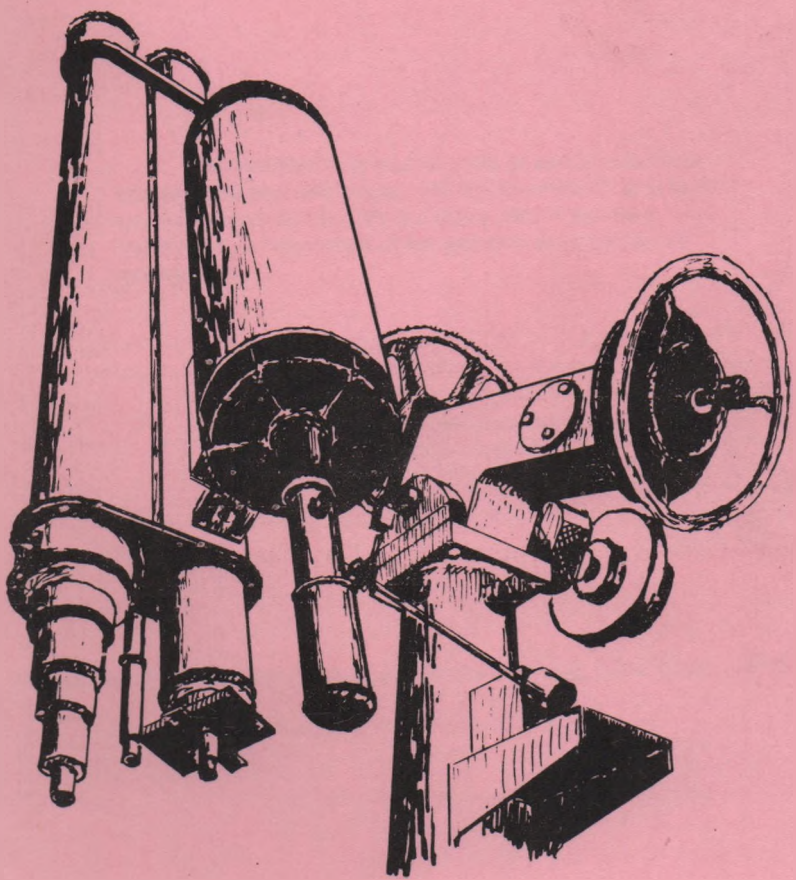
# ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

## 1979

published by the Astronomical Society of Southern Africa



# ASTRONOMICAL HANDBOOK FOR SOUTHERN AFRICA

# 1979

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: Transvaal Centre
Telescopes 30cm cassegrain and
18cm and 15cm refractors.

## CONTENTS



## NOTE

Unless stated otherwise, all times are SOUTH AFRICAN STANDARD TIME. In order to avoid confusion between a.m. and p.m., the 24-hour clock is used (e.g. 1800 hrs. is 6 p.m. and 2100 hrs. is 9 p.m.). Emphasis is given to phenomena visible in the evening sky - between sunset and midnight.


This handbook is produced for the Astronomical Society of Southern Africa. Most of the data it contains have been adapted for Southern Africa from the "Astronomical Ephemeris for 1979" issued jointly by the Nautical Almanac Offices of the Royal Greenwich Observatory, Herstmonceux and the U S. Naval Observatory, Washington D.C. Additional information has also been supplied direct from the Herstmonceux Office and from the Hydrographer, South African Navy.

Thanks are due to Messrs G and C Larmuth for the preparation of much of the data.

All correspondence concerning this booklet should be addressed to the Handbook Editor, Astronomical Society of S.A 8 Glebe Road,Rondebosch 7700, Cape. Further copies can also be obtained from the same address. Enclose a postal order or cheque (in favour of the Astronomical Society of Southern Africa) for R1 per copy.

Although every care has been taken in the compilation of the Handbook, it is distributed and sold on the explicit understanding that neither the Astronomical Society of Southern Africa nor any of its members accepts any responsibility for errors.

Dit is met spyt dat ons u meedeel dat as gevolg van beperkte fondse en produksiefasiliteite dit nie moontlik is om hierdie 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

Boyden observatory, situated at Mazelspoort, 25 km from Bloemfontein is operated by the department of Astronomy of the University of The Orange Free State. Observing facilities include the 1,5m Rockefeller Reflector. The site offers good observing conditions, without being remote from a large centre. Enquiries as to use of the observatory should be addressed to the Director.

On the other hand, the observatory sites in the hearts of Cape Town and Johannesburg have become unsuitable with the rapid expansion of those cities. The South African Astronomical Observatory - a joint venture between the South African Council for Scientific and Industrial Research and the British Science Research Council, has merged their facilities and moved the larger instruments to a new site near Sutherland in the Karroo. Observing continues at Cape Town which is also the Headquarters of the S.A.A.O. The S.A.A.O. outstation at Hartebeespoort continues to share the site with the Leiden Observatory Southern Station which has a 45cm reflector and a 25cm photographic refractor.

The Radio Astronomy Observatory at Hartebeesthoek, near Krugersdorp is used by the National Institute for Telecommunications Research for observations on extragalactic radio sources while the Rhodes University Radio Astronomy Group uses the same facilities to study Ionized Hydrogen regions associated with star formation and supernova remnants within the galaxy at a wavelength of 2,3 GHz. The Rhodes group results are reduced in Grahamstown.

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

## OBSERVATORIES OPEN TO THE PUBLIC

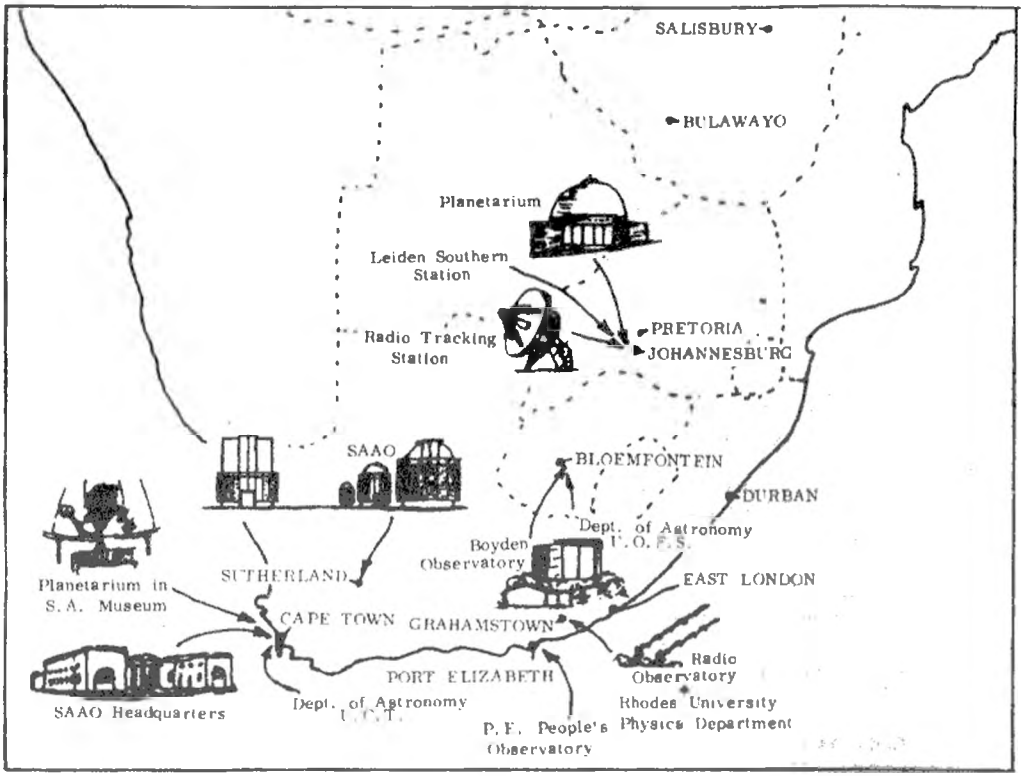
Visiting nights at Boyden Observatory are generally held around the time of first quarter. Enquiries should be made direct to the Observatory. Numbers are restricted to twenty persons on each occasion.

SAAO Headquarters, Observatory, Cape are open to visitors on the second Saturday each month at 8.00 p.m. No tickets are necessary but parties of more than ten persons should contact the observatory in advance.

## PLANETARIA

The major planetarium in South Africa is that situated on the grounds of the University of the Witwatersrand (entrance in Yale Road - alongside M1). It is equipped with a highly complex Zeiss projector and seats over 400 persons.

A smaller planetarium, with a Spitz projector and seating approximately 70, is located within the South African Museum, Cape Town. Shows are given each Saturday at 3.00 p.m., each Sunday at 3.30 p.m., and at 11.00 a.m. and 3.30 p.m. on public holidays. Further information can be obtained by phoning the museum at 41-2668.




## TEACHING DEPARTMENTS

Both the University of the Orange Free State and the University of Cape Town have departments of astronomy - concerned with optical astronomy - while the Physics department of Rhodes University specialises in radio astronomy. The UOFS department is incorporated into Boyden Observatory and is headed by the director, Prof. A.H. Jarrett. Prof. Brian Warner occupies the chair of Astronomy at UCT. His department makes use of the SAAO observing facilities at Sutherland. The Physics Department at Rhodes has its own radio observatory outside Grahamstown.

## 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 copies of "Sky and Telescope", an excellent and very popular monthly magazine published in the United States. It provides up to date information on both professional and amateur activities, together with news of space research and other related subjects. The Society's annual subscription is R15.00 and there is an entrance fee of R2.50. Information can be obtained from the Honorary Secretary, Astronomical Society of Southern Africa, c/o The South African Astronomical Observatory, P.O. Box 9, Observatory 7935, Cape.

## LOCAL CENTRES OF THE SOCIETY

Autonomous local Centres of the Society hold regular meetings in Cape Town, Bloemfontein, Durban, Pietermaritzburg, Pretoria and Salisbury. Visitors are very welcome at meetings and may, if they wish, join a Centre, without becoming a full member (i.e. receiving publications for R15 subscription of the Society.

CAPE CENTRE (Cape Town) - Meetings on 2nd Wednesday of the month (except Jan. and Dec.) at the South African Astronomical Observatory at 8.00 p.m. The Centre possesses a small observtory housing the 30cm Ron Atkins Telescope. There is also an active occultation section. Secretarial address: c/o S.A.A.O. Box 9 Observatory 7935. Information on meetings also available from telephone (day time) 69-8531 ext. 256, 41-3471 ext. 286 evenings 65-6976.

TRANSVAAL CENTRE (Johannesburg) - Alternate lecture and observing meetings are held on the 2nd Wednesday of each month. There is a very enthusiastic lunar occultation group which observes grazing occultations within a radius of approximately 250 km of Johannesburg. Mirror making classes are held at suitable intervals and the centre has its own aluminising plant. Secretarial address: Box 1595, Edenvale 1610. Telephone 609 4686.

NATAL CENTRE (Durban) - Monthly meetings are held every third Wednesday at 7.45 p.m. at St. Paul's Church Hall, Church Street, Durban (near G.P.O.) and the Committee meets in private homes on the Monday evening after the general meeting. Secretarial address: Box 2704, Durban 4000. Telephone 323411 Office, 723187 Home.

NATAL MIDLANDS CENTRE (Pietermaritzburg) - Meetings are held monthly at various venues. Secretarial address 17 Yalta Rd., Pietermaritzburg 3201. Telephone 5-4038.

FREE STATE CENTRE (Bloemfontein) - Meetings are held every third Wednesday of the month. For further information contact Mr F.C. Neser telephone 22-1142, 108 Japie Neser St, Uitsig Bloemfontein.

PRETORIA CENTRE - Meetings are held on the 4th Wednesday of each month (except December) at 8 p.m., the venue alternating between the University of South Africa and the Christian Brothers' College, Silverton Road. The Centre's observatory containing a 32cm reflector is situated on the latter site. For information contact the Secretary, Mr W.R. Windisch, 932 Crots Street, Rietfontein, Pretoria 0084.

SALISBURY CENTRE - The Centre holds fairly frequent meetings, usually at eight o'clock in the evening at which talks on various subjects are given and/or films shown. In addition, social "star-gazing" sessions are arranged at intervals, at which telescopes are set up by those members who possess them and made available for observing by all members present.

The address of the Salisbury Centre is P.O. Box UA. 428, Union Avenue Salisbury and the Hon. Secretary (to whom communications should be addressed) is Mr. W.L. Stedman telephone number 5-0921.

## OBSERVING SECTIONS OF THE SOCIETY

These sections exist to coordinate and encourage 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.

# DIARY 1979

## JANUARY

| | | |
|---|---|---|
| 1$^{d}$ | 21$^{h}$ | Juno 0°.2 S. of Moon |
| 5 | 00 | Earth at Perihelion |
| 9 | 20 | Aldebaran 0°.5 S. of Moon |
| 14 | 13 | Jupiter 4° N. of Moon |
| 15 | 20 | Venus 8° N. of Antares |
| 18 | 18 | Saturn 2° N. of Moon |
| 18 | 08 | Venus greatest elong. W. (47°) |
| 20 | 14 | Mars in conjunction with Sun |
| 22 | 23 | Uranus 4° S. of Moon |
| 24 | 17 | Jupiter at opposition |
| 25 | 00 | Venus 2° S. of Moon |
| 25 | 03 | Neptune 4° S. of Moon |
| 26 | 20 | Venus 1°.9 N. of Neptune |
| 30 | 02 | Juno 0°.4 S. of Moon |

## FEBRUARY

| | | |
|---|---|---|
| 6 | 02 | Aldebaran 0°.3 S. of Moon Occ$^{n}$. |
| 9 | 08 | Mercury in superior conjunction |
| 10 | 12 | Jupiter 4° N. of Moon |
| 13 | 21 | Saturn 3° N. of Moon |
| 19 | 07 | Uranus 4° S. of Moon |
| 21 | 13 | Neptune 4° S. of Moon |
| 23 | 17 | Venus 3° S. of Moon |
| 24 | 15 | Uranus stationary |
| 26 | 19 | Total eclipse of Sun (not visible in S.A.) |
| 27 | 14 | Juno 0°.5 S. of Moon |
| 27 | 20 | Mercury 0°.6 N. of Moon |

## MARCH

| | | |
|---|---|---|
| 1 | 20 | Saturn at opposition |
| 5 | 09 | Aldebaran 0°.2 S. of Moon Occ$^{n}$. |
| 8 | 03 | Mercury greatest elong. E. (18°) |
| 9 | 14 | Jupiter 5° N. of Moon |
| 12 | 23 | Saturn 3° N. of Moon |
| 13 | 23 | Total eclipse of Moon (visible from S.A.) |
| 14 | 17 | Mercury stationary |
| 18 | 13 | Uranus 4° S. of Moon |
| 20 | 20 | Neptune 4° S. of Moon |
| 21 | 07 | Equinox |
| 23 | 12 | Neptune stationary |
| 24 | 16 | Mercury in inferior conjunction |
| 25 | 11 | Venus 2° S. of Moon |
| 26 | 03 | Jupiter stationary. |
| 27 | 04 | Mars 0°.7 S. of Moon |

## APRIL

| | | |
|---|---|---|
| 1$^{d}$ | 18$^{h}$ | Aldebaran 0°.3 S. of Moon Occ$^{n}$. |
| 2 | 00 | Mercury 3° N. of Mars |
| 5 | 20 | Jupiter 5° N. of Moon |
| 6 | 03 | Mercury stationary |
| 9 | 03 | Saturn 3° N. of Moon |
| 14 | 17 | Uranus 4° S. of Moon |
| 17 | 01 | Neptune 4° S. of Moon |
| 21 | 15 | Mercury greatest elong. W. (27°) |
| 24 | 05 | Venus 0 .3 S. of Moon |
| 24 | 15 | Mercury 1° S. of Moon |
| 25 | 01 | Mars 2° N. of Moon |
| 29 | 03 | Aldebaran 0°.4 S. of Moon |

## MAY

| | | |
|---|---|---|
| 3 | 08 | Jupiter 4° N. of Moon |
| 5 | 10 | Mercury 2° S. of Mars |
| 6 | 09 | Saturn 3° N. of Moon |
| 10 | 06 | Saturn stationary |
| 10 | 08 | Uranus at opposition |
| 11 | 23 | Uranus 4° S. of Moon |
| 14 | 07 | Neptune 4° S. of Moon |
| 20 | 08 | Venus 1°.1 S. of Mars |
| 23 | 21 | Mars 3° N. of Moon |
| 24 | 00 | Juno 1° S. of Moon |
| 30 | 01 | Mercury in superior conjunction |
| 31 | 00 | Jupiter 4° N. of Moon |

## JUNE

| | | |
|---|---|---|
| 2 | 18 | Saturn 2° N. of Moon |
| 8 | 06 | Uranus 4° S. of Moon |
| 10 | 14 | Neptune 4° S. of Moon |
| 10 | 17 | Neptune at opposition |
| 20 | 05 | Venus 5° N. of Aldebaran |
| 21 | 18 | Mars 5° N. of Moon |
| 22 | 02 | Solstice |
| 22 | 14 | Aldebaran 0°.4 S. of Moon Occ$^{n}$. |
| 23 | 00 | Mercury 5° S. of Pollux |
| 23 | 02 | Venus 4° N. of Moon |
| 26 | 20 | Mercury 5° N. of Moon |
| 27 | 16 | Jupiter 3° N. of Moon |
| 30 | 03 | Saturn 2° N. of Moon |

## JULY

| | | |
|---|---|---|
| 4$^{d}$ | 00$^{h}$ | Earth at aphelion |
| 4 | 00 | Mercury greatest elong. E. (26°) |
| 5 | 13 | Uranus 5° S. of Moon |
| 7 | 22 | Neptune 4° S. of Moon |
| 10 | 10 | Mars 5° N. of Aldebaran |
| 17 | 04 | Mercury stationary |
| 20 | 01 | Aldebaran 0°.3 S. of Moon Occ$^{n}$. |
| 20 | 14 | Mars 5° N. of Moon |
| 26 | 17 | Uranus stationary |
| 27 | 16 | Saturn 2° N. of Moon |
| 31 | 19 | Mercury in inferior conjunction |

## AUGUST

| | | |
|---|---|---|
| 1 | 22 | Uranus 5° S. of Moon |
| 10 | 14 | Mercury stationary |
| 13 | 11 | Jupiter in conjunction with Sun |
| 16 | 01 | Aldebaran 0°.2 S. of Moon Occ$^{n}$. |
| 18 | 10 | Mars 5° N. of Moon |
| 19 | 06 | Mercury greatest elong. W. (19°) |
| 21 | 04 | Mercury 2° N. of Moon |
| 22 | 19 | Annular Eclipse of Sun (not visible from S.A.) |
| 25 | 12 | Venus in superior conjunction |
| 29 | 05 | Uranus 5° S. of Moon |
| 30 | 11 | Mercury 0°.7 N. of Jupiter |
| 31 | 15 | Neptune 4° S. of Moon |

## SEPTEMBER

| | | |
|---|---|---|
| 6 | 11 | Total eclipse of moon (not visible in S.A.) |
| 10 | 16 | Saturn in conjunction with Sun |
| 12 | 13 | Aldebaran 0°.2 S. of Moon |
| 13 | 07 | Mercury in superior conjunction |
| 15 | 01 | Mars 6° S. of Pollux |
| 16 | 05 | Mars 5° N. of Moon |
| 17 | 03 | Vesta stationary |
| 19 | 00 | Jupiter 2° N. of Moon |
| 23 | 19 | Equinox |
| 25 | 13 | Uranus 5° S. of Moon |
| 26 | 15 | Jupiter 0°.3 N. of Regulus |
| 27 | 22 | Neptune 4° S. of Moon |

## OCTOBER

| | | |
|---|---|---|
| 2 | 14 | Mercury 1°.9 N. of Spica |
| 5 | 09 | Venus 3° N. of Spica |
| 9 | 22 | Aldebaran 0°.3 S. of Moon Occ$^{n}$. |
| 14 | 22 | Mars 4° N. of Moon |
| 16 | 17 | Jupiter 1° N. of Moon |
| 18$^{d}$ | 07$^{h}$ | Saturn 0°.7 N. of Moon Occ$^{n}$. |
| 22 | 02 | Mercury 3° S. of Uranus |
| 22 | 10 | Venus 5° S. of Moon |
| 22 | 22 | Uranus 5° S. of Moon |
| 23 | 00 | Mercury 8° S. of Moon |
| 25 | 05 | Neptune 4° S. of Moon |
| 27 | 18 | Venus 0°.2 S. of Uranus |
| 29 | 18 | Mercury greatest elong. E. (24°) |

## NOVEMBER

| | | |
|---|---|---|
| 6 | 08 | Aldebaran 0°.4 S. of Moon Occ$^{n}$. |
| 8 | 22 | Mercury 2° S. of Venus |
| 9 | 20 | Mercury stationary |
| 11 | 16 | Venus 4° N. of Antares |
| 12 | 12 | Mars 3° N. of Moon |
| 12 | 17 | Regulus 1° N. of Moon |
| 13 | 09 | Jupiter 0°.8 N. of Moon Occ$^{n}$. |
| 14 | 20 | Saturn 0°.3 N. of Moon |
| 17 | 19 | Mars 1°.6 N. of Regulus |
| 20 | 06 | Mercury in inferior conjunction |
| 20 | 07 | Venus 2° S. of Neptune |
| 21 | 13 | Neptune 4° S. of Moon |
| 21 | 16 | Venus 6° S. of Moon |
| 25 | 04 | Mercury 1°.7 N. of Uranus |
| 29 | 12 | Mercury stationary |

## DECEMBER

| | | |
|---|---|---|
| 3 | 18 | Aldebaran 0°.5 S. of Moon |
| 5 | 02 | Mercury 2° N. of Uranus |
| 7 | 18 | Mercury greatest elong. W. (21°) |
| 10 | 01 | Regulus 0°.8 N. of Moon Occ$^{n}$. |
| 10 | 20 | Mars 2° N. of Moon |
| 10 | 22 | Jupiter 0°.4 N. of Moon |
| 12 | 07 | Saturn 0°.01 S. of Moon |
| 12 | 22 | Neptune in conjunction with Sun |
| 13 | 19 | Mars 1°.7 N. of Jupiter |
| 16 | 20 | Uranus 5° S. of Moon |
| 17 | 22 | Mercury 4° S. of Moon |
| 19 | 00 | Mercury.6° N. of Antares |
| 21 | 19 | Venus 5° S. of Moon |
| 22 | 13 | Solstice |
| 27 | 07 | Jupiter stationary |
| 27 | 09 | Mercury 1°.4 S. of Neptune |
| 31 | 02 | Aldebaran 0°.4 S. of Moon |

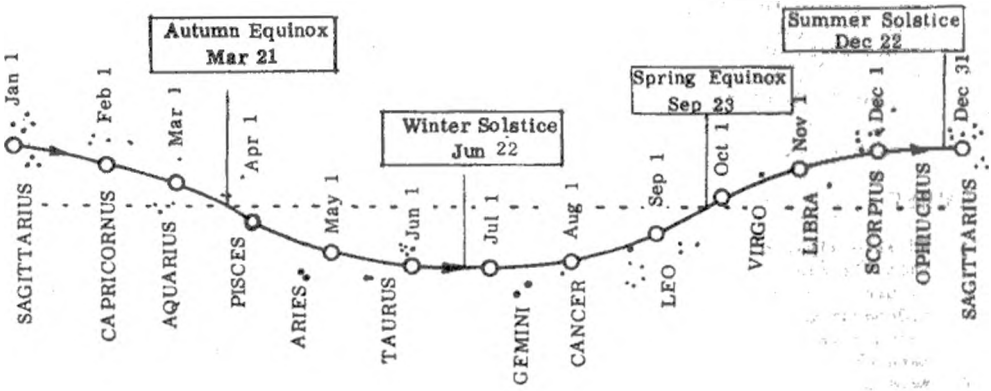
# THE SUN 1979

## BASIC DATA

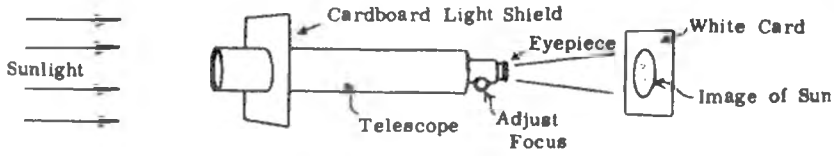
Diameter: 1 392 000 km (109 times Earc
Diameter: 1 392 000 km (109 times Earth diameter)
Mass: 1,99 x $10^{30}$ kg (330 000 times Earth Mass)
Surface Temperature: Approx. 6000° C
Temperature at centre: Approx. 10 million°C

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 around the Sun is not quite circular. In 1978 we will be closest to the Sun on January 2 (perihelion - approx. distance 147 million km.) and furthest from the Sun on July 5 (aphelion - approx. 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 disk 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 disk - if monitored over a period of a week or so, the rotation of the Sun should be apparent.



## TIMES OF SUNRISE AND SUNSET

| | CAPE TOWN | | | | DURBAN | | | | BLOEMFONTEIN | | | | JOHANNESBURG | | | | SALISBURY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SUNRISE | | SUNSET | | SUNRISE | | SUNSET | | SUNRISE | | SUNSET | | SUNRISE | | SUNSET | | SUNRISE | | SUNSET | |
| | h | m | h | m | h | m | h | m | h | m | h | m | h | m | h | m | h | m | h | m |
| Jan 1 | 05 | 35 | 20 | 01 | 04 | 58 | 19 | 01 | 05 | 21 | 19 | 18 | 05 | 18 | 19 | 04 | 05 | 24 | 18 | 35 |
| 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 | 56 | 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 | 06 | 18 | 29 | 05 | 57 | 18 | 15 |
| 21 | 06 | 49 | 18 | 58 | 05 | 59 | 18 | 08 | 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 | 05 | 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 | 08 | 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 | 08 | 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 | 08 | 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 | 08 | 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 |

## SOLAR ECLIPSES

**The Total Eclipse of the Sun on February 26th will be seen only from North America and Greenland. Mid eclipse will be at $19^h22^m$.**

**The Annular Eclipse of the Sun on August 22 will be seen only from South America and Antarctica. Mid eclipse will be at $19^h53^m$.**

# THE MOON 1979

## BASIC DATA

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

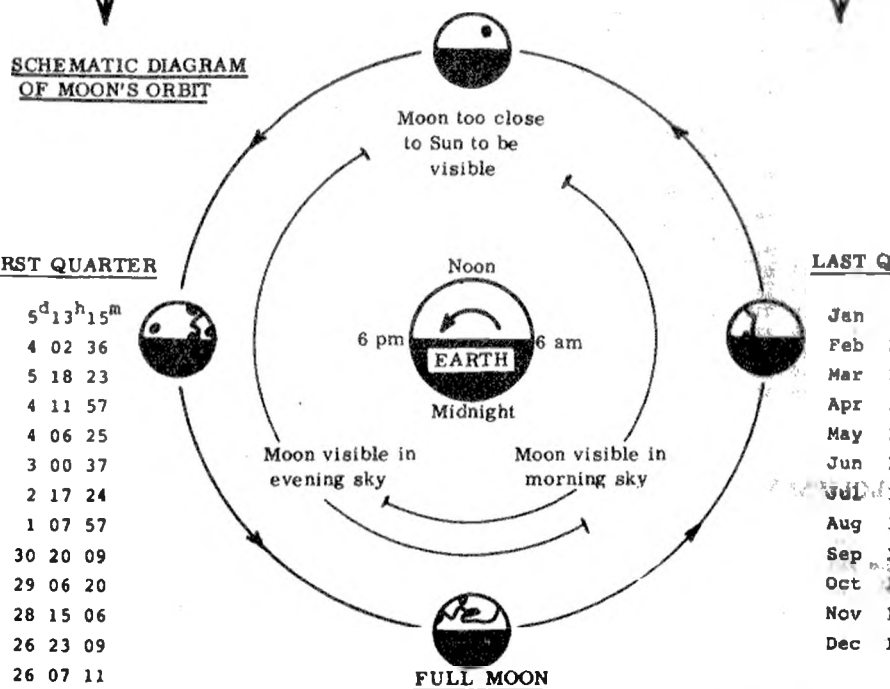
## PHASES AND VISIBILITY

### NEW MOON

| | | | | | |
|---|---|---|---|---|---|
| Jan | $28^d08^h20^m$ | May | $26^d02^h00^m$ | Sep | $21^d11^h47^m$ |
| Feb | 26 18 45 | Jun | 24 13 58 | Oct | 21 04 23 |
| Mar | 28 04 59 | Jul | 24 03 41 | Nov | 19 20 04 |
| Apr | 26 15 15 | Aug | 22 19 10 | Dec | 19 10 23 |

SUNLIGHT

SUNLIGHT




### FIRST QUARTER

| | |
|---|---|
| Jan | $5^d13^h15^m$ |
| Feb | 4 02 36 |
| Mar | 5 18 23 |
| Apr | 4 11 57 |
| May | 4 06 25 |
| Jun | 3 00 37 |
| Jul | 2 17 24 |
| Aug | 1 07 57 |
| Aug | 30 20 09 |
| Sep | 29 06 20 |
| Oct | 28 15 06 |
| Nov | 26 23 09 |
| Dec | 26 07 11 |

### LAST QUARTER

| | |
|---|---|
| Jan | $21^d13^h23^m$ |
| Feb | 20 03 17 |
| Mar | 21 13 22 |
| Apr | 19 20 30 |
| May | 19 01 57 |
| Jun | 17 07 01 |
| Jul | 16 12 59 |
| Aug | 14 21 02 |
| Sep | 13 08 15 |
| Oct | 12 23 24 |
| Nov | 11 18 24 |
| Dec | 11 15 59 |

### FULL MOON

| | | | | | |
|---|---|---|---|---|---|
| Jan | $13^d09^h09^m$ | May | $12^d04^h01^m$ | Sep | $6^d12^h59^m$ |
| Feb | 12 04 39 | Jun | 10 13 55 | Oct | 5 21 35 |
| Mar | 13 23 14 | Jul | 9 21 59 | Nov | 4 07 47 |
| Apr | 12 15 15 | Aug | 8 05 21 | Dec | 3 20 08 |

## THE MOON'S ORBIT

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

| MOON AT PERIGEE | | | | | | MOON AT APOGEE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 28 | May | 18 | Oct | 4 | Jan | 15 | May | 5 | Sep | 19 |
| Feb | 26 | Jun | 13 | Nov | 1 | Feb | 11 | Jun | 1 | Oct | 16 |
| Mar | 26 | Jul | 11 | Nov | 29 | Mar | 10 | Jun | 29 | Nov | 13 |
| Apr | 23 | Aug | 8 | Dec | 23 | Apr | 7 | Jul | 27 | Dec | 11 |
| | | Sep | 6 | | | | | Aug | 23 | | |

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.

## LUNAR ECLIPSE

There will be a partial eclipse of the Moon visible from Southern Africa on March 13/14.

| | $^{d}\ ^{h}\ ^{m}$ |
|---|---|
| Moon enters penumbra | 13 20 11.7 |
| Moon enters umbra | 13 21 29.7 |
| Middle of eclipse | 13 23 08.8 |
| Moon leaves umbra | 14 00 08.1 |
| Moon leaves penumbra | 14 02 05.9 |

Magnitude of the eclipse 0.858. First contact of Umbra with Limb of Moon is at 139° East of North point of Moon. Last contact of Umbra with limb of Moon at 104° West of North point of Moon.

The total eclipse of the Moon on September 6th will be about local noon and hence will not be visible from Africa.

## 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 period 4,5 to 3,0 billion years ago. This has produced the heavily cratered topography now visible. Some particularly large impacts caused large circular depressions, which were flooded by molten lava from the Moon's interior. These are the maria basins which appear smoother and darker then 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 or so deep.

## MAP OF THE MOON'S NEAR SIDE


## LIBRATIONS

Jan 25 Feb 21 Mar 21
Apr 17 May 15 Jun 10
Jul 7 Aug 4/31 Sep 27
Oct 24 Nov 20 Dec 17

Jan 11 Feb 7 Mar 6
Apr 2/30 May 27 Jun 23
Jul 20 Aug 16 Sep 12
Oct 10 Nov 7 Dec 3

Dates of Maximum Exposure of Indicated Limbs

Jan 22 Feb 19 Mar 18
Apr 15 May 11 Jun 8
Jul 6 Aug 3/31 Sep 28
Oct 25 Nov 20 Dec 5

Jan 7 Feb 4 Mar 4
Apr 1/29 May 26 Jun 22
Jul 19 Aug 15 Sep 12
Oct 11 Nov 8 Dec 17

## JOHANNESBURG – TIMES OF THE MOONRISE AND MOONSET

| | JANUARY | | FEBRUARY | | MARCH | | APRIL | | MAY | | JUNE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| 1 | 08h06m | 21h27m | 10h03m | 22h15m | 08h45m | 20h49m | 10h26m | 21h38m | 10h53m | 21h57m | 11h38m | 23h12m |
| 2 | 09 11 | 22 13 | 11 03 | 22 56 | 09 47 | 21 32 | 11 20 | 22 26 | 11 39 | 22 48 | 12 15 | |
| 3 | 10 14 | 22 56 | 12 01 | 23 38 | 10 46 | 22 16 | 12 12 | 23 16 | 12 22 | 23 39 | 12 51 | 00 03 |
| 4 | 11 15 | 23 37 | 12 57 | | 11 43 | 23 01 | 13 00 | | 13 03 | | 13 26 | 00 54 |
| 5 | 12 14 | | 13 52 | 00 20 | 12 38 | 23 47 | 13 44 | 00 06 | 13 40 | 00 30 | 14 01 | 01 46 |
| 6 | 13 12 | 00 17 | 14 44 | 01 05 | 13 30 | | 14 26 | 00 56 | 14 17 | 01 21 | 14 38 | 02 38 |
| 7 | 14 08 | 00 58 | 15 35 | 01 50 | 14 19 | 00 34 | 15 05 | 01 47 | 14 52 | 02 12 | 15 18 | 03 33 |
| 8 | 15 03 | 01 39 | 16 22 | 02 38 | 15 04 | 01 23 | 15 42 | 02 38 | 15 27 | 03 04 | 16 01 | 04 30 |
| 9 | 15 56 | 02 21 | 17 07 | 03 27 | 15 48 | 02 12 | 16 18 | 03 29 | 16 04 | 03 56 | 16 48 | 05 29 |
| 10 | 16 48 | 03 06 | 17 49 | 04 17 | 16 28 | 03 03 | 16 54 | 04 20 | 16 43 | 04 51 | 17 42 | 06 29 |
| 11 | 17 38 | 03 52 | 18 29 | 05 08 | 17 06 | 03 53 | 17 30 | 05 13 | 17 24 | 05 47 | 18 39 | 07 30 |
| 12 | 18 25 | 04 41 | 19 07 | 05 59 | 17 44 | 04 44 | 18 07 | 06 06 | 18 09 | 06 45 | 19 40 | 08 28 |
| 13 | 19 08 | 05 31 | 19 43 | 06 50 | 18 19 | 05 36 | 18 47 | 07 01 | 18 59 | 07 44 | 20 44 | 09 24 |
| 14 | 19 50 | 06 21 | 20 18 | 07 41 | 18 55 | 06 28 | 19 29 | 07 57 | 19 53 | 08 43 | 21 47 | 10 15 |
| 15 | 20 29 | 07 12 | 20 53 | 08 32 | 19 31 | 07 20 | 20 15 | 08 54 | 20 50 | 09 41 | 22 50 | 11 02 |
| 16 | 21 06 | 08 03 | 21 30 | 09 24 | 20 08 | 08 13 | 21 05 | 09 52 | 21 51 | 10 37 | 23 53 | 11 47 |
| 17 | 21 42 | 08 53 | 22 07 | 10 17 | 20 48 | 09 07 | 21 59 | 10 49 | 22 53 | 11 29 | | 12 29 |
| 18 | 22 17 | 09 44 | 22 48 | 11 21 | 21 31 | 10 02 | 22 56 | 11 45 | 23 55 | 12 18 | 00 54 | 13 10 |
| 19 | 22 52 | 10 36 | 23 32 | 12 08 | 22 17 | 10 59 | 23 57 | 12 39 | | 13 03 | 01 53 | 13 51 |
| 20 | 23 29 | 11 29 | | 13 05 | 23 08 | 11 57 | | 13 30 | 00 57 | 13 46 | 02 52 | 14 32 |
| 21 | | 12 22 | 00 21 | 14 04 | | 12 53 | 00 59 | 14 18 | 01 58 | 14 28 | 03 50 | 15 16 |
| 22 | 00 08 | 13 19 | 01 15 | 15 02 | 00 04 | 13 50 | 02 02 | 15 03 | 02 59 | 15 09 | 04 47 | 16 01 |
| 23 | 00 52 | 14 17 | 02 14 | 16 00 | 01 03 | 14 43 | 03 04 | 15 47 | 03 59 | 15 51 | 05 42 | 16 49 |
| 24 | 01 38 | 15 18 | 03 18 | 16 55 | 02 05 | 15 35 | 04 07 | 16 30 | 04 59 | 16 34 | 06 35 | 17 38 |
| 25 | 02 32 | 16 19 | 04 24 | 17 47 | 03 10 | 16 23 | 05 09 | 17 13 | 05 58 | 17 19 | 07 26 | 18 30 |
| 26 | 03 31 | 17 20 | 05 31 | 18 36 | 04 15 | 17 10 | 06 11 | 17 57 | 06 56 | 18 07 | 08 13 | 19 21 |
| 27 | 04 35 | 18 18 | 06 37 | 19 22 | 05 20 | 17 55 | 07 12 | 18 41 | 07 51 | 18 56 | 08 56 | 20 13 |
| 28 | 05 41 | 19 12 | 07 43 | 20 06 | 06 24 | 18 38 | 08 11 | 19 27 | 08 44 | 19 46 | 09 37 | 21 04 |
| 29 | 06 49 | 20 03 | | | 07 27 | 19 22 | 09 08 | 20 16 | 09 33 | 20 38 | 10 14 | 21 55 |
| 30 | 07 56 | 20 49 | | | 08 29 | 20 06 | 10 01 | 21 06 | 10 17 | 21 29 | 10 50 | 22 46 |
| 31 | 09 00 | 21 33 | | | 09 29 | 20 51 | | | 10 59 | 22 21 | | |

## JOHANNESBURG – TIMES OF MOONRISE AND MOONSET

| | JULY | | AUGUST | | SEPTEMBER | | OCTOBER | | NOVEMBER | | DECEMBER | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| 1 | 11h24m | 23h37m | 11h48m | 00h05m | 12h49m | 01h40m | 13h37m | 02h17m | 15h38m | 03h20m | 16h33m | 03h23m |
| 2 | 11 59 | | 12 30 | 01 00 | 13 47 | 02 37 | 14 40 | 03 07 | 16 42 | 04 03 | 17 34 | 04 08 |
| 3 | 12 35 | 00 28 | 13 16 | 01 56 | 14 49 | 03 34 | 15 46 | 03 56 | 17 46 | 04 47 | 18 35 | 04 55 |
| 4 | 13 13 | 01 21 | 14 07 | 02 55 | 15 55 | 04 28 | 16 53 | 04 43 | 18 50 | 05 32 | 19 33 | 05 45 |
| 5 | 13 52 | 02 16 | 15 04 | 03 54 | 17 02 | 05 20 | 17 58 | 05 28 | 19 52 | 06 18 | 20 28 | 06 36 |
| 6 | 14 37 | 03 13 | 16 06 | 04 53 | 18 09 | 06 09 | 19 04 | 06 13 | 20 51 | 07 07 | 21 18 | 07 29 |
| 7 | 15 28 | 04 13 | 17 11 | 05 50 | 19 16 | 06 55 | 20 07 | 06 57 | 21 47 | 07 57 | 22 04 | 08 24 |
| 8 | 16 23 | 05 13 | 18 19 | 06 44 | 20 21 | 07 40 | 21 09 | 07 44 | 22 39 | 08 50 | 22 44 | 09 17 |
| 9 | 17 24 | 06 13 | 19 26 | 07 34 | 21 24 | 08 25 | 22 10 | 08 31 | 23 26 | 09 43 | 23 24 | 10 09 |
| 10 | 18 27 | 07 11 | 20 32 | 08 21 | 22 26 | 09 09 | 23 05 | 09 20 | | 10 35 | | 11 01 |
| 11 | 19 33 | 08 06 | 21 35 | 09 06 | 23 25 | 09 54 | 23 58 | 10 10 | 00 10 | 11 28 | 00 01 | 11 51 |
| 12 | 20 39 | 08 57 | 22 38 | 09 49 | | 10 40 | | 11 01 | 00 50 | 12 19 | 00 36 | 12 42 |
| 13 | 21 43 | 09 44 | 23 38 | 10 31 | 00 21 | 11 28 | 00 47 | 11 53 | 01 27 | 13 10 | 01 10 | 13 33 |
| 14 | 22 46 | 10 29 | | 11 14 | 01 14 | 12 17 | 01 32 | 12 44 | 02 02 | 14 01 | 01 44 | 14 25 |
| 15 | 23 47 | 11 10 | 00 37 | 11 59 | 02 05 | 13 08 | 02 12 | 13 35 | 02 36 | 14 51 | 02 20 | 15 18 |
| 16 | | 11 51 | 01 33 | 12 45 | 02 51 | 13 59 | 02 51 | 14 26 | 03 11 | 15 43 | 02 58 | 16 13 |
| 17 | 00 47 | 12 33 | 02 27 | 13 32 | 03 34 | 14 50 | 03 28 | 15 17 | 03 47 | 16 36 | 03 40 | 17 10 |
| 18 | 01 45 | 13 16 | 03 19 | 14 21 | 04 14 | 15 41 | 04 03 | 16 08 | 04 24 | 17 30 | 04 26 | 18 08 |
| 19 | 02 42 | 14 00 | 04 07 | 15 12 | 04 52 | 16 32 | 04 37 | 16 59 | 05 03 | 18 26 | 05 16 | 19 06 |
| 20 | 03 38 | 14 46 | 04 52 | 16 02 | 05 27 | 17 23 | 05 12 | 17 51 | 05 47 | 19 23 | 06 12 | 20 03 |
| 21 | 04 30 | 15 34 | 05 34 | 16 54 | 06 02 | 18 13 | 05 48 | 18 43 | 06 34 | 20 19 | 07 12 | 20 57 |
| 22 | 05 22 | 16 24 | 06 14 | 17 45 | 06 36 | 19 04 | 06 26 | 19 38 | 07 26 | 21 16 | 08 14 | 21 47 |
| 23 | 06 10 | 17 16 | 06 51 | 18 36 | 07 11 | 19 56 | 07 07 | 20 33 | 08 22 | 22 10 | 09 17 | 22 34 |
| 24 | 06 53 | 18 07 | 07 26 | 19 26 | 07 48 | 20 48 | 07 51 | 21 29 | 09 21 | 23 01 | 10 19 | 23 19 |
| 25 | 07 35 | 18 58 | 08 01 | 20 16 | 08 26 | 21 42 | 08 39 | 22 25 | 10 22 | 23 49 | 11 21 | |
| 26 | 08 13 | 19 49 | 08 35 | 21 08 | 09 07 | 22 37 | 09 31 | 23 19 | 11 24 | | 12 23 | 00 00 |
| 27 | 08 50 | 20 40 | 09 11 | 22 00 | 09 53 | 23 33 | 10 27 | | 12 25 | 00 34 | 13 24 | 00 41 |
| 28 | 09 25 | 21 30 | 09 47 | 22 53 | 10 42 | | 11 26 | 00 12 | 13 27 | 01 17 | 14 24 | 01 23 |
| 29 | 09 59 | 22 21 | 10 26 | 23 47 | 11 36 | 00 28 | 12 28 | 01 03 | 14 29 | 01 59 | 15 24 | 02 05 |
| 30 | 10 34 | 23 13 | 11 09 | | 12 34 | 01 23 | 13 31 | 01 50 | 15 31 | 02 41 | 16 24 | 02 50 |
| 31 | 11 10 | | 11 57 | 00 43 | | | 14 34 | 02 35 | | | 17 21 | 03 37 |

## CAPE TOWN – TIMES OF MOONRISE AND MOONSET
## 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 | 08h34m | 22h13m | 10h43m | 22h51m | 09h26m | 21h23m | 11h16m | 22h04m | 11h44m | 22h22m | 12h25m | 23h43m |
| 2 | 09 42 | 22 56 | 11 45 | 23 29 | 10 31 | 22 03 | 12 12 | 22 52 | 12 30 | 23 14 | 13 00 | |
| 3 | 10 48 | 23 37 | 12 47 | | 11 33 | 22 45 | 13 03 | 23 41 | 13 12 | | 13 32 | 00 36 |
| 4 | 11 53 | | 13 45 | 00 08 | 12 32 | 23 27 | 13 52 | | 13 51 | 00 06 | 14 05 | 01 30 |
| 5 | 12 55 | 00 15 | 14 42 | 00 49 | 13 28 | | 14 35 | 00 32 | 14 26 | 00 59 | 14 38 | 02 24 |
| 6 | 13 55 | 00 52 | 15 35 | 01 31 | 14 21 | 00 12 | 15 15 | 01 23 | 15 00 | 01 53 | 15 12 | 03 20 |
| 7 | 14 54 | 01 29 | 16 26 | 02 16 | 15 10 | 00 59 | 15 52 | 02 15 | 15 33 | 02 46 | 15 49 | 04 18 |
| 8 | 15 52 | 02 08 | 17 14 | 03 03 | 15 56 | 01 48 | 16 27 | 03 09 | 16 06 | 03 41 | 16 30 | 05 18 |
| 9 | 16 46 | 02 48 | 17 58 | 03 52 | 16 37 | 02 39 | 17 01 | 04 02 | 16 39 | 04 36 | 17 15 | 06 19 |
| 10 | 17 39 | 03 31 | 18 38 | 04 44 | 17 17 | 03 30 | 17 33 | 04 57 | 17 15 | 05 34 | 18 07 | 07 21 |
| 11 | 18 29 | 04 17 | 19 17 | 05 35 | 17 52 | 04 23 | 18 07 | 05 51 | 17 54 | 06 32 | 19 04 | 08 22 |
| 12 | 19 17 | 05 06 | 19 52 | 06 29 | 18 27 | 05 16 | 18 41 | 06 48 | 18 37 | 07 33 | 20 05 | 09 20 |
| 13 | 19 59 | 05 56 | 20 26 | 07 22 | 19 00 | 06 10 | 19 18 | 07 45 | 19 25 | 08 34 | 21 11 | 10 14 |
| 14 | 20 39 | 06 48 | 20 58 | 08 16 | 19 34 | 07 05 | 19 58 | 08 44 | 20 18 | 09 34 | 22 17 | 11 03 |
| 15 | 21 16 | 07 41 | 21 32 | 09 09 | 20 07 | 07 59 | 20 42 | 09 43 | 21 15 | 10 33 | 23 23 | 11 49 |
| 16 | 21 51 | 08 34 | 22 05 | 10 04 | 20 41 | 08 55 | 21 30 | 10 42 | 22 16 | 11 27 | | 12 29 |
| 17 | 22 24 | 09 27 | 22 40 | 11 00 | 21 19 | 09 52 | 22 24 | 11 41 | 23 20 | 12 19 | 00 28 | 13 08 |
| 18 | 22 56 | 10 21 | 23 18 | 11 57 | 21 59 | 10 50 | 23 21 | 12 37 | | 13 05 | 01 32 | 13 47 |
| 19 | 23 29 | 11 14 | | 12 56 | 22 44 | 11 48 | | 13 30 | 00 25 | 13 48 | 02 34 | 14 24 |
| 20 | | 12 10 | 00 00 | 13 55 | 23 33 | 12 47 | 00 23 | 14 19 | 01 30 | 14 28 | 03 37 | 15 03 |
| 21 | 00 03 | 13 07 | 00 47 | 14 55 | | 13 45 | 01 27 | 15 05 | 02 34 | 15 06 | 04 38 | 15 44 |
| 22 | 00 39 | 14 06 | 01 40 | 15 54 | 00 29 | 14 41 | 02 33 | 15 47 | 03 39 | 15 45 | 05 36 | 16 27 |
| 23 | 01 20 | 15 06 | 02 39 | 16 51 | 01 28 | 15 34 | 03 39 | 16 28 | 04 42 | 16 23 | 06 34 | 17 14 |
| 24 | 02 06 | 16 09 | 03 44 | 17 44 | 02 33 | 16 23 | 04 45 | 17 07 | 05 45 | 17 04 | 07 28 | 18 03 |
| 25 | 02 58 | 17 11 | 04 52 | 18 33 | 03 40 | 17 09 | 05 50 | 17 47 | 06 46 | 17 47 | 08 18 | 18 55 |
| 26 | 03 55 | 18 11 | 06 02 | 19 19 | 04 48 | 17 52 | 06 55 | 18 27 | 07 46 | 18 32 | 09 04 | 19 47 |
| 27 | 05 00 | 19 08 | 07 11 | 20 02 | 05 56 | 18 33 | 07 59 | 19 10 | 08 42 | 19 21 | 09 46 | 20 40 |
| 28 | 06 08 | 20 00 | 08 20 | 20 43 | 07 04 | 19 14 | 09 00 | 19 54 | 09 35 | 20 11 | 10 24 | 21 34 |
| 29 | 07 19 | 20 48 | | | 08 10 | 19 54 | 09 59 | 20 41 | 10 24 | 21 03 | 10 59 | 22 27 |
| 30 | 08 29 | 21 31 | | | 09 15 | 20 36 | 10 53 | 21 31 | 11 08 | 21 56 | 11 33 | 23 20 |
| 31 | 09 36 | 22 11 | | | 10 17 | 21 19 | | | 11 48 | 22 49 | | |

## CAPE TOWN – TIMES OF MOONRISE AND MOONSET
## FOR PORT ELIZABETH SUBTRACT 28 MINUTES

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

## DURBAN – TIMES OF MOONRISE AND MOONSET
## FOR BLOEMFONTEIN ADD 19 MINUTES

| | JANUARY | | FEBRUARY | | MARCH | | APRIL | | MAY | | JUNE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| 1 | 07h47m | 21h16m | 09h49m | 22h00m | 08h32m | 20h34m | 10h17m | 21h20m | 10h44m | 21h38m | 11h28m | 22h55m |
| 2 | 08 53 | 22 02 | 10 51 | 22 41 | 09 35 | 21 15 | 11 12 | 22 07 | 11 31 | 22 29 | 12 05 | 23 47 |
| 3 | 09 58 | 22 43 | 11 50 | 23 21 | 10 36 | 21 58 | 12 03 | 22 57 | 12 13 | 23 21 | 12 39 | |
| 4 | 11 01 | 23 23 | 12 47 | | 11 34 | 22 42 | 12 51 | 23 47 | 12 53 | | 13 13 | 00 39 |
| 5 | 12 01 | | 13 43 | 00 03 | 12 29 | 23 28 | 13 36 | | 13 31 | 00 13 | 13 47 | 01 32 |
| 6 | 13 00 | 00 03 | 14 36 | 00 46 | 13 21 | | 14 17 | 00 38 | 14 06 | 01 05 | 14 23 | 02 26 |
| 7 | 13 57 | 00 42 | 15 26 | 01 31 | 14 10 | 00 15 | 14 55 | 01 30 | 14 40 | 01 56 | 15 02 | 03 22 |
| 8 | 14 53 | 01 22 | 16 14 | 02 19 | 14 56 | 01 04 | 15 32 | 02 21 | 15 14 | 02 49 | 15 43 | 04 20 |
| 9 | 15 47 | 02 03 | 16 59 | 03 08 | 15 39 | 01 54 | 16 07 | 03 13 | 15 50 | 03 43 | 16 30 | 05 20 |
| 10 | 16 39 | 02 47 | 17 40 | 03 59 | 16 19 | 02 45 | 16 41 | 04 05 | 16 27 | 04 39 | 17 23 | 06 20 |
| 11 | 17 29 | 03 33 | 18 19 | 04 50 | 16 57 | 03 36 | 17 16 | 04 59 | 17 07 | 05 36 | 18 19 | 07 21 |
| 12 | 18 17 | 04 22 | 18 57 | 05 42 | 17 33 | 04 28 | 17 52 | 05 53 | 17 51 | 06 35 | 19 21 | 08 20 |
| 13 | 19 00 | 05 12 | 19 32 | 06 33 | 18 07 | 05 20 | 18 31 | 06 49 | 18 40 | 07 35 | 20 25 | 09 15 |
| 14 | 19 41 | 06 03 | 20 06 | 07 26 | 18 42 | 06 13 | 19 12 | 07 46 | 19 33 | 08 34 | 21 29 | 10 05 |
| 15 | 20 19 | 06 55 | 20 40 | 08 17 | 19 17 | 07 06 | 19 56 | 08 45 | 20 30 | 09 33 | 22 33 | 10 52 |
| 16 | 20 56 | 07 46 | 21 15 | 09 11 | 19 53 | 08 00 | 20 46 | 09 43 | 21 32 | 10 28 | 23 37 | 11 35 |
| 17 | 21 30 | 08 38 | 21 52 | 10 05 | 20 32 | 08 56 | 21 39 | 10 41 | 22 34 | 11 19 | | 12 16 |
| 18 | 22 04 | 09 29 | 22 32 | 11 00 | 21 13 | 09 52 | 22 37 | 11 37 | 23 37 | 12 08 | 00 40 | 12 56 |
| 19 | 22 38 | 10 22 | 23 14 | 11 58 | 21 58 | 10 50 | 23 38 | 12 30 | | 12 52 | 01 40 | 13 36 |
| 20 | 23 14 | 11 16 | | 12 56 | 22 49 | 11 48 | | 13 20 | 00 41 | 13 34 | 02 41 | 14 16 |
| 21 | 23 52 | 12 11 | 00 02 | 13 55 | 23 44 | 12 45 | 00 41 | 14 08 | 01 43 | 14 14 | 03 40 | 14 58 |
| 22 | | 13 09 | 00 56 | 14 54 | | 13 41 | 01 44 | 14 52 | 02 45 | 14 54 | 04 38 | 15 42 |
| 23 | 00 34 | 14 08 | 01 55 | 15 51 | 00 44 | 14 34 | 02 48 | 15 34 | 03 47 | 15 35 | 05 34 | 16 30 |
| 24 | 01 20 | 15 09 | 02 59 | 16 46 | 01 47 | 15 25 | 03 52 | 16 16 | 04 48 | 16 17 | 06 27 | 17 19 |
| 25 | 02 13 | 16 10 | 04 05 | 17 36 | 02 52 | 16 13 | 04 56 | 16 57 | 05 48 | 17 01 | 07 18 | 18 11 |
| 26 | 03 11 | 17 11 | 05 13 | 18 25 | 03 58 | 16 58 | 05 59 | 17 40 | 06 47 | 17 48 | 08 05 | 19 03 |
| 27 | 04 15 | 18 09 | 06 21 | 19 09 | 05 05 | 17 41 | 07 01 | 18 23 | 07 43 | 18 37 | 08 47 | 19 55 |
| 28 | 05 22 | 19 02 | 07 28 | 19 52 | 06 10 | 18 23 | 08 02 | 19 09 | 08 35 | 19 27 | 09 27 | 20 47 |
| 29 | 06 31 | 19 52 | | | 07 14 | 19 06 | 08 59 | 19 57 | 09 24 | 20 19 | 10 04 | 21 39 |
| 30 | 07 39 | 20 37 | | | 08 17 | 19 49 | 09 53 | 20 47 | 10 09 | 21 11 | 10 39 | 22 30 |
| 31 | 08 45 | 21 19 | | | 09 18 | 20 33 | | | 10 50 | 22 03 | | |

## DURBAN – TIMES OF MOONRISE AND MOONSET
## FOR BLOEMFONTEIN ADD 19 MINUTES

| | JULY | | AUGUST | | SEPTEMBER | | OCTOBER | | NOVEMBER | | DECEMBER | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| 1 | 11h12m | 23h22m | 11h32m | h m | 12h30m | 01h32m | 13h18m | 02h08m | 15h23m | 03h07m | 16h22m | 03h07m |
| 2 | 11 46 | | 12 12 | 00 50 | 13 27 | 02 29 | 14 22 | 02 57 | 16 29 | 03 49 | 17 24 | 03 51 |
| 3 | 12 20 | 00 15 | 12 57 | 01 47 | 14 30 | 03 25 | 15 29 | 03 46 | 17 34 | 04 31 | 18 26 | 04 37 |
| 4 | 12 57 | 01 09 | 13 48 | 02 46 | 15 36 | 04 19 | 16 37 | 04 31 | 18 39 | 05 15 | 19 25 | 05 26 |
| 5 | 13 36 | 02 05 | 14 44 | 03 46 | 16 44 | 05 09 | 17 44 | 05 15 | 19 42 | 06 00 | 20 20 | 06 17 |
| 6 | 14 19 | 03 03 | 15 47 | 04 45 | 17 53 | 05 58 | 18 51 | 05 58 | 20 42 | 06 48 | 21 09 | 07 10 |
| 7 | 15 09 | 04 03 | 16 52 | 05 41 | 19 01 | 06 43 | 19 56 | 06 41 | 21 39 | 07 38 | 21 56 | 08 04 |
| 8 | 16 03 | 05 04 | 18 01 | 06 34 | 20 07 | 07 26 | 20 59 | 07 26 | 22 31 | 08 31 | 22 37 | 08 58 |
| 9 | 17 04 | 06 04 | 19 09 | 07 24 | 21 12 | 08 09 | 22 00 | 08 13 | 23 18 | 09 24 | 23 15 | 09 51 |
| 10 | 18 08 | 07 03 | 20 16 | 08 09 | 22 15 | 08 52 | 22 57 | 09 01 | | 10 17 | 23 50 | 10 44 |
| 11 | 19 14 | 07 57 | 21 21 | 08 52 | 23 16 | 09 36 | 23 50 | 09 51 | 00 01 | 11 09 | | 11 36 |
| 12 | 20 21 | 08 47 | 22 25 | 09 34 | | 10 22 | | 10 42 | 00 40 | 12 02 | 00 24 | 12 27 |
| 13 | 21 27 | 09 33 | 23 27 | 10 15 | 00 13 | 11 09 | 00 38 | 11 34 | 01 17 | 12 54 | 00 57 | 13 19 |
| 14 | 22 31 | 10 16 | | 10 57 | 01 06 | 11 58 | 01 23 | 12 26 | 01 51 | 13 45 | 01 30 | 14 12 |
| 15 | 23 33 | 10 56 | 00 27 | 11 41 | 01 56 | 12 49 | 02 03 | 13 18 | 02 24 | 14 37 | 02 05 | 15 07 |
| 16 | | 11 36 | 01 24 | 12 26 | 02 43 | 13 40 | 02 41 | 14 10 | 02 58 | 15 30 | 02 42 | 16 03 |
| 17 | 00 35 | 12 17 | 02 19 | 13 13 | 03 25 | 14 32 | 03 17 | 15 02 | 03 32 | 16 24 | 03 23 | 17 01 |
| 18 | 01 35 | 12 58 | 03 10 | 14 02 | 04 04 | 15 24 | 03 51 | 15 53 | 04 08 | 17 19 | 04 07 | 18 00 |
| 19 | 02 32 | 13 41 | 03 59 | 14 53 | 04 42 | 16 15 | 04 24 | 16 45 | 04 47 | 18 16 | 04 57 | 18 58 |
| 20 | 03 29 | 14 27 | 04 44 | 15 44 | 05 16 | 17 08 | 04 58 | 17 38 | 05 28 | 19 14 | 05 52 | 19 55 |
| 21 | 04 22 | 15 15 | 05 25 | 16 36 | 05 50 | 17 59 | 05 33 | 18 32 | 06 15 | 20 11 | 06 52 | 20 48 |
| 22 | 05 13 | 16 05 | 06 04 | 17 28 | 06 23 | 18 51 | 06 10 | 19 28 | 07 07 | 21 08 | 07 55 | 21 38 |
| 23 | 06 02 | 16 57 | 06 41 | 18 20 | 06 57 | 19 44 | 06 50 | 20 24 | 08 02 | 22 01 | 08 59 | 22 24 |
| 24 | 06 45 | 17 49 | 07 15 | 19 11 | 07 32 | 20 37 | 07 32 | 21 20 | 09 02 | 22 52 | 10 02 | 23 07 |
| 25 | 07 26 | 18 41 | 07 48 | 20 02 | 08 10 | 21 32 | 08 20 | 22 17 | 10 03 | 23 40 | 11 06 | 23 47 |
| 26 | 08 04 | 19 33 | 08 22 | 20 55 | 08 50 | 22 28 | 09 12 | 23 11 | 11 06 | | 12 08 | |
| 27 | 08 39 | 20 24 | 08 56 | 21 48 | 09 34 | 23 24 | 10 07 | | 12 09 | 00 23 | 13 10 | 00 27 |
| 28 | 09 13 | 21 15 | 09 31 | 22 42 | 10 23 | | 11 07 | 00 03 | 13 12 | 01 05 | 14 12 | 01 08 |
| 29 | 09 46 | 22 07 | 10 10 | 23 37 | 11 17 | 00 20 | 12 10 | 00 53 | 14 15 | 01 46 | 15 13 | 01 48 |
| 30 | 10 20 | 23 00 | 10 51 | | 12 15 | 01 15 | 13 13 | 01 40 | 15 18 | 02 27 | 16 14 | 02 32 |
| 31 | 10 55 | 23 54 | 11 38 | 00 34 | | | 14 18 | 02 24 | | | 17 13 | 03 18 |

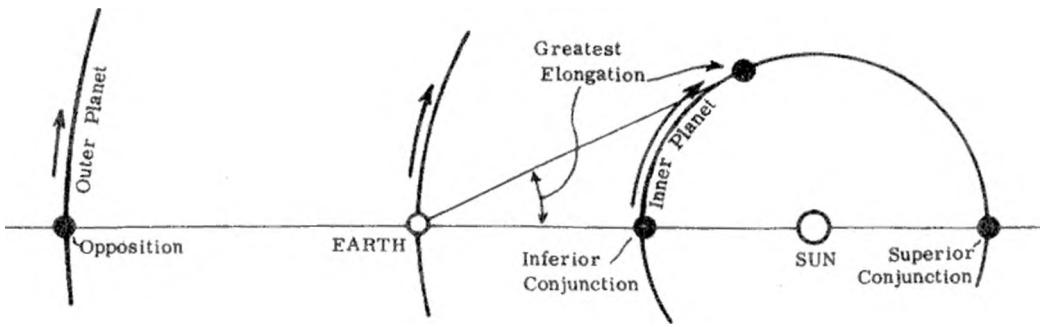
# THE PLANETS 1979

## 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 | $23^h 56^m$ | $23^\circ 27'$ |
| 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 | 1426 | 29,5 | 95,2 | 120,8 | 10 14 | 26 44 |
| Uranus | 2868 | 84,0 | 14,6 | 47,1 | 10 49 | 97 53 |
| Neptune | 4494 | 164,8 | 17,3 | 44,6 | 14 ? | 28 48 |
| Pluto | 5896 | 247,6 | 0,9? | ? | 6d? | ? |

## GENERAL

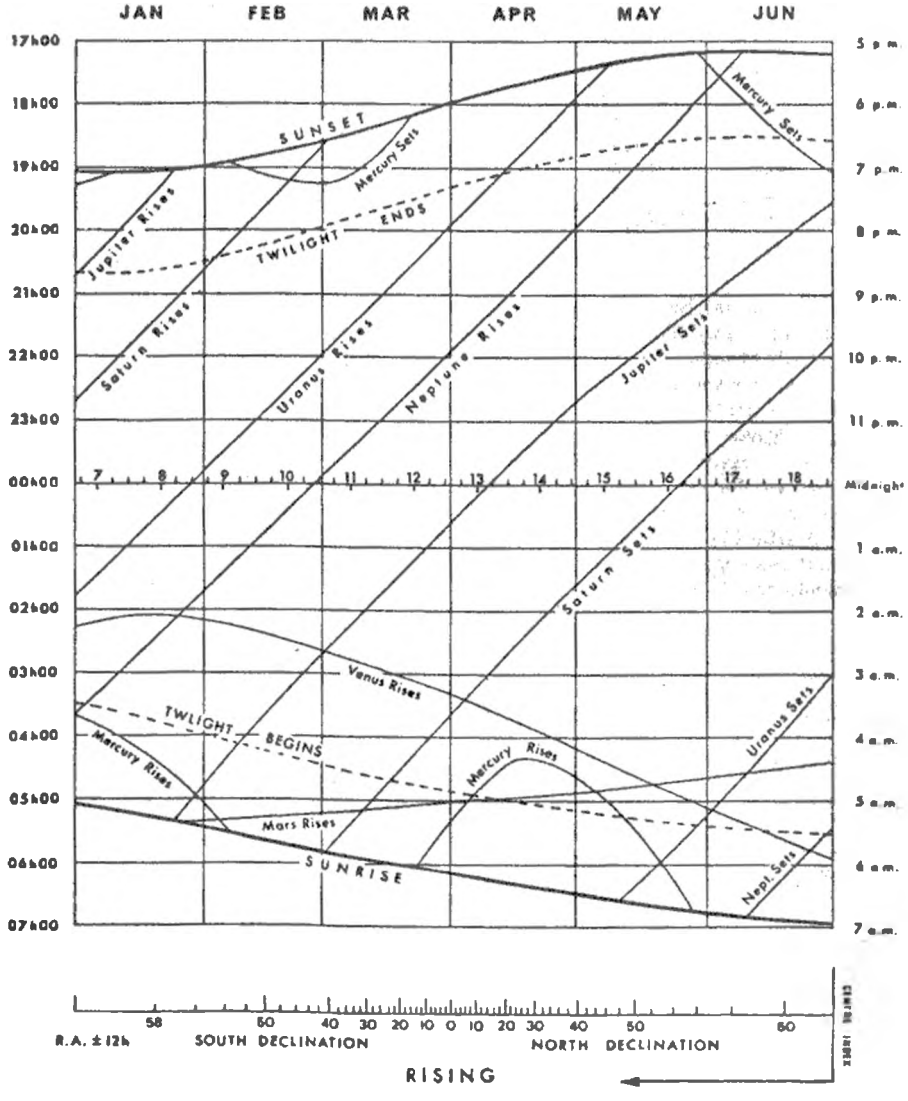
Apart from Uranus, Neptune and Pluto, the planets of our solar system are amongst the brightest objects in the night sky. Unlike the distant stars, their relative positions do not remain fixed, but continually change as, like the Earth, they orbit around the Sun. Their apparent movements against the 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 1978 are listed chronologically in the Diary (pages 4 and 5) and are also mentioned in the text below.



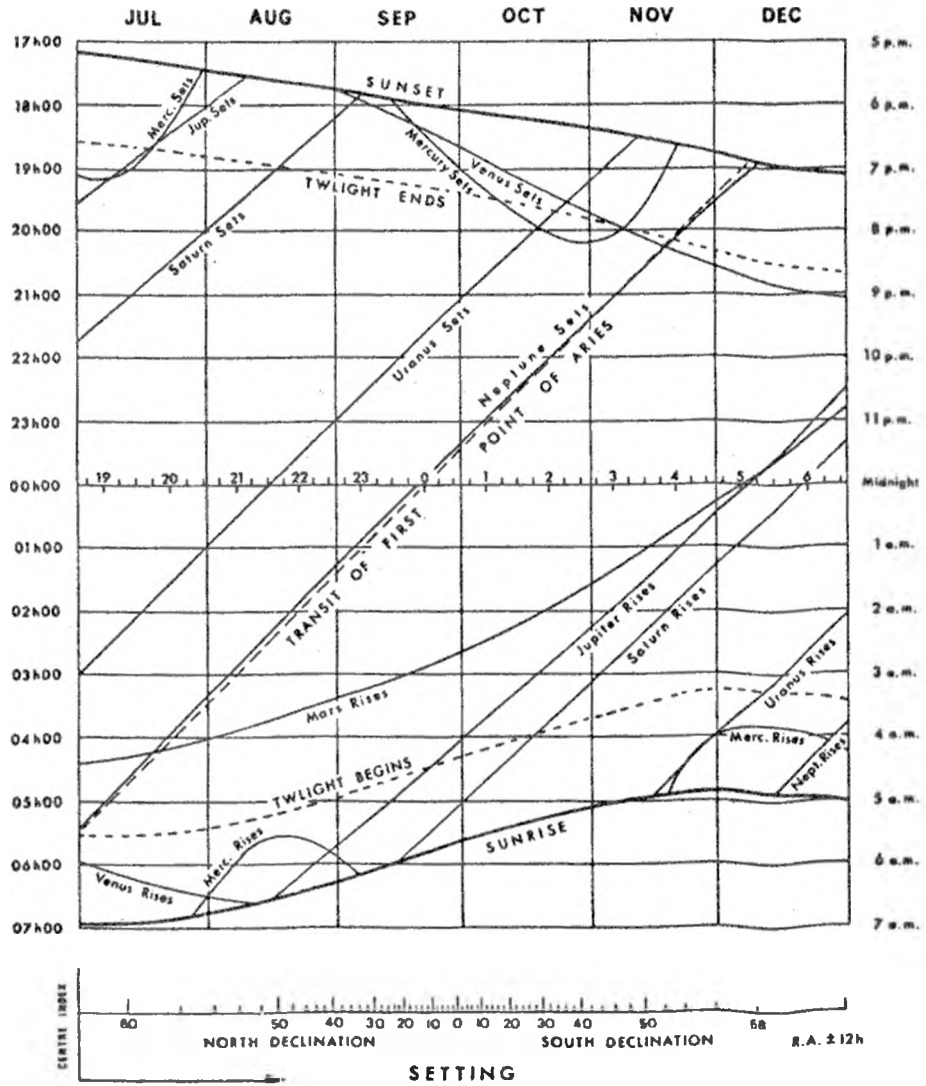
## TIMES OF RISING AND SETTING

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.

The scales at the bottom of these pages are for finding rising or setting times of any object of which the right ascension and declination are known. Set dividers or a strip of paper from the index at the centre of the scale to the object's declination and in the direction desired for either



rising or setting. Measure this same distance and direction along the midnight line, beginning at the objects right ascension indicated by the numerals. (Should this end point fall outside the chart, 12 hours should be added to or subtracted from the right ascension. Reset the dividers using the end of the scale instead of the centre index, and measure in the opposite direction to that first used). Through the point established draw a line parallel to the First Point of Aries transit line (indicated by the dashed line on the chart).



## 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

The innermost planet, Mercury, resolves around the Sun faster than any of the other planets. Being close to the Sun it can only be seen just after sunset or just before sunrise, when it is near greatest elongation (greatest angle between Mercury and Sun as seen from the Earth). Except when in transit, it can never be seen near inferior conjunction (passing between Earth and Sun) or near superior conjunction (passing round the far side of the Sun). The angular diameter of Mercury's disc rarely exceeds 10 seconds of arc so it is difficult to make out any features on the disc, but phases (like those of the Moon) might just be visible. Close up photography by the Mariner 10 spacecraft has shown that the planet's surface is incredibly similar to that of the moon.

| | | d h | | d h | | d h |
|---|---|---|---|---|---|---|
| Superior conjunction | Feb. | 9 08 | May. | 30 01 | Sept. | 13 07 |
| Greatest elongation E | Mar. | 8 03(18°) | July | 4 00(26°) | Oct. | 29 18(24°) |
| Stationary ... .. | Mar. | 14 17 | July | 17 04 | Nov. | 9 20 |
| Inferior conjunction | Mar. | 24 16 | July | 31 19 | Nov. | 20 06 |
| Stationary ... .. | Apr. | 6 03 | Aug. | 10 14 | Nov. | 29 12 |
| Greatest elongation W | Apr. | 21 15(27°) | Aug. | 19 06(19°) | Dec. | 7 18(21°) |

## VENUS

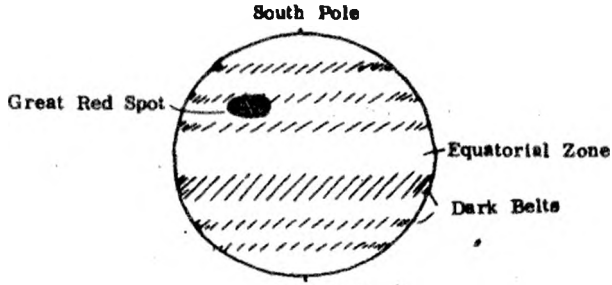
Venus will be seen in the morning sky till June but after that will be too close to the sun for viewing till about the beginning of October after which it will be in the evening sky till the end of the year. Its apparent diameter will change from 31"in January to 10" in August and to 12" at the end of the year. It will be brightest -4.3 at the beginning of January and -3.5 in early August.

## MARS

Mars is too close to the sun for viewing until about April and is a morning star for most of the rest of the year. Its magnitude will stay at about +1.4 till October and it will brighten to +0.3 at the end of December, while its apparent diameter varies from 4" in January to 10" in December and its distance from the earth varies between 2.4 AU in January and 1.0 AU in December.

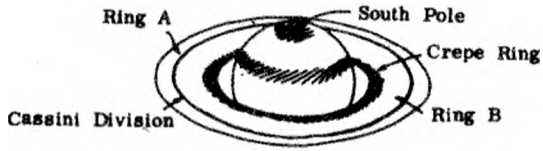
## JUPITER

Jupiter is a prominent object in the evening sky till July and from late August it will be a morning sky object, moving into the evening sky in December. It is at its brightest (magnitude -2)in January and December. Because of its large angular size (43 seconds of arc at opposition), Jupiter makes an excellent object for a small telescope. It is often possible to see features on the disc: dark and light cloud bands running parallel to the equator and spots, in particular the famous Great Red Spot. These are indicated in the diagram below The Great Red Spot is not always visible because of the rotation of the planet. Also clearly visible are four of Jupiter's fourteen moons. An entire section of this Handbook is devoted to the movements of these satellites and the Phenomena associated with them (see page 23).



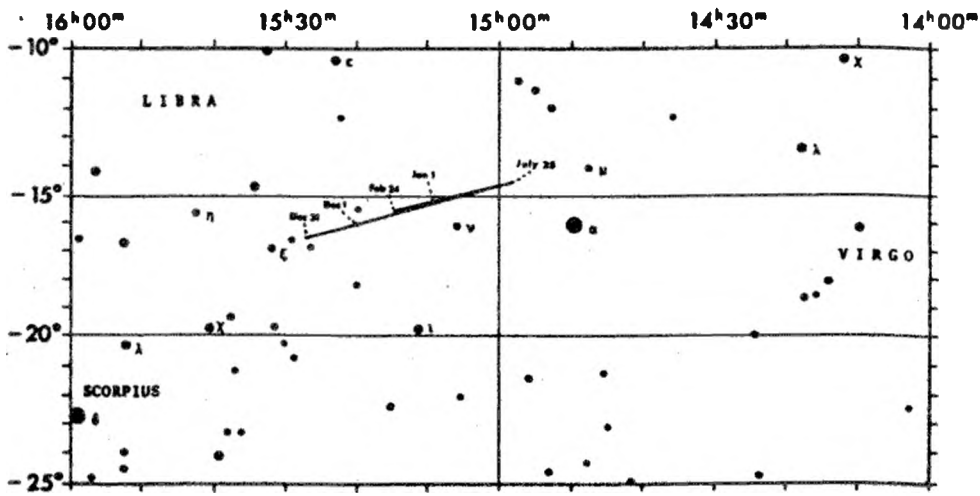

## SATURN

Saturn, in the constellation of Leo till late October and in Virgo thereafter, will be clearly seen inthe evening sky till August and in the morning sky from October until the end of the year. Unfortunately it will never be very high above the horizon because of its northerly declination. It is at its greatest brightness (magnitude 0.5) at opposition on March 1. The diagram below shows its appearance through a small telescope (the scale is the same as for the Jupiter diagram) - including the spectacular ring system. The angle of the ring varies from $4^{\circ}$ in January to $7^{\circ}$ in May and to being end-on on October 27 after which the angle will open up to $2^{\circ}$ by the end of the year, with the north side of the rings then visible.



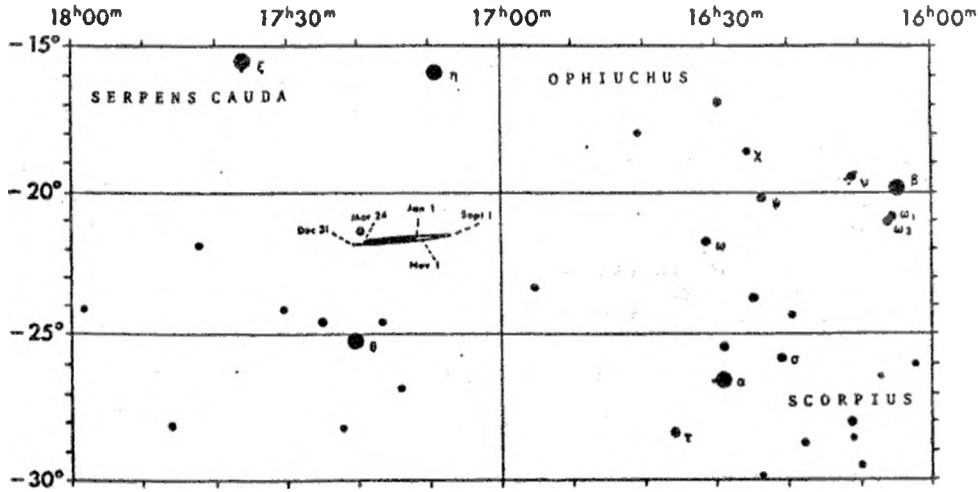

## URANUS

Uranus, at opposition on May 10 and conjunction on November 14, is in the constellation of Libra all year. It is on the border of naked eye visibility (magnitude 5.7 at opposition) and may be found with the aid of binoculars and references to the accompanying finding chart, which shows all of the stars in the region down to the same faintness. With a small telescope, its disc (angular diameter 4 seconds of arc) may just be distinguished. Uranus is now known to have rings similar to those of Saturn.



## NEPTUNE

Neptune lies in the constellation of Ophiuchus close to the conspicuous constellation of Scorpius. It is far too faint to be seen with the naked eye - magnitude 7,7 at opposition on June 10 - but may be located using the finding chart below (which shows all stars down to magnitude 7,7) and a small telescope. Its angular diameter is only 2,5 seconds of arc, but its non-stellar appearance should aid in identification.




## PLUTO

During the year Pluto moves in the constellation of Virgo between the coordinates RA $13^h26^m$ and $13^h44^m$ and Dec $+7^\circ31'$ and $+9^\circ47'$. Since it is very faint, magnitude 14, it can only be found using a large telescope and specially prepared finding charts.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 26 | $18^h44^m$ | III Tr E | Jun | 6 | $19^h47^m$ | I Sh E | Jun | 29 | $17^h01^m$ | I Tr I |
| | | 19 37 | III Sh I | | 7 | 17 08 | I Ec R | | | 17 25 | IV Oc R |
| | | 20 40 | IV Oc D | | 10 | 18 05 | II Tr I | | | 17 44 | I Sh I |
| | 27 | 17 37 | II Sh E | | | 19 58 | II Sh I | | | 19 19 | I Tr E |
| | 28 | 20 02 | I Tr I | | | 20 54 | II Tr E | | | 19 22 | IV Ec D |
| | | 21 06 | I Sh I | | 12 | 17 03 | II Ec R | | 30 | 17 21 | I Ec R |
| | 29 | 17 22 | I Oc D | | 13 | 17 40 | III Oc R | Jul | 5 | 17 01 | II Sh I |
| | | 20 45 | I Ec R | | | 17 45 | III Ec D | | | 18 37 | II Tr E |
| | 30 | 17 52 | I Sh E | | | 18 30 | I Tr I | | 8 | 17 15 | III Tr I |
| Jun | 1 | 20 07 | II Oc D | | | 19 25 | I Sh I | - - - - - - - - - - - - |
| | 2 | 19 25 | III Tr I | | 14 | 19 03 | I Ec R | Dec | 15 | 00 21 | I Tr E |
| | 3 | 17 22 | II Sh I | | 19 | 19 40 | II Ec R | | 17 | 00 59 | III Ec D |
| | | 18 09 | II Tr E | | 20 | 18 23 | III Oc D | | 20 | 23 14 | III Tr E |
| | | 20 12 | II Sh E | | 21 | 17 52 | I Oc D | | 22 | 23 20 | I Oc R |
| | 4 | 17 04 | IV Sh I | | 22 | 17 19 | I Tr E | | 27 | 00 56 | II Tr E |
| | 5 | 19 22 | I Oc D | | | 18 07 | I Sh E | | | 22 29 | III Sh E |
| | 6 | 17 25 | III Ec R | | 26 | 17 51 | II Oc D | | | 23 30 | III Tr I |
| | | 17 30 | I Sh I | | 28 | 17 16 | II Sh E | | 29 | 00 40 | I Sh I |
| | | 18 48 | I Tr E | | | 19 52 | I Oc D | | 30 | 22 28 | I Tr E |

# THE MOONS OF JUPITER AND SATURN 1979

## JUPITER'S MOON

One of the most popular sights for an observer with a small telescope is Jupiter and its moons. Four of Jupiter's fourteen moons are large enough to be seen very easily - they would even be visible to the naked eye were it not for the glare of the mother planet. In order of increasing distance from Jupiter, the four moons are Io, which orbits once around Jupiter in less than 2 days; Europa, 3½ days; Ganymede, 7 days; and Callisto which takes 17 days for a full circuit. All the orbits lie in Jupiter's equatorial plane and the system is seen almost edge on. As the moons circle Jupiter, they appear to oscillate from side to side alternatively passing in front of and behind the planet. Their configurations change from night to night and are shown in the diagrams on pages 26 and 27.

## EVENTS RELATED TO THE MOONS PASSING IN FRONT OF AND BEHIND JUPITER

The table below lists all events occurring between the end of twilight and just after midnight when the planet is above the horizon in Southern Africa.
Explanation of table:

Date and predicted times are given - these are for mid-phenomena and are not instantaneous.
The moons concerned are I - Io III - Ganymede
II - Europa IV - Callisto

Phenomena - the abbreviations used are:

| | | | | | |
|---|---|---|---|---|---|
| Ec. | - | Eclipse: the satellite passes through the shadow of Jupiter | D | - | Disappearance |
| Oc. | - | Occultation: the satellite is obscured by the disk of Jupiter | R | - | Reappearance |
| Tr. | - | Transit: the satellite crosses the disk of Jupiter | I | - | Ingress |
| Sh. | - | Shadow transit: the shadow of the satellite transits the disk | E | - | Egress |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 21h09m | II Sh I | Jan | 10 | 22h01m | II Oc R | Jan | 21 | 22h13m | IV Tr E |
| | | 22 16 | II Tr I | | | 22 07 | I Sh E | | 24 | 23 38 | I Tr I |
| | | 23 29 | I Sh I | | | 22 28 | I Tr E | | | 23 39 | I Sh I |
| | 2 | 00 01 | II Sh E | | 17 | 00 29 | I Ec D | | | 23 39 | II Oc D |
| | | 20 40 | I Ec D | | | 19 48 | III Sh I | | | 23 44 | III Tr I |
| | | 23 31 | I Oc R | | | 20 29 | III Tr I | | | 23 46 | III Sh I |
| | 3 | 19 47 | II Oc R | | | 21 06 | II Ec D | | 25 | 20 50 | I Oc D |
| | | 20 14 | I Sh E | | | 21 45 | I Sh I | | | 23 11 | I Ec R |
| | | 20 44 | I Tr E | | | 21 55 | I Tr I | | 26 | 20 20 | I Tr E |
| | 4 | 22 58 | IV Sh I | | | 23 22 | III Sh E | | | 20 23 | I Sh E |
| | 8 | 23 45 | II Sh I | | 18 | 00 01 | I Sh E | | | 21 03 | II Tr E |
| | 9 | 00 32 | II Tr I | | | 00 04 | III Tr E | | | 21 10 | II Sh E |
| | | 22 35 | I Ec D | | | 00 11 | I Tr E | | 29 | 23 34 | IV Oc D |
| | 10 | 19 22 | III Sh E | | | 00 14 | II Oc R | Feb | 1 | 22 34 | I Oc D |
| | | 19 51 | I Sh E | | | 18 58 | I Ec D | | 2 | 19 48 | I Tr I |
| | | 20 12 | I Tr I | | | 21 25 | I Oc R | | | 20 01 | I Sh I |
| | | 20 47 | III Tr E | | 21 | 21 31 | IV Sh E | | | 20 25 | II Tr I |

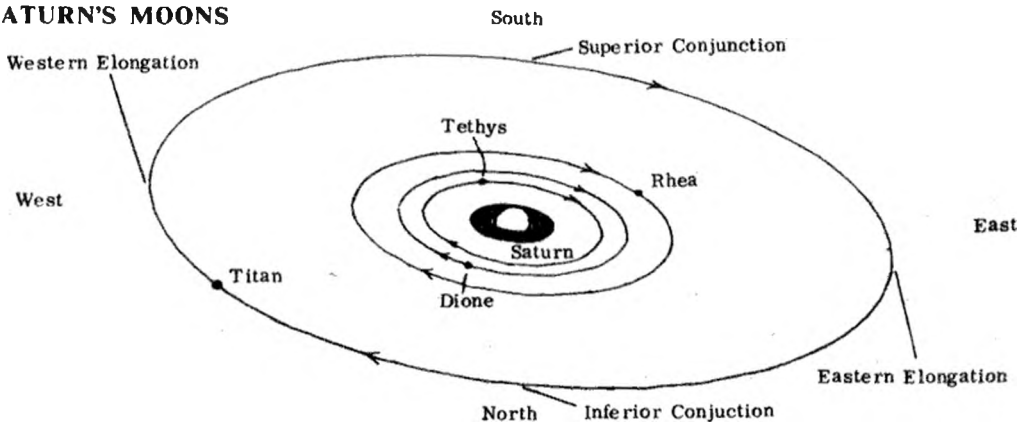
| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feb | 2 | 20h54m | II Sh I | Mar | 6 | 21h43m | II Tr E | Apr | 6 | 17h47m | IV Oc R |
| | | 22 04 | I Tr E | | | 23 35 | II Sh E | | | 18 22 | I Ec R |
| | | 22 17 | I Sh E | | 8 | 19 53 | III Tr I | | | 19 15 | III Sh E |
| | | 23 19 | II Tr E | | | 23 26 | III Tr E | | 7 | 17 59 | II Tr I |
| | | 23 49 | II Sh E | | | 23 41 | III Sh I | | | 20 30 | II Sh I |
| | 3 | 19 34 | I Ec R | | 11 | 23 03 | I Tr I | | | 20 50 | II Tr E |
| | 4 | 21 26 | III Ec R | | 12 | 00 02 | I Sh I | | | 23 21 | II Sh E |
| | 9 | 00 19 | I Oc D | | | 18 13 | IV Tr E | | 9 | 17 34 | II Ec R |
| | | 21 32 | I Tr I | | | 20 19 | I Oc D | | 10 | 00 43 | III Oc D |
| | | 21 55 | I Sh I | | | 22 57 | IV Sh I | | 11 | 00 56 | I Tr I |
| | | 22 42 | II Tr I | | | 23 38 | I Ec R | | | 22 13 | I Oc D |
| | | 23 31 | II Sh I | | 13 | 18 30 | I Sh I | | 12 | 19 24 | I Tr I |
| | | 23 49 | I Tr E | | | 19 46 | I Tr E | | | 20 39 | I Sh I |
| | 10 | 00 12 | I Sh E | | | 20 46 | I Sh E | | | 21 39 | I Tr E |
| | | 21 29 | I Ec R | | | 21 16 | II Tr I | | | 22 55 | I Sh E |
| | 11 | 20 02 | III Oc D | | | 23 19 | II Sh I | | 13 | 18 05 | III Tr E |
| | | 20 53 | II Ec R | | 14 | 00 07 | II Tr E | | | 19 39 | III Sh I |
| | 15 | 18 54 | IV Ec D | | 15 | 20 30 | II Ec R | | | 20 17 | I Ec R |
| | | 23 33 | IV Ec R | | | 23 27 | III Tr I | | | 23 14 | III Sh E |
| | 16 | 23 16 | I Tr I | | 19 | 00 53 | I Tr I | | 14 | 17 23 | I Sh E |
| | | 23 50 | I Sh I | | | 21 25 | III Ec R | | | 20 33 | II Tr I |
| | 17 | 00 59 | II Tr I | | | 22 09 | I Oc D | | | 23 07 | II Sh I |
| | | 20 30 | I Oc D | | 20 | 19 20 | I Tr I | | | 23 11 | IV Tr I |
| | | 23 24 | I Ec R | | | 20 25 | I Sh I | | | 23 24 | II Tr E |
| | 18 | 19 28 | II Oc D | | | 20 27 | IV Oc D | | 16 | 20 10 | II Ec R |
| | | 19 59 | I Tr E | | | 21 36 | I Tr E | | 19 | 21 18 | I Tr I |
| | | 20 34 | I Sh E | | | 22 41 | I Sh E | | | 22 34 | I Sh I |
| | | 23 23 | III Oc D | | | 23 42 | II Tr I | | | 23 34 | I Tr E |
| | | 23 27 | II Ec R | | 21 | 20 02 | I Ec R | | 20 | 18 29 | III Tr I |
| | 22 | 19 17 | III Sh E | | 22 | 18 02 | II Oc D | | | 18 39 | I Oc D |
| | 23 | 22 20 | IV Tr I | | | 23 05 | II Ec R | | | 22 02 | III Tr E |
| | 24 | 22 16 | I Oc D | | 24 | 18 07 | II Sh E | | | 22 12 | I Ec R |
| | 25 | 19 29 | I Tr I | | 26 | 20 40 | III Oc R | | | 23 38 | III Sh I |
| | | 20 13 | I Sh I | | | 21 48 | III Ec D | | 21 | 18 02 | I Tr E |
| | | 21 44 | I Tr E | | | 23 59 | I Oc D | | | 19 18 | I Sh E |
| | | 21 45 | II Oc D | | 27 | 21 11 | I Tr I | | | 23 10 | II Tr I |
| | | 22 29 | I Sh E | | | 22 20 | I Sh I | | 23 | 17 22 | II Oc D |
| | 26 | 19 48 | I Ec R | | | 23 26 | I Tr E | | | 19 08 | IV Ec D |
| | 27 | 19 22 | II Tr E | | 28 | 00 36 | I Sh E | | | 22 46 | II Ec R |
| | | 20 58 | II Sh E | | | 18 27 | I Oc D | | 24 | 17 26 | III Ec R |
| Mar | 1 | 19 41 | III Sh I | Mar | 28 | 21 57 | I Ec R | | 25 | 17 53 | II Sh E |
| | | 19 56 | III Tr E | | 29 | 17 54 | I Tr E | | 26 | 23 13 | I Tr I |
| | | 23 16 | III Sh E | | | 19 05 | I Sh E | | 27 | 20 32 | I Oc D |
| | 4 | 00 03 | I Oc D | | | 20 29 | II Oc D | | | 22 30 | III Tr I |
| | | 21 15 | I Tr I | | | 21 41 | IV Sh E | | 28 | 17 42 | I Tr I |
| | | 22 07 | I Sh I | | 31 | 17 52 | II Sh I | | | 18 57 | I Sh I |
| | | 23 31 | I Tr E | | | 18 17 | II Tr E | | | 19 58 | I Tr E |
| | 5 | 00 04 | II Oc D | | | 20 44 | II Sh E | | 29 | 18 36 | I Ec R |
| | | 00 23 | I Sh E | Apr | 2 | 20 51 | III Oc D | | 30 | 19 59 | II Oc D |
| | | 18 30 | I Oc D | | 3 | 00 27 | III Oc R | May | 1 | 17 47 | III Ec D |
| | | 21 43 | I Ec R | | | 23 03 | I Tr I | | | 21 26 | III Ec R |
| | 6 | 18 51 | II Tr I | | 4 | 00 15 | I Sh I | | | 21 53 | IV Tr E |
| | | 18 52 | I Sh E | | | 20 20 | I Oc D | | 2 | 17 39 | II Sh I |
| | | 20 42 | II Sh I | | | 23 53 | I Ec R | | | 17 58 | II Tr E |

The Moons of Jupiter continued on page 25

| May | | | | May | | | | May | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $20^h 30^m$ | II | Sh E | 9 | $20^h 38^m$ | II | Tr E | 16 | $20^h 30^m$ | II | Tr I |
| 4 | 22 29 | I | Oc D | 10 | 18 01 | IV | Ec R | 18 | 19 54 | II | Ec R |
| 5 | 19 39 | I | Tr I | 11 | 17 17 | II | Ec R | 19 | 19 14 | III | Sh E |
| | 20 52 | I | Sh I | 12 | 21 36 | I | Tr I | 20 | 20 54 | I | Oc D |
| | 21 55 | I | Tr E | | 22 47 | I | Sh I | 21 | 18 03 | I | Tr I |
| 6 | 20 31 | I | Ec R | 13 | 18 56 | I | Oc D | | 19 11 | I | Sh I |
| 7 | 17 38 | I | Sh E | 14 | 17 16 | I | Sh I | 21 | 20 20 | I | Tr E |
| 8 | 20 23 | III | Oc R | | 18 21 | I | Tr E | | 21 28 | I | Sh E |
| | 21 47 | III | Ec D | | 19 33 | I | Sh E | 22 | 18 50 | I | Ec R |
| 9 | 17 48 | II | Tr I | 15 | 20 56 | III | Oc D | 25 | 17 23 | II | Oc D |
| | 20 16 | II | Sh I | | | | | | | | |

The Moons of Jupiter continued on page 22

## SATURN'S MOONS

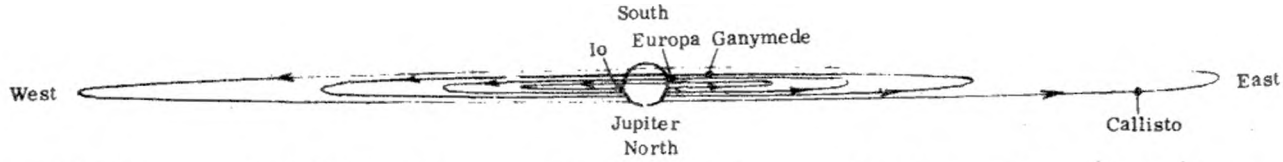


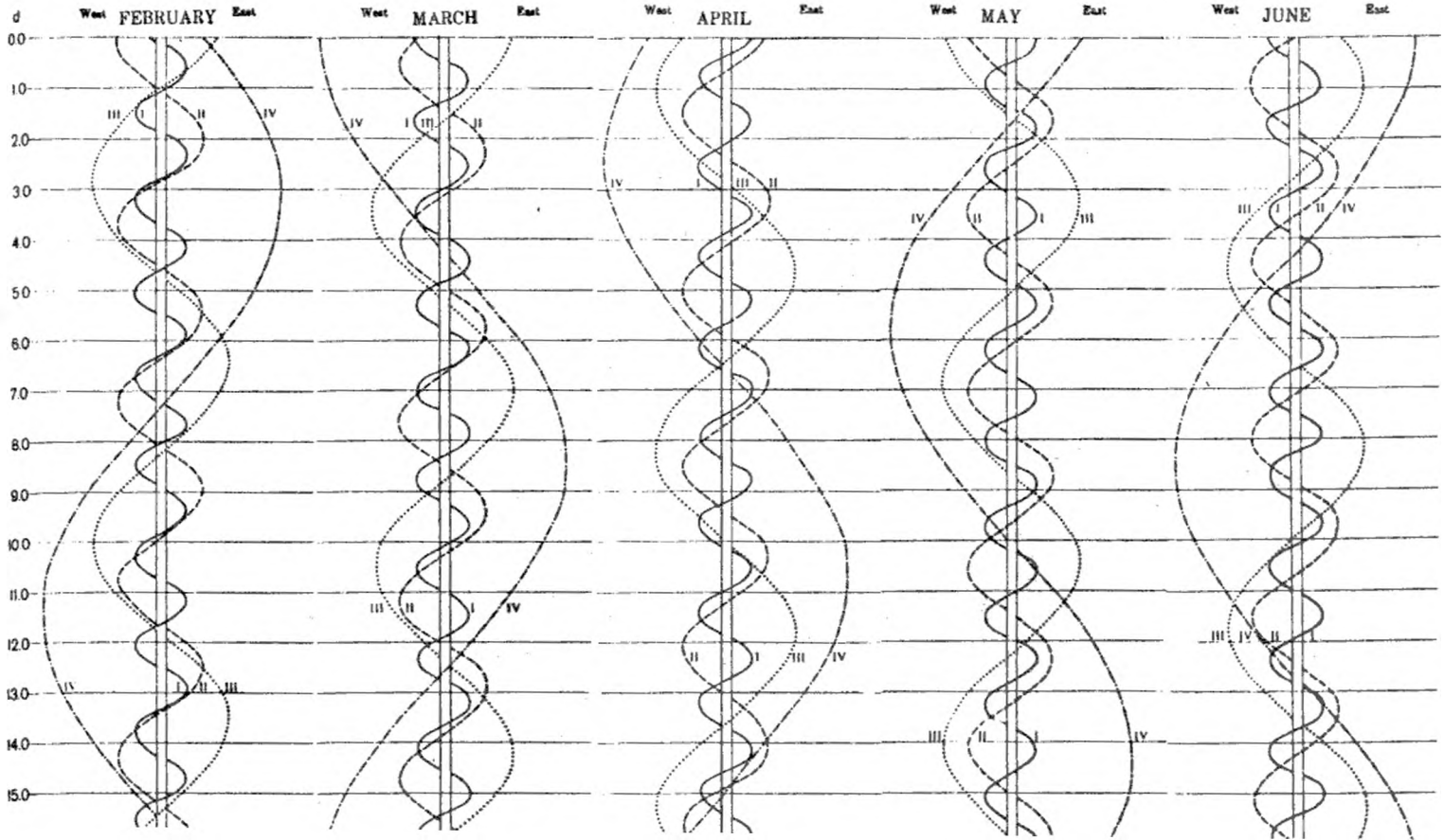

Saturn's moons are considerably fainter than the four Galilean moons of Jupiter. The diagram shows the orbits of four of Saturn's ten moons. The easiest to find is Titan (magnitude 8,5), according to the diagram and the information in the table below (which covers the period when Saturn is clearly visible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

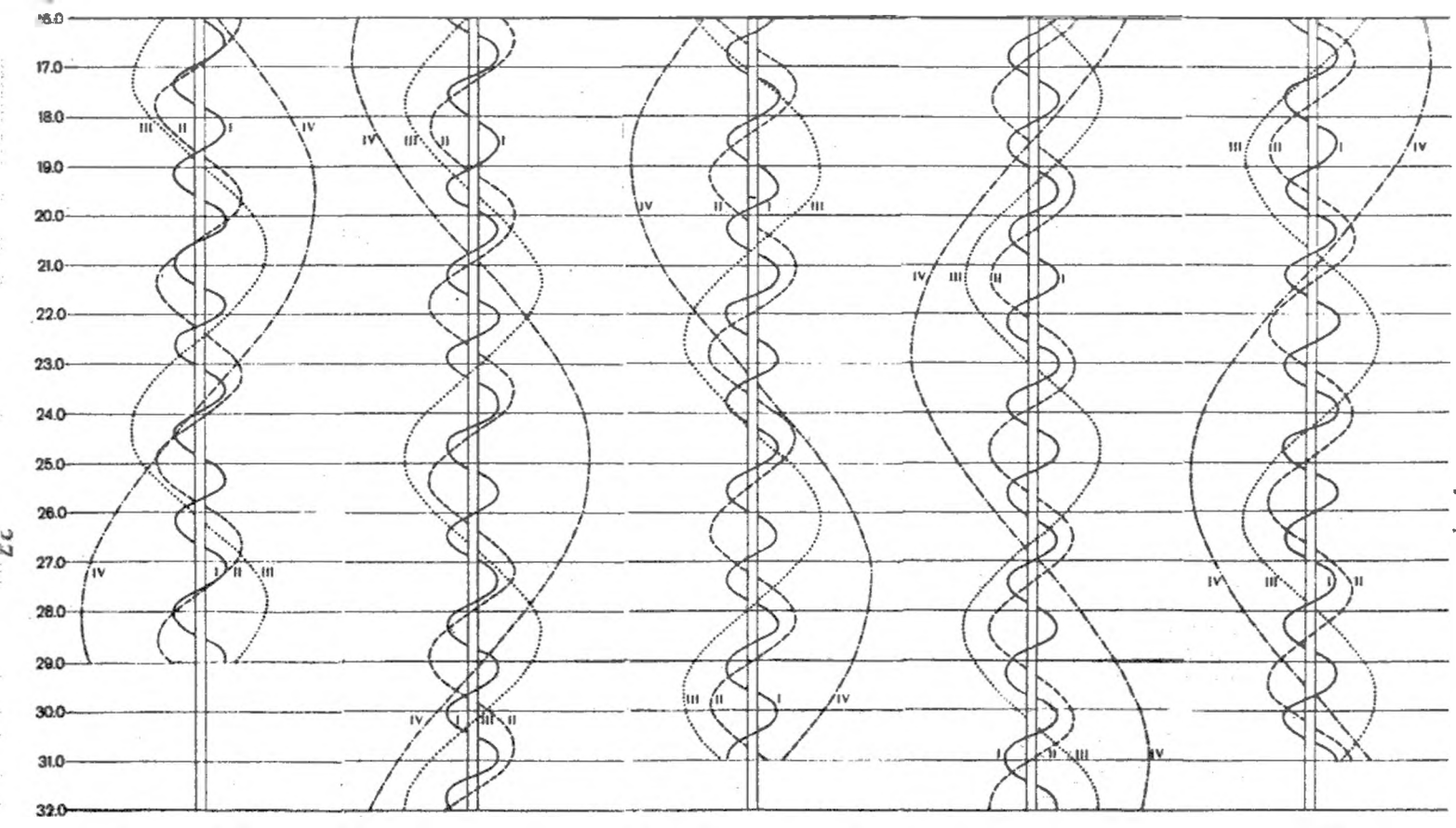
TITAN 1979

| Eastern Elongation | Inferior Conjunction | Western Elongation | Superior Conjunction |
|---|---|---|---|
| Jan 7, 23 | Jan 11, 26 | Jan 14, 30 | Jan 3, 19 |
| Feb 8, 23 | Feb 11, 27 | Feb 15 | Feb 4, 19 |
| Mar 11, 27 | Mar 15, 31 | Mar 3, 19 | Mar 7, 23 |
| Apr 12, 28 | Apr 16 | Apr 4, 20 | Apr 8, 24 |
| May 14, 30 | May 2, 18 | May 6, 22 | May 10, 26 |
| Jun 15 | Jun 3, 19 | Jun 7, 23 | Jun 11, 27 |
| Jul 1, 17 | Jul 5, 21 | Jul 9, 25 | Jul 13, 29 |
| Aug 2 | - - - | - - - | - - - |
| - - - | - - - | - - - | - - - |
| Oct 21 | Oct 25 | Oct 29 | Oct 17 |
| Nov 6, 22 | Nov 10, 26 | Nov 14, 30 | Nov 2, 18 |
| Dec 8, 24 | Dec 12, 28 | Dec 16 | Dec 4, 20 |

## CHANGING CONFIGURATIONS OF JUPITER'S MOONS






The four bright moons of Jupiter always appear close to a straight line passing through the planet 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 chang during the five months when Jupiter is prominent in the evening sky. For each month, time increases downward; the disk of Jupiter is stretched to make the central column and horizontal lines, representing 2 a.m. (0 hrs. Universal time), are shown for every day of the month. The wavy lines show how the Moons appear to oscillate from one side of the planet to the other.

# COMETS AND METEORS

## COMETS

Comets are celestial bodies moving around the sun, mostly in very elongated orbits. The typical comet consists of a nucleus surrounded by a hazy aura of gas and dust called the coma, and in many cases there is a tial stretching away from the sun. Faint comets, several of which are discovered each year, usually appear only as fuzzy patches without nucleus or tail, though there may be a central condensation.

While they are believed to be true members of the solar system, comets differ radically from the planets in that their orbits, besides being highly eccentric, are inclined at all angles to the plane of the ecliptic, and their motion may be direct (like that of the planets) or retrograde. Compared with that of a planet, a comet's mass is almost negligible; nearly all this mass is concentrated in the nucleus, which is believed to be not one solid piece but composed of many separate particles of various sizes.

Comets are the most mysterious and capricious of solar system objects and the nature of the physical changes which they exhibit is still not fully understood.

Observers with quite modest equipment, say a refracting telescope of not less than 7.5 cm, can do useful work by following known comets and reporting on their appearance. The ability to make accurate brightness estimates is especially useful and well worth cultivating. Sweeping the sky for new comets, though requiring considerable patience and perseverance, is also well within the scope of the equipment mentioned.

Many of the fainter comets are undoubtedly escaping detection, particularly in the Southern skies which are not being as intensively searched as the Northern. There is a need for more amateurs to undertake this work.

Interested persons are asked to contact the Director of the Comet and Meteor Section at 90 Malan Street, Riviera, Pretoria 0084.

## METEORS

Meteors or "shooting stars" result from small bodies entering the Earth's upper atmosphere, and are generally seen in greater abundance after midnight (due to the direction of the Earth's motion) than in the early evening.

There are two categories of meteors - the sporadic ones and the showers. A meteor shower comes from a certain direction in space (the Radiant) and is thought to be associated with the remains of a comet. When the Earth passes close to the comet's original orbit, such a shower can be expected. A list of these predicted showers is given in the table opposite.

The term "shower" is perhaps misleading (as the table indicates); the most prolific of these showers normally yields an average of less than one meteor per minute. On rare occasions however, as in the case of the Leonids, there is a phenomenal rise in the number of meteors observed.

There is always the possibility of new showers occurring, and any large-scale meteor activity observed on dates other than those mentioned should be reported without delay.

Reports by a reliable observer of the number of meteors seen coming from a particular radiant in a given period are always useful, but the best work is done by organised teams making a full sky coverage.

"Fireballs" are meteors of a luminosity equalling or exceeding that of the brightest planets. Accurate reports of their path among the stars, or their altitude and azimuth, at specific times, are of great value, particularly if made by observers at different places along the trajectory. Details of brightness (compared with Venus, Moon etc.) size and form, colours and any train or streak, are also important.

## PREDICTED METEOR SHOWERS 1979

| | Shower | Radiant R.A. | Radiant Dec. | Date | Maximum Hourly Rate | Transit of Radiant (approx.) | Recommended Time of Watch | Conditions at Maximum |
|---|---|---|---|---|---|---|---|---|
| Mar 14 - Mar 18 | Corona Australids | $16^h20^m$ | $-48^\circ$ | Mar 16 | 5 | $04^h45^m$ | $02^h30^m$ - dawn | Unfavourable |
| Apr 19 - Apr 24 | April Lyrids | 18 08 | +32 | Apr 22 | 15 | 04 15 | $00^h$ - $02^h$ | Favourable |
| May 1 - May 12 | Eta Aquarids | 22 24 | 00 | May 5 | 18 | 07 30 | $02^h$ - dawn | Favourable |
| Apr 20 - Jul 30 | Sco-Sgr System | 18 00 | -30 | Jun 14 | ? | 00 30 | $20^h$ - $22^h$ | Unfavourable |
| Jun 10 - Jun 21 | June Lyrids | 18 32 | +35 | Jun 16 | 8 | 01 00 | $20^h$ - $23^h$ | Favourable |
| Jun 17 - Jun 26 | Ophiuchids | 17 20 | -20 | Jun 20 | 8 | 23 30 | $20^h$ - $24^h$ | Favourable |
| *Jun 26 - Jun 29 | Cetids (?New) | $\pm$02 00 | -15 | Jun 28 | ? | 07 40 | $03^h$ - dawn | Favourable |
| Jul 10 - Aug 5 | Capricornids | 21 00 | -15 | Jul 25 | 8 | 00 50 | $23^h$ - $02^h$ | Favourable |
| Jul 15 - Aug 15 | Delta Aquarids | 22 36 | (-17<br>( 00 | Jul 27 | 35 | 02 10 | $22^h$ - $24^h$ | Favourable |
| Jul 15 - Aug 20 | Pisces Australids | 22 40 | -30 | Jul 30 | 11 | 02 10 | $00^h$ - $04^h$ | Favourable |
| Jul 15 - Aug 25 | Alpha Capricornids | 20 36 | -10 | Aug 2 | 10 | 00 00 | $01^h$ - $03^h$ | Unfavourable |
| Jul 15 - Aug 24 | Iota Aquarids | (22 04<br>(22 32 | - 6<br>-15 | Aug 6 | 12 | (01 10<br>(01 40 | $22^h$ - $24^h$ | Unfavourable |
| Oct 16 - Oct 27 | Orionids | 06 24 | +15 | Oct 21 | 35 | 04 30 | $02^h$ - dawn | Favourable |
| Oct 10 - Dec 5 | Taurids | (03 44<br>(03 44 | +14<br>+21 | Nov 8 | 16 | (00 50<br>(00 50 | $21^h$ - $23^h$ | Unfavourable |
| Nov 14 - Nov 20 | Leonids | 10 08 | +22 | Nov 17 | 10 | 06 30 | $02^h$ - dawn | Favourable |
| Dec 3 - Dec 5 | Phoenicids | 01 00 | -55 | Dec 4 | ? | 20 10 | $21^h$ - $24^h$ | Unfavourable |
| Dec 7 - Dec 15 | Geminids | 07 28 | +32 | Dec 13<br>Dec 14 | 55 | 02 00 | $21^h$ - $01^h$ | Unfavourable |
| Dec 5 - Jan 7 | Velaids | 09 56 | -51 | Dec 29 | ? | 03 30 | $03^h$ - dawn | Favourable |

* Attention is drawn to the suspected new shower in Cetus.

# THE STARS

## CONSTELLATIONS

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

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

## STAR NAMES

Within each constellation, the brightest star is generally labelled $\alpha$ (Alpha), the next $\beta$ (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.

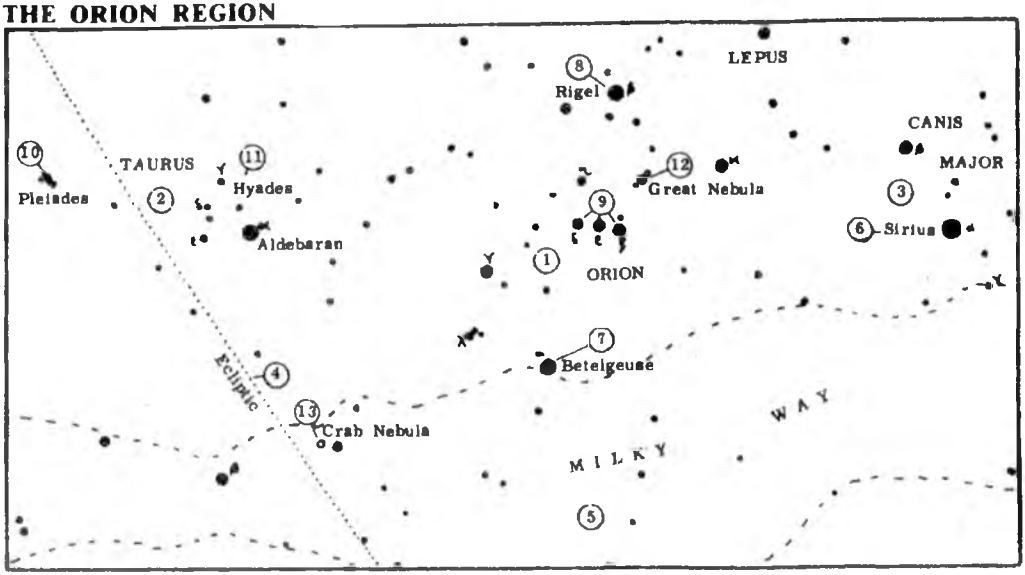
## NEBULAE

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

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

(5) 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.

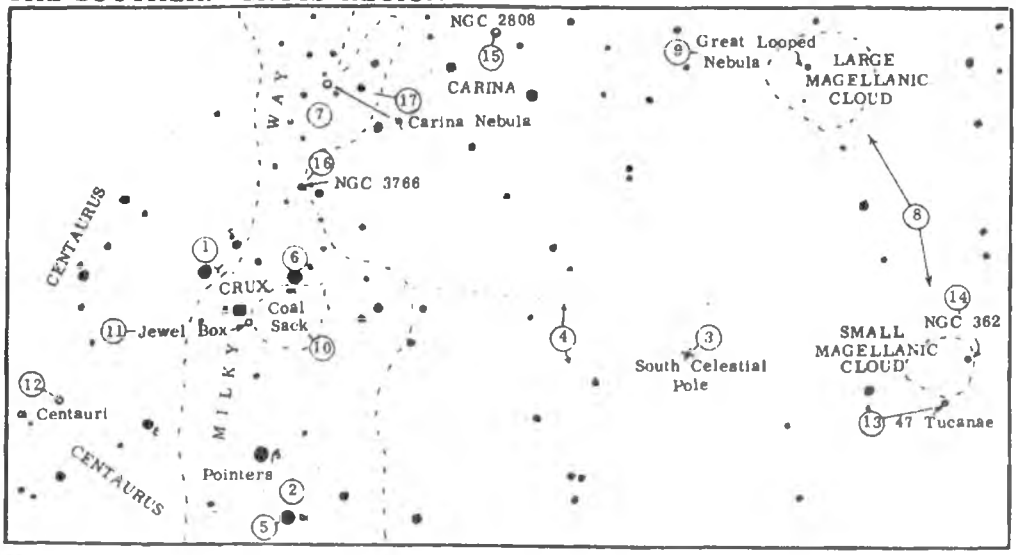
(10) The Pleiades or Seven Sisters form the best known nearby star cluster. Six or seven stars are visible to the naked eye, binoculars or a small telescope show more.

(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).

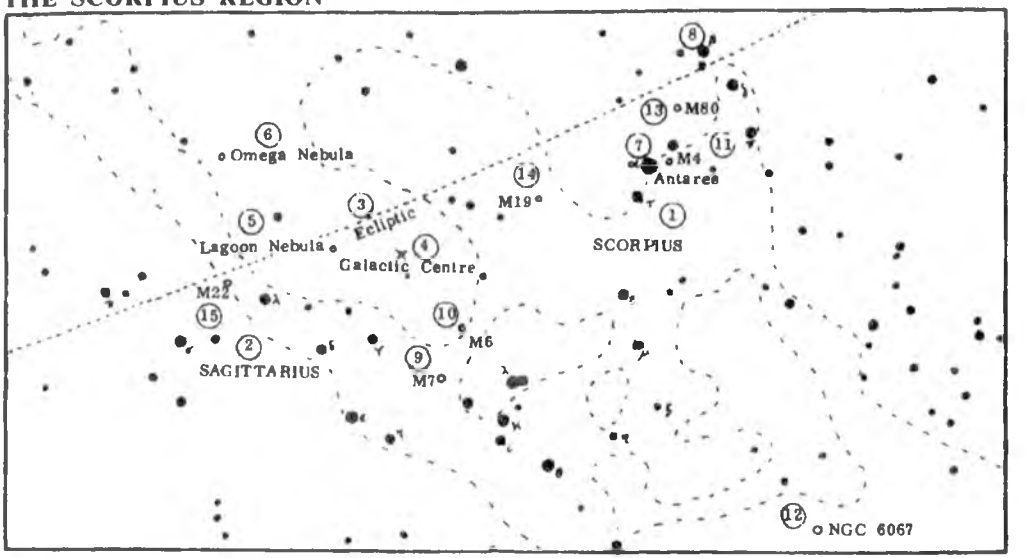
(11) Herschel's "Jewel Box" - a galactic cluster containing stars of different colours. (Small telescope or binoculars).

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

This region includes a number of galactic clusters including (9) M7, (10) 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 General Catalogue of Variable Stars lists some 20 000 stars. Professional observatories cannot possibly monitor all of these and the observation of variable stars is a field the therefore in which amateurs can make real contributions to astronomical knowledge.

Of the 20 000 stars, at least 2 000 are suitable for monitoring by Southern Hemisphere observers but less than 200 are in fact observed from South Africa and a still smaller number receive adequate attention from southern observers.

The Variable Star Section of the ASSA 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 Variable Star Observers and the Variable Star Section of the Royal Astronomical Society of New Zealand. These bodies combine the South African observers' light estimates with those from other parts of the world. The resulting light curves and tables are sent to a large number of professional observatories where astronomers are interested in investigating certain of the stars more fully.

In addition to the international work, the VSS of the ASSA supplies information direct to certain South African astronomers. It is in a position to warn observatories of sudden changes in certain "VIP" stars before the overseas bodies can do so. Some of these VIP stars are:

| | | | | | |
|---|---|---|---|---|---|
| R Coronae Borealis variables (decrease in brightness): | | | | | |
| 123753 | UW Cen | 181146 | RS Tel | 191033 | RY Sgr |
| 145971 | S Aps | 181824 | GU Sgr | | |
| Increase in brightness: | | | | | |
| U Geminorum variables: | | 040971 | VW Hyi | 132554 | BV Cen |
| Novae: | | 063462a | RR Pic | 174406 | RS Oph |
| Flare star: | | 013418 | UV Ceti | | |

Most of the above stars could be observed every night and would still not be over-observed.

Many long period variable stars vary through a large range of brightness. This means that even approximate estimates by beginners can generate quite acceptable light curves. Some of these stars are relatively easy to locate and identify and this makest them very suitable for new observers. Examples of this class of stars are:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 025050 | R Hor | 043262 | R Ret | 134236 | RT Cen | 174162 | W Pav |
| 034625 | U Eri | 054331 | S Col | 161122 a | R Sco | 180222a | VX Sgr |
| 035124 | T Eri | 091868 | RW Car | 161122 b | S Sco | 180363 | R Pav |
| 040725 | W Eri | 094953 | Z Vel | 165030 a | RR Sco | 191019 | R Sgr |
| | | | | | | 214247 | R Gru |

Several variable stars are situated near the South Celestial Pole and can be observed throughout the year during the evening hours. Three such stars are:

| | | | | | |
|---|---|---|---|---|---|
| 055686 | R Oct | 131283 | U Oct | 172486 | S Oct |

Others will need early morning observing sessions for fuller coverage.

A few variables are so bright that they can be monitored throughout their cycles without optical aid. 071044 $L^2$ Puppis is such a star. Norton's Star Atlas names several more.

Beginners are encouraged to practice variable star observing by following the easy-to-observe stars listed below through the brighter parts of their variations, using naked eye or binoculars.

| | | Approximate magnitude range | Approximate dates of maxima 1979 |
|---|---|---|---|
| 021403 | o Ceti (Mira) | 2.0 - 10.1 | September 28 |
| 092962 | R Carinae | 3.9 - 10.0 | September 28 |
| 100661 | S Carinae | 4.5 - 9.9 | Jan. 28, June 25, November 20 |

From the above it can be seen that there are variable stars to suit amateurs with different amounts of experience, ability, optical aid and spare time. Amateurs who want to start observing stars in any of the above catagories should contact the Director of the Variable Star Section, Mr. J. Hers, P.O. Box 48, Sedgefield 6573, Telephone 113. New observers will be given charts of a few easy objects and (if possible) a certain amount of instruction at the eyepiece. When writing, prospective observers should give brief details of their equipment.

# ORDINARY OCCULTATIONS

An occultation occurs when the moon passes in front of a star. The disappearance or reappearance of the star is an instantaneous event, or almost so, and is therefore easily timed. Time signals are broadcast continuously through the 24 hours from station ZUO (see page 43) and, radio propagation permitting, occultation timings can be made, either by eye and ear or by stop watch.

The essential record of a occultation observation consists of

(i) Date and observed time of the event (to a tenth of a second if possible). Universal Time is preferable.

(ii) The Z.C. number of the star.

(iii) Whether disappearance or reappearance.

(iv) The observer's estimate of the accuracy of the observation.

(v) Whether the time given in (i) has been corrected for personal error, and if so by how much.

Also required are the size and type of telescope used, the method of timing used, and the position of the telescope.

The telescope position must be to an accuracy of 1" or better in latitude and longitude and 30 metres or better in altitude. An observer can usually read his position off a 1/50 000 map published by the Director General of Trig. Survey, Mowbray, or his equivalent in other countries. Positions determined astronomically are NOT acceptable, no matter how carefully determined.

Timings of occultations are very valuable in determining the moon's shape and motion and constitute a field in which the amateur astronomer, often with only a small, unsophisticated telescope, can make an extremely useful contribution. Interested persons 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, Rhodesia.

Predictions of occultations of stars brighter than magnitude 7,5, supplied by H.M. Nautical Almanac Office, are reproduced on the next two pages.

Explanation of Table:

Z.C. - the number of the star in the "Catalogue of 3539 Zodiacal Stars for the Equinox 1950.0" by James Robertson (U.S. Naval Observatory, 1939). A short index of the brighter stars is given on page 47.

Mag. - the visual magnitude of the star

P - Phase. 1 = Disappearance 2 = Reappearance

El. of Moon - the elongation of the Moon. $0^{\circ}$ = New Moon, $90^{\circ}$ = First Quarter, $180^{\circ}$ = Full Moon, $270^{\circ}$ = Last Quarter.

U.T. - The predicted time in Universal Time which is exactly two hours behind South African Standard Time. For example $0^{h}55^{m},9$ UT is $2^{h}55^{m},9$ a.m. SAST.

a,b - the approximate time of an occultation at a place $\Delta\lambda$ degrees west and $\Delta\phi$ degrees north of the city concerned is

$$\text{Predicted time} + a.\Delta\lambda + b.\Delta\phi$$

where a and b are in minutes of time.

P - the position angle on the Moon's limb, measured eastward from the north point.

N - no occultation A - Moon at very low altitude

S - sunlight interferes G - grazing occultation

| Date | | Z.C. No. | Mag. | P. | El. of Moon | CAPE TOWN E. 18.500, S. 33.900 U.T. | a | b | P | JOHANNESBURG E. 28.000, S. 26.200 U.T. | a | b | P | SALISBURY E. 31.100, S. 17.700 U.T. | a | b | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ° | h m | m | m | ° | h m | m | m | ° | h m | m | m | ° |
| Jan. | 4 | 50 | 6.0 | 1 | 82 | 21 07.4 | -0.5 | +1.2 | 87 | | A | | | | A | | |
| | 10 | 832 | 4.7 | 1 | 153 | | N | | | | N | | | 20 18.8 | . | . | 131 |
| | 10 | 836 | 5.5 | 1 | 153 | | N | | | | N | | | 21 44.5 | . | . | 159 |
| | 16 | 1439 | 5.9 | 2 | 209 | 1 03.0 | -2.7 | 0.0 | 273 | 1 21.7 | -2.0 | -1.2 | 308 | 1 08.3 | -1.0 | -3.5 | 342 |
| | 16 | 1441 | 6.4 | 2 | 209 | 1 49.9 | . | . | 240 | 2 24.2 | -2.1 | +0.1 | 284 | 2 23.7 | -1.4 | -1.6 | 316 |
| | 16 | 1442 | See-saw | 2 | 210 | | N | | | 2 30.3 | -2.8 | +1.6 | 255 | 2 41.8 | -1.8 | -0.4 | 290 |
| | 17 | 15504 | 5.8 | 2 | 220 | 1 56.1 | . | . | 349 | | N | | | | N | | |
| | 31 | 3530 | 7.0 | 1 | 49 | | S | | | 17 59.7 | -0.5 | +2.1 | 42 | 18 22.6 | -0.1 | +3.5 | 12 |
| Feb. | 3 | 404 | 5.2 | 1 | 88 | 21 01.0 | -0.9 | +2.5 | 40 | | N | | | | N | | |
| | 5 | 650 | 5.7 | 1 | 111 | | N | | | | N | | | 17 33.4 | . | . | 123 |
| | 6 | 7874 | 7.5 | 1 | 123 | 18 25.8 | -2.8 | -1.1 | 113 | 18 48.5 | -3.0 | -0.1 | 97 | 19 01.4 | -3.1 | +1.0 | 74 |
| | 7 | 943 | 6.2 | 1 | 135 | | N | | | 23 03.2 | -0.2 | -1.6 | 146 | 22 59.1 | -0.9 | -0.1 | 111 |
| | 7 | 9474 | 5.2 | 1 | 135 | 23 24.7 | -2.0 | +3.0 | 48 | | N | | | | N | | |
| | 16 | 1921 | 5.9 | 2 | 234 | 22 05.3 | -0.7 | -1.6 | 286 | 21 58.5 | -0.8 | -2.2 | 312 | 21 37.4 | -0.3 | -3.5 | 343 |
| | 16 | 1924 | 5.8 | 2 | 234 | 22 53.8 | -1.4 | -0.9 | 263 | 22 58.1 | -1.5 | -1.7 | 294 | 22 44.9 | -1.2 | -2.5 | 321 |
| | 19 | 2279 | 6.2 | 2 | 270 | | A | | | 22 37.1 | -0.3 | -0.6 | 261 | 22 30.5 | -0.1 | -1.1 | 289 |
| | 20 | 2433 | 6.5 | 2 | 283 | 24 22.1 | -0.3 | -1.0 | 267 | 24 15.2 | -0.3 | -1.6 | 298 | 23 57.7 | +0.3 | -2.8 | 332 |
| Mar. | 4 | 609 | 7.5 | 1 | 80 | 18 23.7 | -1.9 | +1.4 | 71 | 18 55.7 | -1.7 | +2.6 | 46 | | N | | |
| | 6 | 886 | 7.0 | 1 | 103 | | N | | | | N | | | 17 59.8 | . | . | 139 |
| | 7 | 1038 | 6.8 | 1 | 115 | 20 02.5 | -2.3 | +0.7 | 88 | 20 37.7 | -2.7 | +2.8 | 54 | | N | | |
| | 8 | 1158 | 5.2 | 1 | 127 | 22 06.0 | -1.5 | +0.5 | 106 | 22 29.2 | -1.7 | +1.9 | 68 | | N | | |
| | 9 | 1258 | 6.7 | 1 | 136 | 17 40.4 | . | . | 159 | 17 37.8 | -2.5 | -2.4 | 132 | 17 31.0 | -2.9 | -1.2 | 106 |
| | 12 | 14864 | 4.6 | 1 | 161 | 1 16.1 | +0.1 | -2.7 | 169 | 1 10.4 | -0.6 | -0.4 | 125 | 1 13.6 | -0.9 | +0.6 | 91 |
| | 18 | 2128 | 5.8 | 2 | 229 | | N | | | 1 33.5 | -3.2 | +0.6 | 261 | 1 40.0 | -2.7 | -1.2 | 295 |
| | 24 | 30154 | 5.3 | 2 | 306 | | N | | | 1 56.4 | -1.1 | +1.7 | 213 | 2 05.4 | -0.9 | +0.1 | 251 |
| Apr. | 2 | 832 | 4.7 | 1 | 72 | 17 25.7 | -1.7 | -1.2 | 137 | 17 38.7 | -1.7 | +0.1 | 107 | 17 49.2 | -1.9 | +1.0 | 79 |
| | 2 | 836 | 5.5 | 1 | 72 | 18 29.5 | . | . | 156 | 18 31.1 | -1.0 | -0.1 | 116 | 18 37.7 | -1.3 | +0.8 | 86 |
| | 3 | 9854 | 6.9 | 1 | 84 | | G | | | 18 40.8 | -1.3 | -0.5 | 124 | 18 45.1 | -1.7 | +0.4 | 94 |
| | 5 | 1235 | 7.4 | 1 | 107 | | N | | | | N | | | 21 45.2 | -0.2 | -1.1 | 135 |
| | 5 | 1238 | 6.1 | 1 | 107 | 22 00.4 | -0.7 | +0.4 | 113 | | A | | | | N | | |
| | 7 | 1439 | 5.9 | 1 | 129 | 19 55.2 | -2.0 | -1.2 | 129 | 20 13.7 | -2.7 | +0.3 | 94 | 20 39.7 | . | . | 49 |
| | 7 | 1441 | 6.4 | 1 | 129 | 21 08.6 | -0.8 | -2.3 | 158 | 21 11.8 | -1.7 | -0.4 | 118 | 21 19.3 | -2.4 | +0.9 | 85 |
| | 7 | 1442 | See-saw | 1 | 129 | | N | | | 21 32.5 | -0.9 | -1.6 | 145 | 21 28.6 | -1.7 | -0.4 | 112 |
| | 8 | 15504 | 5.8 | 1 | 140 | 21 08.2 | -3.5 | +1.9 | 67 | | N | | | | N | | |
| | 10 | 1658 | 6.4 | 1 | 152 | | N | | | | N | | | 1 01.0 | -0.3 | -1.4 | 143 |
| | 16 | 23724 | 4.4 | 1 | 224 | 2 14.8 | -2.0 | -2.7 | 143 | 2 24.9 | -2.4 | -0.5 | 109 | 2 35.1 | -2.5 | +1.1 | 77 |
| | 16 | 23724 | 4.4 | 2 | 224 | 3 18.4 | -2.1 | +2.6 | 237 | 3 49.4 | -1.7 | +1.0 | 265 | | S | | |
| | 16 | 24954 | 6.0 | 2 | 235 | | N | | | 22 20.2 | -1.6 | 0.0 | 251 | 22 19.9 | -1.4 | -1.1 | 283 |
| | 17 | 2547 | 6.4 | 2 | 248 | | N | | | | N | | | 21 54.4 | -1.7 | +2.1 | 220 |
| | 18 | 2826 | 4.0 | 1 | 262 | | N | | | | N | | | 23 52.6 | -0.8 | -2.4 | 130 |
| | 19 | 2826 | 4.0 | 2 | 262 | | N | | | | N | | | 0 52.6 | -2.3 | +1.6 | 231 |
| | 20 | 3109 | 6.5 | 2 | 288 | | N | | | | A | | | 23 43.9 | -0.4 | +0.2 | 245 |
| | 21 | 3112 | 6.2 | 2 | 288 | | N | | | | N | | | 0 07.2 | -0.8 | +1.7 | 215 |
| | 22 | 3270 | 6.1 | 2 | 302 | 1 47.7 | -0.4 | -0.5 | 251 | 1 45.7 | -0.6 | -1.3 | 282 | | G | | |
| May | 4 | 1405 | 7.0 | 1 | 98 | 20 50.4 | -1.2 | +0.6 | 103 | 21 14.3 | -1.5 | +2.9 | 59 | | N | | |
| | 9 | 1921 | 5.9 | 1 | 153 | 17 45.8 | -1.2 | -1.5 | 106 | 17 55.7 | -2.6 | +0.1 | 72 | | N | | |
| | 9 | 1924 | 5.8 | 1 | 154 | 18 43.2 | -1.4 | -1.9 | 124 | 18 51.4 | -2.7 | -0.6 | 90 | | N | | |
| | 10 | 1941 | 4.8 | 1 | 156 | 0 53.3 | . | . | 175 | 0 46.3 | -0.9 | -0.8 | 132 | 0 46.8 | -0.9 | +0.2 | 100 |
| | 14 | 2460 | 6.1 | 2 | 206 | 1 33.8 | -2.2 | +0.4 | 271 | 1 53.8 | -2.2 | -0.7 | 297 | 1 40.8 | . | . | 341 |
| June | 5 | 18754 | 6.5 | 1 | 122 | | N | | | 18 01.3 | -1.3 | -3.2 | 157 | 17 46.4 | -2.4 | -1.8 | 125 |
| | 6 | 19944 | 6.5 | 1 | 134 | | N | | | | N | | | 20 08.7 | . | . | 171 |
| | 6 | 2008 | 6.6 | 1 | 135 | 22 55.1 | -1.2 | -1.3 | 142 | 23 02.5 | -1.1 | +0.1 | 110 | 23 11.2 | -1.0 | +1.2 | 78 |
| | 8 | 2128 | 5.8 | 1 | 148 | 0 31.9 | -1.1 | -0.7 | 134 | 0 39.5 | -0.7 | +0.3 | 108 | 0 46.9 | -0.4 | +1.1 | 78 |
| | 13 | 30154 | 5.3 | 2 | 226 | 20 07.0 | +0.2 | -1.9 | 299 | | N | | | | N | | |
| | 15 | 3188 | 5.4 | 2 | 241 | 0 21.6 | -1.7 | -2.4 | 296 | | N | | | | N | | |
| | 15 | 33224 | 6.4 | 2 | 254 | | A | | | 21 54.8 | -0.3 | -1.8 | 293 | | N | | |
| | 19 | 219 | 5.1 | 2 | 296 | 3 49.1 | -0.9 | +1.1 | 218 | 4 09.3 | -1.6 | +1.1 | 229 | | S | | |
| | 27 | 1323 | 6.3 | 1 | 35 | | S | | | 16 04.2 | -1.0 | -0.3 | 120 | 16 09.7 | -1.4 | +0.8 | 88 |
| | 29 | 1531 | 5.9 | 1 | 57 | 16 35.9 | -2.7 | +1.5 | 78 | | N | | | | N | | |
| July | 1 | 1732 | 7.0 | 1 | 79 | | N | | | | G | | | 17 29.4 | -1.5 | -2.1 | 143 |

| Date | Z.C. No. | Mag. | P. | El. of Moon | CAPE TOWN E. 18.500, S. 33.900 | | | | JOHANNESBURG E. 28.000, S. 26.200 | | | | SALISBURY E. 31.100, S. 17.700 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | U.T. | a | b | P | U.T. | a | b | P | U.T. | a | b | P |
| | | | | ° | h m | m | m | ° | h m | m | m | ° | h m | m | m | ° |
| July 4 | 2072 | 6.7 | 1 | 115 | 21 23.7 | -1.4 | -1.2 | 139 | 21 32.9 | -1.2 | +0.1 | 108 | 21 42.5 | -1.1 | +1.3 | 76 |
| 5 | 2184 | 7.0 | 1 | 126 | 18 44.5 | -1.4 | -2.9 | 149 | 18 49.2 | -2.5 | -0.9 | 110 | 18 58.2 | -3.4 | +1.1 | 76 |
| 7 | 2460 | 6.1 | 1 | 152 | 17 37.5 | -0.5 | -2.9 | 145 | 17 30.7 | -1.5 | -1.4 | 107 | 17 31.0 | -2.3 | +0.3 | 74 |
| 8 | 2495d | 6.0 | 1 | 154 | 0 14.2 | -1.3 | +1.0 | 89 | 0 33.8 | -0.7 | +1.5 | 71 | 0 52.1 | 0.0 | +2.8 | 40 |
| 11 | 3109 | 6.5 | 2 | 207 | 19 02.8 | +0.4 | -3.7 | 324 | | N | | | | N | | |
| 11 | 3112 | 6.2 | 2 | 208 | 19 44.6 | -0.3 | -1.6 | 288 | | N | | | | N | | |
| 11 | 3131 | 5.5 | 2 | 209 | 23 18.7 | -2.2 | -1.9 | 294 | | N | | | | N | | |
| 13 | 3430d | 5.7 | 2 | 237 | 22 26.5 | -0.7 | +1.0 | 216 | 22 40.1 | -1.2 | +0.3 | 242 | 22 43.7 | -1.7 | -0.6 | 271 |
| Aug. 1 | 2128 | 5.8 | 1 | 94 | | N | | | | N | | | 17 51.5 | . | . | 171 |
| 1 | 2133 | 5.6 | 1 | 95 | 18 20.4 | -2.5 | +1.2 | 80 | | N | | | | N | | |
| 2 | 2279 | 6.2 | 1 | 108 | 22 50.6 | -0.6 | +0.7 | 102 | 23 00.8 | -0.1 | +1.1 | 83 | | A | | |
| 4 | 2433 | 6.5 | 1 | 122 | 0 42.9 | +0.2 | +2.0 | 57 | | A | | | | N | | |
| 4 | 2555d | 7.5 | 1 | 133 | 20 49.0 | -2.1 | +0.9 | 81 | 21 19.7 | -1.6 | +2.3 | 56 | | G | | |
| 5 | 2731 | 6.5 | 1 | 147 | | N | | | 21 26.4 | . | . | 143 | 21 21.3 | -2.6 | -0.5 | 106 |
| 9 | 3353 | 3.8 | 1 | 203 | | N | | | 19 27.8 | . | . | 143 | 19 11.0 | -0.8 | -0.9 | 97 |
| 9 | 3353 | 3.8 | 2 | 203 | | N | | | 19 49.0 | . | . | 181 | 20 12.0 | -1.2 | +1.2 | 227 |
| 10 | 3383 | 6.5 | 2 | 206 | | N | | | | N | | | 2 06.0 | . | . | 173 |
| 28 | 2089 | 6.8 | 1 | 64 | 17 18.0 | . | . | 173 | 17 13.7 | -1.7 | -1.1 | 129 | 17 16.1 | -1.8 | +0.3 | 97 |
| 30 | 2365 | 7.1 | 1 | 89 | 20 38.0 | -1.2 | -0.1 | 121 | 20 48.9 | -0.7 | +0.5 | 101 | 20 57.6 | -0.3 | +1.2 | 74 |
| 31 | 2485 | 7.4 | 1 | 100 | | N | | | 16 34.1 | -2.1 | -3.7 | 147 | 16 23.1 | -2.8 | -1.1 | 110 |
| 31 | 2495d | 6.0 | 1 | 100 | 18 03.3 | -2.3 | -1.1 | 117 | 18 24.3 | -2.4 | +0.6 | 89 | 18 43.3 | -2.1 | +2.4 | 56 |
| Sept. 1 | 2640d | 6.1 | 1 | 113 | | N | | | 16 50.5 | -2.1 | -3.9 | 144 | 16 39.4 | -2.7 | -1.0 | 106 |
| 1 | 2647 | 6.4 | 1 | 113 | 17 34.6 | -2.1 | -1.9 | 122 | 17 50.0 | -2.6 | 0.0 | 92 | 18 05.8 | -2.8 | +1.9 | 60 |
| 1 | 2649d | 6.6 | 1 | 113 | | N | | | | N | | | 18 30.3 | -3.2 | -3.2 | 138 |
| 1 | 2653d | 6.4 | 1 | 113 | | N | | | 18 49.4 | -2.7 | -2.0 | 129 | 18 59.4 | -2.7 | 0.0 | 96 |
| 2 | 2826 | 4.0 | 1 | 127 | 19 48.0 | -2.3 | -0.4 | 102 | 20 11.7 | -2.2 | +0.8 | 82 | 20 29.3 | -1.7 | +1.9 | 56 |
| 3 | 2986 | 6.4 | 1 | 142 | 23 00.2 | -1.9 | +0.1 | 108 | 23 18.3 | -1.3 | +0.6 | 97 | 23 28.7 | -0.9 | +1.0 | 75 |
| 4 | 3131 | 5.5 | 1 | 155 | 19 39.4 | -1.6 | +2.2 | 32 | 20 23.6 | . | . | 357 | | N | | |
| 9 | 219 | 5.1 | 2 | 215 | 3 04.2 | -1.5 | +1.7 | 235 | 3 30.9 | -1.4 | +1.5 | 245 | | S | | |
| 25 | 2184 | 7.0 | 1 | 46 | | N | | | 17 52.6 | -1.0 | -1.5 | 144 | 17 49.2 | -0.7 | -0.2 | 111 |
| 27 | 2454 | 7.2 | 1 | 70 | 18 57.5 | -1.6 | -1.0 | 135 | 19 07.2 | -1.1 | 0.0 | 113 | 19 13.3 | -0.7 | +0.7 | 87 |
| 30 | 2922 | 7.4 | 1 | 109 | 21 14.9 | -2.3 | -1.2 | 131 | 21 28.0 | -1.5 | -0.2 | 116 | 21 33.7 | -0.9 | +0.5 | 91 |
| Oct. 1 | 3066 | 6.0 | 1 | 122 | 19 38.1 | -2.3 | +0.1 | 92 | 20 03.7 | -2.1 | +0.9 | 79 | 20 20.8 | -1.6 | +1.7 | 57 |
| 2 | 3083d | 7.3 | 1 | 124 | 0 25.1 | . | . | 141 | | A | | | | A | | |
| 3 | 3353 | 3.8 | 1 | 149 | | N | | | 17 19.0 | . | . | 142 | 17 04.0 | -1.8 | -0.8 | 96 |
| 3 | 3360 | 6.3 | 1 | 149 | 18 06.1 | -1.7 | -2.2 | 114 | 18 14.2 | -2.1 | -0.6 | 90 | 18 22.0 | -2.1 | +0.9 | 63 |
| 15 | 1371 | 6.4 | 2 | 292 | 2 10.5 | -1.2 | -2.6 | 316 | 1 59.1 | . | . | 339 | | N | | |
| 18 | 4006 | 1.4 | 1 | 325 | | N | | | 02 32.6 | -0.3 | -1.6 | 113 | 02 24.0 | -0.4 | -0.6 | 89 |
| 18 | 4006 | 1.4 | 2 | 325 | 03 44.0 | -0.6 | -1.1 | 264 | 03 41.9 | -1.0 | -1.4 | 284 | 03 30.6 | -1.0 | -2.0 | 308 |
| 23 | 2279 | 6.2 | 1 | 28 | 17 59.3 | -0.2 | +1.4 | 79 | | A | | | | N | | |
| 25 | 2555d | 7.5 | 1 | 53 | 19 13.5 | -0.3 | +1.7 | 68 | 19 27.3 | +0.3 | +1.9 | 53 | | A | | |
| 27 | 2889 | 7.1 | 1 | 79 | 21 51.5 | 0.0 | +1.4 | 73 | | A | | | | A | | |
| 30 | 3322d | 6.4 | 1 | 119 | 21 55.0 | -0.8 | +2.2 | 44 | 22 18.0 | -0.4 | +2.4 | 35 | 22 42.7 | +0.4 | +4.0 | 6 |
| 31 | 3461 | 6.4 | 1 | 131 | | N | | | 18 37.9 | . | . | 121 | 18 39.5 | -3.1 | -0.1 | 91 |
| 31 | 3465 | 6.5 | 1 | 132 | 19 31.1 | -2.4 | 0.0 | 88 | 19 57.1 | -2.4 | +0.7 | 81 | 20 13.3 | -2.0 | +1.5 | 61 |
| Nov. 2 | 219 | 5.1 | 1 | 161 | 23 21.8 | -2.1 | +0.5 | 97 | 23 45.0 | -1.6 | +0.9 | 86 | 23 59.3 | -1.4 | +1.4 | 65 |
| 6 | 653 | 4.8 | 2 | 202 | 2 01.4 | -2.0 | -0.2 | 297 | 2 10.0 | . | . | 328 | | N | | |
| 13 | 4005 | -1.6 | 1 | 285 | 7 10.6 | . | . | 38 | | N | | | | N | | |
| 13 | 4005 | -1.6 | 2 | 285 | 7 26.7 | . | . | 18 | | N | | | | N | | |
| 24 | 2986 | 6.4 | 1 | 62 | 20 40.0 | +0.3 | +2.2 | 38 | | A | | | | N | | |
| 25 | 3120 | 7.0 | 1 | 73 | | N | | | | N | | | 17 50.7 | -2.6 | -0.9 | 116 |
| 27 | 3405 | 7.0 | 1 | 100 | | S | | | | S | | | 17 29.2 | -1.2 | +3.2 | 24 |
| 27 | 3430d | 5.7 | 1 | 102 | 22 04.4 | -0.9 | +0.6 | 106 | 22 15.9 | -0.4 | +0.8 | 92 | | A | | |
| Dec. 9 | 1487d | 1.3 | 2 | 251 | | A | | | 21 55.1 | -0.6 | -2.0 | 306 | 21 35.7 | -0.9 | -3.6 | 336 |
| 12 | 4006 | 1.3 | 1 | 276 | | N | | | | N | | | 05 44.6 | -0.8 | -4.0 | 168 |
| 12 | 4006 | 1.3 | 2 | 276 | | N | | | | N | | | 06 50.0 | -3.0 | +1.6 | 256 |
| 23 | 3238 | 7.0 | 1 | 58 | 20 15.0 | +0.3 | +2.8 | 18 | | N | | | | N | | |
| 24 | 3379 | 6.4 | 1 | 70 | | N | | | | G | | | 19 31.8 | -0.8 | 0.0 | 107 |
| 24 | 3383 | 6.5 | 1 | 71 | 19 46.5 | -0.6 | +1.7 | 63 | 20 03.6 | -0.2 | +1.8 | 52 | | A | | |
| 25 | 3528 | 7.5 | 1 | 85 | 21 09.4 | -0.5 | +1.4 | 76 | | A | | | | A | | |
| 27 | 2694 | 7.3 | 1 | 111 | 22 42.0 | -0.7 | +3.0 | 22 | | N | | | | N | | |

4005 = JUPITER 4006 = SATURN

# GRAZING OCCULTATIONS

When a star moves tangentially to the limb of the Moon, and is occulted for a very short period only - a few minutes, or even seconds - a grazing occultation is said to occur. Because the limb, as seen from the Earth, is in fact the outline of numerous mountains and valleys, there may be several disappearances and reappearances, which are not only fascinating to observe, but which may be accurately timed to yield valuable data on the relative positions of star and Moon, in both right ascension and declination, 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 H.M. Nautical Almanac Office 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 $10^{\circ}$ above the observer's horizon ($2^{\circ}$ 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 of time which, when added to the time at the beginning of the track, 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 75mm refractor is ideal for average events, but better 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: Mr. J. Hers, P.O. Box 48, Sedgefield 6573. Telephone: 113.

## EXPLANATION OF COLUMN HEADINGS IN TABLES

No. - the number of the track on the map. An asterisk denotes that the same is double - notes are given below.

Z.C. - the number of the star in the Zodiacal Catalogue.

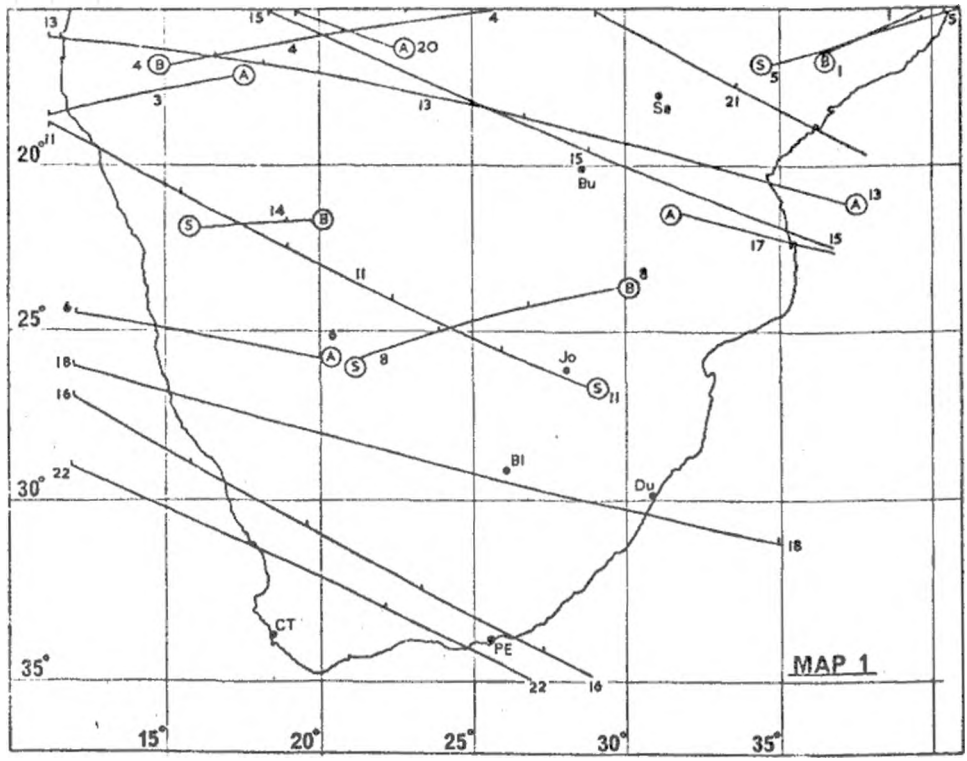
Date

Beginning - an arbitrary time of the beginning of the track in the west.

Sunlit - the percentage of the Moon's disk lit by the Sun

Limit - N = northern limit (a complete occultation takes place south of the track)
S = southern limit (complete occultation north of the track)

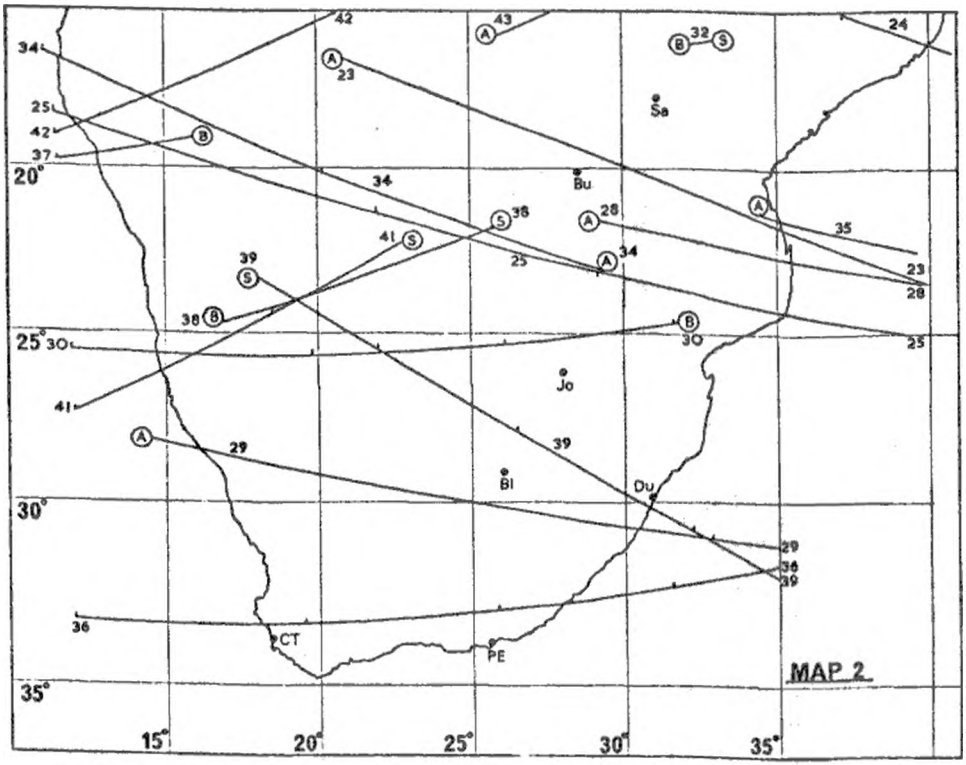
## JANUARY TO MARCH




| | Zc | Mag. | Time (U.T.) at the beginning of the track in the west | | | Percent sunlit | N or S limit | | Zc | Mag. | Time (U.T.) at the beginning of the track in the west | | | Percent sunlit | N or S limit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | hr min | % | | | | | | | hr min | % | |
| 1 | 3146 | 6.5 | JANUARY | 1 | 16 47 | 12 | N | 14 | 886 | 7.0 | MARCH | 6 | 17 43 | 62 | S |
| 3 | 3385 | 6.6 | JANUARY | 30 | 18 36 | 9 | N | 15 | 1158 | 5.2 | MARCH | 8 | 22 50 | 80 | N |
| 4 | 3530 | 7.0 | JANUARY | 31 | 18 32 | 17 | N | 16 | 2128 | 5.8 | MARCH | 18 | 0 21 | 83 | S |
| 5 | 109 | 6.5 | FEBRUARY | 1 | 16 43 | 26 | S | 17 | 3008 | 6.9 | MARCH | 24 | 0 44 | 20 | S |
| 6 | 404 | 5.2 | FEBRUARY | 3 | 21 35 | 49 | N | 18* | 3015 | 5.3 | MARCH | 24 | 1 34 | 20 | S |
| 8* | 650 | 5.7 | FEBRUARY | 5 | 17 51 | 68 | S | 20 | 1238 | 6.1 | APRIL | 5 | 22 40 | 65 | N |
| 11 | 2167 | 7.5 | FEBRUARY | 19 | 2 40 | 59 | S | 21 | 1439 | 5.9 | APRIL | 7 | 20 51 | 81 | N |
| 13 | 609 | 7.5 | MARCH | 4 | 19 10 | 42 | N | 22* | 2495 | 6.0 | APRIL | 16 | 21 44 | 78 | S |

| Track No | Zc | |
|---|---|---|
| 8 | 650 | is a spectroscopic binary. |
| 18 | 3015 | is the mean of the double star Aitken 14099. The components are of magnitude 5.8 and 6.3; separation 0".2 in p.a. 115°. |
| 22 | 2495 | is the mean of the two brightest components of the triple star Aitken 10465. These components are of magnitude 6.3 and 7.4; separation 1".9 in p.a. 262°. The third component is of 11th magnitude at a wide separation. |

**APRIL TO JUNE**

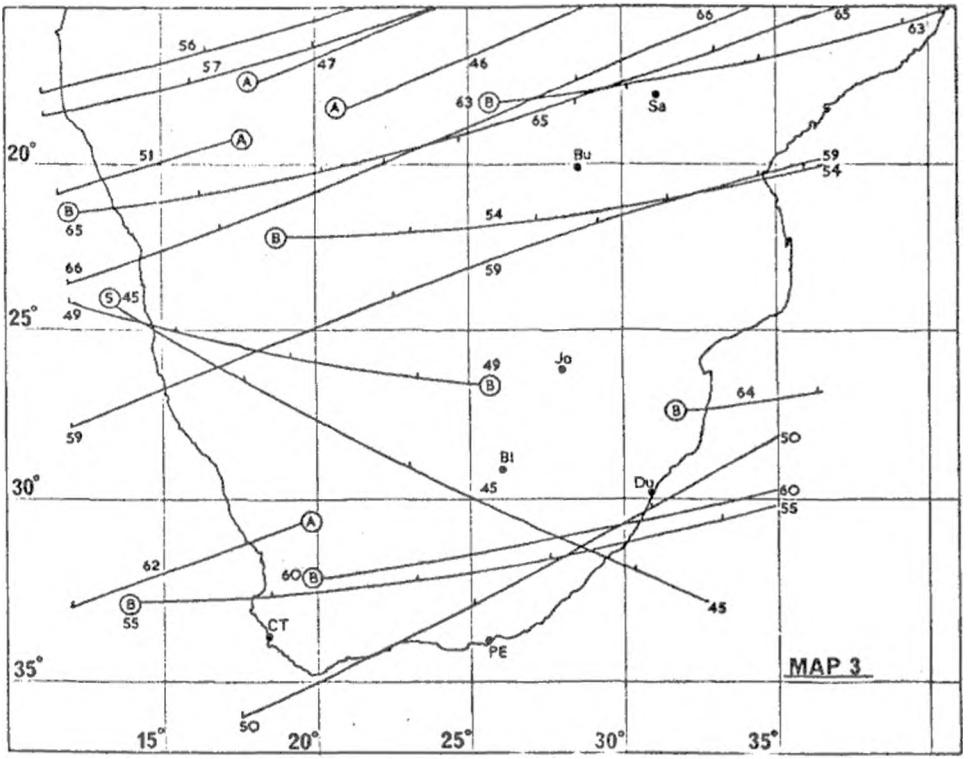



| | ZC | MAG. | TIME (U.T.) AT THE BEGINNING OF THE TRACK IN THE WEST | | | PERCENT SUNLIT % | N OR S LIMIT | | ZC | MAG. | TIME (U.T.) AT THE BEGINNING OF THE TRACK IN THE WEST | | | PERCENT SUNLIT % | N OR S LIMIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | HR MIN | | | | | | | | HR MIN | | |
| 23 | 2647 | 6.4 | APRIL | 17 | 21 33 | 68 | S | 35 | 3066 | 6.0 | MAY | 17 | 21 19 | 61 | S |
| 24* | 2653 | 6.4 | APRIL | 17 | 22 20 | 68 | S | 36* | 3083 | 7.3 | MAY | 18 | 1 19 | 59 | S |
| 25 | 2826 | 4.0 | APRIL | 19 | 0 2 | 56 | S | 37 | 3238 | 7.0 | MAY | 19 | 2 59 | 47 | S |
| 28 | 3112 | 6.2 | APRIL | 20 | 23 47 | 34 | S | 38 | 109 | 6.5 | MAY | 22 | 4 7 | 16 | N |
| 29 | 3119 | 6.7 | APRIL | 21 | 0 45 | 33 | S | 39 | 1360 | 7.5 | MAY | 31 | 16 34 | 30 | N |
| 30 | 3131 | 5.5 | APRIL | 21 | 3 0 | 33 | S | 41 | 354 | 5.5 | JUNE | 20 | 4 36 | 18 | N |
| 32 | 3280 | 7.4 | APRIL | 22 | 3 34 | 22 | N | 42 | 475 | 7.4 | JUNE | 21 | 4 27 | 11 | N |
| 34 | 1405 | 7.0 | MAY | 4 | 21 19 | 57 | N | 43 | 618 | 7.2 | JUNE | 22 | 4 1 | 5 | S |

24 2653 is the mean of the two brightest components of the triple star Aitken 11240. These components are of magnitude 6.9 and 7.4; separation 0".4 in p.a. 131°. The third component is of magnitude 9.4 at a separation of 17".2 in p.a. 52° from the mean position.

36 3083 is the brightest component of the double star Aitken 14638. The companion is of magnitude 11.3; separation 4".9 in p.a. 170°.

## JUNE TO SEPTEMBER



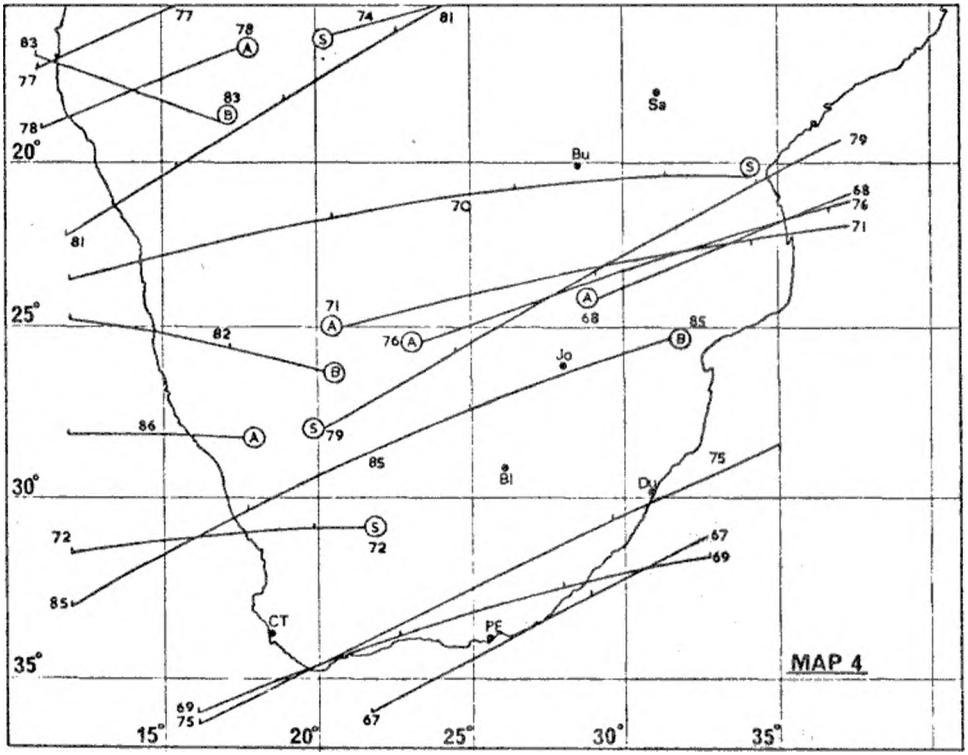

| | ZC | MAG. | TIME (U.T.) AT THE BEGINNING OF THE TRACK IN THE WEST | | | PERCENT SUNLIT % | N OR S LIMIT |
|---|---|---|---|---|---|---|---|
| | | | | | HR MIN | | |
| 45 | 1531 | 5.9 | JUNE | 29 | 16 55 | 23 | N |
| 46 | 862 | 7.5 | JULY | 21 | 3 35 | 8 | N |
| 47 | 863 | 6.7 | JULY | 21 | 3 46 | 8 | N |
| 49 | 2133 | 5.6 | AUGUST | 1 | 18 38 | 54 | N |
| 50 | 269 | 7.3 | AUGUST | 13 | 0 6 | 70 | N |
| 51 | 2372 | 6.4 | AUGUST | 30 | 22 42 | 50 | S |
| 54* | 2649 | 6.6 | SEPTEMBER | 1 | 18 27 | 70 | S |
| 55* | 2653 | 6.4 | SEPTEMBER | 1 | 18 48 | 70 | S |

| | ZC | MAG. | TIME (U.T.) A. THE BEGINNING OF THE TRACK IN THE WEST | | | PERCENT SUNLIT % | N OR S LIMIT |
|---|---|---|---|---|---|---|---|
| | | | | | HR MIN | | |
| 56 | 2658 | 5.4 | SEPTEMBER | 1 | 20 28 | 71 | S |
| 57 | 2828 | 6.0 | SEPTEMBER | 2 | 20 16 | 81 | S |
| 59 | 1060 | 7.4 | SEPTEMBER | 15 | 2 31 | 33 | N |
| 60 | 2184 | 7.0 | SEPTEMBER | 25 | 18 7 | 15 | S |
| 62 | 2460 | 6.1 | SEPTEMBER | 27 | 21 13 | 34 | S |
| 63 | 2578 | 6.4 | SEPTEMBER | 28 | 16 54 | 43 | S |
| 64 | 2745 | 6.9 | SEPTEMBER | 29 | 16 32 | 54 | S |
| 65 | 2755 | 6.6 | SEPTEMBER | 29 | 17 47 | 54 | S |
| 66 | 2764 | 6.3 | SEPTEMBER | 29 | 19 50 | 55 | S |

54 2649 is the brightest component of the triple star Aitken 10086. The brighter companion is of magnitude 9.6 at a wide separation; the second companion of magnitude 10.1 is at a separation of 10".4 in p.a. 132°.

55 2653 is the mean of the two brightest components of the triple star Aitken 11240. These components are of magnitude 6.9 and 7.4; separation 0".4 in p.a. 131°. The third component is of magnitude 9.4 at a separation of 17".2 in p.a. 52° from the mean position.

## SEPTEMBER TO DECEMBER




| | ZC | MAG. | TIME (U.T.) AT THE BEGINNING OF THE TRACK IN THE WEST | | | PERCENT SUNLIT | N OR S LIMIT |
|---|---|---|---|---|---|---|---|
| | | | | HR | MIN | % | |
| 67 | 2922 | 7.4 | SEPTEMBER 30 | 21 | 34 | 67 | S |
| 68 | 1006 | 6.9 | OCTOBER 11 | 22 | 42 | 60 | N |
| 69 | 1025 | 7.4 | OCTOBER 12 | 1 | 45 | 59 | N |
| 70 | 1260 | 7.0 | OCTOBER 14 | 2 | 15 | 40 | N |
| 71 | 1371 | 6.4 | OCTOBER 15 | 1 | 32 | 31 | N |
| 72 | 1375 | 5.6 | OCTOBER 15 | 3 | 18 | 30 | N |
| 74 | 2865 | 5.9 | OCTOBER 27 | 17 | 3 | 39 | S |
| 75 | 940 | 5.7 | NOVEMBER 7 | 21 | 57 | 85 | N |
| 76 | 1203 | 7.1 | NOVEMBER 9 | 22 | 36 | 67 | N |
| 77 | 2833 | 7.0 | NOVEMBER 23 | 18 | 15 | 16 | S |
| 78 | 2846 | 6.9 | NOVEMBER 23 | 19 | 42 | 17 | S |
| 79 | 3120 | 7.0 | NOVEMBER 25 | 17 | 43 | 36 | S |
| 81 | 3412 | 6.4 | NOVEMBER 27 | 19 | 12 | 59 | S |
| 82 | 1501 | 7.3 | DECEMBER 10 | 1 | 16 | 65 | N |
| 83 | 2137 | 6.4 | DECEMBER 16 | 3 | 29 | 11 | N |
| 85 | 3379 | 6.4 | DECEMBER 24 | 19 | 18 | 34 | S |
| 86 | 269 | 7.3 | DECEMBER 27 | 23 | 6 | 69 | N |

: THE TICKS ARE AT 10 MINUTE INTERVALS.

# TIME SYSTEMS AND TELESCOPE SETTINGS

This section is intended to serve established amateurs and professional 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 SUO

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 |
| 100 MHz | 80 w | 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 (formally known as Greenwich Mean Time) at the next minute. (A special coding indicating UTI 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 for 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.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Jan | 1 | $12^h03^m24^s$ | May | 11 | $11^h56^m21^s$ | Sep | 18 | $11^h54^m19^s$ |
| | 11 | 12 07 48 | | 21 | 11 56 29 | | 28 | 11 50 50 |
| | 21 | 12 11 13 | | 31 | 11 57 32 | Oct | 8 | 11 47 42 |
| | 31 | 12 13 26 | Jun | 10 | 11 59 15 | | 18 | 11 45 17 |
| Feb | 10 | 12 14 16 | | 20 | 12 01 21 | | 28 | 11 43 52 |
| | 20 | 12 13 49 | | 30 | 12 03 29 | Nov | 7 | 11 43 41 |
| Mar | 2 | 12 12 18 | Jul | 10 | 12 05 13 | | 17 | 11 44 53 |
| | 12 | 12 09 56 | | 20 | 12 06 15 | | 27 | 11 47 29 |
| | 22 | 12 07 04 | | 30 | 12 06 24 | Dec | 7 | 11 51 16 |
| Apr | 1 | 12 04 03 | Aug | 9 | 12 05 31 | | 17 | 11 55 53 |
| | 11 | 12 01 12 | | 19 | 12 03 42 | | 27 | 12 00 51 |
| | 21 | 11 58 48 | | 29 | 12 01 04 | | 31 | 12 02 48 |
| May | 1 | 11 57 08 | Sep | 8 | 11 57 50 | | | |

## SIDEREAL TIME ON THE 30° MERIDIAN

Sidereal Time is given by the line of Right Ascension coinciding with the meridian.

| | | At 0 hrs SAST | At 21 hrs SAST | | | At 0 hrs SAST | At 21 hrs SAST | | | At 0 hrs SAST | At 21 hrs SAST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | $6^h41^m$ | $3^h44^m$ | May | 11 | $15^h13^m$ | $12^h17^m$ | Sep | 18 | $23^h46^m$ | $20^h49^m$ |
| | 11 | 7 20 | 4 23 | | 21 | 15 53 | 12 56 | | 28 | 2 25 | 21 29 |
| | 21 | 8 00 | 5 03 | | 31 | 16 32 | 13 36 | Oct | 8 | 1 05 | 22 08 |
| | 31 | 8 39 | 5 43 | Jun | 10 | 17 12 | 14 15 | | 18 | 1 44 | 22 48 |
| Feb | 10 | 9 19 | 6 22 | | 20 | 17 51 | 14 55 | | 28 | 2 24 | 23 27 |
| | 20 | 9 58 | 7 01 | | 30 | 18 31 | 15 34 | Nov | 7 | 3 03 | 0 06 |
| Mar | 2 | 10 37 | 7 41 | Jul | 10 | 19 10 | 16 13 | | 17 | 3 42 | 0 46 |
| | 12 | 11 17 | 8 20 | | 20 | 19 50 | 16 53 | | 27 | 4 22 | 1 25 |
| | 22 | 11 56 | 9 00 | | 30 | 20 29 | 17 32 | Dec | 7 | 5 01 | 2 05 |
| Apr | 1 | 12 36 | 9 39 | Aug | 9 | 21 09 | 18 12 | | 17 | 5 41 | 2 44 |
| | 11 | 13 15 | 10 19 | | 19 | 21 48 | 18 51 | | 27 | 6 20 | 3 24 |
| | 21 | 13 55 | 10 58 | | 29 | 22 27 | 19 31 | | 31 | 6 36 | 3 39 |
| May | 1 | 14 34 | 11 37 | Sep | 8 | 23 07 | 20 10 | | | | |

## 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 | $+\ 8^m$ | Salisbury | $-\ 4^m$ |
| 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 is 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 | $1^h36^m,8$ | $-57^o21'$ | 0,6 | B5 | Procyon | $7^h38^m,1$ | $+5^o\ 17'$ | 0,5 | F5 |
| Aldebaran | 4 34 ,6 | +16 28 | 1,1 | K5 | Regulus | 10 07 ,1 | +12 05 | 1,3 | B8 |
| Rigel | 5 13 ,4 | - 8 14 | 0,3 | B8 | Spica | 13 24 ,0 | -11 02 | 1,2 | B2 |
| Betelgeuse | 5 53 ,9 | + 7 24 | 0,4 | M0 | Arcturus | 14 14 ,6 | +19 18 | 0,2 | K0 |
| Canopus | 6 23 ,4 | -52 41 | -0,9 | F0 | Antares | 16 28 ,0 | -26 23 | 1,2 | M1 |
| Sirius | 6 44 ,1 | -16 41 | -1,6 | A0 | Altair | 19 49 ,7 | +8 48 | 0,9 | A5 |

# ASSA OFFICE BEARERS

## COUNCIL

President: Mr R.F. Hurly
Vice-Presidents: Mr M.A. Gray, Dr M. Feast, Prof. B. Warner
Members: Messrs J. Hers, J. Vincent, G. Muller, Dr E. Baart
Secretary: Mr T.W. Russo
Treasurer: Mr G. Orpen
Business Manager: Mr W.C. Bentley

## CAPE CENTRE

Chairman: Miss P. Booth
Vice-Chairman: Mr K.G. Burke
Secretary: Dr J.F. Dean
Treasurer: Mr N. Saville
Auditor: Mr G. Orpen
Council Representative: Mr H.B. Molyneux
Committee: Messrs J. Bondietti, J. Churms, W. Grimwood, J. Parsons, C.R.G. Turk, Dr L.H. Holroyd

## NATAL CENTRE

Chairman: Dr H. Campbell
Vice-Chairman: Mr J. Barker
Secretary: Mr M.A. Gray
Assistant Secretary: Mr K. Harrison
Treasurer: Mrs J. Barker
Assistant Treasurer: Mr R. Field
Council Representative: Mr G. Hobson
Curator of Instruments: Mr R. Field
Observing Section: Mr J. da Silva Campos
Occultations and Phenomena: Mr W. Spiers (assisted by Mr S. Booysen)
Lecture Team: Messrs H. Campbell, A Gray, K. Harrison, P. Rodman
P.R.O.: Mr M.A. Gray
Ndaba Editorial: Messrs K. Harrison, P. Rodman (assisted by M. Gray)

## NATAL MIDLANDS CENTRE

Chairman: Mrs S.B. Dale
Secretary: Mr M. Jackson
Treasurer: Mrs N. Prosser
Committee: Messrs R.H. Dale, G. Kay-Hards, J. Watson, P. Welch, Dr G. Prosser
Council Representative: Dr G. Prosser

## SALISBURY CENTRE

Chairman: Mr C.J. Armstrong
Secretary: Mr W.L. Stedman
Treasurer: Mr M.A. Godfrey
Committee: Messrs C.B. Archer, J.V. Vincent

## PRETORIA CENTRE

Chairman: Mr J.C. Bennett
Vice-Chairman: Mr K. Sterling
Secretary/Treasurer: Mr W.R. Windisch
Librarian: Dr D.P. Bennewith
Curator of Instruments: Mr J.R. Starkey
Council Representative: Mr J. Wolterbeek
Committee: Drs P.D. Bennewith, A. Smith, Messrs J. Eschberger, M.A. Komorous, R. Matthews, J.R. Starkey

## TRANSVAAL CENTRE

Chairman: Mr G. Marshall
Vice-Chairman: Mr T. Voorveldt
Secretary: Mrs A. Williams
Treasurer: Mr G. Paxton
Curator of Instruments: Mr R.F. Williams
Planetarium Representative: Mr T. Voorveldt
C.S.I.R. Representative: Mr J. Bruwer
P.R.O.: Mr V. Righthouse
Librarian: Mrs D. Voorveldt
Council Representative: Mrs A. Williams
Pretoria Centre Representative: Mr J. Bennett
Committee: Dr S. Amoils, Messrs J. Barsby, D. Miche, C. Papadopoulos, G. Pulik, R. Williams, G. Willies, J. van Zyl

## FREE STATE CENTRE

Chairman: Mr G.M. Walker
Vice-Chairman: Mr B. Viljoen
Secretary/Treasurer: Mr F.C. Neser
Council Representative: Mr G. Walker

## PAST PRESIDENTS

| | | | | | |
|---|---|---|---|---|---|
| 1922-23 | S.S. Hough | 1941-42 | H. Knox Shaw | 1960-61 | G.G. Cillie |
| 1923-24 | R.T.A. Innes | 1942-43 | A.F.I. Forbes | 1961-62 | M.D. Overbeek |
| 1924-25 | J.K.E. Halm | 1943-44 | W.H. van den Bos | 1962-63 | A.J. Wesselink |
| 1925-26 | W. Reid | 1944-45 | A.W.J. Cousins | 1963-64 | A.G.F. Morrisby |
| 1926-27 | H. Spencer Jones | 1945-46 | R.H. Stoy | 1964-65 | H.C. Lagerwey |
| 1927-28 | A.W. Roberts | 1946-47 | W.P. Hirst | 1965-66 | A. Menzies |
| 1928-29 | A.W. Long | 1947-48 | J. Jackson | 1966-67 | G.R. Atkins |
| 1929-30 | H.E. Wood | 1948-49 | A.E.H. Bleksley | 1967-68 | J. Hers |
| 1930-31 | D. Cameron-Swan | 1949-50 | W.S. Finsen | 1968-69 | J.C. Bennett |
| 1931-32 | H.L. Alden | 1950-51 | H.E. Krumm | 1969-70 | J. Churms |
| 1932-33 | H. Spencer Jones | 1951-52 | A.D. Thackeray | 1970-71 | W.C. Bentley |
| 1933-34 | D.G. McIntyre | 1952-53 | J.C. Bentley | 1971-72 | A.H. Jarrett |
| 1934-35 | J.K.E. Halm | 1953-54 | David S. Evans | 1972-73 | K.J. Sterling |
| 1935-36 | J. Jackson | 1954-55 | P. Kirchhoff | 1973-74 | G.A. Harding |
| 1936-37 | H.E. Houghton | 1955-56 | W.H. van den Bos | 1974-75 | C. Papadopoulos |
| 1937-38 | J.S. Paraskevopoulos | 1956-57 | S.C. Venter | 1975-76 | P.A.T. Wild |
| 1938-39 | T. Mackenzie | 1957-58 | M.W. Feast | 1976-77 | S. Booysen |
| 1939-40 | R.A. Rossiter | 1958-59 | H. Haffner | 1977-78 | B. Warner |
| 1940-41 | E.B. Ford | 1959-60 | P. Smits | | |

## HONORARY SECRETARIES

| | | | | | |
|---|---|---|---|---|---|
| 1922 | H.W. Schonegevel | 1923 | H.E. Houghton | 1934 | H.W. Schonegevel |
| 1922 | T. Mackenzie | 1930 | S. Skewes | 1935 | A. Menzies |
| 1923 | C.L. O'Brien Dutten | 1931 | H. Horrocks | 1965 | T.W. Russo |

## HONORARY MEMBERS

| | | |
|---|---|---|
| Prof. A.E. Bleksley | Dr W.S. Finsen | Dr R.H. Stoy |
| Dr A.W.J. Cousins | Mr H.E. Krumm | Dr A.G. Velghe |
| Mr R.P. de Kock | Dr J.H. Oort | Dr A.J. Wesselink |
| Dr David S. Evans | Mr M.D. Overbeek | Sir Richard Woolley |
| Prof. Ch. Fehrenbach | Dr J. Schilt | |

## GILL MEDALLISTS

| | | | | | |
|---|---|---|---|---|---|
| 1956 | H. Knox Shaw | 1960 | W.H. van den Bos | 1967 | W.S. Finsen |
| 1957 | W.P. Hirst | 1963 | A.W.J. Cousins | 1970 | J.C. Bennett |
| 1958 | J. Jackson | 1965 | R.H. Stoy | 1976 | A.D. Thackeray |

# JULIAN DATE AT 1400 HOURS

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2443 | 2443 | 2443 | 2443 | 2443 | 2444 | 2444 | 2444 | 2444 | 2444 | 2444 | 2444 |
| 1 | 875 | 906 | 934 | 965 | 995 | 026 | 056 | 087 | 118 | 148 | 179 | 209 |
| 2 | 876 | 907 | 935 | 966 | 996 | 027 | 057 | 088 | 119 | 149 | 180 | 210 |
| 3 | 877 | 908 | 936 | 967 | 997 | 028 | 058 | 089 | 120 | 150 | 181 | 211 |
| 4 | 878 | 909 | 937 | 968 | 998 | 029 | 059 | 090 | 121 | 151 | 182 | 212 |
| 5 | 879 | 910 | 938 | 969 | 999 | 030 | 060 | 091 | 122 | 152 | 183 | 213 |
| 6 | 880 | 911 | 939 | 970 | *000 | 031 | 061 | 092 | 123 | 153 | 184 | 214 |
| 7 | 881 | 912 | 940 | 971 | *001 | 032 | 062 | 093 | 124 | 154 | 185 | 215 |
| 8 | 882 | 913 | 941 | 972 | *002 | 033 | 063 | 094 | 125 | 155 | 186 | 216 |
| 9 | 883 | 914 | 942 | 973 | *003 | 034 | 064 | 095 | 126 | 156 | 187 | 217 |
| 10 | 884 | 915 | 943 | 974 | *004 | 035 | 065 | 096 | 127 | 157 | 188 | 218 |
| 11 | 885 | 916 | 944 | 975 | *005 | 036 | 066 | 097 | 128 | 158 | 189 | 219 |
| 12 | 886 | 917 | 945 | 976 | *006 | 037 | 067 | 098 | 129 | 159 | 190 | 220 |
| 13 | 887 | 918 | 946 | 977 | *007 | 038 | 068 | 099 | 130 | 160 | 191 | 221 |
| 14 | 888 | 919 | 947 | 978 | *008 | 039 | 069 | 100 | 131 | 161 | 192 | 222 |
| 15 | 889 | 920 | 948 | 979 | *009 | 040 | 070 | 101 | 132 | 162 | 193 | 223 |
| 16 | 890 | 921 | 949 | 980 | *010 | 041 | 071 | 102 | 133 | 163 | 194 | 224 |
| 17 | 891 | 922 | 950 | 981 | *011 | 042 | 072 | 103 | 134 | 164 | 195 | 225 |
| 18 | 892 | 923 | 951 | 982 | *012 | 043 | 073 | 104 | 135 | 165 | 196 | 226 |
| 19 | 893 | 924 | 952 | 983 | *013 | 044 | 074 | 105 | 136 | 166 | 197 | 227 |
| 20 | 894 | 925 | 953 | 984 | *014 | 045 | 075 | 106 | 137 | 167 | 198 | 228 |
| 21 | 895 | 926 | 954 | 985 | *015 | 046 | 076 | 107 | 138 | 168 | 199 | 229 |
| 22 | 896 | 927 | 955 | 986 | *016 | 047 | 077 | 108 | 139 | 169 | 200 | 230 |
| 23 | 897 | 928 | 956 | 987 | *017 | 048 | 078 | 109 | 140 | 170 | 201 | 231 |
| 24 | 898 | 929 | 957 | 988 | *018 | 049 | 079 | 110 | 141 | 171 | 202 | 232 |
| 25 | 899 | 930 | 958 | 989 | *019 | 050 | 080 | 111 | 142 | 172 | 203 | 233 |
| 26 | 900 | 931 | 959 | 990 | *020 | 051 | 081 | 112 | 143 | 173 | 204 | 234 |
| 27 | 901 | 932 | 960 | 991 | *021 | 052 | 082 | 113 | 144 | 174 | 205 | 235 |
| 28 | 902 | 933 | 961 | 992 | *022 | 053 | 083 | 114 | 145 | 175 | 206 | 236 |
| 29 | 903 | | 962 | 993 | *023 | 054 | 084 | 115 | 146 | 176 | 207 | 237 |
| 30 | 904 | | 963 | 994 | *024 | 055 | 085 | 116 | 147 | 177 | 208 | 238 |
| 31 | 905 | | 964 | | *025 | | 086 | 117 | | 178 | | 239 |

*2444