Nature Watch

The Treasures of the Night Sky

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In our previous article 'On observing the night sky'[1] we had introduced the reader to the stars and constellations and suggested how they may be observed. In this article we will provide a few technical details, which we had deliberately left out earlier and also introduce the reader to a number of the other remarkable objects that may be seen in the sky.

Stars, Constellations and Star Charts

You will recall that the sky is divided into 88 distinct regions called constellations and many of these can be conveniently identified by the patterns that their brighter stars appear to make. In this context, it should be pointed out that the stars in a constellation are not necessarily close together; what we see are their projections onto the celestial globe.

Although all stars move slowly relative to one another this motion is so slow that most stars appear to remain fixed in their positions over the duration of centuries. Thus the constellations are a convenient mapping of the sky. However, for accurate astronomical work the positions of the stars are better described by their coordinates on the celestial globe. In this mapping *the declination* or *dec* (δ), is the latitude on this globe measured in degrees, minutes and seconds while the *right ascension* or *RA* (α) is the longitude measured in hours, minutes and seconds. This is illustrated in *Figure* 1, which shows a region of the sky prominent in winter with the constellations Auriga, Perseus, Taurus and Orion holding forth in all their brilliance. The map shows the boundaries of the constellations, the brightest stars and the dec and RA lines. Thus, Capella, the brightest star in Auriga, has the coordinates RA 5^h13^m Dec 45°57'. This precise description

[1] Part 1. On Observing the Night Sky, *Resonance*, Vol.6, No.7, pp.89-96, 2001.

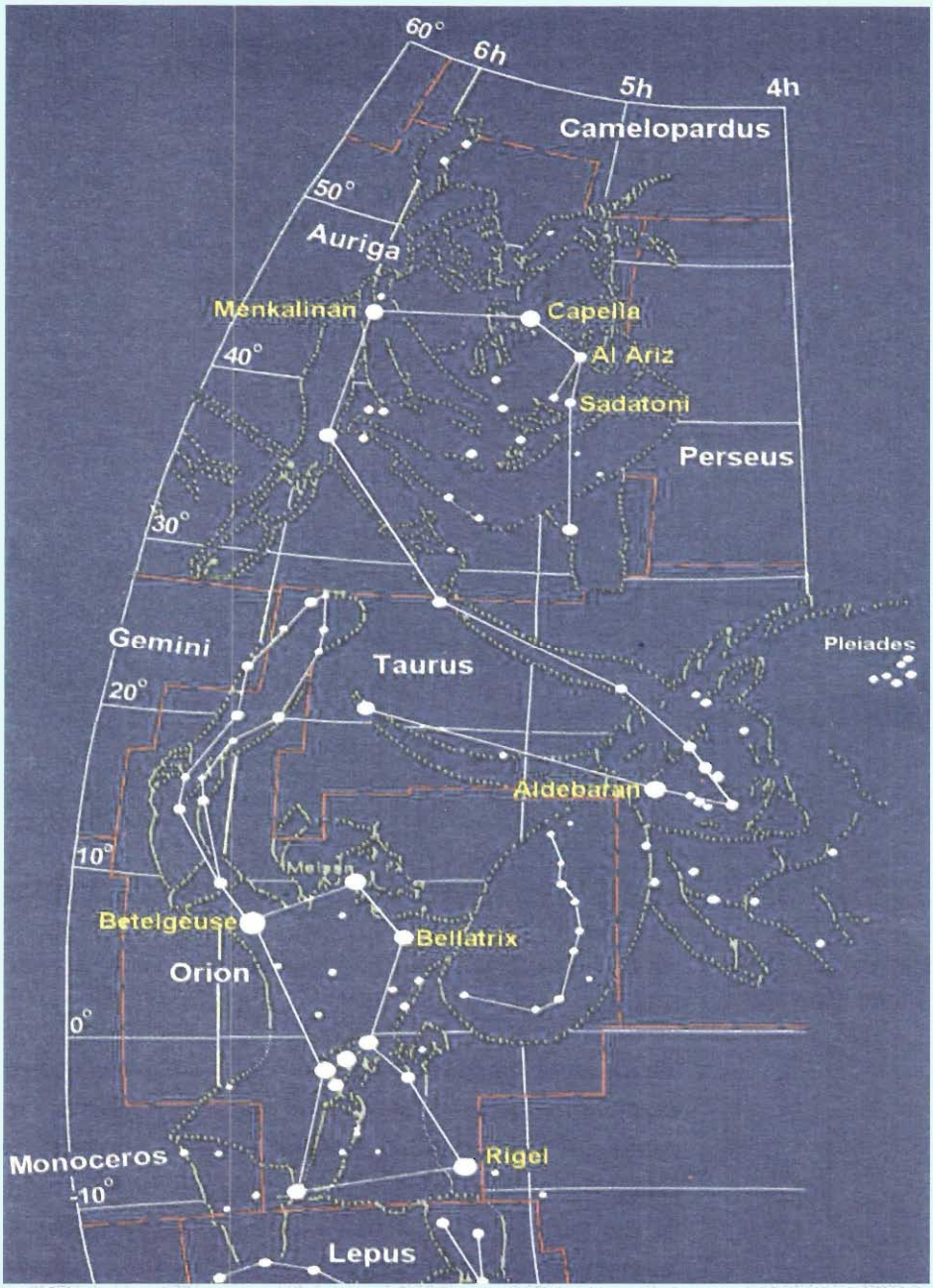

Figure 1. The sky map of the neighbourhood of Orion the hunter, with the right ascension and declination coordinates marked. Also shown are the fanciful outlines of Auriga the charioteer, Taurus the bull and Lepus the hare. The Messier objects indicated by an M are star clusters or nebulosities. A star map like this would be useful in identifying faint stars, nebulosities and clusters.

Star	Name	Sanskrit Name	Apparent Visual Magnitude	Absolute Magnitude	Distance (ly)
α CMaA	Sirius	लुब्धक	–1.47	+1.45	8.7
α Car	Canopus	अगस्तय	–0.72	–3.1	98
α Boo	Arcturus	स्वाती	–0.06	–0.3	36
α Cen A	Rigil Kentaurus	मित्र	0.01	+4.39	4.3
α Lyr	Vega	अभिजित	0.04	+0.5	26.5
α Aur	Capella	ब्रम्हहृदय	0.05	–0.6	45
β Ori A	Rigel	राजन्य	0.14	–7.1	900
α CMi A	Procyon	प्रस्वा	0.37	+2.7	11.3
α Ori	Betelgeuse	काक्षी	0.41	–5.6	520
α Eri	Achernar	अग्रनद	0.51	–2.3	118
β Cen AB	Hadar	मित्रक	0.63	–5.2	490
α Aql	Altair	श्रवण	0.77	+2.2	16.5
α Tau A	Aldebaran	रोहिणी	0.86	–0.7	68
α Vir	Spica	चित्रा	0.91	–3.3	220
α Sco A	Antares	ज्येष्ठा	0.92	–5.1	520
α PsA	Fomalhaut	मीनास्य	1.15	+2.0	22.6
β Gem	Pollux	पुनर्वसु	1.16	+1.0	35
α Cyg	Deneb	हंस	1.26	–7.1	1600
β Cru	Mimosa	त्रिशङ्कु शिर	1.28	–4.6	490
α Leo A	Regulus	मघा	1.36	–0.7	87

Table 1. Some of the brightest stars in the night sky.

would be essential if one had to automatically set a telescope on this star.

There are a variety of ways in which stars are named. For example the brightest star in the night sky is Sirius. It is also commonly called the Dog Star as it is the most prominent star in Canis Major, the Big Dog. Technically it is, as the brightest star in the constellation, α Canis Majoris; the Sanskrit name is Lubdhaka. One should not be worried by this apparent profusion of names; most stars other than the brightest ones just have the name based on their hierarchy in their constellation. *Table* 1 lists the 21 brightest stars in the sky, and gives some of their names and properties.

A star, which is just a spherical mass of primarily hydrogen gas fuelled by the nuclear reactions taking place in its core, is principally characterized by its intrinsic luminosity or brightness and its temperature, which is manifested by its colour. Hot stars are bluish in colour while cooler stars tend to be reddish. How bright they appear to an observer on Earth depends not just on their luminosity but also on how far away they are; remember the inverse square law of light. This is reflected in *Table* 1. In astronomy the brightness of a star is indicated by its *magnitude*, the precise definition of this logarithmic scale is not of relevance here. Suffice it to say that the brightest stars are of the 1st magnitude while the faintest stars that can be seen by the naked eye are of about the 5th magnitude.

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The Moon and the Planets

The moon is the brightest object in the night sky and to most observers a minor irritant as moonlight is always an impediment to viewing faint objects. On the other hand, it provides a very useful landmark or skymark for a beginner, to identify a constellation or a planet. For example, the almanac tabulates that on August 14th Saturn appears to be almost touching the moon; on August 15th Jupiter is about half a degree to the south of the moon; and on August 16th Venus will be about 2 degrees south of the moon. These ideas can be used to identify the planets. Likewise, the moon appears close to some bright stars, whose names are also indicated in the monthly maps.

Lunar motion has a period of about 28 days and it is always a good idea to utilize the period around new moon for sky watching. However, the moon is itself an object worthy of observation: its phases, its craters, its tendency to occult, or hide, other objects are all of interest. This is especially true if a small telescope is available. In fact, on 14th and 15th August the moon will be occulting Saturn and Jupiter respectively; from India we will be able to watch only the beginning of the Saturn occultation and the ending of the Jupiter occultation.

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Unlike the stars the planets, which do not essentially radiate out heat and light, are cold bodies in the inventory of our Solar System, visible only by the light they reflect from the Sun. They move about the sun in elliptical orbits, which by and large lie in a plane through the Sun, called the ecliptic. The inner planets are comparatively dense and are similar to the earth in composition and hence are called the terrestrial planets. On the other hand the outer planets with the exception of Pluto are gaseous in composition, of low density and similar to Jupiter and so are called the Jovian planets. Since most of the planets have orbits that lie in the ecliptic you will note, based on *Figure* 3 of Part 1, that the planets and the moon and indeed the Sun will, through the years, appear to trace paths through the same 12 zodiacal constellations. Apart from this characteristic there is of course nothing special about these constellations.

Planets are worth watching. Patience is essential for an observer to identify the planets. The first clue to identify them is the fact that they do not twinkle. They need to be monitored night after night. By marking their position in the stellar background one will find that (a) their positions change, the rate being different for each planet, (b) their brightnesses change as well.

The ones that are very easily seen with the naked eye are Venus, Mars, Saturn and Jupiter. Mercury too can be seen but since it is very close to the sun, it can only be seen near sunrise or sunset, very close to the horizon. Uranus and Neptune will require small telescopes and Pluto a little more effort. Note that since the planets are wandering stars they cannot be located in fixed positions on star charts; their moving positions have to be given in almanacs or on regularly changed charts. Many newspapers such as *The Hindu* carry star charts each month with the position of the planets marked on them.

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We strongly recommend your observing the motion of the planets through the ecliptic and if a telescope is available the red disc and polar caps of Mars, the beautiful rings of Saturn, the moons of Jupiter and the bluish disc of Uranus.

Comets, Meteors and Meteor Showers

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The solar system, which was born about 5 billion years ago, from the interstellar gas and dust out of which our own sun was born, consists of many objects all of which take part in the general rotation of the system. The principal objects, apart from the Sun, are the planets and their moons all of which lie in the ecliptic. Comets are very interesting objects, whose orbits can take any orientation with respect to the ecliptic. There are a number of theories of their origin, which need not concern us here, but it is generally known that they are made up of dust, rocky material and frozen gases. Some comets are periodic, i.e. they periodically return to the near neighbourhood of the Sun, while there are others which just make a single appearance before retreating back to the outer reaches of the solar system. The most famous periodic comet is that of Halley which returns approximately every 76 years. *Figure* 2 shows the orbit around the sun of another well-known comet, Comet Hale-Bopp. Comets are at times spectacular because they get partially vapourized by solar radiation as they approach the sun and leave behind them long, magnificent tails that may be visible to the naked eye for weeks. Searching for comets is a popular activity among amateur astronomers as it only requires skill and patience, not powerful equipment. Important points to be remembered in the search for comets are (a) they look different – they are fuzzy objects rather than point objects like the stars, (b) there will be a very small change in their position from night to night.

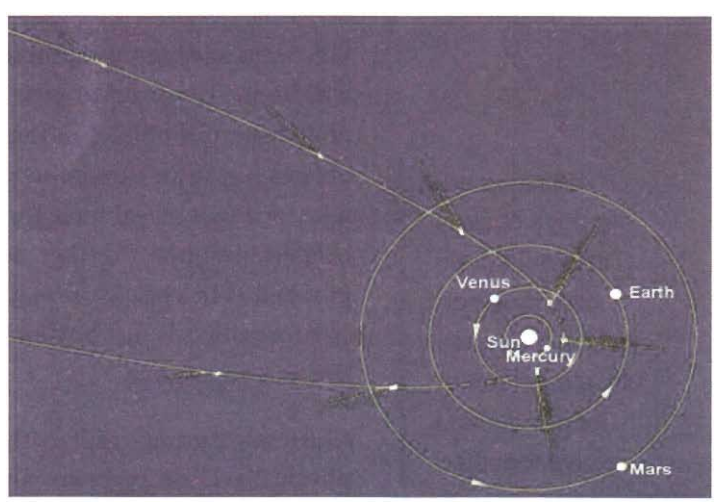

Figure 2. The orbit of the recent bright comet Hale Bopp with the orbit of earth marked. Notice that the comet moves both above and below the plane of the ecliptic. As a consequence, the comet's visibility is not restricted to the zodiacal constellations.

Closely related are meteors [4], which are rocky fragments or particles of interplanetary dust that burn up as they enter Earth's atmosphere. When they do this they leave behind short-lived bright trails that are visible to the naked eye. Meteor

Table 2. The more important meteor showers.

Dates visible	Name	Constellation
January 1-6	Quadrantids	Bootes
April 19-24	Lyrids	Lyra
May 1-8	Eta Aquarids	Aquarius
July 25-August 18	Perseids	Perseus
October 16-21	Orionids	Orion
October 20-November 20	Taurids	Taurus
November 10-25	Leonids	Leo
December 7-15	Geminids	Gemini

trails can be seen through out the year and in every part of the sky. More spectacular, however, are meteor showers, which are bursts that occur at specific times of the year at well defined locations. The locations are referred to as radiants and are identified by the celestial coordinates RA and dec (defined earlier). The designations with the names of the associated constellations are more popular; for example we have the Perseid showers reaching a peak on August 12, the radiant being located in the constellation of Perseus. Similarly, the Leonid showers reaching a peak on November 17th every year has its radiant in Leo. Meteor showers are the remnants of broken up comets that burn up as they cross the Earth in orbit around the Sun. *Table* 2 lists the important meteor showers.

Clusters, Nebulae and Galaxies

Once you have acquired some familiarity with the night sky you will be in a position to view with some optical aid some of the most beautiful objects in the sky. These do not look like point objects but rather resemble clouds or fluffy pieces of cotton. A telescope will reveal their true identity. There may be hundreds of stars grouped together as in a cluster, or billions of stars grouped as in a galaxy. It may be a simple molecular cloud where star formation is just beginning or the remnant of the death of a star as a supernova.

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They are, by and large, of two types: the open or galactic clusters and the globular clusters. The former are in the plane of our galaxy and have no definite shape; the globulars form a halo around the galaxy and are spheroidal in shape. Some of the most beautiful open clusters are in the Sagittarius–Scorpio region shown in *Figure* 5a of Part 1. A fine globular is M79 in Lepus, shown in *Figure* 1. The M in M79 refers to Charles Messier the 18th century astronomer who catalogued about a hundred so called nebulosities.

A real nebula is a cloud of interstellar gas and dust, which is visible only because of stellar light incident on it. This incident light can either be scattered or reemitted by the nebula. Nebulae are often striking objects. One of the most beautiful is the Orion Nebula, marked in *Figure* 1 as M42-M43, which can even be made out with the naked eye; naturally its full beauty requires at least a pair of low powered binoculars.

Galaxies are gigantic collections of stars that are the building blocks of the whole universe. A galaxy can be made up of a 100 billion stars. It is an amazing fact that if one looks in certain regions of the sky with a telescope almost all the objects one sees are galaxies. For the novice observer the most important galaxy, apart from our own Milky Way, is the Andromeda Galaxy, M31, in the constellation of Andromeda, since it is the only external galaxy that is visible to the naked eye. This huge spiral galaxy can be clearly seen on dark nights away from city lights, as a large bright patch or nebulosity. All other galaxies, many of the brighter ones which are in the Leo–Virgo region, require optical aid.

In conclusion, there are so many beautiful and interesting objects to be seen in the sky that it is, in our opinion, well worth the effort required to become familiar with the sky. So get started.

Acknowledgement

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

Suggested Reading

[1] J H Mallas and E Kreimer, *The Messier Album*, Cambridge University Press and Sky Publishing Corporation, 1978.

[2] P N Shankar, *Clusters, Nebulae and Galaxies*, Karnataka Rajya Vijnana Parishad, (also issued as special publication SP 8503B of the National Aerospace Laboratories, Bangalore), 1985.

[3] M Zeilik, *Astronomy: The Evolving Universe*, (3rd Ed), Harper & Row, 1982.

[4] B S Shylaja, Meteors – The Terrestrial and Celestial Connection, *Resonance*, Vol.4, No.11, pp.71-79, 1999.

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