

Nature Watch

On Observing the Night Sky

P N Shankar and B S Shylaja

If you are unfamiliar with the night sky and you look at it on a really clear night, away from the city lights, you are bound to be dazzled and overwhelmed by the apparently innumerable stars that are visible. To the novice it would seem impossible to bring order and understanding to this apparently random profusion of stars of different colours and brightness. In fact, this is exactly how it must have seemed to the ancients. Yet, in not one but a number of geographically distant civilizations, order was found in the night sky and in surprisingly similar ways. Our purpose here is to introduce the reader to the night sky so that he or she, too, can make sense of this rich and beautiful visual field.

However, before we do that let us briefly consider why it is worth our while to do so. First of all, the almost unchanging sky is our direct contact with our early ancestors; they must have seen the sky very much as we see it today and unlike other natural phenomena we have still not been able to disturb it significantly. Secondly, the night sky is an important source of direction pointers; even now pilots and ship navigators depend on pointers such as the Pole Star, at least in emergencies. Thirdly, the sky is nature's own laboratory where spectacular things are happening all the time, accessible to us if only we attempt to see them. And finally, if you have any poetry in your soul, can you fail to be moved by the sight of the Milky Way on a clear night or the sight of a beautiful star cluster or nebulosity through a small telescope?

Mapping the Sky – The Constellations

One of the first things that we acquire when we go to a new country or town is a map. Similarly, when we wish to observe the sky we will need star charts to help us find our way around. By



P N Shankar does research in fluid mechanics at the National Aerospace Laboratories. His other interests include music, sports, science and reading of an omnivorous character.

B S Shylaja obtained her PhD from the Indian Institute of Astrophysics. She is currently associated with Bangalore Association for Science Education, which administers the Jawaharlal Nehru Planetarium in Bangalore. Her work involves teaching and research, besides popularising astronomy.



A close monitoring of the stars will reveal that some of them are not point objects.

history and convention the whole of the sky has been mapped into 88 areas or constellations. It should be emphasized that this mapping, although quite satisfactory, is entirely arbitrary, a consequence of history and tradition alone. The purpose of this mapping into constellations is shown in *Figure 1*. This shows one of the most interesting regions that is clearly visible in the southern sky in the summer months – the Sagittarius-Scorpius region, a region rich in star clusters and nebulosities. A close monitoring of the stars will reveal that some of them are not point objects. Through a telescope or binoculars they would look like thin cloudy patches. Although faint comets and galaxies also look the same away, the term nebulosity only really applies to celestial clouds of gas and dust.

In the picture on the top which is unmarked by mapping lines it is hard to see any pattern and one would find it difficult to recognize the region. In the bottom picture, however, the boundaries of the constellations have been marked, the brighter stars have been labeled and the stars of the constellations have been linked to help the observer see a pattern. By linking the brighter stars we can clearly make out a scorpion in Scorpius and a teapot in Sagittarius, with the tea being apparently poured on the scorpion's tail! The reader will agree that it would be far easier to recognize this portion of the sky with the chart on the top rather than the chart at the bottom. And this is how the mapping into constellations and their presence on star charts help us to find our way in the sky.

The name of the constellation need not actually be related to the positioning of the stars. For example Scorpio may resemble a scorpion, but Aries may not be anywhere close to a ram.

It is important to remember the following points:

- (a) Each constellation is an area of the sky and a collection of stars that are grouped together by convention. The name of the constellation need not actually be related to the positioning of the stars. For example Scorpio may resemble a scorpion, but Aries may not be anywhere close to a ram.
- (b) The stars in a constellation may not be physically close together even though they may appear to be so.



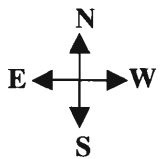
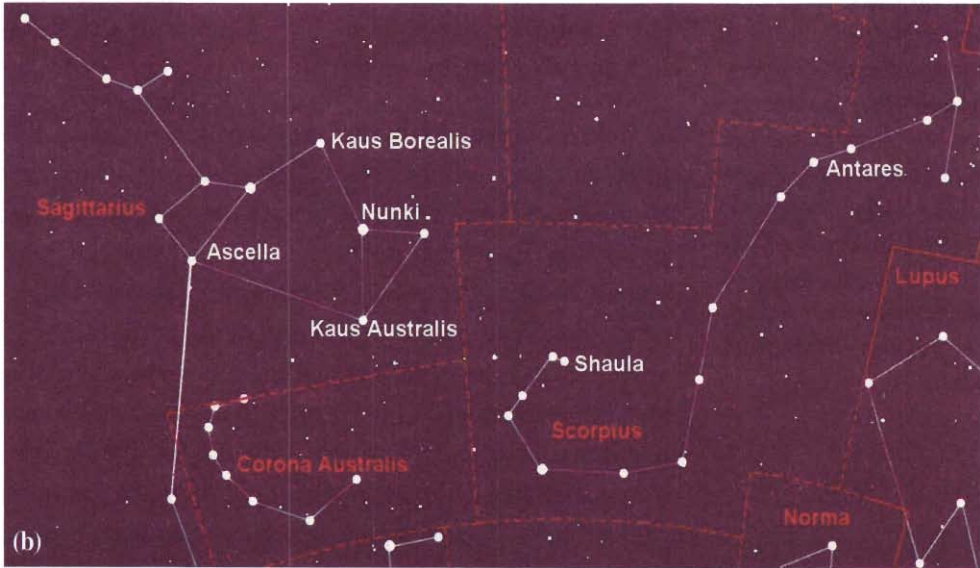
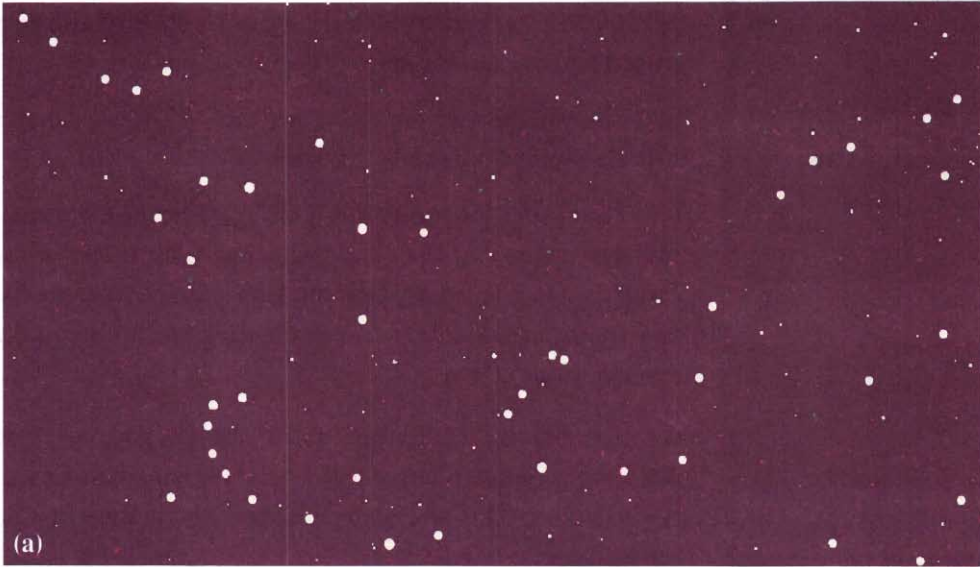


Figure 1. Both parts of this figure show the Sagittarius–Scorpius region of the night sky. Whereas (a) only shows the celestial objects, (b) has the constellation boundaries marked and the brighter stars linked together to suggest patterns. The star maps also give the names of the brighter stars such as Antares and Kaus.



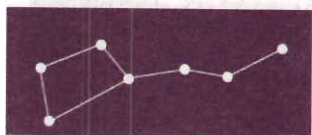
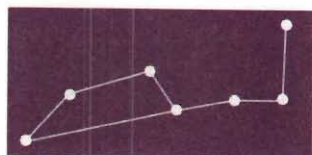


Figure 2. The shapes or patterns of the constellations do not change over human lifetimes or even over decades or centuries. However, they do change over very large times. The figure depicts the example of Ursa Major (Saptarshi Mandala), as seen (from top to bottom) 100,000 years ago, now and as it will appear 100,000 years from now.

(c) The stars in a constellation have names based on the constellation, e.g. α -Centauri, δ -Corvi, etc. with the brightest being named in the order α , β , etc.

(d) The way the stars are linked together in a constellation to help the observer is entirely arbitrary.

(e) The constellations may slowly change their shape because of the slow motion of the stars about our galactic center (see Figure 2). On a day to day basis, on human time scales, the stars and constellations appear to remain fixed in the sky and in relation to one another.

A person serious about learning about the night sky must slowly familiarize himself or herself with at least the important stars and constellations. This is very easy to do and we will show how this can be done.

The Changing Night Sky – The Effects of the Rotation and Revolution of Earth

Let us begin with understanding why the sky does appear different on an almost hourly basis and certainly over months even though the stars and constellations are almost fixed relative to one another. Recall that the Earth rotates on its axis once every 24 hours and revolves around the sun once every $365 \frac{1}{4}$ days. It is these motions of the Earth that cause the night sky to appear to vary on a nightly basis and seasonal basis. It is worth spending a little time understanding this. The Earth moves about the sun in an elliptical orbit in a plane called the ecliptic and its axis of rotation is inclined at an angle of about $23 \frac{1}{2}^\circ$ to the plane of the ecliptic. It is this inclination that causes the seasons on the Earth.

Now it is best to visualize the Sun and Earth in its orbit to be surrounded and enclosed by big spherical shell called the celestial dome, with the stars projected on to the shell, as in a planetarium. Remember now that at any instant half the Earth is facing the sun and the other half has night and it is the night half that sees the night sky. But since the Earth is rotating, 12 hours

later it is the other half that will see the night sky. Since this is continuous, one always sees new stars and constellations rising in the east and current ones setting in the west. Note that this is a day/night phenomenon. However because of the slow revolution of Earth around the Sun, the stars rise and set about 4 mins earlier each day. In other words, if you see a star set at 8 pm today it will set approximately at 7 pm a fortnight later.

Any star that is actually on the axis of the Earth's rotation will remain fixed.

Do all stars rise and set? Clearly any star that is actually on the axis of the Earth's rotation will remain fixed. Polaris, *Dhruva*, in the constellation of Ursa Minor (Saptarishi Mandala) is, to a good approximation, such a star. It remains almost fixed in its northerly position, about 13° above the horizon in Bangalore, night after night, year after year. But over millennia, because of the wobble of the Earth's axis of rotation, it will lose its prominent position (see *Figure 3*). Thus due to the rotation of the Earth we see the sky slowly changing over the night with stars and constellations rising in the east and setting in the west.

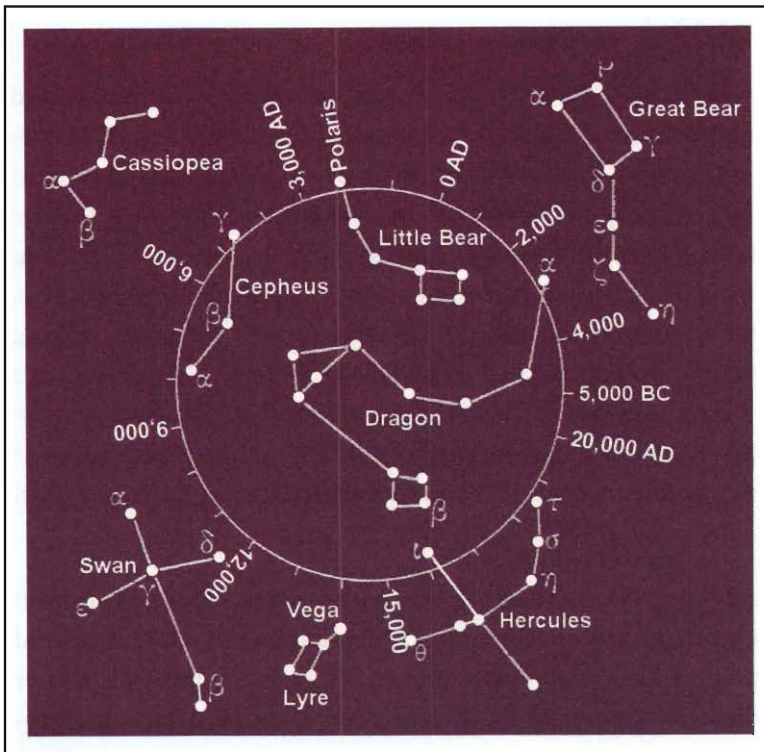


Figure 3. The constellations near the north celestial pole are shown. The current pole star (*Dhruva Nakshatra*) is in Ursa Minoris. Owing to the slow wobbling of the axis of rotation, the axis points to different directions, maintaining the 23.5 degree tilt.. The phenomenon itself is called the precession of equinoxes. The figure shows the drift of the pole – Thuban in Draco or the Dragon was the pole star in 3000 BC; Vega in Lyra will be the pole star in 14,000 AD.

The way to become familiar with the sky is to observe it regularly, even if one can spend only a little time on each occasion.

Now as the Earth slowly moves around its orbit a line drawn from the Sun to the Earth will intersect different points of the celestial dome with a period of one year. Thus the portion of the stellar dome that we see keeps changing and we see different objects in the night sky as the months go by. In fact, in 6 months we see a totally different night sky than the one seen 6 months earlier. Thus the visible constellations actually tell us the time of the year. Finally, one may note that certain constellations actually lie on the plane of the ecliptic. These constellations like Aries, Leo, Libra, etc are called the zodiacal constellations. They are important because the planets, like Mars, Venus and Jupiter, will always be seen in the background of one of the zodiacal constellations since their orbits lie near the ecliptic.

How to Begin

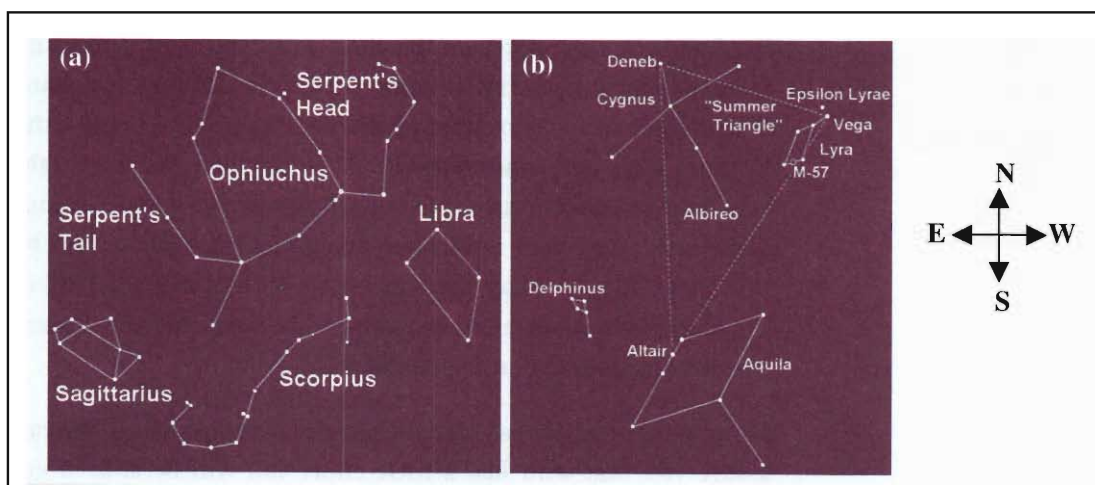
The way to become familiar with the sky is to observe it regularly, even if one can spend only a little time on each occasion. We suggest the following simple steps that will help the novice to get started:

a. Get a star chart or charts appropriate for that month and familiarize yourself with the principal features of the chart during the day so that it will be easier when you actually observe at night. For example if the month is August or September, the star charts shown in *Figures 4a* and *4b* will be useful. The chart in *Figure 4a*, showing the bright stars in Sagittarius and Scorpius, will be appropriate during the early part of the night looking south and west; the one in *Figure 4b*, will be more appropriate looking overhead and north, say at around 9-11pm. Note that the charts show east in the position opposite to the usual one; this is because the charts will be used overhead at night, rather than below head level.

b. During the day itself, decide where you are going to position yourself, a location where your observations will not be hindered by street lights and obstructions. Using a compass or a map or whatever, locate and fix in your mind the true northerly direc-

Note that the charts show east in the position opposite to the usual one; this is because the charts will be used overhead at night, rather than below head level.





tion. Although it is not essential, it may help to get a small, low power torch with the glass covered with a piece of thin, transparent, red plastic sheet. This can be used at night to look at the map without affecting your night vision.

c. Well after dark, around 9 pm, go out to where you plan to position yourself, get into a comfortable position, say, in a comfortable chair or on the ground and close your eyes for a few minutes. This will help to dilate your pupils so that your night vision will be sharper. After this you should not look at any terrestrial lights till your observations are over. Now, keeping in mind where north is, look upwards and try to locate the brightest stars that you noted, in preparation, on the star map. For example, in August-September, looking south and west you should try to locate the teapot of Sagittarius and the striking scorpion-like outline of the principal stars of Scorpius (*Figure 4a*); note that the teapot looks like tea is being poured on the tail of the scorpion. You will also note that Antares, the brightest star in Scorpius, is a brilliant red star. On the other hand if you look overhead and north, you should try to first locate the 'Summer Triangle' formed by the 1st magnitude stars Vega, Deneb and Altair (*Figure 4b*). If you locate these, then try and locate the wings and neck of the swan in Cygnus and the eagle like outline of Aquila. If you have difficulty, and most of you are bound to have at least some to begin with, hold the star chart over

Figure 4(a). Looking southwest, the region of Scorpius, Ophiuchus and Sagittarius can be identified without much difficulty in the evenings of August and September.

(b) At the same time towards zenith or overhead and north, the 'summer triangle' can be seen. The three bright stars are Vega (α Lyrae), Deneb (α Cygni) and Altair (α Aquilae). The recognition of such patterns will help identify the respective constellations.

head and align the north on the chart with true north and using your reddened torch try to locate the bright stars on the chart. With a little regular practice you will soon begin to recognize the brighter stars and constellations. You can then use the bright stars and constellations as pointers to the fainter stars and constellations. And your reward for this pleasurable labour will be the possibility of using the star charts to see, using a pair of binoculars or a small telescope, some of the beautiful star clusters and nebulae marked on the charts.

No amount of advice can take the place of actual practice. We can assure you that with just a little effort you will be able to get familiar with the night sky and enjoy a lifetime of real pleasure. So get started right away.

Acknowledgement

We would like to thank Jayendra Baliga and C S Yogananda for producing the excellent figures in the article.

Suggested Reading

- [1] H A Rey, *The Stars – A New Way To See Them*, Houghton Mifflin, 1981.
- [2] A P Norton, *Norton's Star Atlas*, Gall and Inglis Ltd., 1978.
- [3] P N Shankar, *A Guide To The Night Sky*, Karnataka Rajya Vignana Parishat, 1985.

Address for Correspondence

P N Shankar
CTFD Division, NAL
Bangalore 560 017, India.



I have often said from the podium that although it is gravity that holds my feet to the ground, it is the electromagnetic force that stops me from falling through the ground. Electromagnetism binds the atoms together and puts a solid floor beneath my feet.

Sheldon L Glashow

Higgins Professor of Physics at Harvard University

Interactions

Warner Books, New York, 1988, p.73