

It seems to be generally agreed, now, that the progress of our country will depend to a considerable extent on our ability to develop social consciousness and a culture of science among our people. As has been amply demonstrated a scientific culture cannot be grafted on to an indifferent population by forcing children to learn facts by rote. The first task is to create awareness, to arouse curiosity; a curious person is more likely to find the study of science natural and interesting; and only an interested person is likely to see the need for a rational approach to the understanding of the universe around him. This book is meant to contribute in a small way to the first objective; to create an appreciation for the universe around us.

This book is meant to be used, not just read. It has been written in as simple a style as possible with the emphasis on charts and maps. The user (not reader!) is urged to go out and learn his sky. Since the goal is comprehensive coverage of people and not material, I have tried to keep the book brief so that it can be produced as inexpensively as possible. As a consequence all matters not directly relevant to star gazing in India (eg. the nature of stars, the origin of the universe, the southernmost constellations etc.) have been ignored. First get a person's interest and attention; details will be automatically sought later.

The following pages are addressed primarily to the young. But anybody, irrespective of age, blessed with reasonable vision and curiosity can learn about and enjoy the splendours of the heavens. This guidebook is for all such people; indeed, for all people. Do go out and seek the stars.

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ABOUT THE AUTHOR

P.N. Shankar was born in Bombay in 1944, had his schooling in Bangalore, obtained an undergraduate degree from Imperial College, London, and got his Ph.D. in Engineering Science in 1968 from the California Institute of Technology. After working abroad for 4 years he returned to India in 1972. Since then he has been a scientist at the National Aeronautical Laboratory, Bangalore.

The author is married (to a computer scientist!) and has two children. Apart from amateur astronomy his main interests are music and the popularization of science. He plays the Carnatic flute.

GLOSSARY

Billion: A thousand million or 1,000,000,000.

Celestial Pole: A point about which the daily rotation of the stars appears to take place.

Constellation: A group of stars apparently forming a pattern in the sky; a well defined region of the sky.

Galaxy: A very large collection of stars (typically more than a billion of them) held together by gravity.

Globular Cluster: A symmetrical group of stars that are born and live and move together; form a 'halo' around our galaxy.

Magnitude: Refers to the brightness of a star; the brightest stars are of 1st magnitude, the 2nd magnitude stars are fainter, the 3rd magnitude stars fainter still etc.

Meridian: The imaginary line or great circle in the sky that passes overhead and due north-south of the observer.

Messier Objects: Astronomical objects in the catalogue of the French astronomer Charles Messier (1730-1817); referred to as M 1, M 57, M 93 etc.

Meteor: Shooting star; a small or large piece of solid matter from space that burns up on entering Earth's atmosphere leaving behind a short-lived luminous trail.

Milky Way: The galaxy or large star system to which our Sun belongs; seen, on clear dark nights, as a whitish patch passing through Sagittarius, Cygnus, Monoceros etc.

Million: Ten lakhs or 1,000,000.

Nebula: A cloud of gas and dust that is seen because of the starlight that it reflects or scatters.

Open Cluster: A rather loose, asymmetrical collection of stars that are born and move together; also known as a Galactic Cluster as it lies in the plane of the galaxy,

Planet: A rather cold body that moves about the Sun, seen by the sunlight that it reflects.

Satellite: A moon, natural or artificial.

Star: A hot, luminous, gaseous body that generates heat & light in its interior through nuclear reactions.

Universe: All that is, matter and energy; includes billions of galaxies.

Variable Star: A star whose brightness appears to change with time.

Zenith: The point overhead in the sky.

Zodiac: The region of sky through which the Sun, Moon, and the planets apparently travel; 12 of the constellations in this region are called the zodiacal constellations.

ABOUT THIS BOOK

Purpose

On a clear dark night you go out onto your terrace or to a clearing near your house and see the star studded sky. You find it beautiful but bewildering — there are just too many stars to make any sense of them. But you see groups of stars that seem to make patterns in the sky; if you observe them regularly, you see the same groups appearing and these groups help to bring order to the profusion of stars. These groups are the *constellations*.

The purpose of this book is to help you to identify the brightest stars, the major constellations and the brighter planets. The charts and maps given here have been specially prepared to make it easy for the beginner to find his way by himself. With practice you will find that it is actually quite easy to get to know the night sky. You will find that you will note the changing seasons, not just from the changes in the weather, but by the different constellations that you see in the sky. When you reach that stage, when the bright stars and the constellations are like familiar companions, you will want to know more, maybe do more. You might want to know what the stars really are, what the nebulae and galaxies are, how the universe got started etc. You might want to build a telescope to see the fainter objects. This book cannot help you in these matters — you will have to consult other books listed in the Bibliography. But the book would have served its purpose, having shown you the pleasures offered by the stars — a lifetime of instructive, interesting and wondrous pleasures.

Equipment Needed

No special equipment is needed to get to know your sky. However, a small torch, preferably with the front portion covered with a transparent red paper, would be a help; you could use this to look at the charts in the dark, while identifying the stars seen. If you are fortunate enough to have a pair of binoculars you may use them to see the few star clusters and nebulae that are shown in the Charts. It is a good practice to keep a small notebook and make a record of the observations made each night. Nothing else is really needed.

How to Use This Book

A few lines on how best this guide may be used. The next few sections give briefly all the basic information that is needed to understand the classification of the objects seen in the night sky and their apparent or real motions; please read this material and glance through the Glossary at the beginning of this book so that all the terms used will be understood. Before using the Constellation Charts make sure that you understand how they are to be used; a study of the examples given should help. Once understood, start using these Charts and keep a record of your observations. Once you have mastered an area of the sky given in one of the Charts you might wish to look at the detailed Star Maps given at the end of the book. You will now be confident enough to seek out the fainter stars and constellations which are not given in the Constellation Charts. Once you have located them you can mark these yourself in the Charts and complete them. With practice you will be able to master the sky. You will then wish to probe deeper; consult the books listed for further reading. Best of luck and 'Bon Voyage'.

THE NIGHT SKY

Stars, Shooting Stars & Planets

The stars that you see are objects that shine because of the heat and light that they generate in their interiors. They are made up mostly of hydrogen gas and their radiant energy is due to the conversion of hydrogen to helium in their cores. On any clear night, if you look for a sufficiently long time (may be a few minutes, may be a half hour) in any direction of the sky, you are likely to see a moving point of light with a short-lived trail; these are **shooting stars** or **meteors**. Shooting stars are really not stars at all; they are just grains of dust or rocks from outer space which burn up and shine when they enter Earth's atmosphere. Among the stars that you see, you often find star like objects which, however, do not twinkle; these are the **planets**, comparatively cold objects, which move around the Sun and which shine only because of the sunlight that they reflect. They do not make any light of their own. Many of the planets have **moons** or **satellites**; these are also cold objects which can only reflect the Sun's light.

Our Sun is a star and our Earth is a planet which moves about the Sun once every 36514 days. The Moon is a natural satellite of Earth. We shall have little to say about the Sun and the Moon as our main concern is the distant stars.

Star Clusters, Nebulae & Galaxies

Many stars are often born together, live and move together in groups called **star clusters**. There are two types of clusters; (a) **Open clusters**, in which the stars are somewhat loosely packed with no special shape to the cluster, and (b) **Globular clusters**, in which the stars are rather closely packed in distinctly spherical groupings. Some clusters can be seen with the naked eye or just binoculars (e.g. the Pleiades, w-Centauri etc.).

Stars are born from huge clouds of gas and dust and when they die they leave behind such clouds. These great clouds, which only reflect or scatter starlight, are called **nebulae**. Though one needs some optical aid to see these, a few of them (e.g. the Orion Nebula) are visible to the naked eye on clear dark nights.

Our Sun belongs to a very large collection of stars (about a hundred thousand million of them) called the **Milky Way** galaxy. A **galaxy** is a very large collection of stars that are held together by the force of gravity; note that every galaxy contains many thousands of star clusters. Our galaxy, the Milky Way, is just one among the billions of galaxies that make up the **Universe**. While many external galaxies can be seen with even a small telescope, the only one that can be seen with the naked eye, as a faint patch, is the Andromeda Galaxy (Constellation Chart 1).

Mapping the Heavens — the Constellations

Just as we need maps to locate countries on the globe, cities in countries and localities in cities, we need sky maps to locate the stars and other objects in the skies. Fortunately, for all practical purposes the stars occupy fixed positions in the sky and so their positions can be marked on sky maps. In addition, certain groups of stars *appear* to be together and form apparent patterns in the skies; these star groupings are called **constellations**. Many of the constellations were known to and imaginatively named by the ancients, e.g. Leo (Lion), Ursa Major (Great Bear), Canis Major (Big Dog) etc. Today, the constellations are used to map the whole sky into 88 distinct regions. The main purpose of this small book is to help you to identify and learn about the more important constellations; then you will know where to look if somebody tells you that you can see an interesting object, say, in Aries or some other constellation.

The Changing Night Sky

Though the stars are in almost fixed positions in relation to one another, the night sky *appears to change throughout the night* and more slowly *from season to season* throughout the year. These changes are due to: (a) the *rotation of Earth* on its own axis once every day, and (b) the *revolution of Earth* about the Sun once every year. Just as the Sun and Moon appear to rise in the east and set in the west because of the rotation of Earth, so too do the stars. *The stars and constellations appear to rise in the east and set in the west*; thus the stars and constellations that you see

overhead (**zenith**) at 9pm on some night will appear to set by 3am and a new set of stars will be seen overhead. The whole sky appears to rotate about us once every 24 hours. The axis, or line, about which it rotates passes through the well known star, the **Pole Star** or **Polaris**, and as a consequence *the Pole Star remains fixed* in the northern sky even though all the other stars appear to move through the night. In addition to this rapid nightly motion there is a slow change due to the motion of Earth about the Sun. Each day the stars appear to rise 4 minutes earlier than the previous day or $4 \times 30 = 120$ minutes = 2 hours earlier than the previous month. This means that if you see certain constellations overhead at 9pm tonight you will see a totally different set of constellations overhead at 9pm six months later.

Do not be worried if you do not quite understand why these changes occur (you will certainly understand in due course); but you must keep in mind that the sky appears to rotate from east to west throughout the night and that you see different constellations at different times of the year. It is certain that if you practise observing the stars, these changes will appear obvious and natural to you. You will find the explanation yourself.

A word of caution about the planets (*the Wandering Stars*); as they move about the Sun they appear to us to move with respect to the *fixed stars*, i.e. *they appear to wander in the sky*. As a consequence we cannot include permanently the position of the planets on our Star Maps; they slowly move from constellation to constellation. The 12 constellations through which they move are called the *zodiacal constellations*. A table at the end of the book gives the expected positions of the visible planets over a period of two years.

OBSERVING THE STARS

When to Observe

One can, if one wishes, observe the stars at any time on any clear night of the year. But the best observations can be made on *moonless nights, close to new moon* or *before the moon has risen* or *after it has set*; *bright moon* light makes the stars appear faint. On any given night the clearest views appear after the dust has settled, usually after midnight; but since most people are asleep at such times, the Guide Chart (on page 9) gives the constellations visible around 9pm. As you get experienced and interested you are likely to stay up late or get up early to get the most spectacular views. In our country, the monsoons make observation difficult during the summer months. But some of the best views occur during clear spells soon after a downpour; do not miss these dust free spells which can be most profitable.

Star Names & Magnitudes: The Constellation Charts

The brighter stars often have 3 types of names: (i) a common or popular name, (ii) a Greek, Latin, Arabic or Sanskrit name, and (iii) a name based on their positions in their respective constellations. Thus the Pole Star is also called Polaris or *Dhruva* or a *Urasae Minoris* (a is a letter in the Greek alphabet, listed at the beginning of the book); the *Dog Star* is *Sirius* or a *Canis Majoris*. The fainter stars may just have constellation names or numbers assigned to them e.g. *n-Orionis*, *88 Liones* etc.

In astronomy the stars are classified according to their brightness into magnitude classes, i.e., *the magnitude of a star refers to its brightness* (not its size). The brightest stars are said to be of 1st magnitude; the 2nd magnitude stars are a little fainter, the 3rd magnitude stars still fainter etc! With our naked eyes we can, with practice, on clear dark nights see stars as faint

as 5th or 6th magnitude; but even the beginner should be able to see stars brighter than 4th magnitude. Sirius, the brightest star in the sky, is of 1st magnitude; Polaris, of 2nd magnitude, is fainter; γ Arietis, of 4th magnitude is fainter still; if you can see 56 Orionis of 5th magnitude, or 59 Orionis of 6th magnitude you are doing very well indeed.

The Constellation Charts that follow have been designed to help you to easily find your way about the sky. We have purposely restricted ourselves to the brighter stars and constellations so that the beginner will be able to progress in easy stages. In these Charts only stars of 4th magnitude or brighter and compact constellations, the zodiacal constellations, or ones having a definite pattern have been shown. Once you master these, the fainter stars and constellations can be

identified with the detailed Star Maps given at the end of the book. The Constellation Charts show lines joining the stars to help you identify patterns in the sky. The Charts also show the positions of some clusters and nebulae; the numbers like M 42 refer to the numbers in the catalogue of the famous French astronomer **Charles Messier** (1730-1817).

How to Use The Constellation Charts

The following easy steps (A to D) are suggested for using the Charts:

A. The Guide Chart on page 9 indicates for each month of the year the Constellation Chart that you must use to find the constellations *that will be overhead at about 9pm*. Turn the Guide Chart (GC) to the appropriate month; looking towards the centre of the Chart you will find the major constellations that will be visible around 9pm and the numbers indicate the Constellation Charts to be used.

Example 1: In late January and early February the GC shows that Orion will be overhead around 9pm and that Chart 2 is to be used.

Example 2: In July the GC shows that Ophiuchus and Scorpius are to be seen and that Charts 5 and 6 are to be used for the early part of the month and Chart 6 and 7 for the later half.

B. Before going out, study the relevant Charts and note the *relative positions* of the brightest stars and *the expected patterns to be seen*.

Example 1 (Continued): For Example 1, one sees in Chart 2 that Orion looks like a man with a distinct belt; that the belt points westward to the bright star Aldebaran; that Auriga is a pentagon north of Orion etc.

Example 2 (Continued): For Example 2, one sees from Chart 5 that the brilliant stars α and β Centauri are far to the south and from Chart 6 that Bootes is like a kite somewhat to the north; and from Chart 7 that Scorpius has the distinct shape of a scorpion with a bright red star, Antares, near its head.

C. Remember to note carefully the north-south, east-west directions at your location; later you can use the Pole Star, but in the beginning you should know the directions independently.

D. At around 9pm go outside with this book turned to the relevant Constellation Chart and a small reddened or dim torch. After letting your eyes get used to the dark, *hold the Chart over your head with the Chart's north and east pointing to the true north and east respectively*. With the Chart illuminated dimly try to identify the bright stars and patterns first; once you have located these, the fainter stars can be located in relation to the brighter ones.

Once you have located the constellations shown in the Charts, try to locate the fainter stars and constellations using the Star Maps given at the end of the book. You may fill in the Charts with your observations or draw your own charts in a notebook. Try to be regular and methodical in your observations. A word of warning: if you see a bright 'star' in one of the zodiacal constellations which is not marked in the Charts it is likely to be a planet. Check the Table towards the end of the book which gives planetary positions.

GUIDE CHART

This Chart tells you month wise which constellations will be seen along the meridian (i.e., the north-south line overhead) at around 9pm. The numbers on this Chart indicate the Constellation Charts to be used. Turn the Chart around to the appropriate month and look towards the centre of the Chart; the constellations to be seen and the correct Charts to be used can be read off. If you want to use the Chart at times other than 9pm just remember that the 24 radial lines are 1 hour apart; or that each month later the constellations rise 2 hours earlier.

Example 1: Around September 15, at 9pm, use Charts 8 and 9.

Example 2: Around June 1, at 9pm, use Charts 4, 5 and 9.

Example 3: Around March 1, at 9pm, use Chart 3.

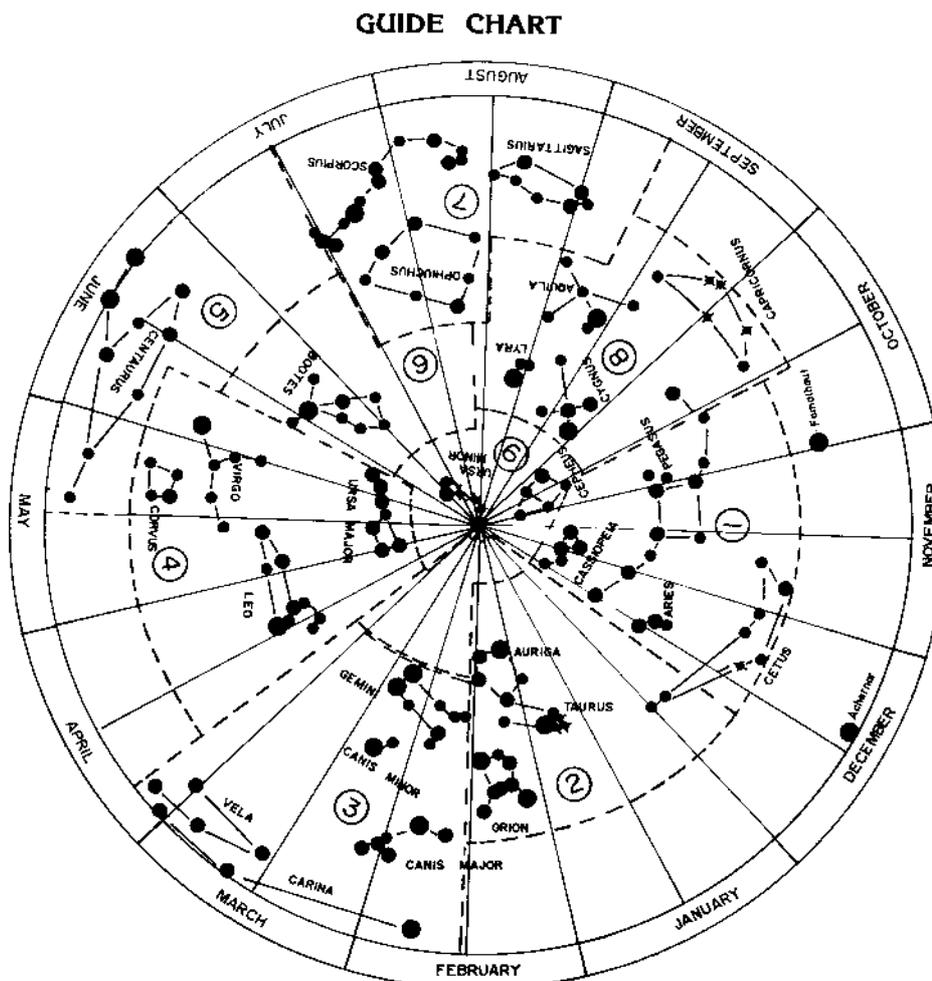
Example 4: Around February 1, at 3am (=6 hours after 9pm; or $6/2 = 3$ months away), use Charts 4 and 5.

Example 5: Around October 15, at 12am (=3 hours after 9pm; or $3/2 = 1.5$ months away), use Charts 1 and 9.

Note

(a) For 9pm the Guide Chart can be used directly without any calculation. If you find it confusing just stick to 9pm for a start; you will figure it out yourself later.

(ii) If more than one Chart has to be used, *use them one at a time* for the different regions of the sky.



CONSTELLATION CHART 1

DIRECTION OF VIEW: Generally looking overhead and north, *Cetus* is to the south.

BEST MONTHS: October to December.

POINTERS & HINTS: The Great Square of *Pegasus* is unmistakable and is the landmark (skymark?) for this area of the sky. Alpha and Beta *Pegasi* point to the Pole Star and indicate the north-south axis; they also point to the bright star *Fomalhaut* (in *Piscis Austrinus*) which is not shown in this Chart.

CONSTELLATIONS:

Cassiopeia: Bright; looks like a distorted letter M or W.

Andromeda: Looks like a curved horn starting from the north-eastern corner of the Great Square. First trace alpha, beta and gamma which are bright; then locate the fainter northern limb. The *Andromeda Galaxy* (M 31) is located slightly to the west of γ ; on clear dark nights it can be seen as a hazy patch; try to locate it.

Pegasus: After locating the Great Square trace the long curved tower limb starting from alpha and going to bright epsilon (shown on Chart 8); then locate the small triangle near beta.

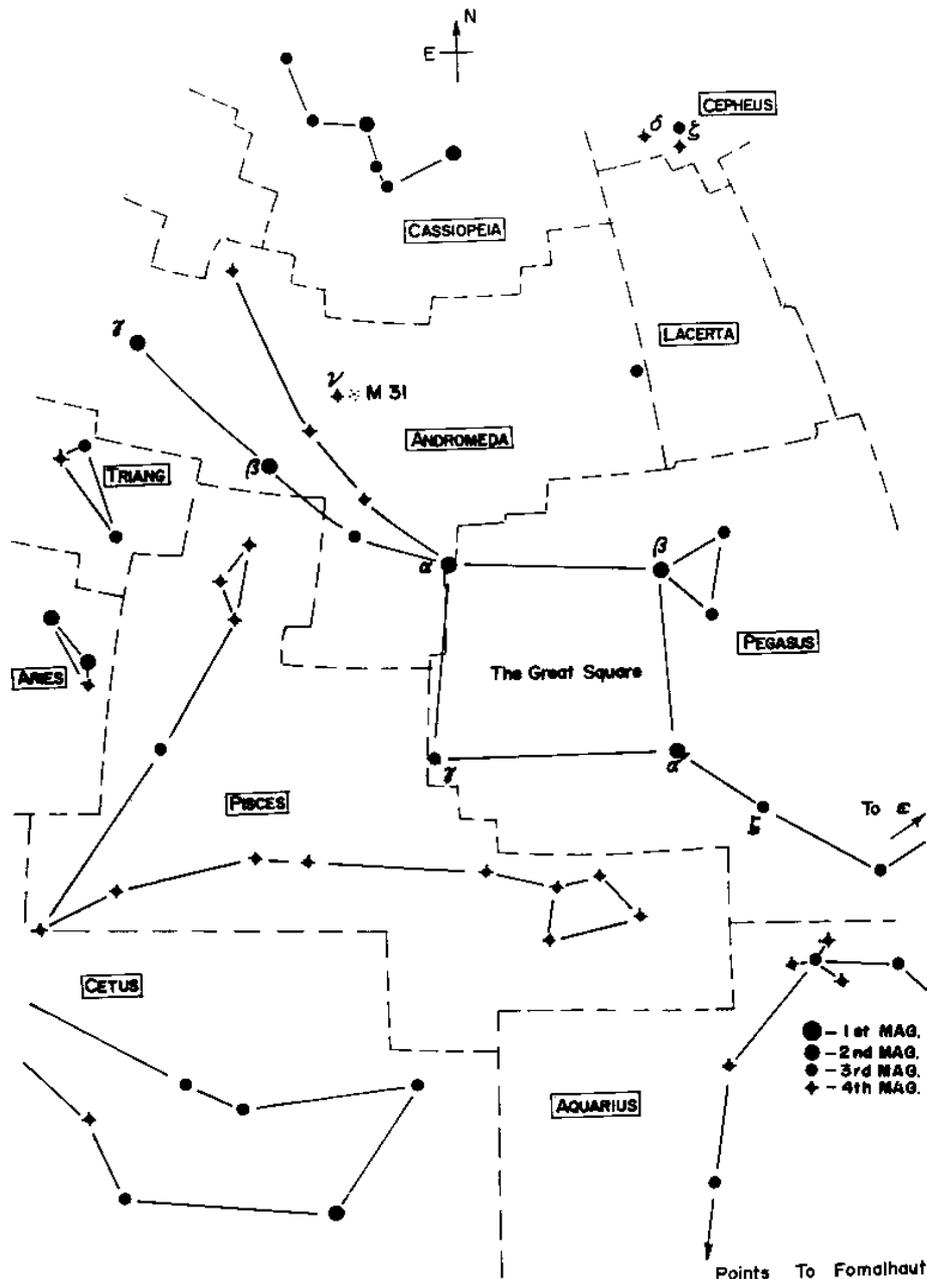
Aries (Ram): Zodiacal constellation. Small, but bright and distinct south of *Y-Andromedae*.

Triangulum: Faint, but distinct, between Aries and Andromeda.

Pisces (Fishes): Large but faint zodiacal constellation. Start tracing from the loop south of the Square.

Cetus (Whale): Not very bright and yet not difficult to locate.

CHART 1



CONSTELLATION CHART 2

DIRECTION OF VIEW: Generally looking overhead and north. *Orion* is overhead and south.

BEST MONTHS: December to March.

POINTERS & HINTS: First locate Orion. *Auriga* lies directly north of Orion. The stars of the *Belt of Orion* point to *Aidebaran* and the head of the Bull. The eyes of the Bull point to *A/go* and *Perseus*.

CONSTELLATIONS:

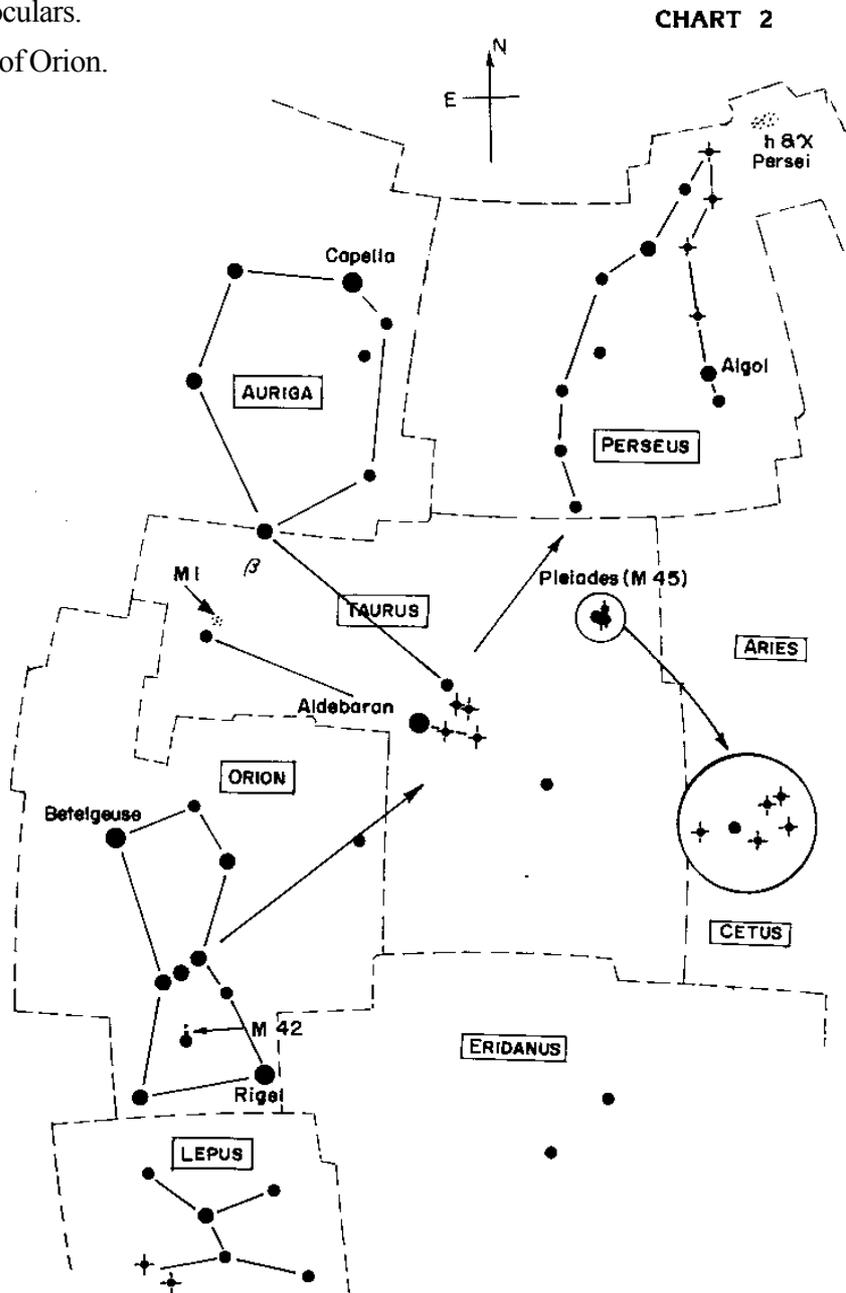
Orion (Hunter): One of the brightest and most unmistakable constellations; has two first magnitude stars, the red giant *Betelgeuse* and the whitish-blue giant *Rigel*. The second magnitude stars of the Belt form a distinct group and are useful as pointers. The famous Great Orion *Nebula* (M 42), which can be seen as a hazy patch on clear nights, lies on the *Sword of Orion*.

Taurus (Bull): One of the more interesting zodiacal constellations. The V-shaped star cluster, including reddish *Aidebaran*, is called the *Hyades* cluster and forms the head of the Bull. To the northwest of this cluster lies the well known but faint star cluster, the *Pleiades* (M 45). This little jewel, known also as the *Seven Sisters* is stunning when viewed through binoculars.

Auriga (Charioteer): Forms a distinct pentagon with Beta *Tauri* in the south. *Capella* is a brilliant yellowish star.

Perseus: Looks like a curved horn. Using the eyes of the Bull as pointers, find the curved limb which starts just north of the *Pleiades*; the reddish variable star *Algol*, which has a period of about 3 days, lies on the other curved limb. Try to see the changes in *Algol*'s brightness over a period of a few days by comparing it to *Aldebaran*. The beautiful double cluster *h & x Persei* lies to the west and north of the tip of the horn. Try to locate the patch on a clear dark night; spectacular through binoculars.

Lepus: Small; south of Orion.



CONSTELLATION CHART 3

DIRECTION OF VIEW: Generally looking overhead and south. Cancer and Gemini are overhead and north.

BEST MONTHS: February to April.

POINTERS & HINTS: The Belt of Orion points to Sirius. Betelgeuse, Sirius and *Procyon* form a perfect equilateral triangle. Gemini lies north of this triangle. The brilliant star *Canopus* lies south of Sirius.

CONSTELLATIONS:

Canis Major (Big Dog): Does indeed look like a dog with Sirius, the brightest star seen in the sky, forming the head.

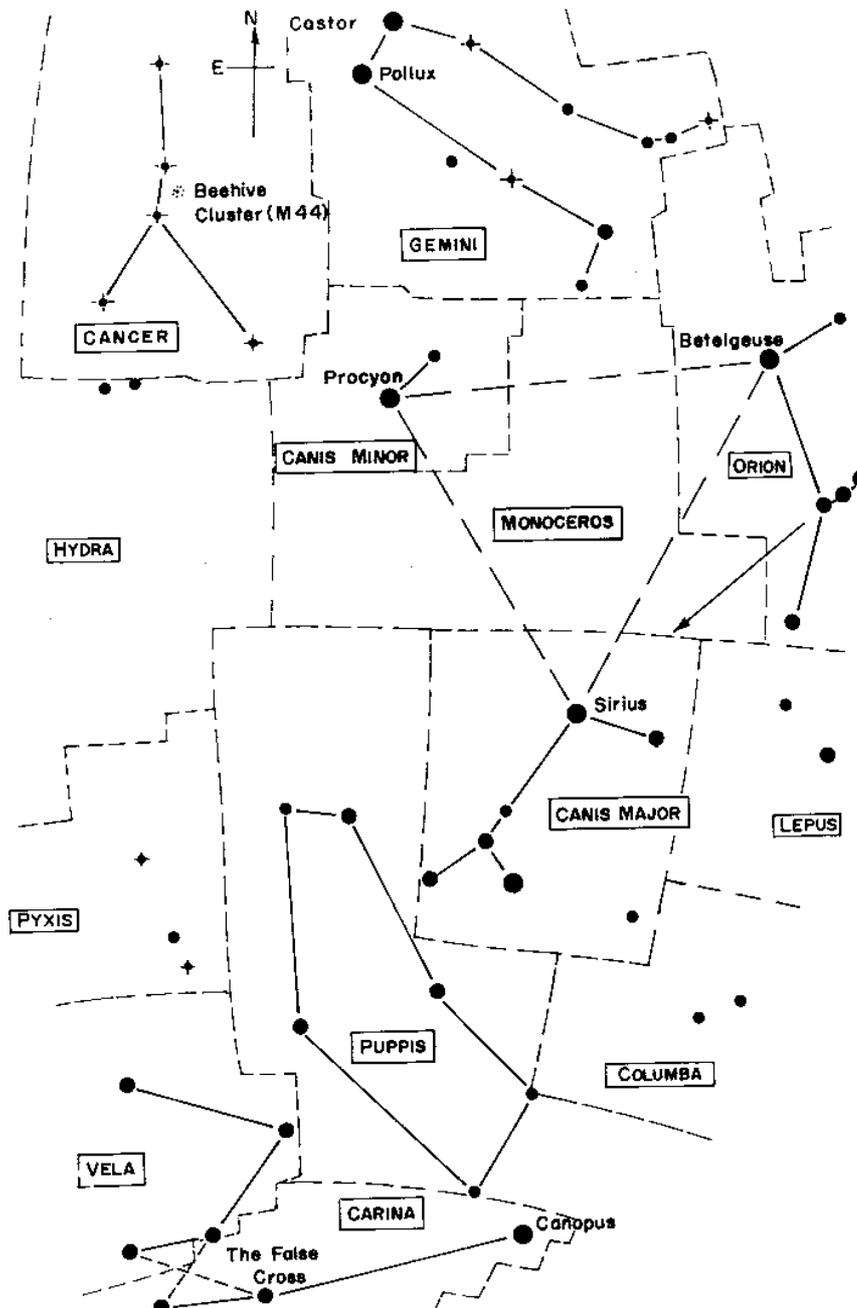
Canis Minor (Little Dog): Procyon alone is of interest.

Gemini (Twins): A zodiacal constellation formed of pairs of stars; the bright stars *Castor* and *Pollux* form the heads of the Twins.

Cancer (Crab): Elusive, faint zodiacal constellation to the east of Gemini. Looks like the Greek letter A. On a clear night one can easily locate the fuzzy patch of the *Beehive Cluster (M 44)*, also known as *Praesepe*; beautiful when seen through binoculars.

Puppis, Vela, Carina and Pyxis: Together form the ship *Argo*, which in Greek mythology carried Jason in his search for the Golden Fleece. The star *Canopus*, a *Cannae*, is the second brightest star in the sky. Note the group of four stars that form a distorted cross, the *False Cross*; a few hours later will rise *Crux*, the true *Southern Cross* (Chart 5). Try to locate and distinguish the two some late night or early morning.

CHART 3



CONSTELLATION CHART 4

DIRECTION OF VIEW: Generally looking overhead and north.

BEST MONTHS: April to June.

POINTERS & HINTS: ρ and α *Ursae Majoris* point to the Pole Star; ζ and γ of the same constellation point to *Regulus* in *Leo*. The tail of the Great Bear points to the bright star *Arcturus* in *Bootes*.

CONSTELLATIONS:

Leo (Lion): This zodiacal constellation is a splendid object in the spring sky. The front portion of the Lion has the distinctive appearance of a sickle or question mark in the north-south direction, with the bright star *Regulus* at the base. *Denebola* is at the hind quarters of the crouching animal.

Virgo (Virgin): Another zodiacal constellation. Locate the *Bowl* to the southeast of the Lion. This region, together with *Coma*, contains a very large number of galaxies that can be seen through a small telescope. *Spica* is the only bright star in this constellation.

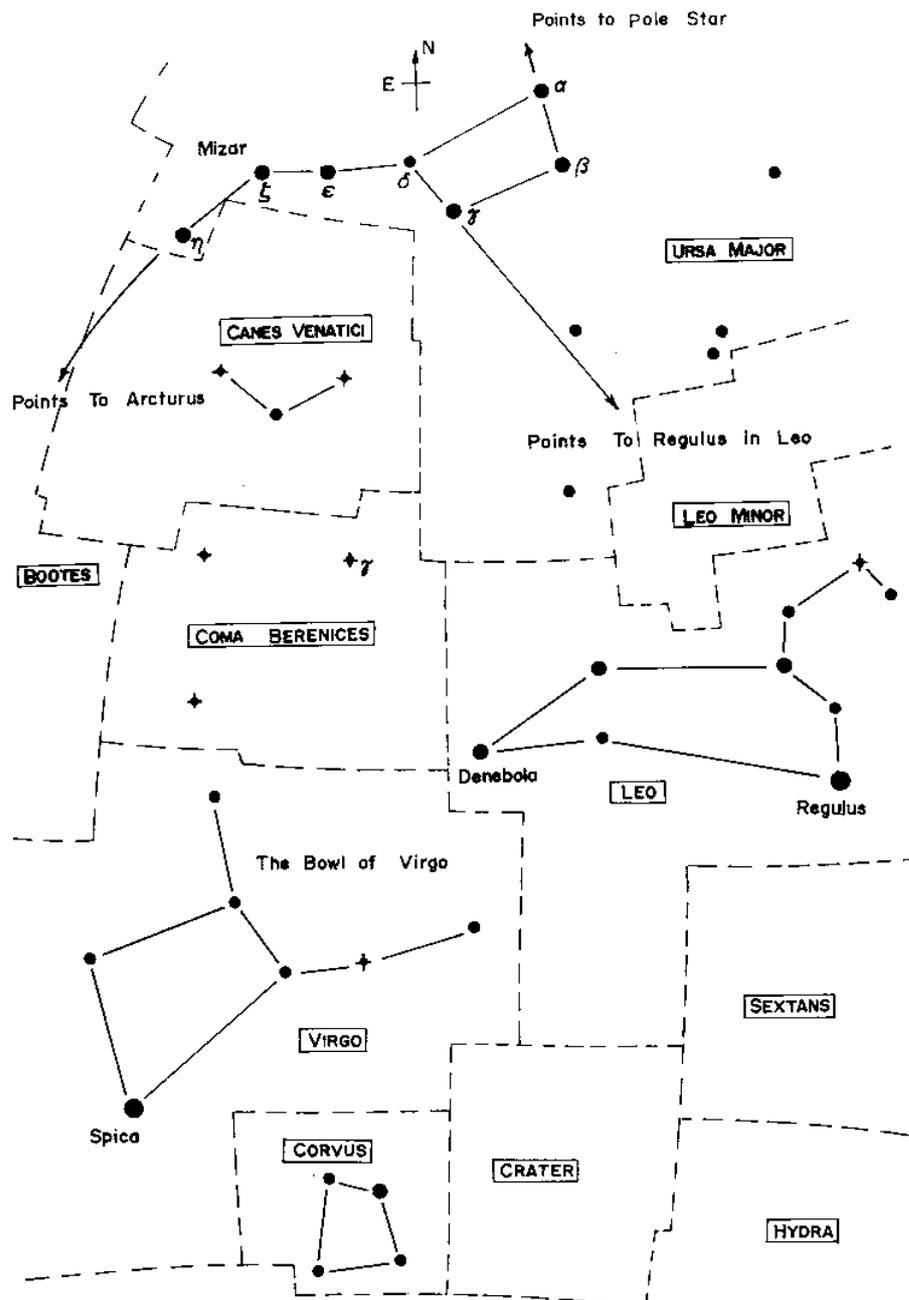
Ursa Major (Great Bear): The most splendid constellation of the northern skies. The seven stars α to η form the *Big Dipper*; i.e., a vessel with a handle; also known as the *Plough*., *Saptarsi* etc. The full constellation is shown in Chart 9A.

Canes Venatici (Hunting Dogs): Faint

Coma Berenices (Berenice's Hair): No stars brighter than fourth magnitude, but on clear nights one can see a whitish patch of stars in this area.

Corvus (Crow): Small, but bright and distinct, south of the Bowl.

CHART 4



CONSTELLATION CHART 5

DIRECTION OF VIEW: Looking south.

BEST MONTHS: May to July, provided skies are clear.

POINTERS & HINTS: The eastern limb of Corvus points to *Centaurus*. The long axis of Crux points to the *Southern Celestial Pole*.

CONSTELLATIONS:

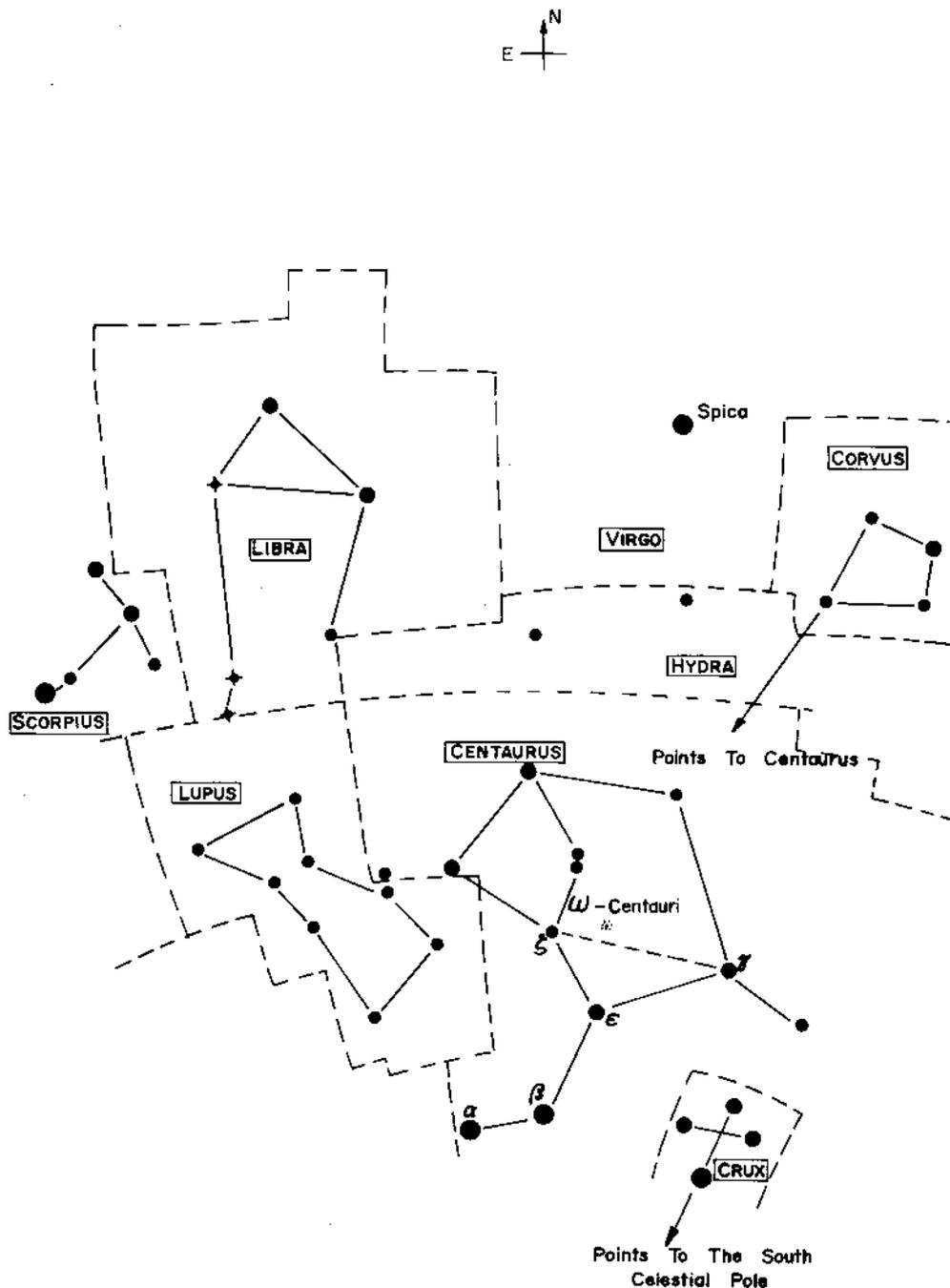
Centaurus: One of the most spectacular constellations of the southern skies. Brilliant alpha the nearest of all bright stars, is the brightest in a rich constellation. Trace the eastern arc, then around to γ and below. Note that epsilon, zeta and gamma form a right triangle; just above the hypotenuse (i.e., the line joining zeta and gamma) lies the splendid globular cluster *w Centauri*. On a clear night, it appears as a whitish patch to the naked eye; with the minimum of aid it can be resolved into a cluster. Try locating it.

Crux (Southern Cross): Small, bright constellation just south of Centaurus. Compare it to the False Cross, which is larger and to its west (Chart 3).

Lupus (Wolf): Has many third magnitude stars.

Libra (Scales): This faint zodiacal constellation lies to the north of Lupus and to the west of the head of the Scorpion.

CHART 5



CONSTELLATION CHART 6

DIRECTION OF VIEW: Generally looking overhead and north.

BEST MONTHS: June to August, provided skies are clear.

POINTERS & HINTS: A sweep along the tail of the Great Bear leads to *Arcturus*. It is best to locate *Arcturus* and *Bootes* and then find the other constellations in relation to *Bootes*.

CONSTELLATIONS:

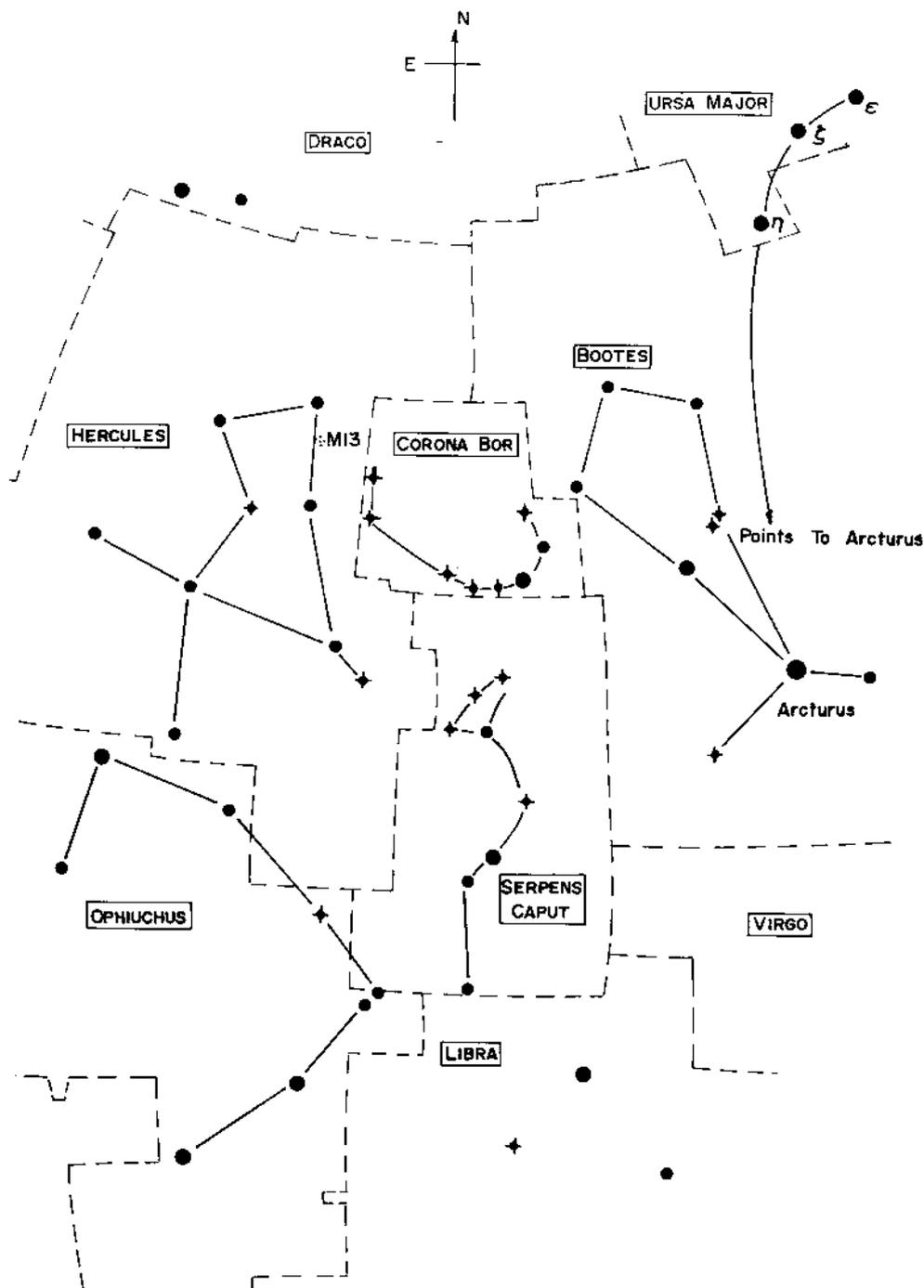
Bootes (Herdsman): Looks like a long kite with the orangish star *Arcturus* near the tail.

Corona Borealis: Except for the second magnitude *Gemma*, the Northern Crown is faint; still it is distinct and beautiful.

Hercules: Large and rather dim. The great globular cluster M 13 can sometimes be seen on clear nights as a hazy star in the position shown.

Serpens Caput (Serpent's Head): Faint but readily recognizable.

CHART 6



CONSTELLATION CHART 7

DIRECTION OF VIEW: Looking overhead and south.

BEST MONTHS: July to September, weather permitting.

POINTERS & HINTS: The Scorpion is unmistakable; locate the others with respect to it. At times the planet Mars will be close to Antares (as in “1984”); watch out for this possibility. The *Milky Way* runs through the *Sagittarius* — *Scorpius* region and as a consequence there are numerous star clusters in this region. Search for them with a pair of binoculars if available.

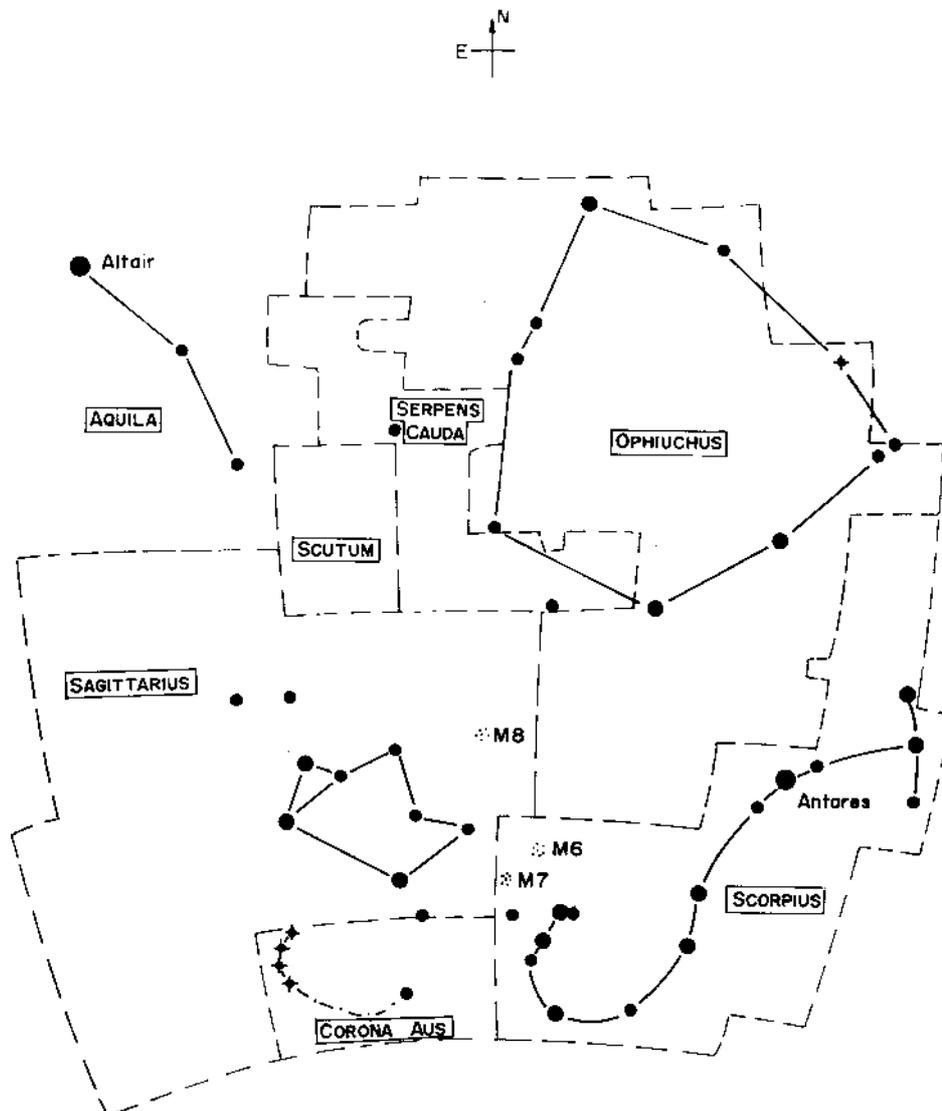
CONSTELLATIONS:

Scorpius (Scorpion): This zodiacal constellation is probably the most spectacular of the southern constellations. The group is made up of bright stars that do indeed trace a large scorpion in the sky. Antares is a bright red star. Between the tail of Scorpius and the spout of the teapot in Sagittarius lie the brilliant open clusters M 6 and M 7, the latter of which is visible to the naked eye.

Sagittarius (Archer): The principal stars of this zodiacal constellation form a distinct teapot in the sky just above the tail of the Scorpion. The centre of our galaxy lies in this direction of the sky. The *Lagoon Nebula* (M 8) is just visible to the naked eye. Excellent hunting ground for star clusters.

Ophiuchus (Serpent Holder): Looks like a large distorted circle north of Scorpius and south of Hercules.

CHART 7



CONSTELLATION CHART 8

DIRECTION OF VIEW: Generally overhead and north; Capricornus is to the south.

BEST MONTHS: August to October.

POINTERS & HINTS: The Summer *Triangle* formed by *Vega*, *Deneb* and *Altair* and the Northern Cross formed by the principal stars of *Cygnus* are unmistakable. Once these are located all the other stars and constellations in the region can be easily identified.

CONSTELLATIONS:

Lyra (Lyre): A small constellation; but *Vega* the fifth brightest star in the heavens, is a brilliant object. The *Ring Nebula* (M 57) cannot be seen without some optical aid.

Cygnus (Swan): A lovely constellation with the head at α and the two wings spread on either side of the *Deneb*— β axis. As the Milky Way passes through this region, it is rich in star fields.

Aquila (Eagle): The Eagle's head is near *Altair*.

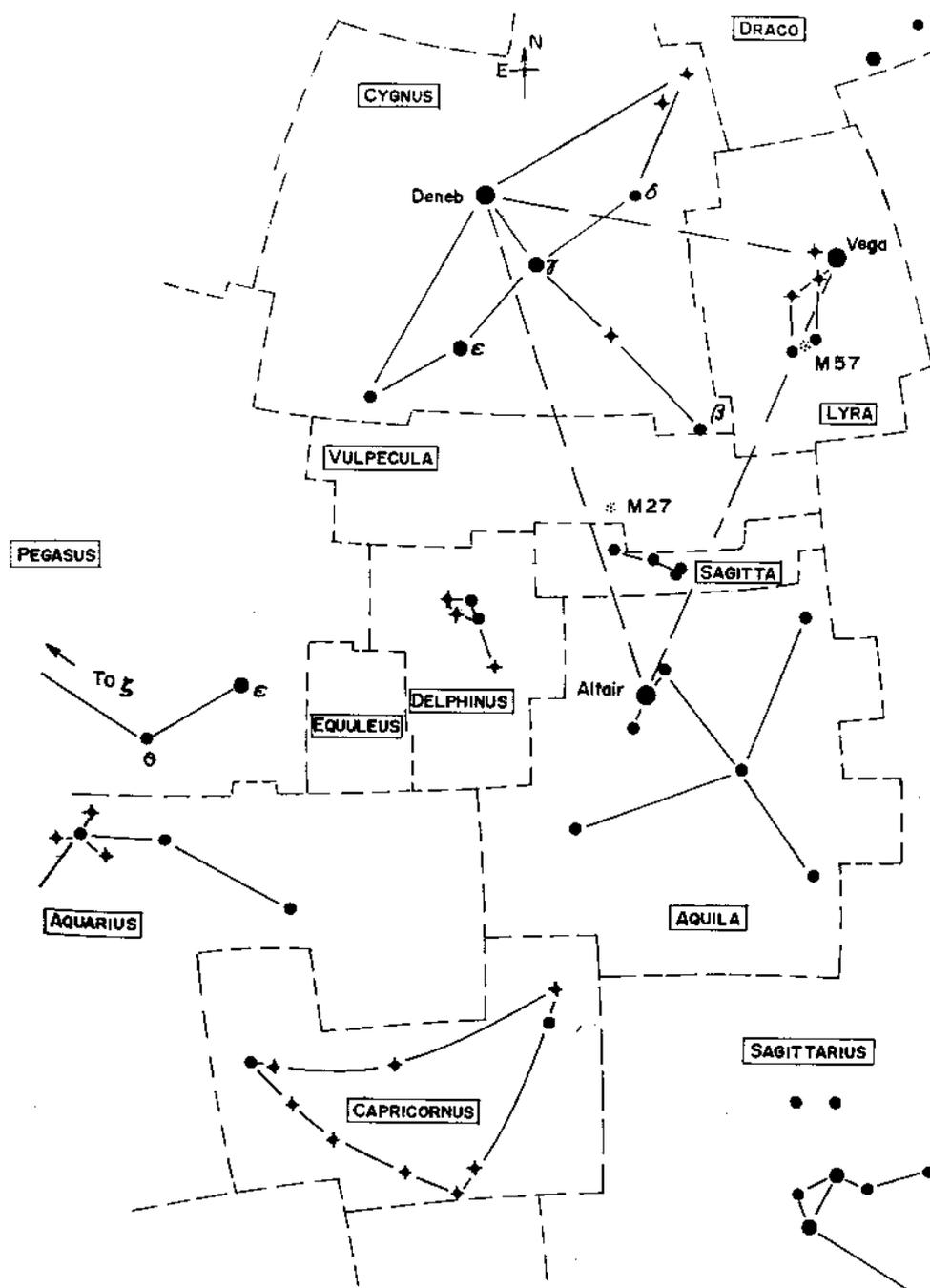
Sagitta : A small, faint arrow above *Altair*.

Delphinus (Dolphin): Small and faint but beautiful.

Capricornus (Sea Goat): A zodiacal constellation which looks like a large, faint, crescent moon.

Aquarius (Water Carrier): This zodiacal constellation is large and indistinct. It starts above *Capricornus* and curves below *Pegasus* (see Chart 1).

CHART 8



CONSTELLATION CHARTS 9A & 9B

DIRECTION OF VIEW: Looking north.

BEST MONTHS: April to June for 9A and September to November for 9B.

POINTERS & HINTS: Remember that *Polaris*, the *Pole Star*, remains in a fixed position throughout the year; it is always due north at an elevation equal to your latitude. Thus if your latitude is 13° , the Pole Star will be 13° above the northern horizon. beta and alpha *Ursae Majoris* point to *Polaris*.

CONSTELLATIONS:

Ursa Major (Great Bear): The Great Bear in all his glory is a truly splendid sight. Though the stars other than those of the Big Dipper are fainter than second magnitude, the Bear can be easily made out on clear dark nights. Start with the Dipper, locate the two symmetrical pairs of legs, and find the head and the Bear falls into place.

Ursa Minor (Little Bear): Is a faint constellation too close to the horizon as seen from the southern parts of our country. In the north it should not be too difficult to find on clear dark nights; visible throughout the year in the north.

Draco (Dragon): Is long and faint.

Ciphers: Looks like a house with sloping roofs. *S Cephei* is a famous variable star.

CHART 9A

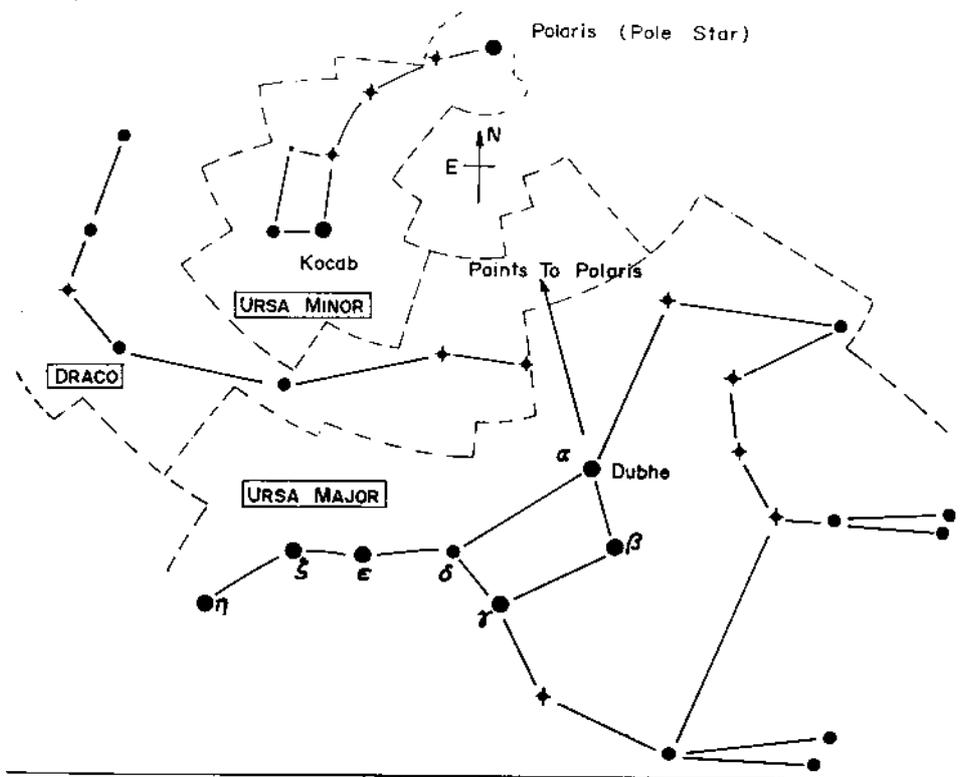
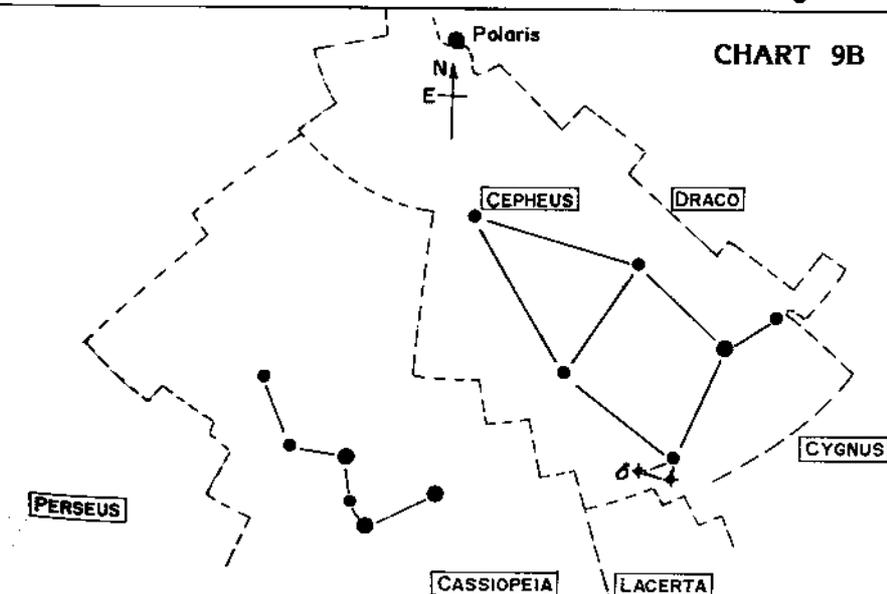


CHART 9B



OBSERVING THE PLANETS

Of the 8 planets of the Sun other than **Earth**, only **Mercury**, **Venus**, **Mars**, **Jupiter** and **Saturn** are visible to the naked eye; **Uranus** and **Neptune** are visible through small telescopes but **Pluto** requires a fairly powerful instrument to be seen.

Mercury: Not easy to spot as it is always close to the Sun, It can only be seen low on the horizon just before sunrise or soon after sunset.

Venus: Brightest object in the sky after the Sun and the Moon. It is seen either as the *Evening Star* after sunset or as the *Morning Star* before sunrise.

Mars: Distinctly reddish in colour.

Jupiter: Brighter than Sirius. Four of its moons, *Io*, *Europa*, *Ganymede* and *Callisto* can be seen through even small telescopes.

Saturn: Appears yellowish in colour. Its beautiful rings can be easily seen with the aid of a small telescope.

Recall that the planets appear to wander about the sky with a preference for the zodiacal constellations. The expected positions of Venus, Mars, Jupiter and Saturn over a period of two years are shown on the opposite page.

PLANETARY POSITIONS

| | | Venus | | Mars | Jupiter | Saturn |
|------|-----|--------|-----|--------|---------|--------|
| 1985 | Jan | Cap,Aq | (E) | Aq | Sa | Li |
| | Feb | P | (E) | P | Sa,Cap | Li |
| | Mar | P | (E) | P | Cap | Li,Sc |
| | Apr | P | (O) | Ar | Cap | Li,Sc |
| | May | P | (M) | T | Cap | Li |
| | Jun | P | (M) | T,G | Cap | Li |
| | Jul | Ar | (M) | G | Cap | Li |
| | Aug | T,G | (M) | Can | Cap | Li |
| | Sep | Can | (M) | Le | Cap | Li |
| | Oct | Le | (M) | Le | Cap | Li |
| | Nov | V | (M) | V | Cap | Li,Sc |
| | Dec | Li | (O) | V | Cap | Sc |
| 1986 | Jan | Sa | (O) | Li | Cap | Sc |
| | Feb | Cap | (O) | Li,Sc | Cap | Sc,O |
| | Mar | Aq | (E) | O | Aq | O |
| | Apr | P,Ar | (E) | Sa | Aq | O |
| | May | T | (E) | Sa | Aq | O |
| | Jun | G | (E) | Sa | Aq | O |
| | Jul | Le | (E) | Sa | Aq | Sc |
| | Aug | Le, V | (E) | Sa | Aq | Sc |
| | Sep | V | (E) | Sa | Aq | Sc |
| | Oct | Li | (E) | Sa,Cap | Aq | Sc |
| | Nov | Li | (M) | Cap | Aq | O |
| | Dec | V, Li | (M) | Aq | Aq | O |

Ar=Aries, Aq=Aquarius, Can=Cancer, Cap=Capricornus,
G=Gemini, Le=Leo, Li=Libra, O=Ophiuchus, P=Pisces,
Sa=Sagittarius, Sc=Scorpius, T=Taurus, V=Virgo

(M)=Morning, (E)=Evening, (O)=Poor or no visibility

METEORS AND METEOR SHOWERS

When particles of interplanetary dust or rocky fragments enter Earth's atmosphere, they burn up leaving behind short-lived bright trails. These can be seen in any part of the sky at any time of the year. But especially spectacular are meteor showers; these bursts of meteors occur at specific times of the year in well defined locations of the sky. They are believed to be the remains of broken up comets that burn up as they cross Earth in orbit around the Sun. The table below shows some of the important meteor showers. Try spotting them.

| Dates visible | Name | Constellation |
|-----------------|--------------|---------------|
| Jan 1—Jan 6 | Quadrantids | Bootes |
| Apr 19-Apr 24 | Lyrids | Lyra |
| May 1—May 8 | Eta Aquarids | Aquarius |
| Jul 25 — Aug 18 | Perseids | Perseus |
| Oct 16—Oct 21 | Orionids | Orion |
| Oct 20— Nov 30 | Taurids | Taurus |
| Dec 7— Dec 15 | Geminids | Gemini |

COMMON & SANSKRIT NAMES OF SOME CONSTELLATIONS

| International Name | Common Name | Sanskrit Name |
|--------------------|----------------|---------------|
| Aquarius* | Water Carrier | कुंभ |
| Aquila | Eagle | गरुड |
| Aries* | Ram | मेष |
| Auriga | Charioteer | सारथी |
| Bootis | Herdsman | भूतप |
| Cancer* | Crab | कर्क |
| Canis Major | Big Dog | बृहल्लुब्धक |
| Capricornus* | Sea Goat | मकर |
| Cassiopeia | Cassiopeia | शर्मिष्ठा |
| Cetus | Whale | तिमिंगल |
| Corona Borealis | Northern Crown | उत्तर मुकुट |
| Cygnus | Swan | |
| Gemini* | Twins | मिथुन |
| Leo* | Lion | सिंह |
| Libra* | Scales | तुला |
| Orion | Hunter | मृग |
| Perseus | Perseus | ययाति |
| Pisces* | Fishes | मीन |
| Sagittarius* | Archer | धनु |
| Scorpius* | Scorpion | वृश्चिक |
| Taurus* | Bull | वृषभ |
| Ursa Major | Great Bear | सप्तर्षी |
| Ursa Minor | Little Bear | ध्रुवमत्स्य |
| Virgo* | Virgin | कन्या |

(* Zodiacal Constellation)

THE 21 BRIGHTEST STARS

| Proper Name | Constellation Name | Sanskrit Name |
|-------------|---------------------------|---------------|
| Sirius | α Canis Majoris | व्याध |
| Canopus | α Carinae | अगस्त्य |
| Rigel Kent | α Centauri | मित्र |
| Arcturus | α Bootis | स्वाती |
| Vega | α Lyrae | अभिजित |
| Rigel | β Orionis | राजन्य |
| Capella | α Aurigae | ब्रम्हहृदय |
| Procyon | α Canis Minoris | प्रश्वा |
| Achernar | α Eridani | अग्रनद |
| Hadar | β Centauri | मित्रक |
| Altair | α Aquilae | श्रवण |
| Aldebaran | α Tauri | रोहिणी |
| Acrux | α Crucis | |
| Betelgeuse | α Orionis | काक्षी |
| Antares | α Scorpii | ज्येष्ठा |
| Spica | α Virginis | चित्रा |
| Pollux | β Geminorum | |
| Fomalhaut | α Piscis Austrinus | मीन |
| Deneb | α Cygni | हंस |
| Mimosa | β Crucis | |
| Regulus | α Leonis | मघ |

BIBLIOGRAPHY

Books For Further Reading

There are numerous excellent books of interest but unfortunately they are rather expensive or difficult to obtain. Here are a few that you might like to consult:

Hoyle, F. 1960 *Frontiers of Astronomy*, New American Library
 Moore, P. 1983 *The Guinness Book of Astronomy*, Guinness Norton, A.P.
 1978 *Ho/ion's Star Atlas*, Gaf & Inglis Ltd
 Paranjpe, G.R. 1978 *Akasa Darsana Atlas*, NCERT

Rey, H.A. 1981 *The Stars – A New Way Those Them*, Houghton Mifflin

Sagan, C. 1981 *The Cosmic Connection*, Papermac

Texereau, J. 1963 *How To Make A Telescope*, Doubleday Anchor

A magazine that you are likely to enjoy reading is *Sky & Telescope* (Sky Publishing Corp., Cambridge, Mass., USA).

STAR MAPS

1. The Star Maps, adapted from Norton's Star Atlas, supplied with this book show all stars of 5th magnitude and brighter; all stars of 6th magnitude and fainter have been omitted.

2. Some of the brighter clusters and nebulae are shown but most of these will require some optical aid to be seen. The Messier objects, most of which are included, are marked thus: 13^M , 104^M etc.

3. The Maps are to be used in the same way as the Constellation Charts, i.e., held overhead with the Maps' north pointing north etc.

4. It is suggested that the Maps be opened out and pasted on to stiff cardboard of the right size and covered with thin transparent plastic sheets.