

1981

Stars and telescopes : a resource book for teachers of lower school science

Clifton L. Smith

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Stars and Telescopes



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S T A R S

A N D

T E L E S C O P E S

S T A R S A N D T E L E S C O P E S

A Resource Book
for Teachers of Lower School Science

by
CLIFTON L. SMITH

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Stirling Highway
NEDLANDS WA 6009

1981



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AIMS AND OBJECTIVES

This resource book has been designed to meet the needs of teachers of lower school science who wish to gain experience in celestial astronomy in order to conduct an observational evening for lower school science students.

The material will be treated at an elementary level, and is intended for teachers who require the acquisition of knowledge, skills and experience in the space sciences.

This resource book will consider;

- * Types of star groupings: double stars, binary stars, open star clusters, globular clusters, galaxies, and constellations.
- * Types of stars: main sequence stars, red giants, variable stars, white dwarfs, black dwarfs, and neutron stars.
- * Types of telescopes: prime focus, newtonian focus, cassegrain focus, coudé focus, and Schmidt design telescopes.
- * Teaching Aids: planispheres, angle measurers, star maps, celestial sphere, constellation simulator.

Later, we will discuss celestial observations activities suitable for lower school science activity work by;

- * Naked eye observations: recognition of prominent constellations and stars, and the measurement of angular distances.



*Binocular observations: gross properties of celestial objects.

*Telescope observations: detailed properties of celestial objects.



STAR GROUPINGS

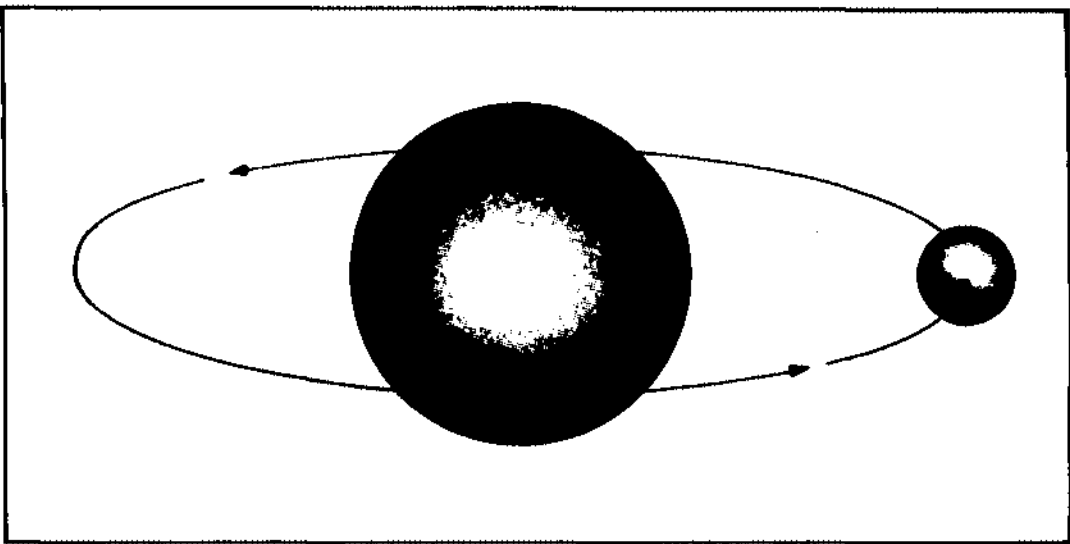
Stars tend to group in a variety of types of formations. These formations are usually the result of gravitational attraction between the stars.

Some stars are solitary, isolated occupants of space. However, most stars within a galaxy are associated with other stars. Several types of star associations occur, ranging from just several stars in the grouping to extremely large star clusters.

1. Binary Star System

Most stars in our Galaxy are not solitary, but are bound by the force of gravity to one, and sometimes many, companions. About half of all star systems are binary or multiple systems. In binary star systems the two stars move around each other in elliptical orbits.

Example: Alpha Centauri

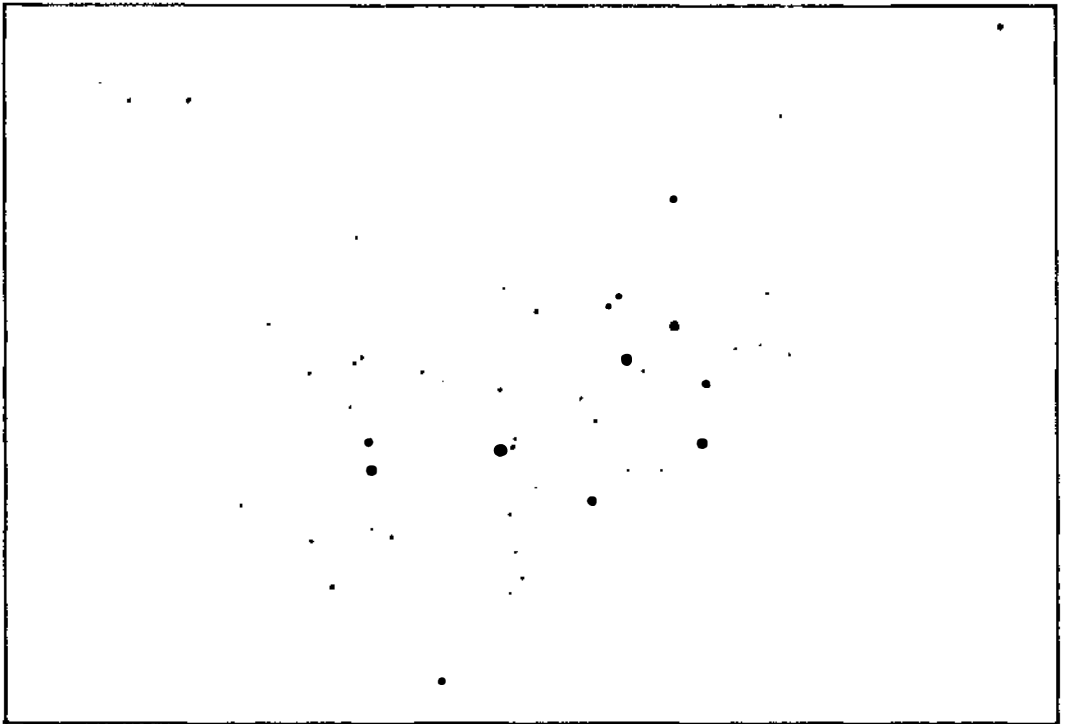




2. Open Star Cluster

Open star clusters, or galactic clusters, are loose and irregular aggregations of stars containing several hundred to several thousand stars. Individual stars in the open cluster are easily resolved with a telescope, and in some cases can be seen with the naked eye. Open clusters are mainly located close to the galactic plane, which is recognised as the Milky Way in the heavens at night.

Examples: Hyades, Pleiades (Seven Sisters)

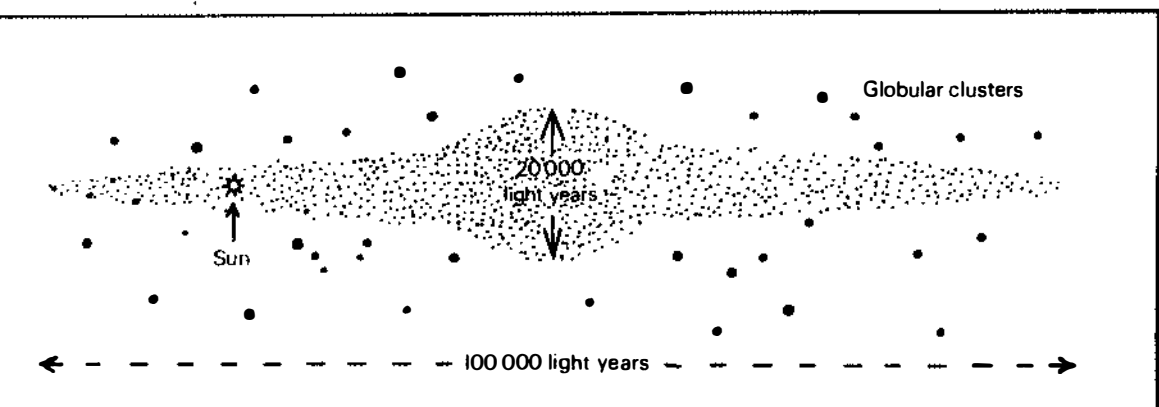
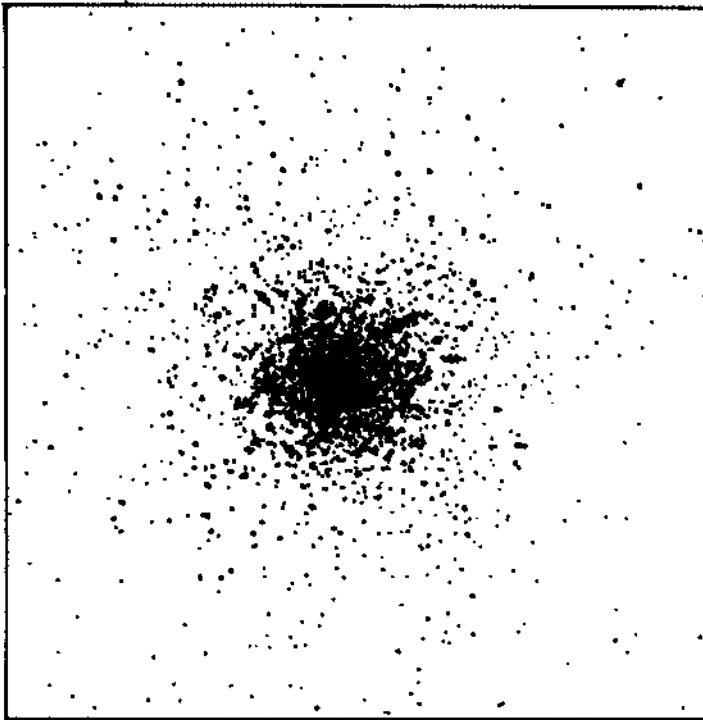




3. Globular Cluster

Globular clusters are relatively tightly packed clusters of stars containing hundreds of thousands or millions of stars in spherical symmetry. Globular clusters are symmetrically distributed around the nucleus of the galaxy. Stars in globular clusters are generally older than stars in the galactic arms.

Examples: Omega Centauri and 47 Tucanae.





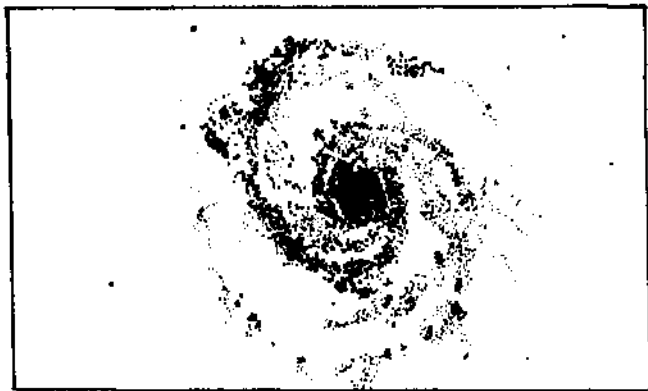
4. Galaxies

Galaxies are now thought to be the basic unit of the Universe. That is, the Universe contains galaxies. Galaxies are celestial structures with a large number of stars gravitationally held together. Typically about 1×10^{11} stars compose a galaxy, with each star possessing a mass comparable to that of our Sun.

Three major types of galaxies are observed.

(a) Elliptical galaxies have stars symmetrically distributed in an ellipsoid, with dimensions differing from galaxy to galaxy.

(b) Spiral galaxies possess the characteristic star spiral arms which sweep out behind the rotating galactic nucleus. Normal spiral galaxies have a central nucleus of stars with radiating spiral arms. Barred spiral galaxies have a distinct "bar" of stars through the nucleus, and from which two spiral arms trail.

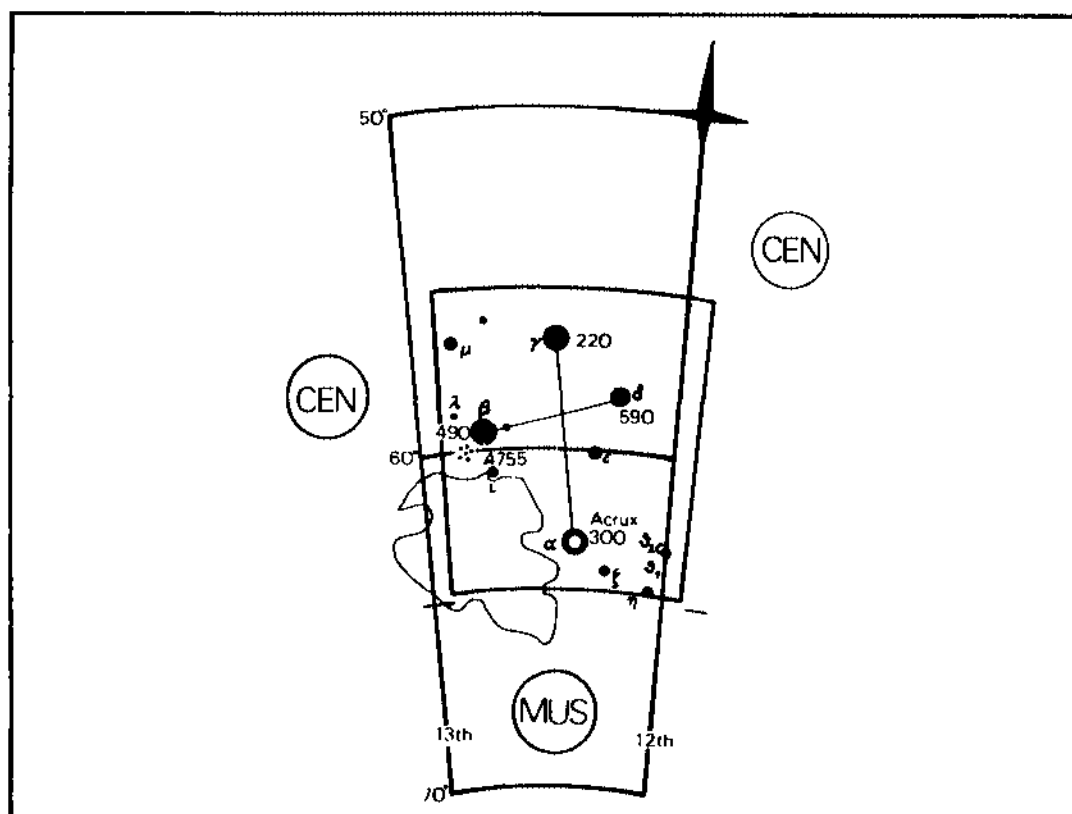


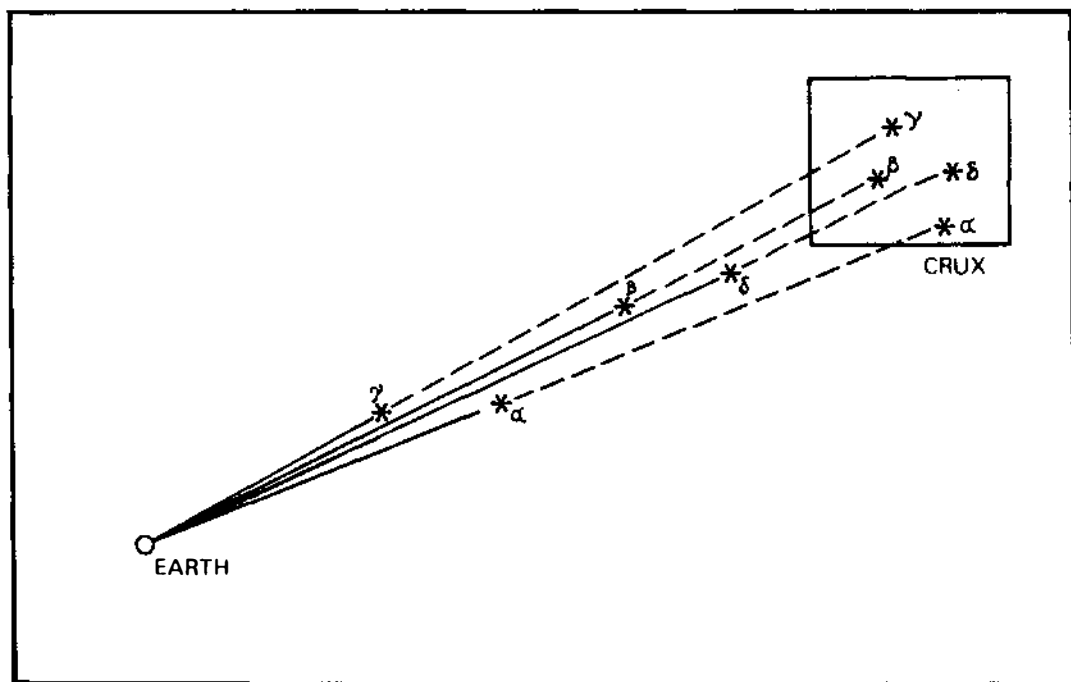
(c) Irregular galaxies are generally smaller galaxies which do not possess structure or symmetry. Their shape is probably due to lack of rotation. The Large Magellanic and Small Magellanic Clouds are irregular galaxies close to our galaxy, the Milky Way.



5. Constellations

Constellations are arbitrary patterns of the brighter stars in the heavens. They do not portray real groupings of stars, which may be greatly dispersed at varying distances in space. The ancient mythological names have been retained in Latin form. Each star in the constellation is described by a greek letter of the alphabet, with α designated to the brightest star, β to the next brightest star, etc. For example, α Crux is the brightest star in the Southern Cross.





The famous southern hemisphere constellation of CRUX is composed of stars at varying distances from Earth.

- α Crux : 300 light years
- β Crux : 490 light years
- γ Crux : 200 light years
- δ Crux : 590 light years



TYPES OF STARS

Stars are born from interstellar hydrogen gas and dust in the galactic arms. A gravitational collapse of the gas nebula causes the internal pressure and temperature to increase. When the temperature is sufficiently high (6 million K), fusion reactions commence converting hydrogen to helium and releasing enormous quantities of energy. The hydrogen fusion reaction is referred to as hydrogen burning, and the gas cloud is now a protostar.

When the gravitational contraction forces are in equilibrium with the thermal pressure of the gas of the star, the star is then in its stable hydrogen burning phase. Our Sun is undergoing hydrogen burning, and is termed a Main Sequence star.

After about 1×10^{10} years, the hydrogen in the core will have been consumed and the fusion reactions cease. Gravitational collapse will recommence, further increasing the stellar central pressure and temperature. At about 30 million K helium fusion reactions begin, again arresting the gravitational collapse and distending the outer gas envelope of the star. This bloated outer envelope of gas will become cooler and hence redder, with an increase in stellar radius by a factor of 1000. The star is now in the Red Giant phase.

Further progressive gravitational collapses occur as core fuel depletes, produces fusion reactions for C, N, O, etc, up to Fe. Iron is the terminating nuclide in the series as it does not undergo fusion reactions. During these phases of the burning reactions the star becomes unstable with its outer gas envelope expanding and contraction. The stellar object is now a Variable Star.



Because of the gross instabilities within the star together with the extremely high temperature and pressure, the thermal pressure of the stellar core "blows" the outer layers of the star outward into space. Large amounts of energy are dissipated in a Nova event. The remnants of the nova is an intensely hot small core of the star and is called a White Dwarf. The white dwarf radiates into space and gradually cools with time to finally become a Black Dwarf.

If the initial main sequence star was large and produced a Super Red Giant, then a Supernova event will remove a major portion of the star. The remnant remaining contracts inwards to form a Neutron Star, which are thought to be composed of incredibly dense matter.

Gravitation is the key to stellar evolution. It is responsible for the initial formation of the nebula, the commencement of fusion reactions within the protostar, the various phases of evolution, and finally the death of the star when debris is flung outwards into space.

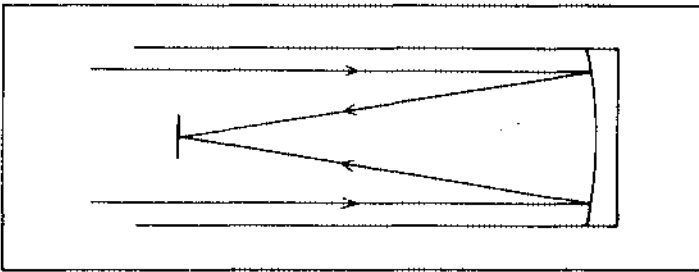


TELESOPES

The function of a telescope is to collect light from a celestial object and to focus this light to an image. Refracting telescopes achieve this outcome by means of a lens, while a reflecting telescope employs a curved mirror.

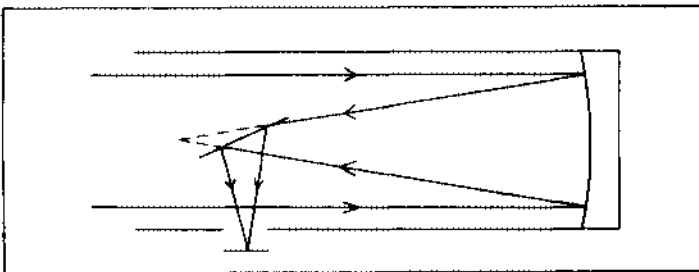
Reflecting telescopes use a parabolic mirror to minimise spherical aberration. Several optical configurations are possible to achieve the production of an image which can be focussed onto a photographic plate or viewed with an eyepiece.

(a) Prime Focus Telescope



The photographic plate or eyepiece is actually situated in the telescope tube.

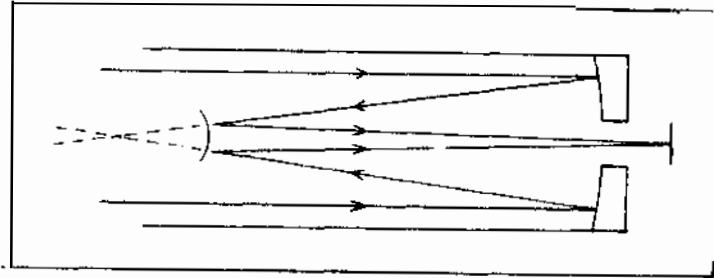
(b) Newtonian Focus



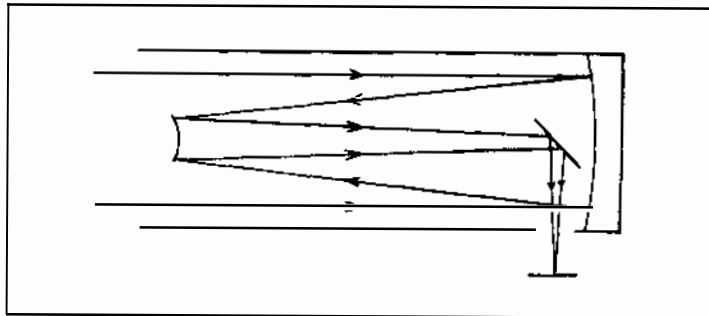


The Newtonian focus takes the light beam from the telescope tube by means of a plane mirror. This configuration requires the camera or eyepiece to be near the top end of the telescope tube.

(c) Cassegrain Focus



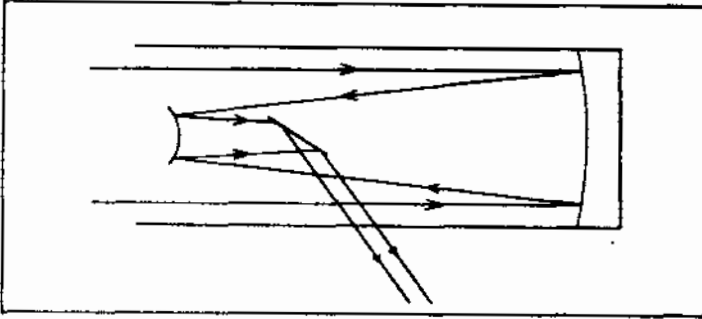
A second small convex mirror in the field of view focusses the image through a hole in the main reflector. This configuration is very convenient to use, however it reduces the light collecting aperture.



However the insertion of a small plane mirror in front of the primary mirror provides a cassegrain focus configuration with side viewing.

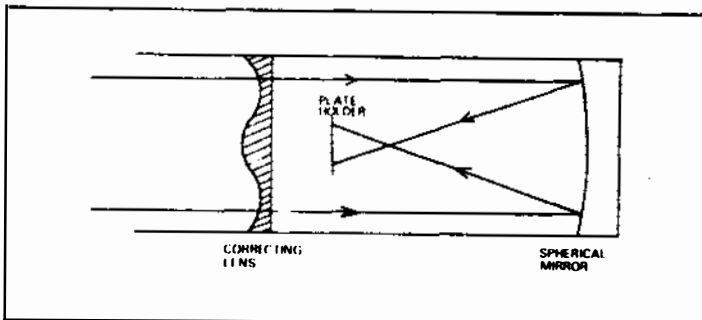


(d) Coudé Focus



An unfocussed image is reflected to a stationary observing station away from the telescope in a separate laboratory. This optical configuration is used with large telescopes and allows the use of heavy analytical equipment.

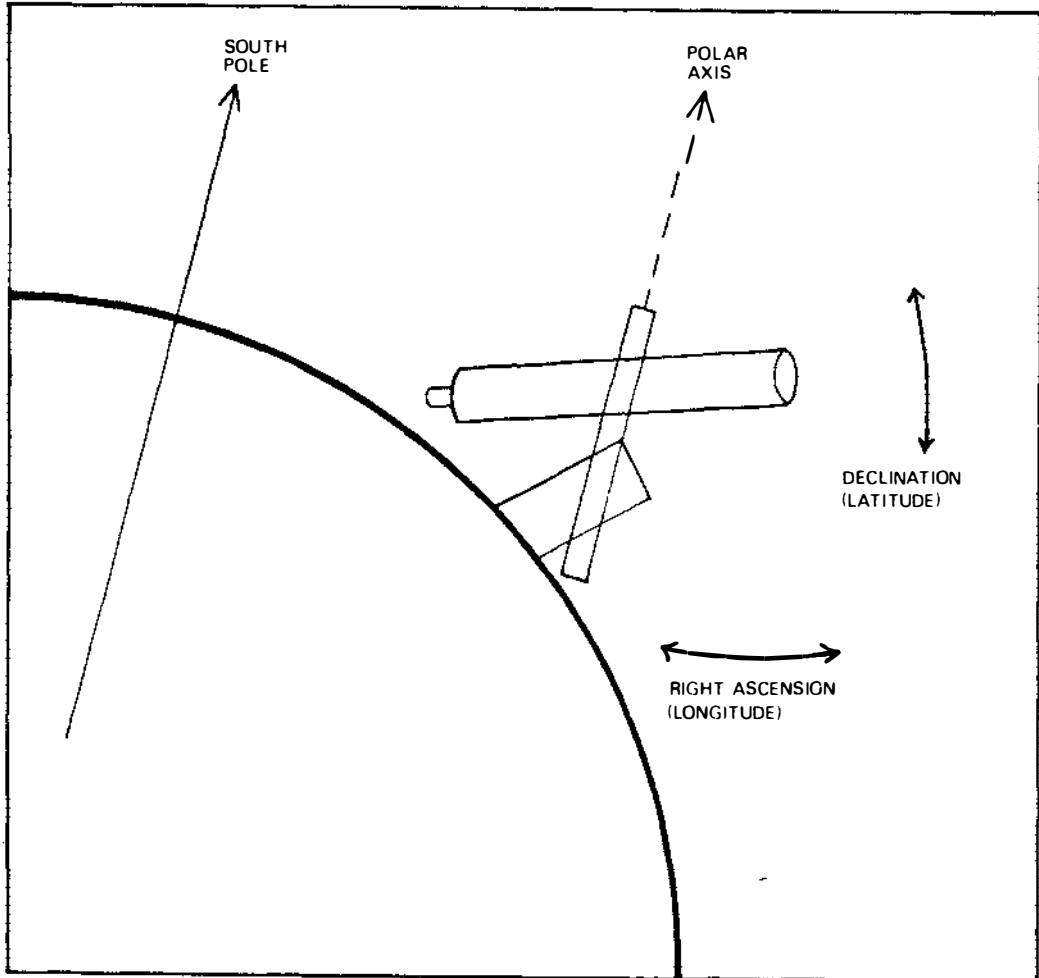
(e) Schmidt Telescope



The Schmidt telescope design is a relatively new innovation employing a spherical mirror as the primary collector, and having a correcting lens at the front end of the tube to compensate for spherical aberration.



EQUATORIAL MOUNTING



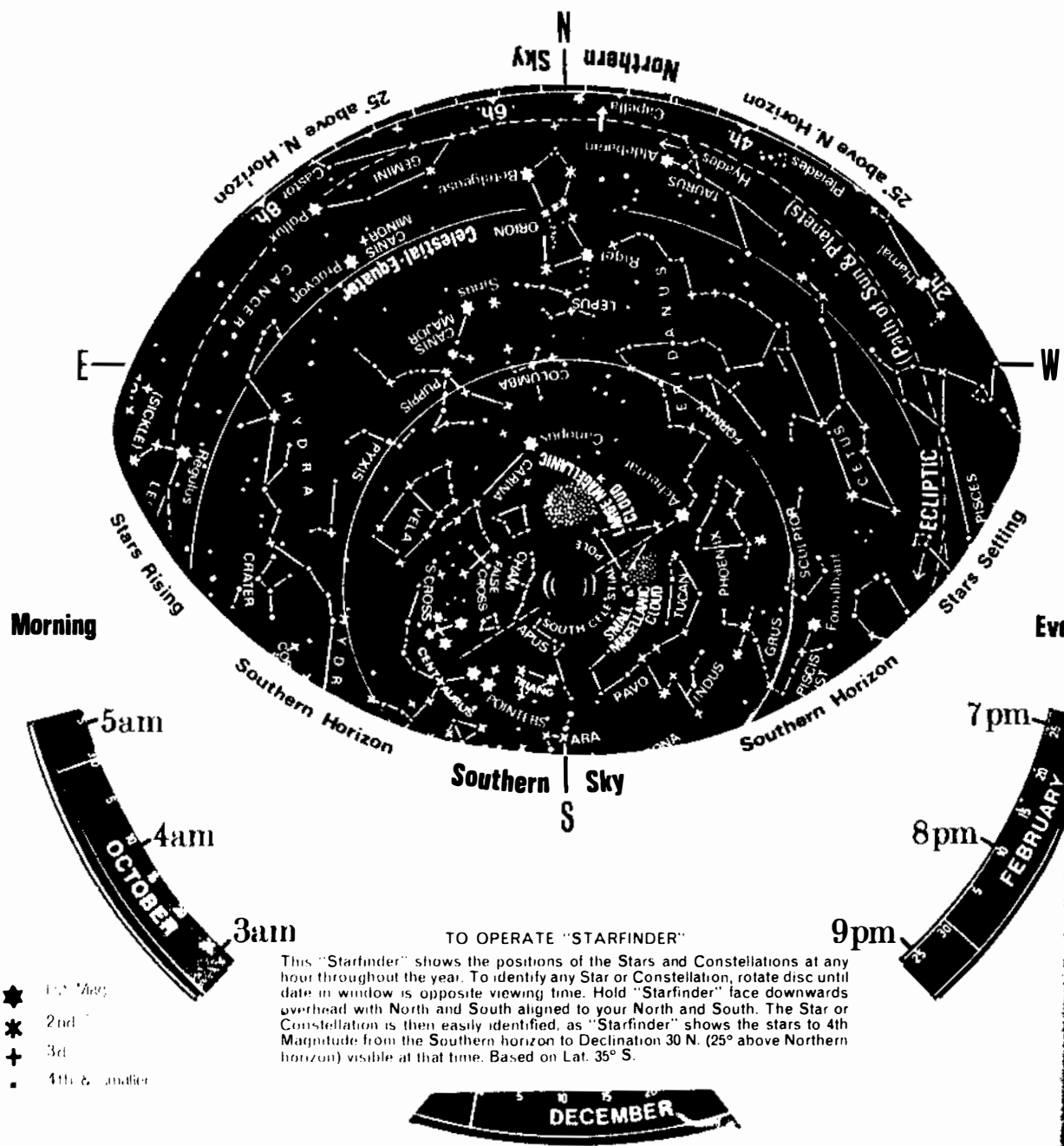
By setting the polar axis of the telescope to the observing latitude on the Earth's surface then the polar axis of the telescope is parallel to the Earth's axis, and hence points to the South Celestial Pole. The latitude of Perth is $31^{\circ}57'$. Thus to compensate for the Earth's rotation during an evening of star viewing, after setting the Declination to that of the star it may be tracked on Right Ascension. The advantage of this type of telescope mounting is that the telescope rotates on one axis only.



PLANISPHERE

A planisphere is a simple device which will allow teachers and students to become familiar with the constellations and stars in the southern sky. It consists of a rotating celestial disc which indicates the relative positions of celestial objects according to the day of the month and the time of the evening.

A variety of planispheres are available. The "Starfinder" planisphere can be obtained from the W.A. Museum at \$1.95 each (1981 price).



Courtesy of Mr. R.L. Sangster, Astronomical Association of South Australia.



ASTRONOMICAL DATA BOOK

The Astronomical Data Book compiled and printed by the Perth Observatory is an invaluable information source for teachers of astronomy. This book has been prepared for local astronomical sites. Generally, such information is difficult to obtain. However, the Perth Observatory have gathered together much astronomical data of local interest.

A sample of some of the contents:

- . Visibility of the Planets
- . Time
The Sun
- . Sunrise and Sunset
- . Moonrise and Moonset
Apsides
- . The Moon Phases
Latitudes and Longitudes of W.A. Towns
- . Latitudes and Longitudes of W.A. Towns (cont.)
Eclipses
- . The Planets and their Satellites
- . The Individual Planets
- . Comets
- . Lunar occultations
- . Variable stars
- . Major Southern Meteor Showers
- . Some Bright Variable Stars
- . Some Bright Double Stars
- . Nonstellar Astronomical Objects
- . Paths of Uranus and Neptune
- . Paths of Mars, Jupiter, and Saturn

A SAMPLE PAGE FROM THE ASTRONOMICAL DATA BOOK

JUPITER 1981

		RA	DEC	MAG	DIAM	DIST	ELONG	LONG	120E	PERTH
		h m	o			AU	o	LAT	25S	W.A.S.T.
								RISE	SET	RISE SET
								h m	h m	h m h m
JAN	1	12 36.9	-2 33	-1.6	36.9	5.342	W 91	23 45	11 58*	0 3 12 20
	11	12 39.2	-2 45	-1.6	38.0	5.182	W 101	23 7	11 21*	23 6 11 23*
	21	12 40.3	-2 49	-1.7	39.2	5.027	W 111	22 29	10 43*	22 27 10 45*
	31	12 40.3	-2 46	-1.8	40.3	4.881	W 121	21 50	10 3*	21 48 10 5*
FEB	10	12 39.0	-2 36	-1.8	41.5	4.750	W 131	21 9	9 22*	21 8 9 24*
	20	12 36.7	-2 18	-1.9	42.5	4.638	W 142	20 28	8 40*	20 27 8 41*
MAR	2	12 33.4	-1 55	-2.0	43.3	4.550	W 153	19 46	7 56*	19 45 7 58*
	12	12 29.4	-1 27	-2.0	43.9	4.489	W 164	19 4	7 12*	19 3 7 13*
	22	12 24.8	-0 57	-2.0	44.2	4.457	W 176	18 21	6 27*	18 20 6 28*
APR	1	12 20.1	-0 26	-2.0	44.2	4.456	E 173	17 38	5 42*	17 54 5 59*
	11	12 15.5	0 3	-2.0	43.9	4.485	E 163	16 55	4 57*	17 11 5 14*
	21	12 11.4	0 28	-1.9	43.3	4.544	E 152	16 12	4 13*	16 29 4 30*
MAY	1	12 8.1	0 48	-1.9	42.5	4.629	E 141	15 30	3 30*	15 47 3 46*
	11	12 5.6	1 2	-1.8	41.6	4.736	E 131	14 49	2 48*	15 6 3 4*
	21	12 4.2	1 8	-1.8	40.5	4.862	E 121	14 9	2 7*	14 26 2 23*
	31	12 3.9	1 7	-1.7	39.4	5.002	E 111	13 29	1 28*	13 46 1 44*
JUN	10	12 4.7	1 0	-1.7	38.2	5.151	E 102	12 50	0 50*	13 7 1 6*
	20	12 6.6	0 45	-1.6	37.1	5.306	E 92	12 12	0 13*	12 29 0 29*
	30	12 9.4	0 24	-1.5	36.1	5.461	E 84	11 35	23 37	11 52 23 54
JUL	10	12 13.2	-0 3	-1.5	35.1	5.615	E 75	10 59	23 2	11 15 23 19
	20	12 17.8	-0 35	-1.4	34.2	5.762	E 67	10 23	22 29	10 39 22 46
	30	12 23.0	-1 11	-1.4	33.4	5.901	E 59	9 48	21 56	10 4 22 13
AUG	9	12 28.9	-1 51	-1.3	32.7	6.028	E 51	9 13	21 24	9 29 21 42
	19	12 35.4	-2 34	-1.3	32.1	6.142	E 43	8 39	20 52	8 54 21 11
	29	12 42.3	-3 19	-1.3	31.6	6.240	E 36	8 5	20 21	8 20 20 40
SEP	8	12 49.6	-4 6	-1.2	31.2	6.321	E 28	7 32	19 51	7 46 20 10
	18	12 57.2	-4 55	-1.2	30.8	6.383	E 20	6 59	19 21	7 12 19 40
	28	13 5.0	-5 44	-1.2	30.6	6.425	E 12	6 25	18 51	6 38 19 11
OCT	8	13 13.0	-6 34	-1.2	30.5	6.447	E 5	5 53	18 21	6 5 18 42
	18	13 21.1	-7 23	-1.2	30.6	6.447	W 3	5 20	17 51	5 31 18 13
	28	13 29.3	-8 11	-1.2	30.7	6.425	W 11	4 47	17 21	4 58 17 43
NOV	7	13 37.3	-8 57	-1.2	30.9	6.383	W 19	4 14	16 52	4 25 17 14
	17	13 45.2	-9 42	-1.3	31.2	6.319	W 27	3 41	16 22	3 51 16 44
	27	13 52.9	-10 24	-1.3	31.6	6.236	W 35	3 8	15 51	3 18 16 15
DEC	7	14 0.2	-11 3	-1.3	32.1	6.133	W 43	2 35	15 20	2 44 15 44
	17	14 7.1	-11 39	-1.4	32.7	6.014	W 51	2 1	14 49	2 10 15 13
	27	14 13.5	-12 11	-1.4	33.5	5.880	W 60	1 27	14 17	1 36 14 42

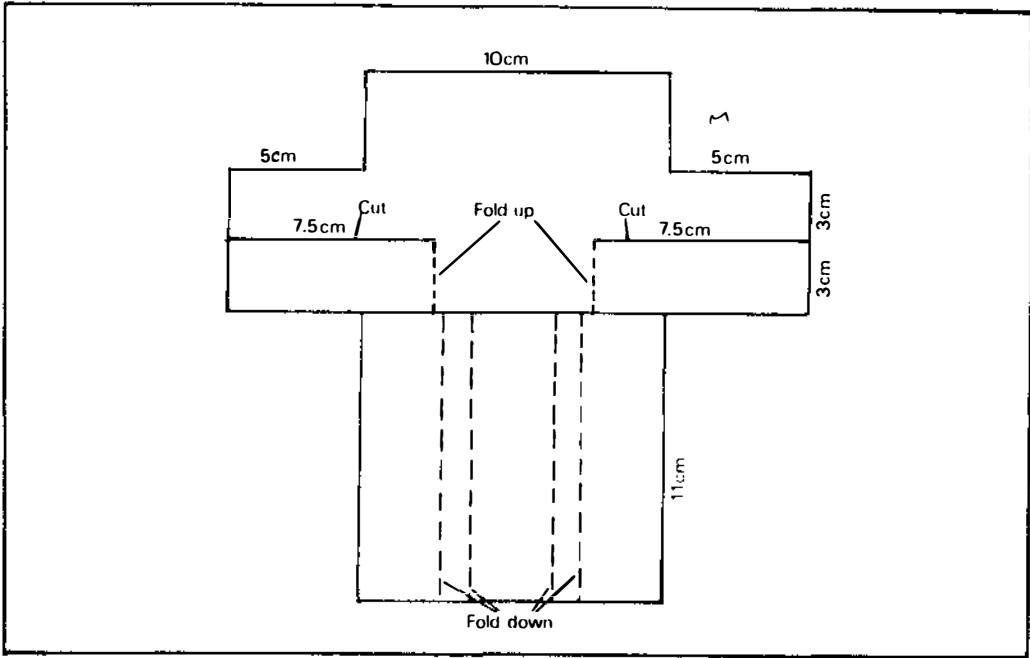
* INDICATES PLANET SETS ON FOLLOWING DAY

STATIONARY	JAN 25 18 ^{d h}	MAY 28 17 ^{d h}
OPPOSITION	MAR 26 14 ^{d h}	
CONJUNCTION	OCT 14 13 ^{d h}	

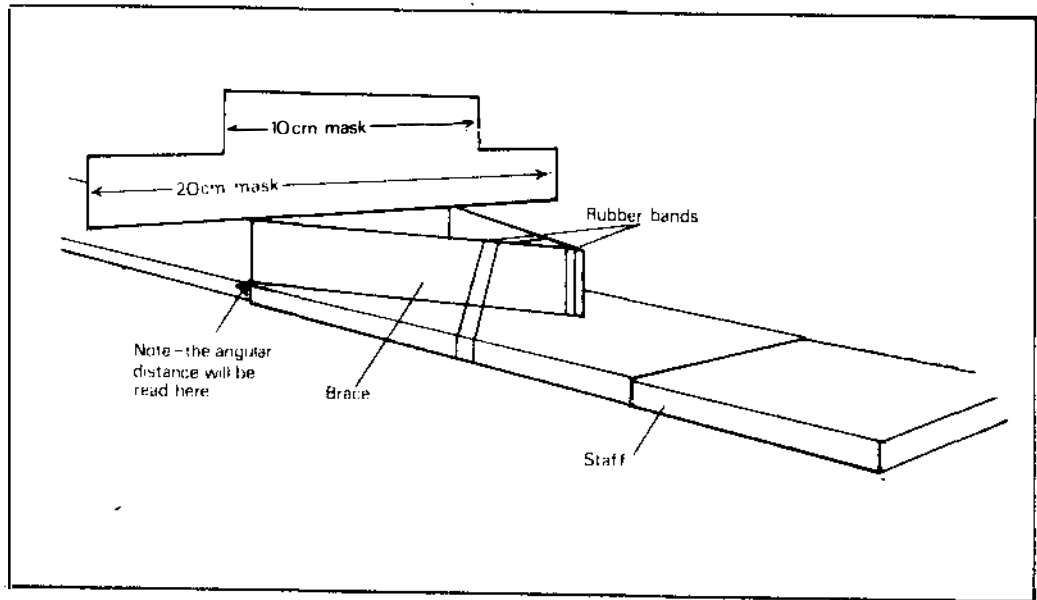


ANGLE MEASURERS

(a) CROSS-STAFF



Using the dimensions and shape indicated, cut and fold the stiff cardboard. This will form the masks of the cross-staff. The metrestick which forms the staff must be calibrated. To do this, write "eye" on one end of the staff. From this base, measure off the distance indicated in the chart. Place a mark at each of these distances, and write the corresponding angle on the staff. Note that two scales must be placed on the staff - one scale for using the 20 cm mask to measure large distances between objects, and another scale for using the 10 cm mask to measure smaller distances. Finally, the masks should be placed on the staff so that they will slide with pressure but will not slip out of place.



To use the cross-staff, place the eye end of the staff on one cheekbone and slide the masks back and forth until one of them exactly covers the space between two sky objects. Using the scale on the staff designated for that mask, you can read off the angular distance between the two objects.

20 cm Transversal

Distance Angle
from (degrees)
eye end
(cm)

14.3 70
15.7 65
17.3 60
19.2 55
21.4 50
22.5 48
23.6 46
24.8 44
26.0 42
27.5 40
29.0 38
30.8 36
32.7 34
34.9 32
37.3 30
38.7 29
40.1 28
41.6 27
43.3 26
45.1 25
47.0 24
49.2 23
51.4 22
54.0 21
56.7 20
58.2 19.5
59.8 19.0
61.4 18.5
62.1 18.0
65.0 17.5
66.9 17.0
69.0 16.5
71.2 16.0
73.5 15.5
76.0 15.0
78.6 14.5
81.4 14.0
84.5 13.5
87.8 13.0
91.3 12.5

10 cm Transversal

Distance Angle
from (degrees)
eye end
(cm)

35.6 16.0
36.7 15.5
38.0 15.0
39.3 14.5
40.7 14.0
42.2 13.5
43.9 13.0
45.7 12.5
47.6 12.0
49.7 11.5
51.9 11.0
54.4 10.5
57.2 10.0
60.2 9.5

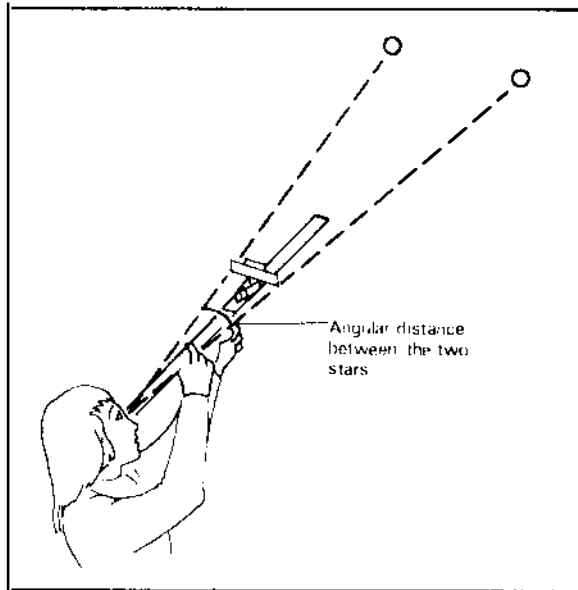




Table contd

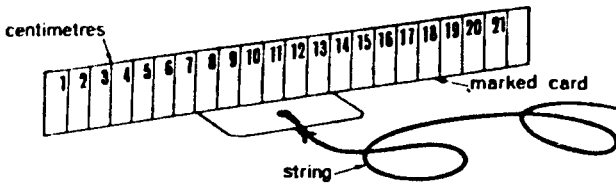
<u>10 cm Transversal</u>	
Distance eye end (cm)	Angle
63.5	9.0
67.3	8.5
71.5	8.0
76.3	7.5
81.8	7.0
88.1	6.5
95.4	6.0



AN ANGLE MEASURER

(P10, Astronomy Student worksheets, Education Department of W.A.)

An angle measurer is a useful device in the study of Astronomy. You will need an angle measurer in several of the experiments which follow.



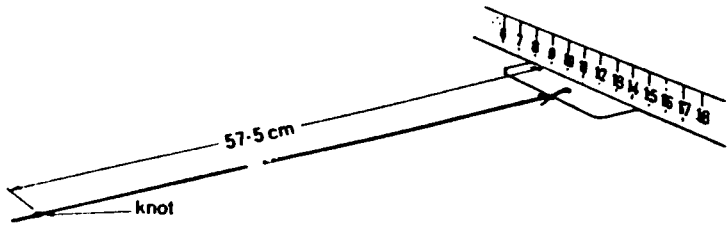
Cut out the ruled strip on the opposite page. Glue this on to a piece of cardboard so that it has a firm backing.

Make a hole at the point indicated on the card.

Tie the string through the hole.

Turn up tab on card and measure a distance of 57.5 cm along the string from the card. (Include depth of tab in this measurement.)

Make a knot in the string at this point.



Now you are ready to use your angle measurer.

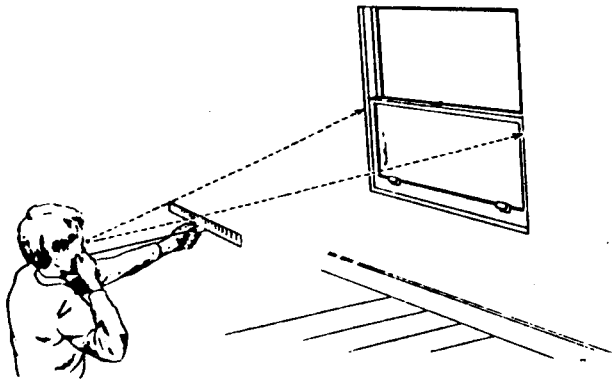
USE IT TO FIND THE ANGULAR WIDTH OF A WINDOW (OR DOOR, IF YOU PREFER).

This is what you do -

- With one hand, hold the knot of the string up to your cheek.
- With the other hand, hold the ruler so that the string is extended its full distance.
- Now move the measurer in line with the window and count the number of marks which fit across the window.
- The number of degrees in the angular width of the window is the SAME as the number of marks, e.g. 13 marks = 13 degrees.

Write your measurement here:

The angular width of the window = _____ degrees.

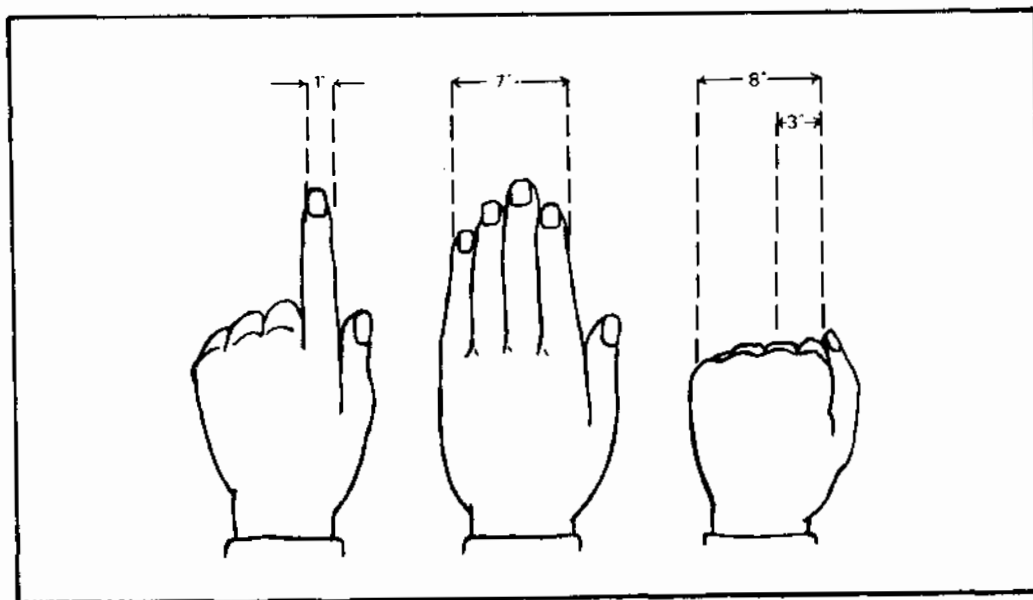




ESTIMATED ANGULAR DISTANCES BY HANDSPANS

The task of finding particular stars in the sky can be facilitated by using handspans for estimating angular distances between stars.

An average handspan extends about 20° , but the handspan of many people differs from this. Smaller angular distances can be estimated by using parts of a handspan, as shown in the diagram below.



Here are some angular distances between prominent southern sky stars.

	Degrees
Alpha Centauri to Beta Centauri	4.5
Alpha Crucis to Beta Crucis	6.0
Alpha Crucis to Beta Centauri	11.8
Alpha Crucis to Alpha Centauri	15.7
Canopus to Achernar	39.4
Canopus to Alpha Centauri	58.0
Alpha Crucis to Achernar	58.9

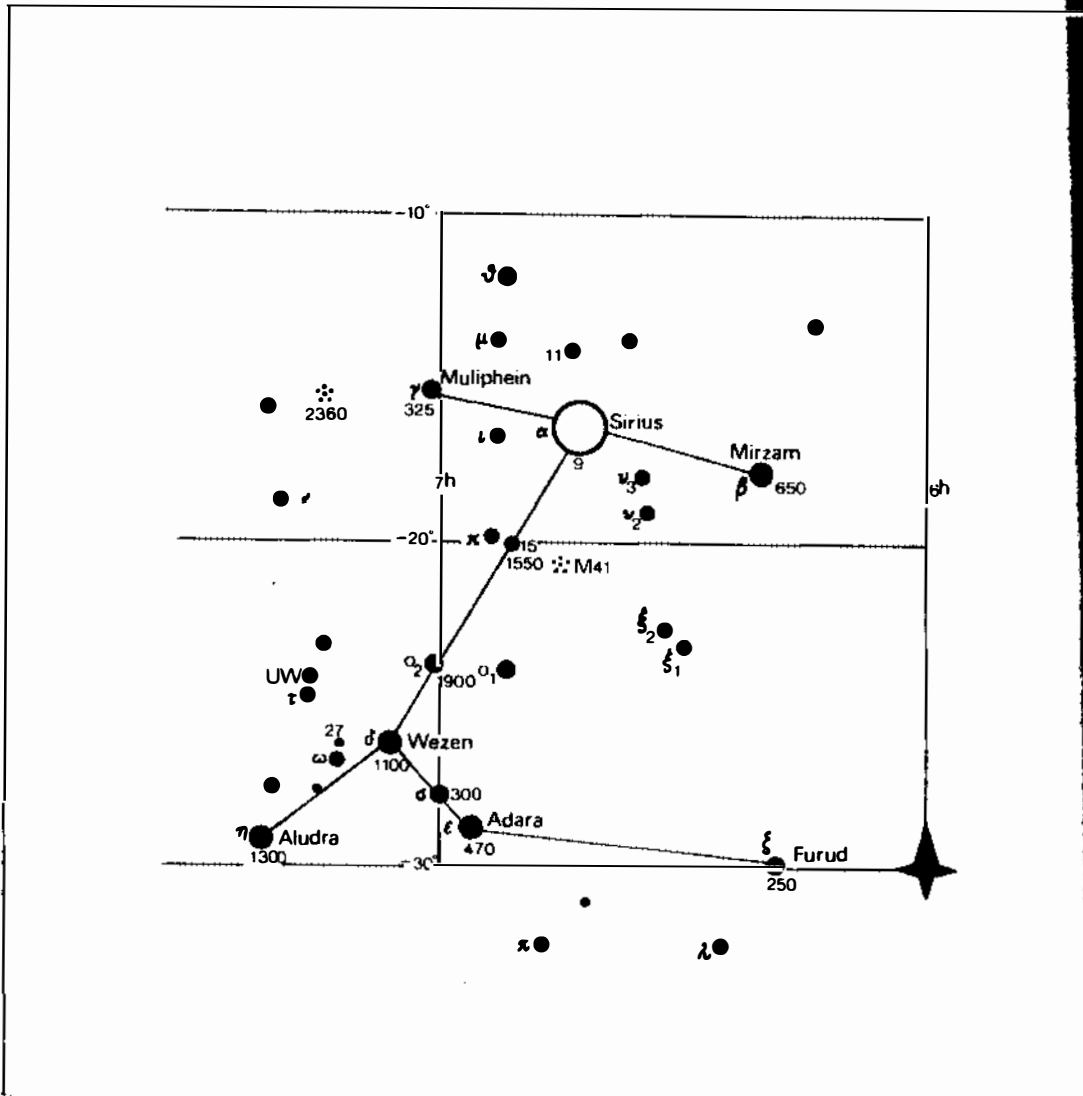
contd



	Degrees
Castor to Pollux	4.5
Betelgeuse to Rigel	18.6
Betelgeuse to Aldebaran	21.4
Rigel to Sirius	23.7
Betelgeuse to Procyon	26.0
Spica to Arcturus	32.8
Altair to Deneb	38.0
Spica to Antares	45.9
Altair to Fomalhaut	59.2

CANIS MAJOR

The Greater Dog

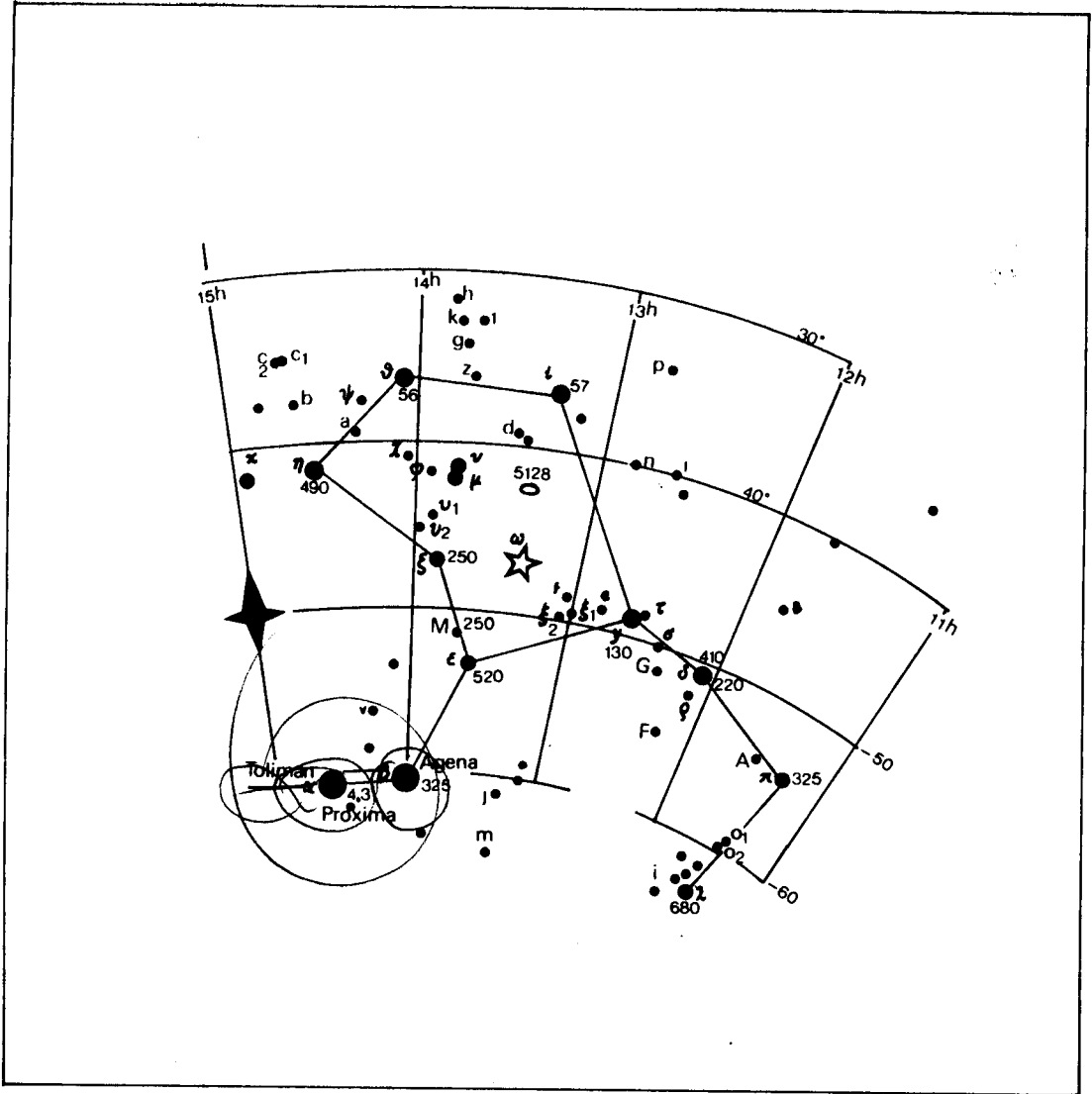


CELESTIAL OBJECT	FEATURES
α Canis Majoris (Sirius)	A large hot bright star at a distance of 9 L.Y. Brightest star in the sky.
β Canis Majoris (Mirzam)	Brighter than Sirius, but at a distance of 650 L.Y.
γ Canis Majoris (Muliphein)	A main sequence star at a distance of 325 L.Y.
δ Canis Majoris (Wezen)	An extremely bright star at a distance of 1100 L.Y.
ϵ Canis Majoris (Adara)	Red super giant star at a distance of 470 L.Y.



URUS (CENTAURI)

The Centaur

**CELESTIAL OBJECT**

FEATURES

Toliman (α Centauri)
Proxima Centauri

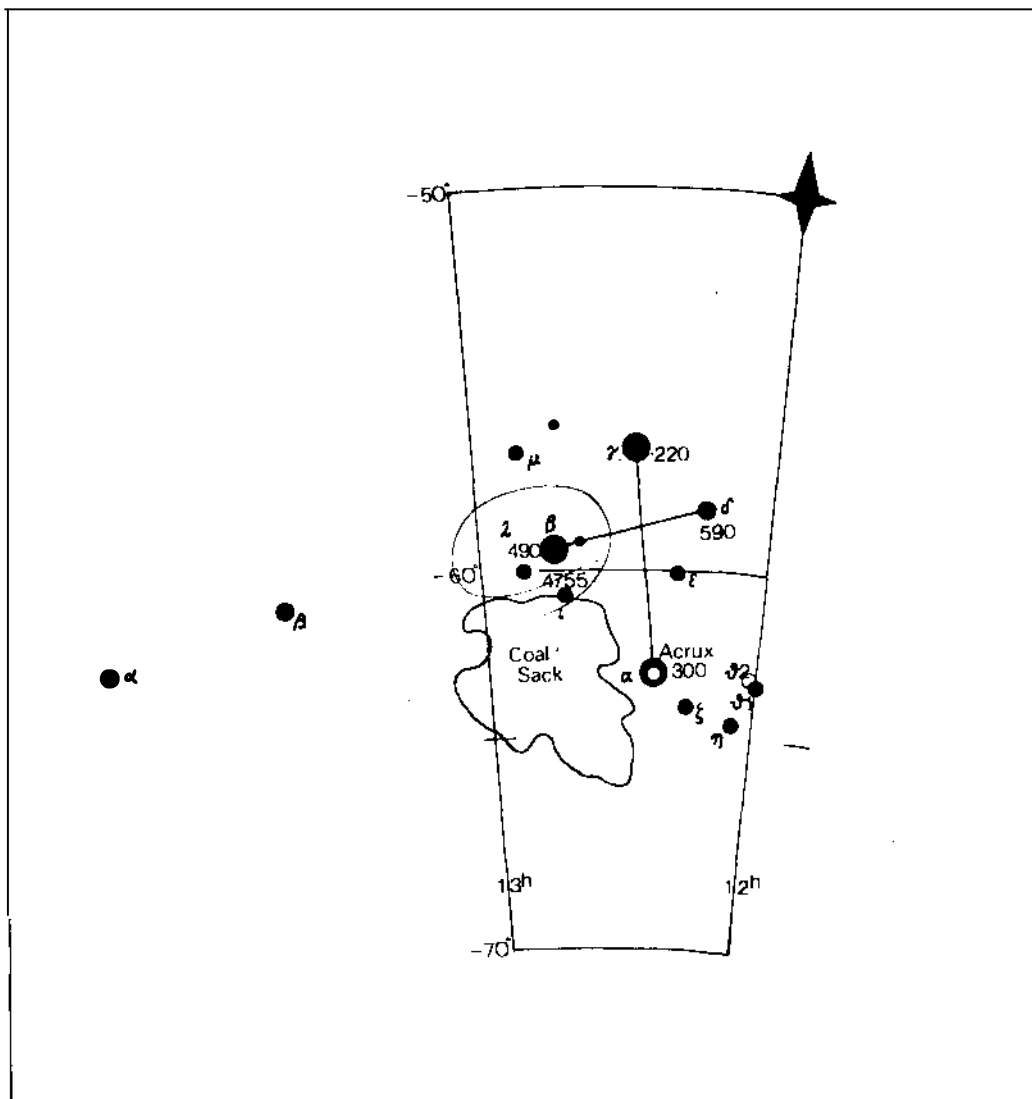
Double star
Red dwarf associated with α Centauri
4.3 LY from Earth, but not visible
to naked eye.

Agena (β Centauri)
w Centauri

Main sequence giant
Giant globular cluster visible to
the unaided eye.
Distance of 5000 parsecs.

CRUX (SOUTHERN CROSS)

The Cross



CELESTIAL OBJECT

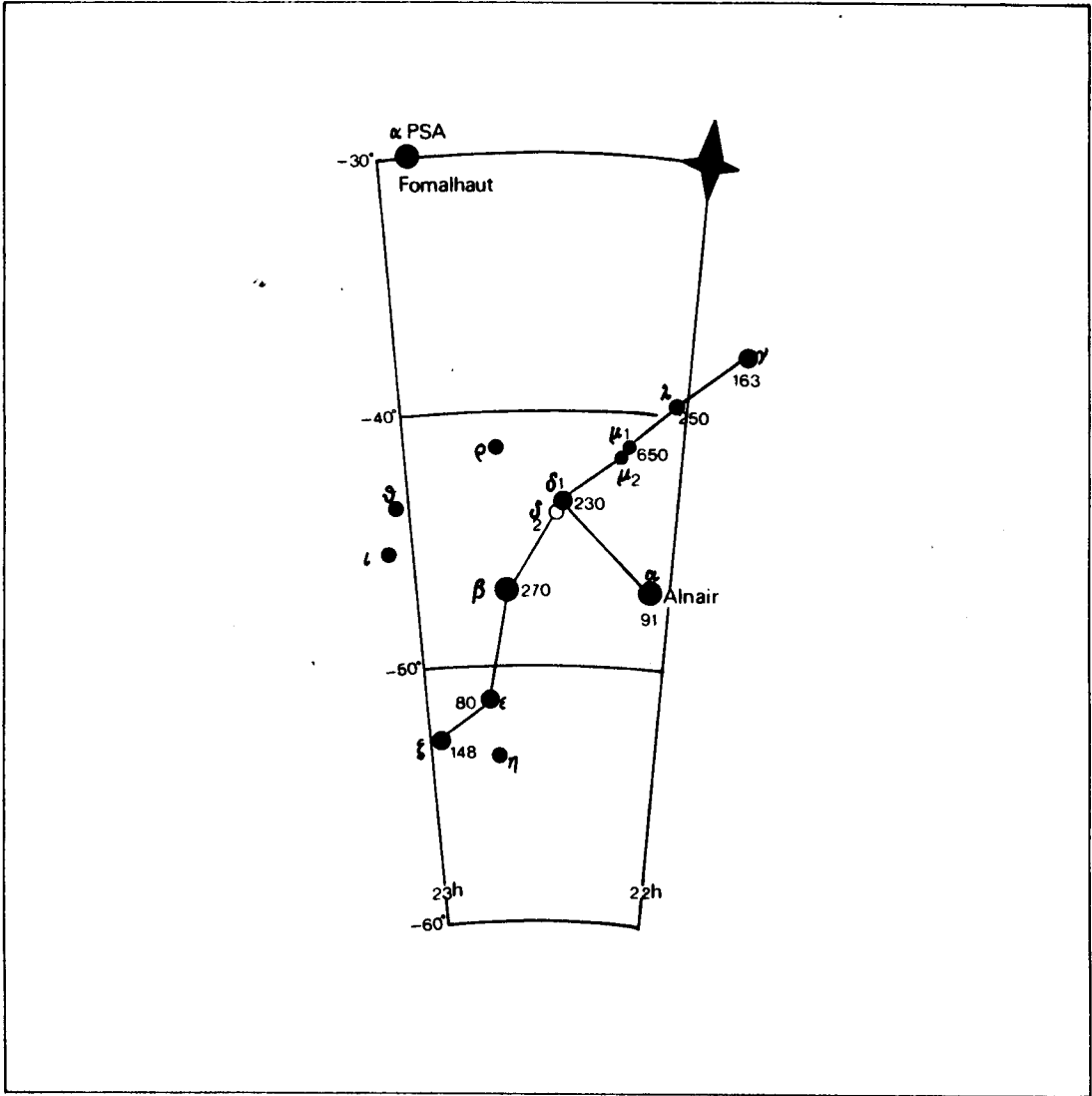
FEATURES

α	Crux	Double main sequence stars (blue)
β	Crux	Main sequence star (blue)
γ	Crux	Red giant (red)
δ	Crux	Main sequence star (blue)
ε	Crux	Main sequence star (orange)
Coal Sack		Dark nebula
Jewell Casket		Star cluster



GRUS

The Crane



CELESTIAL OBJECT

FEATURES

Grus (Alnair)

A white main sequence star at a distance of 91 L.Y.

Grus

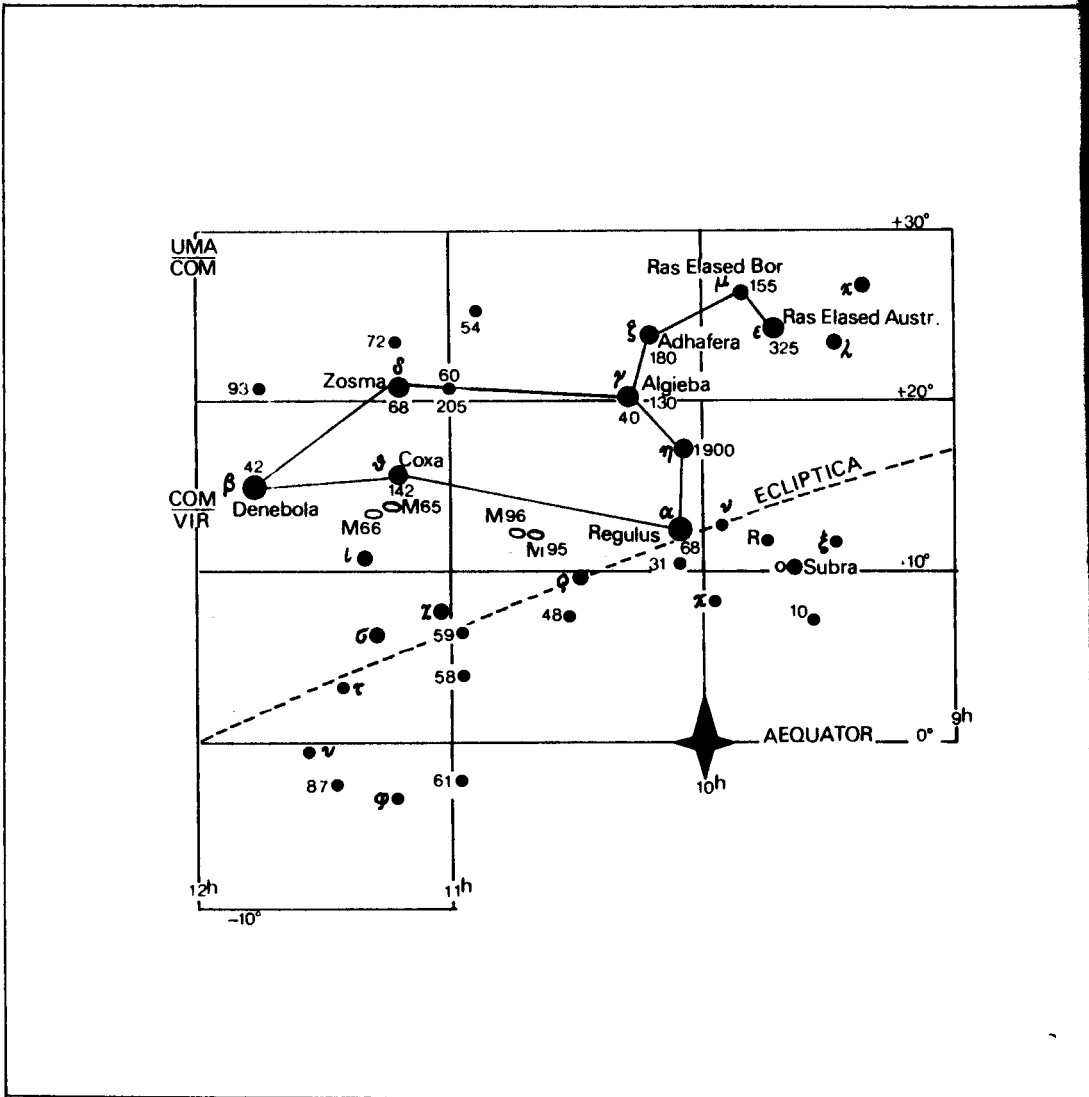
A red cool surfaced star at a distance of 270 L.Y.

Grus

A helium burning star at a distance of 163 L.Y.

LEO

The Lion



CELESTIAL OBJECT

FEATURES

 α Leonis (Regulus)

A helium star of surface temperature 20,000K which lies directly on the ecliptic, and at a distance of 68 L.Y.

 β Leonis (Denebola)

A hot hydrogen burning star at a distance of 42 L.Y.

 γ Leonis (Algieba)

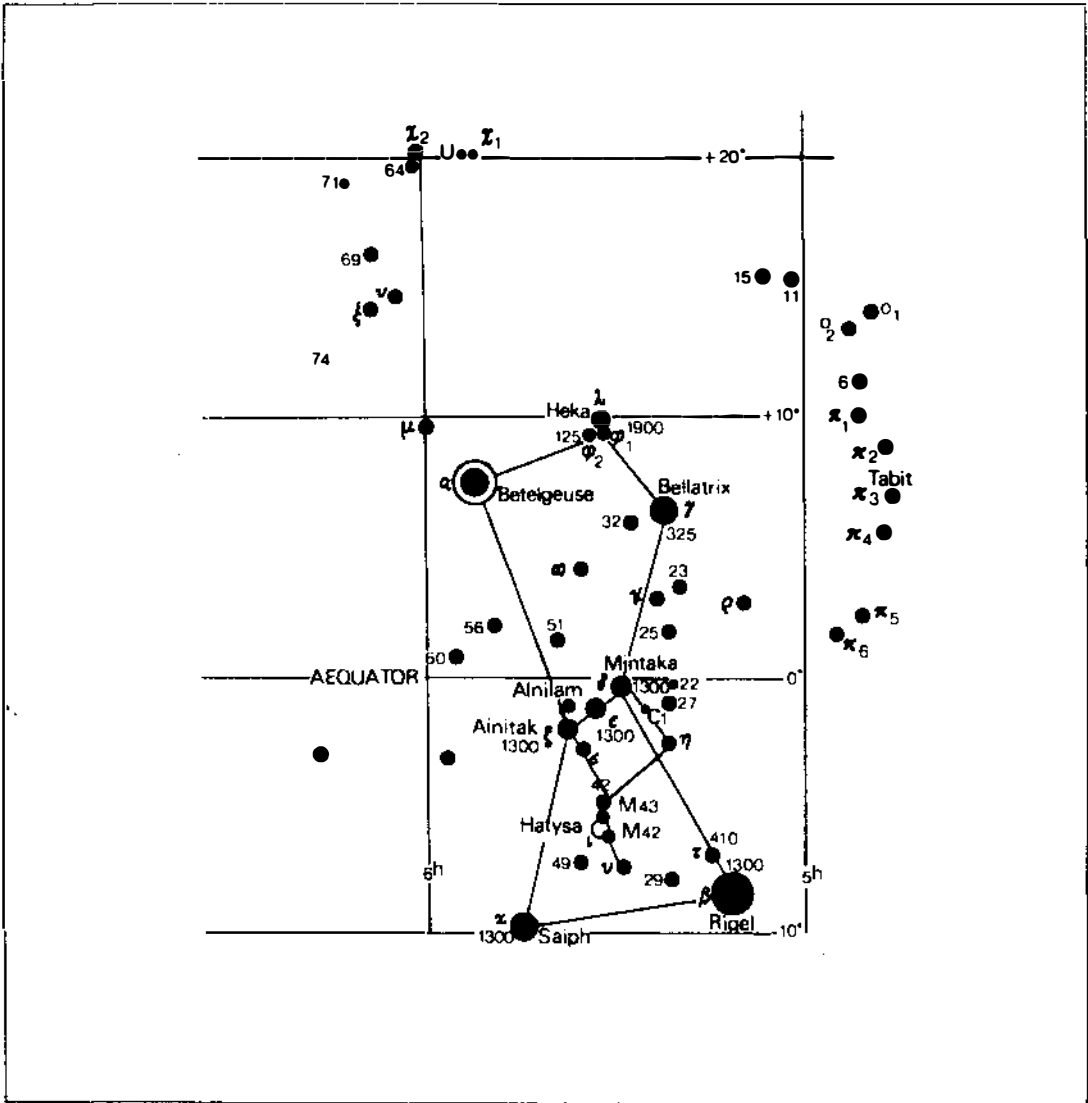
A double system of giant stars, one orange and the other yellow. The system is 130 L.Y. distant.

Leo contains several bright nebulae : M65, M66, M95 and M96, which lie outside our Galaxy.



Betelgeuse
to Rigel

16° 5'



CELESTIAL OBJECT

Orion Nebula (M42)

Rigel

Betelgeuse

Bellatrix

Mintaka

Saiph

FEATURES

Stellar birthplace

Five main sequence stars in complex systems

Red giant variable star (red)

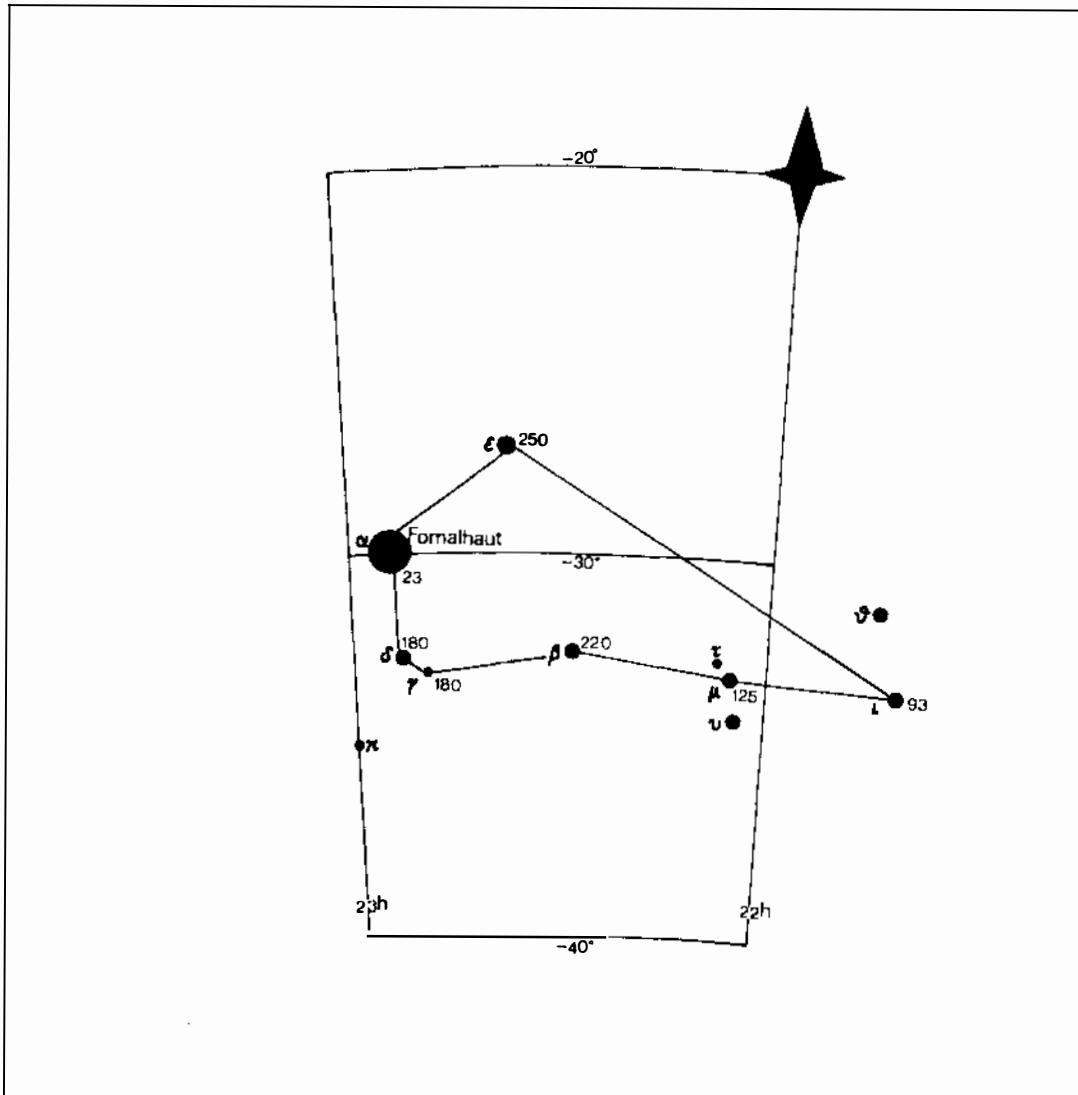
Super giant (blue)

Multiple star system of 5 stars with
a common centre

Super giant

PISCIS AUSTRALIS

The Southern Fish



CELESTIAL OBJECT

FEATURES

α Piscis Austrini (Fomalhaut)

A hot surface main sequence star at a distance of 23 L.Y.

β Piscis Austrini

Also a hydrogen star at a distance of 220 L.Y.

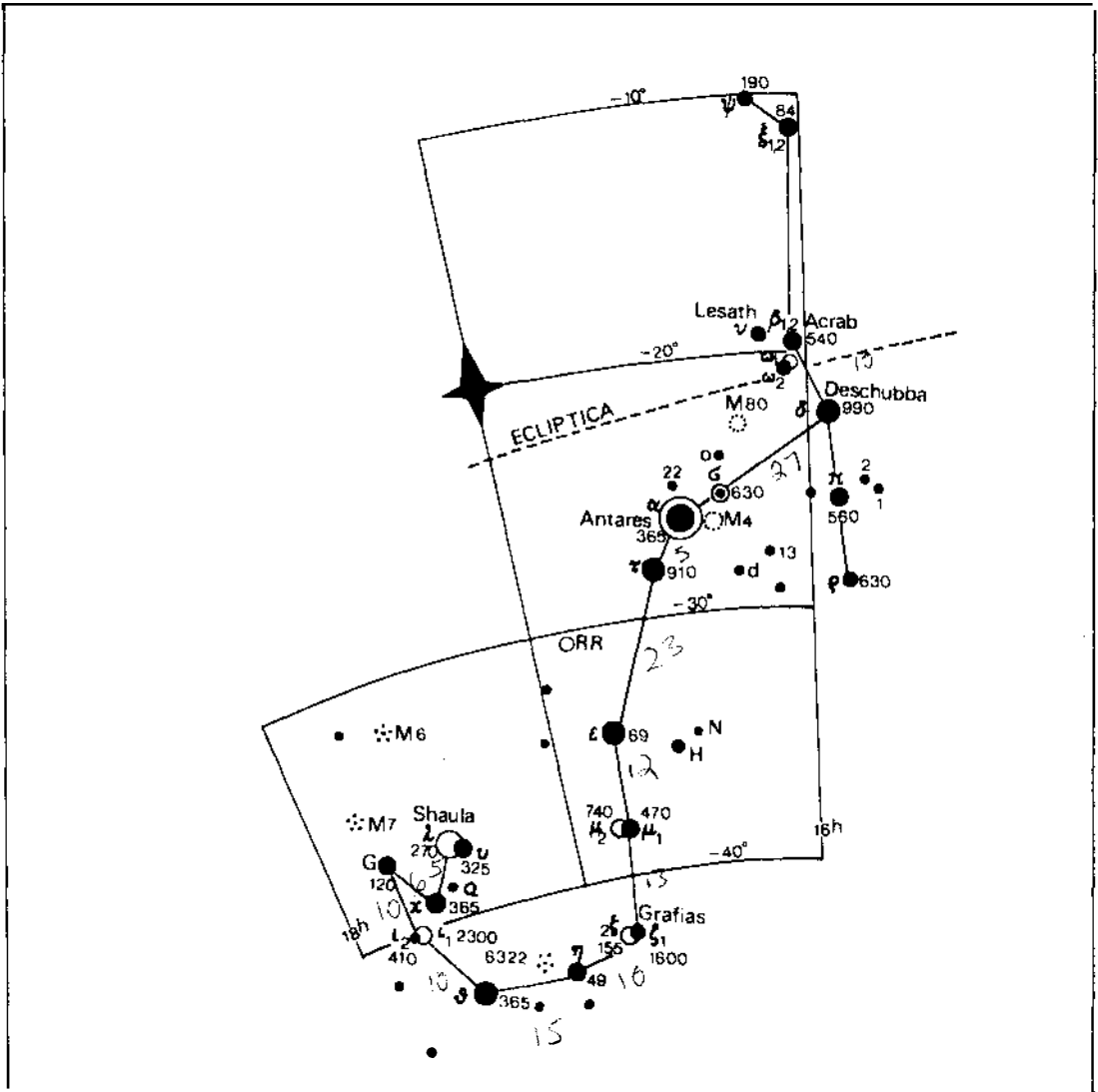
γ Piscis Austrini

A red giant star at 180 L.Y. from Earth.



SCORPIUS (SCORPII)

The Scorpion



CELESTIAL OBJECT

FEATURES

Scorpii (Antares)

Red super giant with a diameter 300 times that of the Sun.

Scorpii (Acrab)

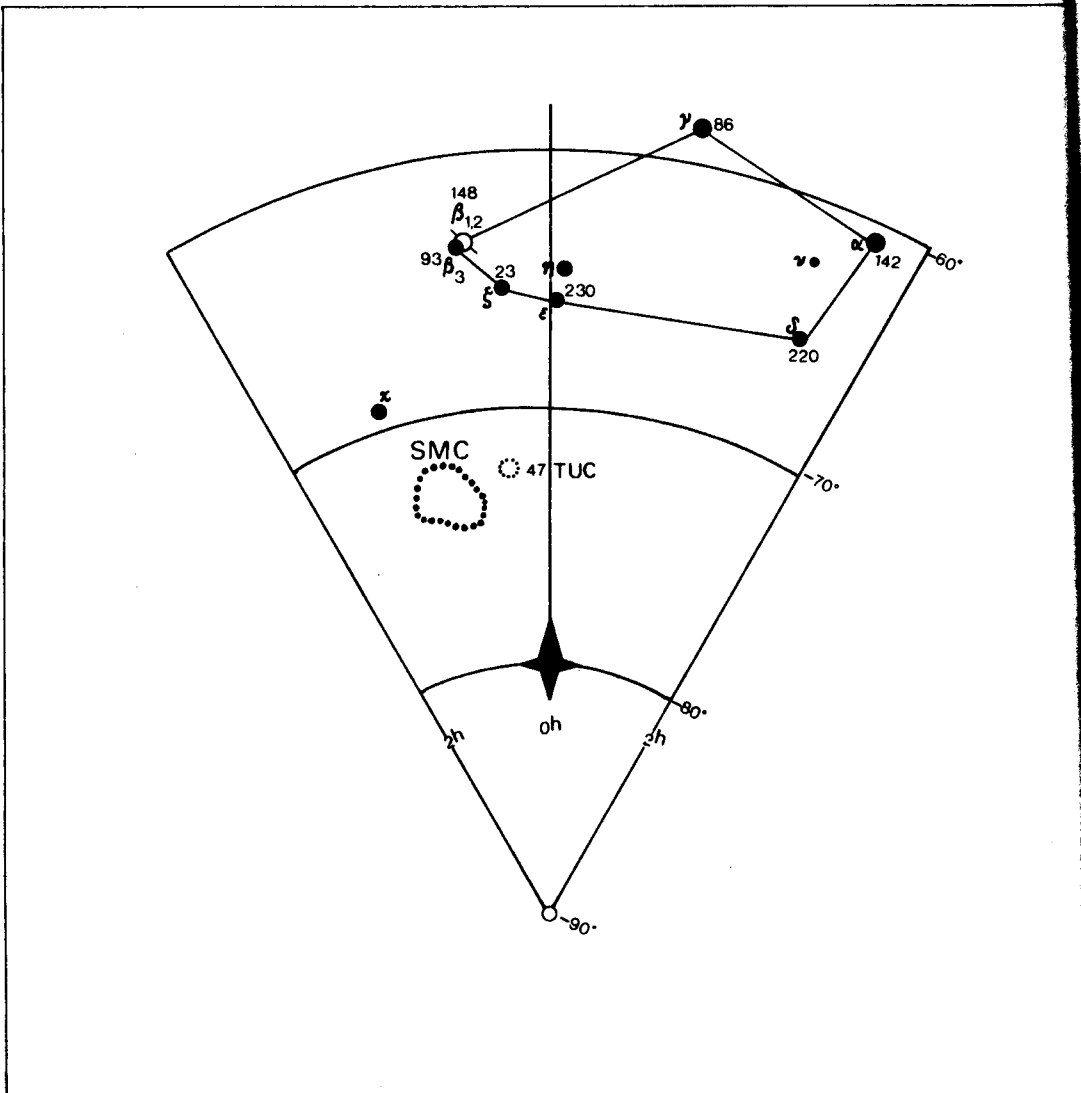
Double stars of hot surface temperature.

Scorpii (Dschubba)

Sub giant.

Scorpii (Shaula)

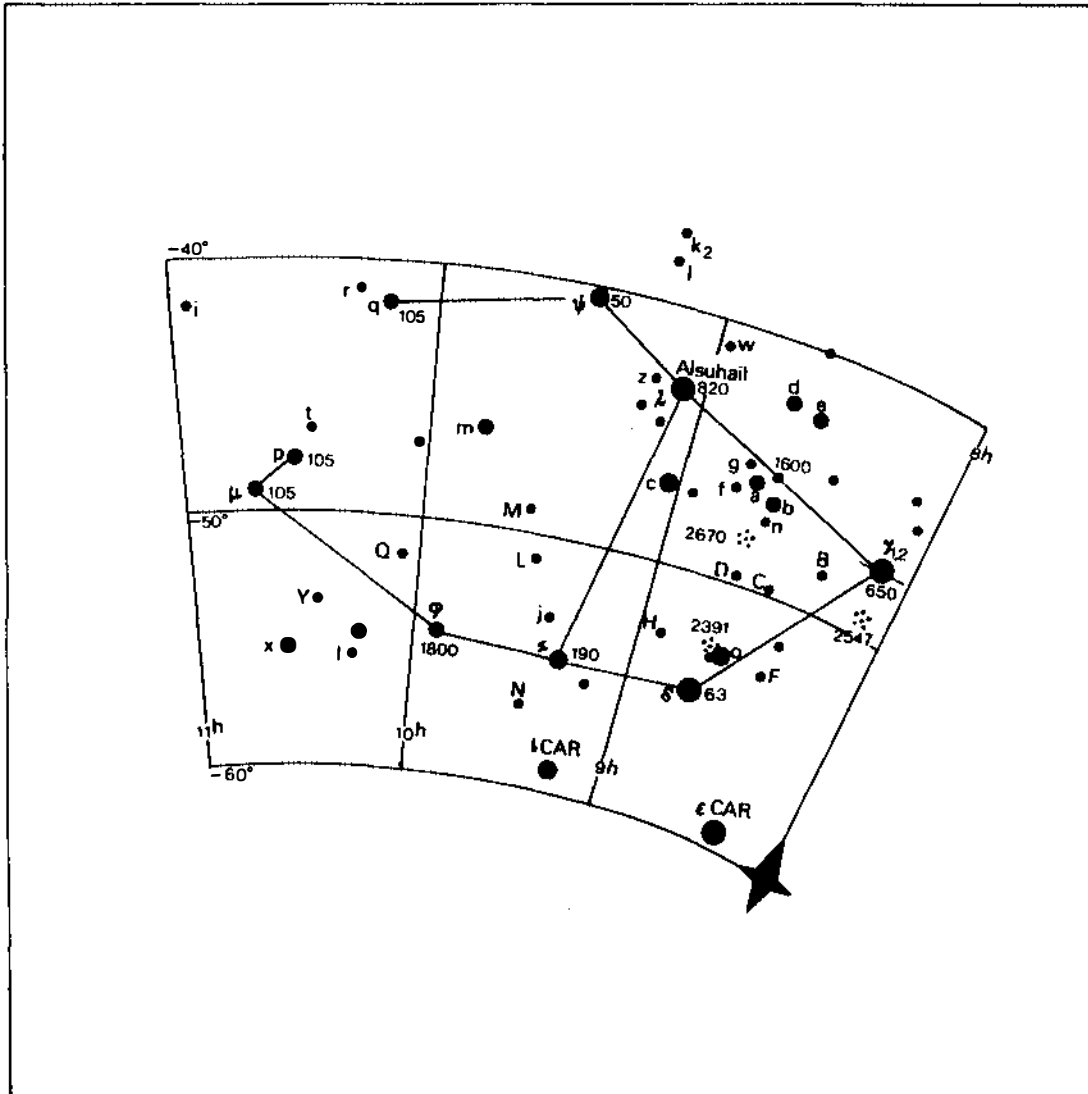
A hot distant star with a small companion of period 5.6 days.



CELESTIAL OBJECT	FEATURES
α Tucanae	A cool main sequence star at a distance of 142 L.Y.
β Tucanae	A binary system, with each component having a surface temperature of 20,000K and at a distance of 148 L.Y.
47 Tucanae	A globular cluster containing in excess of one million stars.
S M C	Small Magellanic Cloud is an irregular galaxy thought to be a companion of our Galaxy.



The Sail



CELESTIAL OBJECT

FEATURES

Velorum

A group of four stars, two of which are seen as a double star. These stars are white hot surfaced stars.

Velorum

A hydrogen star at a distance of 63 L.Y..

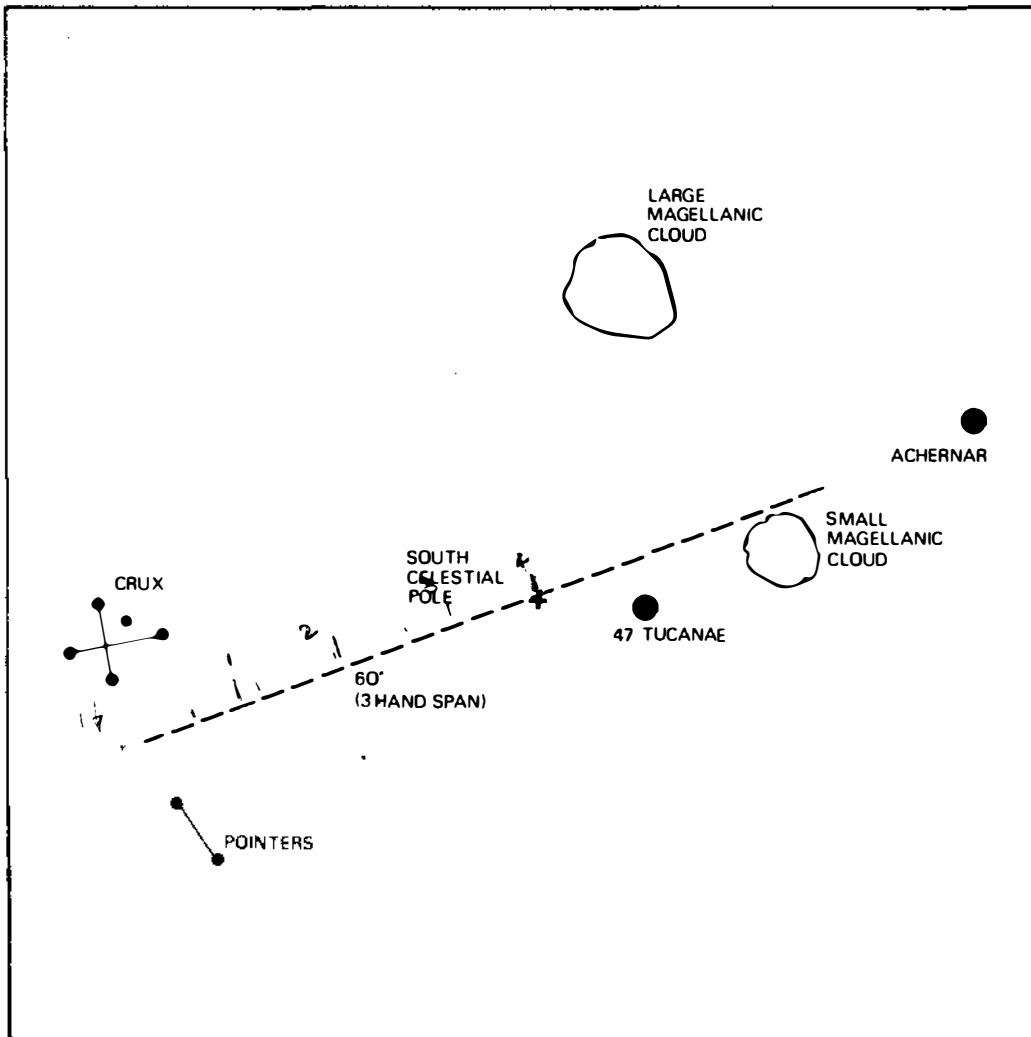
Velorum (Alsuhaill)

Red super-giant at a distance of 820 L.Y.

Velorum

Very similar to our Sun, and at a distance of 105 L.Y.

SOUTH CELESTIAL POLE REGION



CELESTIAL OBJECT

FEATURES

Large Magellanic Cloud
and Small Magellanic
Cloud.

Irregular galaxies in the Local Group
of galaxies.

47 Tucanae

Globular cluster



OBSERVATIONAL ACTIVITIES

Teachers of lower school science may engage in the following activities to become familiar with the observations of celestial objects. This will allow teachers to design suitable worksheets for high school students at the appropriate levels of difficulty.

1. Visual identification of major constellations as indicated in this manual, or from the planisphere.

For example:

- Crux
- Orion
- Centaurus
- Vela
- Canis Major
- Leo

2. Visual identification of prominent stars.

For example:

- A Crux
- α Centauri
- Achernar
- Canopus
- Sirius
- Rigel
- Betelgeuse
- Regulus
- Fomalhaut

3. Visual and magnified identification of celestial objects.

For example:

- Hyades
- Pleiades
- Jewel Casket
- Coal Sack
- Large Magellanic Cloud
- Small Magellanic Cloud
- α Centauri binary system
- 47 Tucanae

4. Measurement of stellar properties.

Angular distance between sets of prominent stars. Altitude (elevation) of stars above observer's horizon. Colour of stars as observed through binoculars.



STAR MAPS AND DATA BOOKS

1. Astronomical Data Book Perth Observatory, W.A.
Available from Perth Observatory for \$1-50 with 45¢ mailing.
2. Becvar, A 1962. Atlas of the Heavens
Czechoslovak Academy of Sciences, Praha.
3. Becvar, A 1964. Atlas of the Heavens II
Czechoslovak Academy of Sciences, Praha.
4. Norton, A.P. 1978. Norton's Star Atlas and Reference Handbook. 17th ed. Gall and Inglis, Edinburgh.
5. Starfinder. Available from W.A. Museum for \$1.80.
6. Tancock, E.O. (ed) 1961. Philips' Chart of the Stars.
George Philip and Son. London.



REFERENCE BOOKS

These books may provide suitable reference materials on stars and telescopes for both teachers and students. However it should be realised that it is not an inclusive list, as many other similar quality books are available.

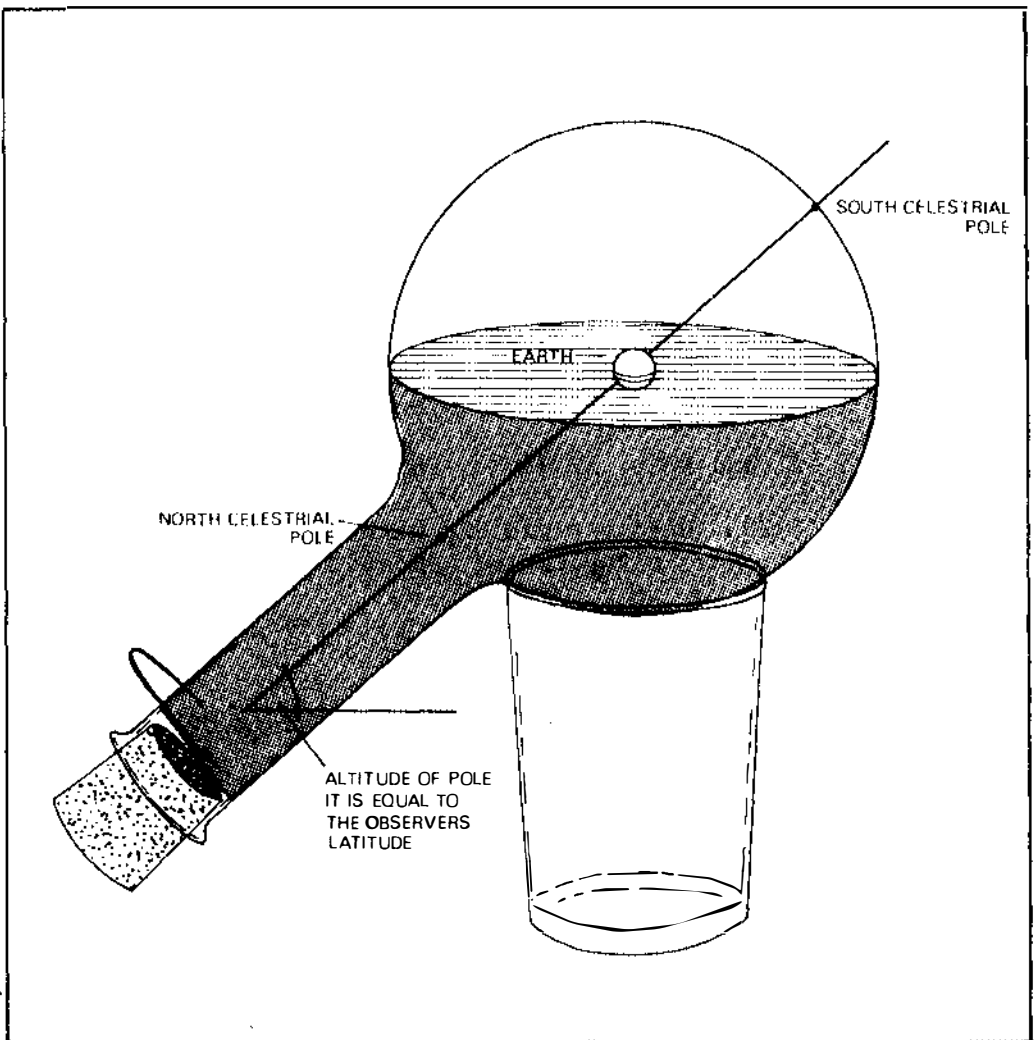
- BARLOW, B.V. 1975. The Astronomical Telescope.
Wykeham Science Series. Wykeham Pub. London.
- BEET, E.A. 1962. Teaching Astronomy in Schools. Cambridge University Press. Cambridge.
- BICKEL, L. 1975. The Southern Universe. Macmillan. London.
- GRIBBIN, J. 1976. Astronomy for the Amateur. Macmillan. London.
- HARTUNG, E.J. 1968. Astronomical Objects. Cambridge University Press. Cambridge.
- KLEPESTA, J. and RUHL, A. 1969. Constellations. Hamlyn. London.
- KNOX, R. 1976. Discover the Sky with Telescope and Camera.
R. Morgan Publishing. Kent.
- MENZEL, D.H. 1964. A Field Guide to the Stars and Planets.
Collins. London.
- MITTON, S. 1977. The Cambridge Encyclopaedia of Astronomy.
Jonathon Cape. London.
- MOORE, P. 1968. Amateur Astronomy. Norton & Co. New York.
- MOORE, P. 1977. The Southern Stars. Rand McNally. London.
- MUIRDEN, J. 1968. Astronomy for Amateurs. Cassell. London.
- PAUL, H.E. 1976. Outer Space Photography for the Amateur.
Amphoto Book Co. New York.
- PAUL, H.E. 1976. Telescopes for sky gazing. Amphoto Book Co.
New York.
- ROBINSON, J.H. 1972. Astronomy Data Book. Wiley. New York.
- WEBB, T.W. 1962. Celestial Objects for Common Telescopes.
Dover Publications. London.



TEACHING AIDS

Celestial Sphere

A simple working model illustrating the apparent movement of stars can be shown by the rotation of the flask, as shown in the diagram.



The axis of the flask is inclined at an angle equal to the latitude of the location (32° for Perth). The spherical portion of the flask represents the celestial sphere, and the water level represents the horizon as perceived by the observer at the centre

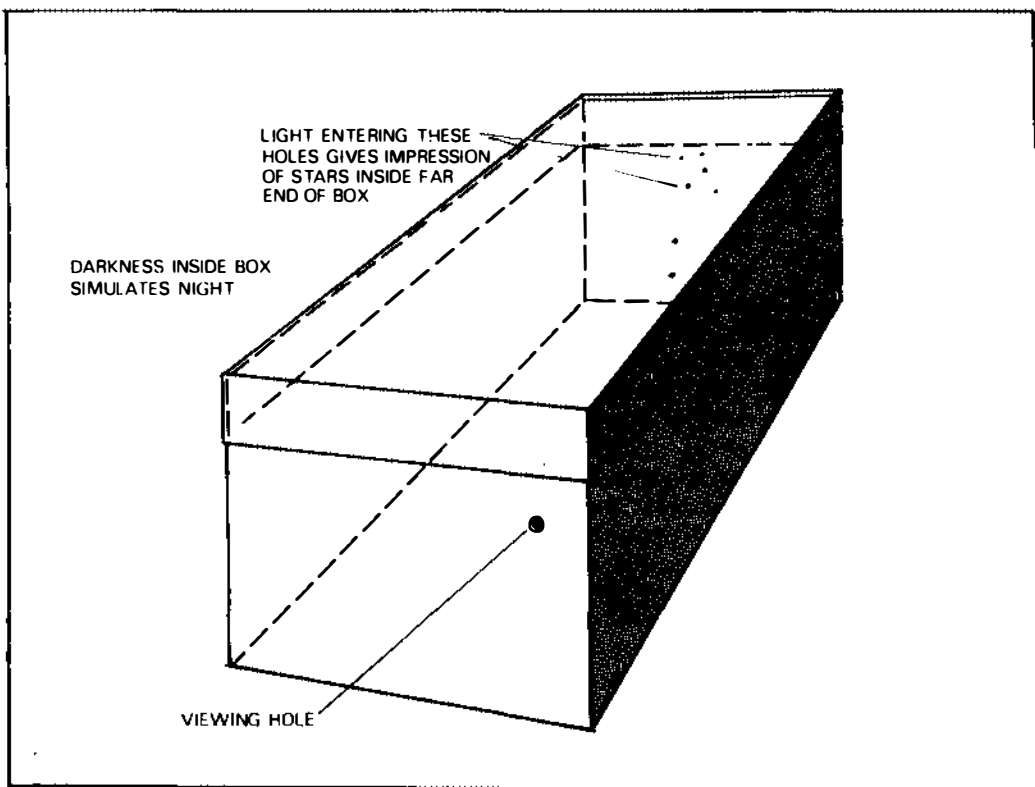


of the sphere. Constellations of stars may be conveniently marked on the surface of the flask. By rotating the flask in the appropriate direction (clockwise direction), the constellations will be seen to rise, reach its zenith, and then set relative to the surface of the water; the water surface indicating the observers horizon.

An observer at the centre of the celestial sphere looks towards the south and notes that, from his point of view, the stars have a clockwise motion. However, when he turns to face north, the stars have an apparent anticlockwise motion. In the real sky the same sort of movements occur, though they are so slow that more than one observation is required for their detection.

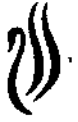
Constellation Simulator

A simulation of bright stars and their movements can be obtained with a simple star demonstration box.





Pinholes are made through one end of a cardboard box to represent a group of stars such as the Southern Cross. These are viewed through a viewing hole about 3 mm diameter made near one corner of the opposite end of the box. For the best effect the star end of the box is pointed towards a bright source of light such as an uncurtained window in day light. Darkness within the box provides a good contrast to the "stars". A variety of constellations can be constructed, to allow students the opportunity to recognise familiar and prominent star patterns. Rotate the box to illustrate the circular movement of the "stars".



SUGGESTIONS FOR AN OBSERVATIONAL EVENING

The following aspects and equipment should be considered when organising an observational evening for high school students.

Useful Equipment

1. Warm clothing
2. Star map
3. Planisphere
4. Torch
5. Clip board
6. Binoculars
7. Telescope
8. Structured work sheet.

Find Out About

1. Weather conditions
2. Time of Sunset
3. Phase of the moon
4. A suitable site with little ambient light
5. Position of prominent constellations at say
8.00 pm on the chosen evening.
6. Planets suitable for viewing.

EDITH COWAN UNIVERSITY



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Stars and telescop 1981
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