 17 | 37 | 47.85 | 60.18 | S | (S) | ( ) |
| 10 | 545 | 4.25 | 2 | 6 | 18 | 6 | 4.34 | 60.40 | S | ( ) | ( ) |
| 11 | 546 | 6.96 | 2 | 6 | 18 | 31 | 26.18 | 60.48 | S | (S) | (B) |
| 12 | 553 | 6.81 | 2 | 6 | 19 | 7 | 49.25 | 60.66 | S | ( ) | (B) |
| 13 | 552 | 2.96 | 2 | 6 | 19 | 13 | 47.12 | 60.61 | S | ( ) | (B) |
| 14 | 542 | 5.85 | 2 | 6 | 19 | 34 | 40.07 | 60.37 | N | (B) | ( ) |
| 15 | 543 | 6.46 | 2 | 6 | 19 | 39 | 24.31 | 60.39 | N | (B) | ( ) |
| 16 | 557 | 6.56 | 2 | 6 | 20 | 0 | 28.02 | 60.82 | S | ( ) | (B) |
| 17 | 548 | 6.68 | 2 | 6 | 20 | 19 | 42.67 | 60.52 | N | ( ) | ( ) |
| 18 | 562 | 6.63 | 2 | 6 | 20 | 43 | 1.77 | 60.97 | S | ( ) | (B) |
| 19 | 701 | 6.49 | 2 | 7 | 18 | 22 | 56.63 | 69.62 | S | (S) | (B) |
| 20 | 810 | 1.78 | 2 | 8 | 15 | 1 | 45.41 | 77.30 | N | ( ) | ( ) |
| 21 | 2227 | 5.82 | 2 | 20 | 23 | 16 | 3.12 | -53.70 | S | ( ) | ( ) |
| 22 | 2235 | 6.21 | 2 | 20 | 23 | 58 | 7.51 | -53.43 | S | ( ) | ( ) |
| 23 | 2404 | 6.86 | 2 | 22 | 2 | 0 | 44.68 | -41.32 | S | ( ) | ( ) |
| 24 | 2925 | 7.50 | 2 | 25 | 3 | 22 | 23.61 | -11.10 | S | ( ) | (S) |
| 25 | 768 | 7.00 | 3 | 7 | 16 | 17 | 37.01 | 51.64 | S | (S) | ( ) |
| 26 | 921 | 6.32 | 3 | 8 | 18 | 3 | 49.21 | 61.66 | N | (B) | ( ) |
| 27 | 2349 | 3.08 | 3 | 20 | 22 | 34 | 8.94 | -68.76 | S | ( ) | ( ) |
| 28 | 2366 | 1.22 | 3 | 21 | 2 | 44 | 11.99 | -67.30 | S | ( ) | ( ) |
| 29 | 2373 | 6.22 | 3 | 21 | 3 | 54 | 14.42 | -66.99 | S | ( ) | ( ) |
| 30 | 2505 | 5.43 | 3 | 21 | 22 | 14 | 15.47 | -57.76 | S | (A) | ( ) |
| 31 | 2702 | 6.78 | 3 | 23 | 2 | 10 | 30.39 | -44.67 | S | ( ) | ( ) |
| 32 | 3018 | 6.33 | 3 | 25 | 0 | 54 | 0.17 | -23.41 | S | (A) | ( ) |

# GRAZING OCCULTATIONS 1987

YEAR 1987 MONTH 4 - 6 ( 33 - 64 )



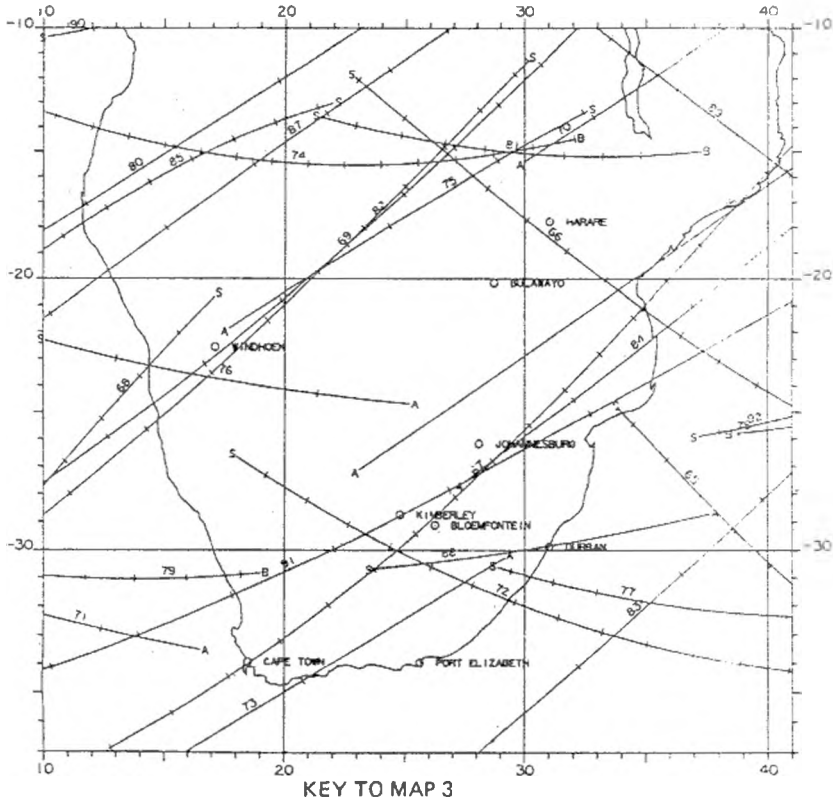

## KEY TO MAP 2

ut

| SEQ | NZC NO | MAG | MON | DAY | H | M | S | SUNLIT(%) | LIMIT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 1032 | 5.54 | 4 | 5 | 20 | 12 | 59.03 | 44.79 | N | ( ) | (A) |
| 34 | 2617 | 4.66 | 4 | 18 | 20 | 36 | 20.93 | -72.32 | S | (A) | ( ) |
| 35 | 2645 | 6.04 | 4 | 19 | 0 | 26 | 59.50 | -70.82 | S | ( ) | ( ) |
| 36 | 2660 | 6.07 | 4 | 19 | 2 | 56 | 7.55 | -70.14 | N | (B) | (S) |
| 37 | 2831 | 5.94 | 4 | 20 | 1 | 29 | 9.26 | -59.42 | S | ( ) | (B) |
| 38 | 2848 | 5.56 | 4 | 20 | 4 | 25 | 22.90 | -58.41 | N | ( ) | (S) |
| 39 | 2985 | 6.88 | 4 | 21 | 2 | 37 | 54.73 | -47.38 | N | (B) | (S) |
| 40 | 3150 | 6.54 | 4 | 22 | 4 | 26 | 57.82 | -35.37 | N | ( ) | (S) |
| 41 | 3271 | 7.09 | 4 | 23 | 0 | 28 | 51.51 | -26.31 | S | (A) | ( ) |
| 42 | 801 | 6.39 | 5 | 1 | 16 | 24 | 28.71 | 12.38 | N | (S) | (A) |
| 43 | 810 | 1.78 | 5 | 1 | 17 | 43 | 9.13 | 12.76 | S | ( ) | ( ) |
| 44 | 967 | 6.91 | 5 | 2 | 17 | 29 | 28.89 | 19.74 | N | ( ) | (A) |
| 45 | 1232 | 6.70 | 5 | 4 | 19 | 1 | 54.14 | 37.12 | N | ( ) | (A) |
| 46 | 1233 | 5.83 | 5 | 4 | 19 | 44 | 15.52 | 37.18 | N | ( ) | (A) |
| 47 | 1436 | 6.92 | 5 | 6 | 16 | 44 | 10.57 | 55.69 | N | (S) | ( ) |
| 48 | 2784 | 3.42 | 5 | 17 | 2 | 20 | 59.77 | -82.66 | N | ( ) | ( ) |
| 49 | 3089 | 5.27 | 5 | 19 | 0 | 9 | 16.06 | -62.38 | S | ( ) | (B) |
| 50 | 3092 | 6.15 | 5 | 19 | 0 | 59 | 14.03 | -62.07 | N | ( ) | ( ) |
| 51 | 3225 | 7.10 | 5 | 19 | 23 | 20 | 8.57 | -51.39 | N | (B) | ( ) |
| 52 | 3236 | 7.10 | 5 | 20 | 2 | 14 | 2.96 | -50.32 | N | ( ) | ( ) |
| 53 | 3375 | 6.86 | 5 | 21 | 3 | 22 | 40.13 | -38.61 | N | ( ) | ( ) |
| 54 | 3496 | 7.24 | 5 | 22 | 0 | 47 | 41.52 | -29.15 | N | (A) | ( ) |
| 55 | 201 | 7.47 | 5 | 24 | 3 | 38 | 38.89 | -11.45 | N | (A) | (S) |
| 56 | 1290 | 6.84 | 6 | 1 | 16 | 5 | 59.20 | 21.41 | N | (S) | ( ) |
| 57 | 1603 | 7.08 | 6 | 4 | 18 | 9 | 31.70 | 49.42 | N | ( ) | ( ) |
| 58 | 3332 | 7.20 | 6 | 17 | 2 | 51 | 59.84 | -64.68 | N | ( ) | ( ) |
| 59 | 3461 | 6.40 | 6 | 17 | 23 | 26 | 19.52 | -54.47 | N | (A) | ( ) |
| 60 | 3465 | 6.50 | 6 | 18 | 1 | 5 | 40.96 | -53.95 | N | ( ) | ( ) |
| 61 | 32 | 7.29 | 6 | 18 | 23 | 12 | 20.73 | -43.66 | N | (A) | ( ) |
| 62 | 35 | 6.43 | 6 | 18 | 23 | 31 | 40.39 | -43.50 | N | (A) | ( ) |
| 63 | 162 | 6.90 | 6 | 20 | 0 | 46 | 10.95 | -32.67 | N | (A) | ( ) |
| 64 | 810 | 1.78 | 6 | 25 | 4 | 37 | 14.87 | -1.05 | N | (A) | ( ) |

# GRAZING OCCULTATIONS 1987

YEAR 1987 MONTH 7 - 9 ( 65 - 92 )



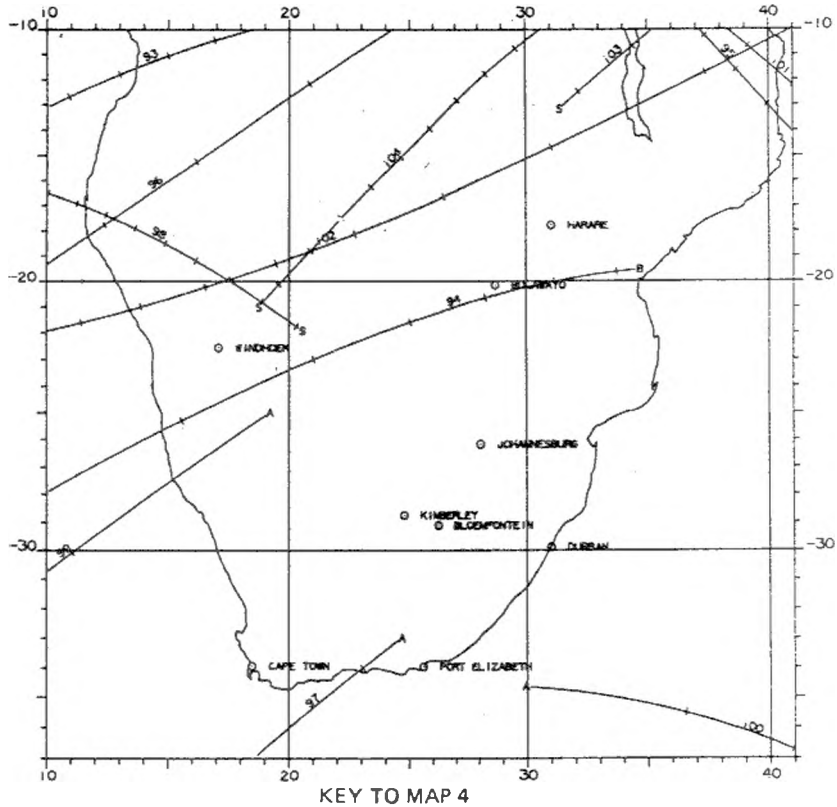

KEY TO MAP 3

ut

| SEQ | NZC NO | MAG | MON | DAY | H | M | S | SUNLIT(%) | LIMIT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 1971 | 5.82 | 7 | 5 | 15 | 32 | 52.92 | 63.51 | N | (S) | ( ) |
| 66 | 2227 | 5.82 | 7 | 7 | 16 | 39 | 37.90 | 83.59 | N | (S) | ( ) |
| 67 | 3412 | 4.40 | 7 | 15 | 0 | 49 | 37.60 | -78.67 | N | ( ) | ( ) |
| 68 | 3430 | 5.71 | 7 | 15 | 4 | 42 | 5.39 | -77.68 | N | ( ) | (S) |
| 69 | 375 | 6.77 | 7 | 19 | 3 | 8 | 28.92 | -36.21 | N | ( ) | (S) |
| 70 | 768 | 7.00 | 7 | 22 | 2 | 33 | 19.86 | -11.93 | N | (A) | ( ) |
| 71 | 1644 | 4.13 | 7 | 29 | 19 | 3 | 55.88 | 13.01 | N | ( ) | (A) |
| 72 | 2332 | 6.16 | 8 | 4 | 16 | 46 | 27.03 | 70.57 | N | (S) | ( ) |
| 73 | 2366 | 1.22 | 8 | 5 | 0 | 33 | 3.12 | 72.99 | S | ( ) | (A) |
| 74 | 2505 | 5.43 | 8 | 5 | 18 | 53 | 22.14 | 81.25 | N | ( ) | (B) |
| 75 | 1032 | 5.54 | 8 | 20 | 3 | 25 | 15.04 | -15.95 | N | (A) | (S) |
| 76 | 1712 | 3.80 | 8 | 26 | 17 | 17 | 25.39 | 4.29 | N | (S) | (A) |
| 77 | 2269 | 5.44 | 8 | 31 | 15 | 58 | 22.24 | 44.42 | N | (S) | ( ) |
| 78 | 2273 | 5.93 | 8 | 31 | 17 | 19 | 41.80 | 44.67 | S | (B) | ( ) |
| 79 | 2286 | 5.41 | 8 | 31 | 18 | 20 | 39.45 | 45.30 | N | ( ) | (B) |
| 80 | 2631 | 6.38 | 9 | 2 | 22 | 22 | 19.73 | 69.03 | S | ( ) | ( ) |
| 81 | 2784 | 3.42 | 9 | 3 | 16 | 26 | 18.38 | 77.85 | N | (S) | (B) |
| 82 | 399 | 5.72 | 9 | 11 | 23 | 2 | 19.03 | -78.17 | N | ( ) | ( ) |
| 83 | 518 | 5.92 | 9 | 12 | 23 | 1 | 29.82 | -69.08 | N | ( ) | ( ) |
| 84 | 673 | 6.61 | 9 | 13 | 23 | 7 | 15.94 | -59.28 | N | (A) | ( ) |
| 85 | 696 | 7.38 | 9 | 14 | 3 | 32 | 50.14 | -57.94 | N | ( ) | (S) |
| 86 | 810 | 1.78 | 9 | 14 | 23 | 35 | 25.04 | -49.29 | S | (A) | ( ) |
| 87 | 824 | 6.24 | 9 | 15 | 1 | 29 | 45.52 | -48.58 | N | ( ) | ( ) |
| 88 | 1992 | 7.22 | 9 | 25 | 16 | 47 | 2.44 | 6.45 | S | (S) | (A) |
| 89 | 2366 | 1.22 | 9 | 28 | 10 | 13 | 58.98 | 28.78 | N | ( ) | ( ) |
| 90 | 2397 | 6.54 | 9 | 28 | 17 | 36 | 3.97 | 30.86 | S | (S) | ( ) |
| 91 | 2405 | 6.38 | 9 | 28 | 18 | 49 | 30.12 | 31.23 | S | ( ) | ( ) |
| 92 | 2540 | 6.99 | 9 | 29 | 15 | 53 | 10.38 | 40.94 | S | (S) | ( ) |

# GRAZING OCCULTATIONS 1987

YEAR 1987 MONTH 10 - 12 ( 93 - 104 )




KEY TO MAP 4

ut

| SEQ | NZC NO | MAG | MON | DAY | H | M | S | SUNLIT(%) | LIMIT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 93 | 921 | 6.32 | 10 | 13 | 2 | 12 | 54.42 | -65.28 | N | ( ) | ( ) |
| 94 | 1189 | 4.99 | 10 | 15 | 1 | 26 | 57.16 | -46.51 | N | ( ) | (B) |
| 95 | 1925 | 1.21 | 10 | 22 | 7 | 53 | 59.90 | -0.19 | S | ( ) | ( ) |
| 96 | 2702 | 6.78 | 10 | 27 | 19 | 21 | 28.21 | 28.22 | S | ( ) | ( ) |
| 97 | 2712 | 7.50 | 10 | 27 | 21 | 2 | 12.90 | 28.95 | S | ( ) | (A) |
| 98 | 1149 | 4.22 | 11 | 11 | 2 | 59 | 45.35 | -72.56 | S | ( ) | (S) |
| 99 | 2644 | 6.26 | 11 | 23 | 18 | 54 | 9.48 | 8.04 | S | ( ) | (A) |
| 100 | 1712 | 3.80 | 12 | 13 | 22 | 50 | 38.09 | -45.06 | S | (A) | ( ) |
| 101 | 1925 | 1.21 | 12 | 16 | 1 | 57 | 48.19 | -24.83 | S | ( ) | ( ) |
| 102 | 2366 | 1.22 | 12 | 19 | 12 | 41 | 57.58 | -2.48 | N | ( ) | ( ) |
| 103 | 3217 | 7.23 | 12 | 24 | 16 | 43 | 30.44 | 20.44 | S | (S) | ( ) |
| 104 | 203 | 6.92 | 12 | 28 | 17 | 52 | 26.92 | 64.34 | S | (S) | ( ) |

## TIME SYSTEMS AND TELESCOPE SETTINGS

This section is intended to serve established amateurs and profession astronomers - i.e. those having some knowledge of time and coordinate systems. Space in the booklet does not permit full explanation, which in any case would appear complicated to the layman.

### TIME SIGNALS FROM RADIO STATION ZUO

Radio signals of mean solar time are generated by the Precise Physical Measurements Division of the National Physical Research Laboratory in Pretoria. They are broadcast by the Post Office, the 2,5 and 5 MHz signals from Olifantsfontein, and the 100 MHz signals from Johannesburg.

| Carrier Frequency | Radiated Power | Time of Transmission |
|---|---|---|
| 2,5 MHz | 4 Kw | 2000 - 0600 SAST |
| 5 MHz | 4 Kw | Continuous |

The signals consist of one pulse per second, each pulse consisting of 5 cycles of 1000 Hz tone. The first pulse in every minute is lengthened to 500 milliseconds. Morse code announcements are made during the minute preceding every fifth minute. They consist of the call sign ZUO (repeated 3 times) and the Universal Time (formerly known as Greenwich Mean Time) at the next minute. (A special coding indicating UT1 minus UTC is also indicated in the first 15 seconds of the minute by slightly lengthened second pulses.)

### SOUTH AFRICAN STANDARD TIME

South African Standard Time (as in everyday use) is mean solar time and the 30° East meridian (which runs east of Johannesburg and just west of Durban) and is exactly 2 hours ahead of Universal Time.

### TIME OF SUN'S TRANSIT OVER 30° MERIDIAN

The table below gives the SAST when the Sun transits the 30° meridian - and a sundial on that meridian reads noon.

| | | h | m | s |
|---|---|---|---|---|
| Jan | 1 | 12 | 03 | 21 |
| | 11 | 12 | 07 | 24 |
| | 21 | 12 | 11 | 11 |
| | 31 | 12 | 13 | 23 |
| Feb | 10 | 12 | 14 | 15 |
| | 20 | 12 | 13 | 48 |
| Mar | 2 | 12 | 12 | 17 |
| | 12 | 12 | 09 | 56 |
| | 22 | 12 | 07 | 04 |
| Apr | 1 | 12 | 04 | 04 |
| | 11 | 12 | 01 | 13 |
| | 21 | 11 | 58 | 49 |
| May | 1 | 11 | 57 | 10 |
| May | 11 | 11 | 56 | 22 |
| | 21 | 11 | 56 | 31 |
| | 31 | 11 | 57 | 34 |
| Jun | 10 | 10 | 11 | 17 |
| | 20 | 12 | 01 | 23 |
| | 30 | 12 | 03 | 31 |
| Jul | 10 | 12 | 05 | 15 |
| | 20 | 12 | 06 | 17 |
| | 30 | 12 | 06 | 26 |
| Aug | 9 | 12 | 05 | 33 |
| | 19 | 12 | 03 | 43 |
| | 29 | 12 | 01 | 05 |
| Sep | 8 | 11 | 57 | 50 |
| Sep | 18 | 11 | 54 | 19 |
| | 28 | 11 | 50 | 50 |
| Oct | 8 | 11 | 47 | 42 |
| | 18 | 11 | 45 | 16 |
| | 28 | 11 | 43 | 51 |
| Nov | 7 | 11 | 43 | 39 |
| | 17 | 11 | 44 | 51 |
| | 27 | 11 | 47 | 27 |
| Dec | 7 | 11 | 51 | 18 |
| | 17 | 11 | 55 | 51 |
| | 27 | 12 | 00 | 50 |
| | 31 | 12 | 02 | 46 |

# TIME SYSTEMS

## SIDERIAL TIME ON THE 30° MERIDIAN

| | At 0 hrs SAST h m | At 21 hrs SAST h m | | At 0 hrs SAST h m | At 21 hrs SAST h m | | At 0 hrs SAST h m | At 21 hrs SAST h m |
|---|---|---|---|---|---|---|---|---|
| Jan 1 | 6 41 | 3 43 | May 11 | 15 13 | 12 16 | Sep 18 | 23 46 | 20 48 |
| 11 | 7 20 | 4 22 | 21 | 15 53 | 12 55 | 28 | 0 25 | 21 28 |
| 21 | 8 00 | 5 02 | 31 | 16 32 | 13 34 | Oct 8 | 1 05 | 22 07 |
| 31 | 8 39 | 5 41 | Jun 10 | 17 12 | 14 14 | 18 | 1 44 | 22 46 |
| Feb 10 | 9 18 | 6 21 | 20 | 17 51 | 14 53 | 28 | 2 24 | 23 46 |
| 20 | 9 58 | 7 00 | 30 | 18 30 | 15 33 | Nov 7 | 3 03 | 0 05 |
| Mar 2 | 10 37 | 7 40 | Jul 10 | 19 10 | 16 12 | 17 | 3 42 | 0 45 |
| 12 | 11 17 | 8 19 | 20 | 19 49 | 16 52 | 27 | 4 22 | 1 24 |
| 22 | 11 56 | 8 58 | 30 | 20 29 | 17 31 | Dec 7 | 5 01 | 2 04 |
| Apr 1 | 12 36 | 9 38 | Aug 9 | 21 08 | 18 11 | 17 | 5 41 | 2 43 |
| 11 | 13 15 | 10 17 | 19 | 21 48 | 18 50 | 27 | 6 20 | 3 22 |
| 21 | 13 54 | 10 57 | 29 | 22 27 | 19 29 | 31 | 6 36 | 3 38 |
| May 1 | 14 34 | 11 36 | Sep 8 | 23 06 | 20 09 | | | |

### CORRECTION FOR PLACES NOT ON THE 30° MERIDIAN

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

To find the sidereal times at SAST 0 hrs and SAST 21 hrs apply the corrections with the sign reversed to the data in the table.

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

### TELESCOPE SETTING

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

### A LIST OF BRIGHT STARS FOR CHECKING TELESCOPE CIRCLES

| Star | R.A. | Dec. | Mag. | Sp. | Star | R.A. | Dec. | Mag. | Sp. |
|---|---|---|---|---|---|---|---|---|---|
| Achernar | $1^h37{,}2^m$ | -57°18' | 0,6 | B5 | Procyon | $7^h38{,}6^m$ | + 5°16' | 0,5 | F5 |
| Aldebaran | 4 35,1 | +16 29 | 1,1 | K5 | Regulus | 10 07,7 | +12 02 | 1,3 | B8 |
| Rigel | 5 13,9 | - 8 13 | 0,3 | B8 | Spica | 13 24,5 | -11,05 | 1,2 | B2 |
| Betelgeuse | 5 54,4 | + 7 24 | 0,4 | M0 | Arcturus | 14 15,0 | +19,15 | 0,2 | K0 |
| Canopus | 6 23,7 | -52,41 | -0,9 | F0 | Antares | 16 28,6 | -26,24 | 1,2 | M1 |
| Sirius | 6 44,6 | -16,41 | -1,6 | A0 | Altair | 19 50,1 | + 8,50 | 0,9 | A5 |

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| | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2446 | 2446 | 2446 | 2446 | 2446 | 2446 | 2446 | 2447 | 2447 | 2447 | 2447 | 2447 |
| 1 | 797 | 828 | 856 | 887 | 917 | 948 | 978 | 009 | 040 | 070 | 101 | 131 |
| 2 | 798 | 829 | 857 | 888 | 918 | 949 | 979 | 010 | 041 | 071 | 102 | 132 |
| 3 | 799 | 830 | 858 | 889 | 919 | 950 | 980 | 011 | 042 | 072 | 103 | 133 |
| 4 | 800 | 831 | 859 | 890 | 920 | 951 | 981 | 012 | 043 | 073 | 104 | 134 |
| 5 | 801 | 832 | 860 | 891 | 921 | 952 | 982 | 013 | 044 | 074 | 105 | 135 |
| 6 | 802 | 833 | 861 | 892 | 922 | 953 | 983 | 014 | 045 | 075 | 106 | 136 |
| 7 | 803 | 834 | 862 | 893 | 923 | 954 | 984 | 015 | 046 | 976 | 107 | 137 |
| 8 | 804 | 835 | 863 | 894 | 924 | 955 | 985 | 016 | 047 | 077 | 108 | 138 |
| 9 | 805 | 836 | 864 | 895 | 925 | 956 | 986 | 017 | 048 | 078 | 109 | 139 |
| 10 | 806 | 837 | 865 | 896 | 926 | 957 | 987 | 018 | 049 | 079 | 110 | 140 |
| 11 | 807 | 838 | 866 | 897 | 927 | 958 | 988 | 019 | 050 | 080 | 111 | 141 |
| 12 | 808 | 839 | 867 | 898 | 928 | 959 | 989 | 020 | 051 | 081 | 112 | 142 |
| 13 | 809 | 840 | 868 | 899 | 929 | 960 | 990 | 021 | 052 | 082 | 113 | 143 |
| 14 | 810 | 841 | 869 | 900 | 930 | 961 | 991 | 022 | 053 | 083 | 114 | 144 |
| 15 | 811 | 842 | 870 | 901 | 931 | 962 | 992 | 023 | 054 | 084 | 115 | 145 |
| 16 | 812 | 843 | 871 | 902 | 932 | 963 | 993 | 024 | 055 | 085 | 116 | 146 |
| 17 | 813 | 844 | 872 | 903 | 933 | 964 | 994 | 025 | 056 | 086 | 117 | 147 |
| 18 | 814 | 845 | 873 | 904 | 934 | 965 | 995 | 026 | 057 | 087 | 118 | 148 |
| 19 | 815 | 846 | 874 | 905 | 935 | 966 | 996 | 027 | 058 | 088 | 119 | 149 |
| 20 | 816 | 847 | 875 | 906 | 936 | 967 | 997 | 028 | 059 | 089 | 120 | 150 |
| 21 | 817 | 848 | 876 | 907 | 937 | 969 | 998 | 029 | 060 | 090 | 121 | 151 |
| 22 | 818 | 849 | 877 | 908 | 938 | 969 | 999 | 030 | 061 | 091 | 122 | 152 |
| 23 | 819 | 850 | 878 | 909 | 939 | 970 | 1000 | 031 | 062 | 092 | 123 | 153 |
| 24 | 820 | 851 | 879 | 910 | 940 | 971 | 1001 | 032 | 063 | 093 | 124 | 154 |
| 25 | 821 | 852 | 880 | 911 | 941 | 972 | 1002 | 033 | 064 | 094 | 125 | 155 |
| 26 | 822 | 853 | 881 | 912 | 942 | 973 | 1003 | 034 | 065 | 095 | 126 | 156 |
| 27 | 823 | 854 | 882 | 913 | 943 | 974 | 1004 | 035 | 066 | 096 | 127 | 157 |
| 28 | 824 | 855 | 883 | 914 | 944 | 975 | 1005 | 036 | 067 | 097 | 128 | 158 |
| 29 | 825 | | 884 | 915 | 945 | 976 | 1006 | 037 | 068 | 098 | 129 | 159 |
| 30 | 826 | | 885 | 916 | 946 | 977 | 1007 | 038 | 069 | 099 | 130 | 160 |
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