

20. In the World of Stars



Let's recall.

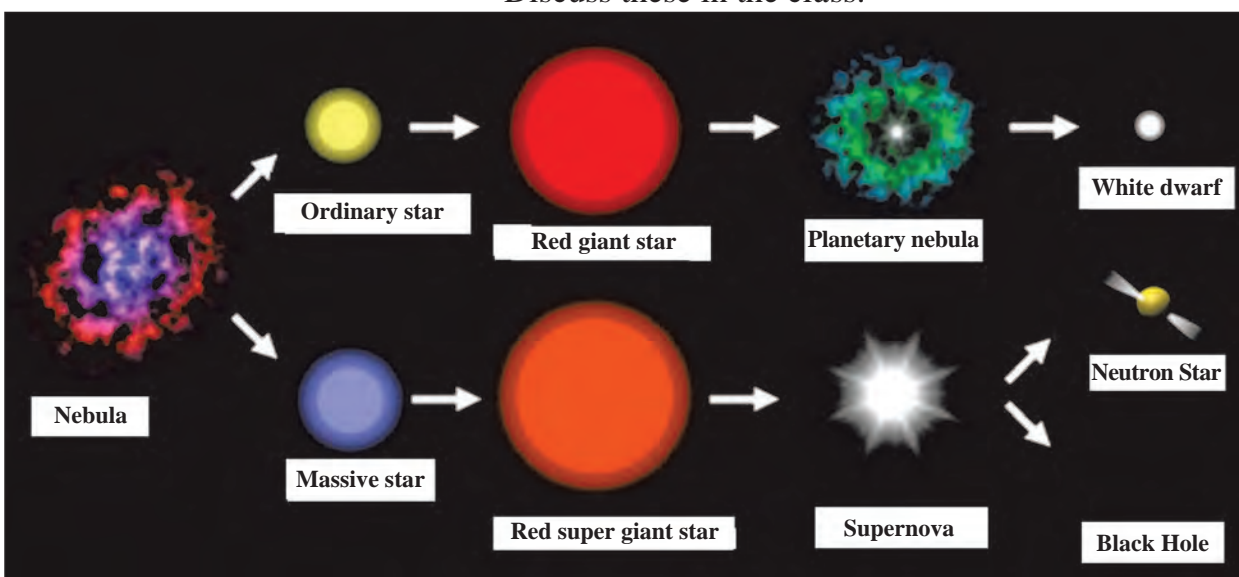
1. What is a galaxy? What are the various components of a galaxy?
2. What are the different types of stars?

We have already learnt about galaxies and stars as well as the solar system and its different components. Stars are born out of nebulae. Nebulae are clouds made up mainly of hydrogen gas and dust particles. The particles in these clouds are attracted towards one another due to the force of gravity. As a result, the cloud contracts and becomes dense and spherical in shape. At the same time, the pressure of the gas at the core of the cloud increases causing the temperature to rise tremendously and energy generation processes start there. Such a spherical cloud of hydrogen is called a 'star'. Later, processes such as contraction, expansion, rise in temperature, etc. bring about changes in the nature of the star. These changes occur over a very long period of time and constitute the lifecycle of stars. The different forms of the stars at various stages during this lifecycle are identified as different types of stars.



Observe and discuss.

The following figure shows different stages in the lifecycle of stars after their birth from a nebula. Discuss these in the class.



20.1 Lifecycle of stars

Our solar system is a tiny part of a galaxy called the Milky Way, which is many, many times larger than the solar system. There are lakhs of stars in the Milky Way, some of them being many times bigger than our Sun. Some of them have their own planetary systems. Stars in the Milky Way show a great diversity in colour, brightness, as well as size. Some stars, which appear to be close to one another making a particular figure are together known as a constellation. We shall learn more about constellations in this chapter. But, before that, let us learn a few basic concepts related to sky watching.

My friend, the internet!

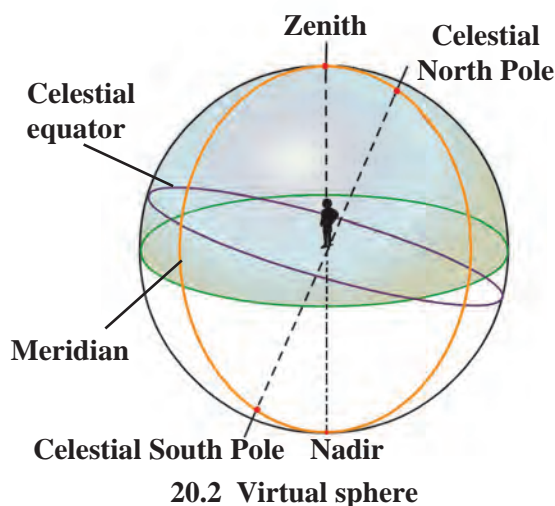
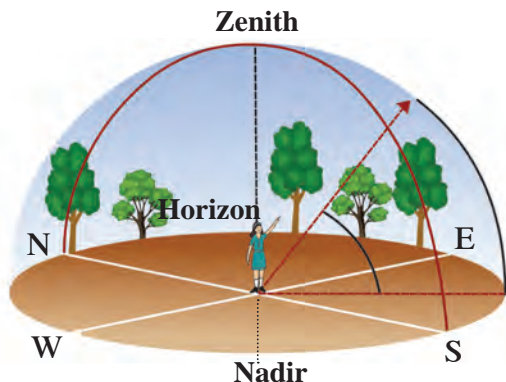
www.avkashvedh.com, www.space.com

Sky watching



Try this.

Stand still in an open space and look into the distance. What do you notice about the ground and the sky? Now, still looking into the distance, turn around yourself and observe the ground and the sky as you do so.



20.2 Virtual sphere

Sky and space

Sky : Standing in an open space, if we look at the sky on a cloudless night, we see numerous stars against a dark background. The portion of earth's atmosphere and the portion beyond that which can be seen in the form of a roof by our eyes while standing on the earth is called the sky.

Space : The continuous, empty space between the spheres (planets, stars, etc.) in the sky is called space. It may contain gas and dust particles. Numerous star clusters have formed in space.

Far away, the sky seems to be touching the ground. The line at which they meet is called the **horizon**. While turning around oneself, the horizon will be seen to form a circle and on looking up, the sky will appear to be a sphere based on this circle. The stars and planets moving in the sky appear to be moving on this sphere. This virtual sphere is called the **celestial sphere**. The circular horizon divides this sphere into two halves.

1. Zenith : While standing on the ground, the point on the celestial sphere exactly above our head is called the zenith.

2. Nadir : While standing on the ground, the point on the celestial sphere exactly below our feet is called the nadir.

3. Celestial poles : If we extend the axis of rotation of the earth in the north and south directions it will penetrate the celestial sphere at points called the celestial North Pole and the celestial South Pole, respectively.

4. Meridian : In astronomy, the great circle which passes through both the celestial poles and the observer's zenith and nadir is called a **meridian**.

5. Celestial equator : If we uniformly expand earth's equator in all directions indefinitely, it will penetrate the celestial sphere along a circle. This circle is known as the **celestial equator**. It is in the same plane as the earth's equator.

6. Ecliptic : The earth moves around the sun, but, seen from the earth, the sun appears to move along a circle on the celestial sphere. This circle describing the apparent motion of the sun around the earth is called the **ecliptic**.

The sun, the moon and the stars are seen to rise in the east and set in the west because the earth rotates from the west to the east. If we observe carefully, we will also notice that stars rise and set 4 minutes earlier every day. That is, if a star rises at 8 pm tonight, it will rise at 7:56 pm tomorrow. Against the background of stars, the sun and the moon appear to move from the west to the east, the sun moving through one degree every day and the moon through 12 to 13 degrees. This happens due to the motion of the earth around the sun and that of the moon around the earth.

Constellations

A group of stars occupying a small portion of the celestial sphere is called a **constellation**. Some of these stars appear to form certain figures of animals, humans or objects. These figures have been named after certain events or beliefs of the times when the constellations were identified. In this way, western observers have divided the celestial sphere into 88 constellations. Similarly, ancient western astronomers put forward the idea of 12 zodiac signs, whereas Indian astronomers suggested the 27 *nakshatras*.

Zodiac sign : The ecliptic has been imagined to be divided into 12 equal parts. Thus each part subtends 30 degrees at the centre of the celestial sphere. Each of these parts is called a *raashi* or zodiac sign. They are named Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius and Pisces.

Nakshatra : The moon completes one revolution around the earth in approximately 27.3 days. The portion traversed by the moon in one day is called a *nakshatra*. So if we divide 360 degrees into 27 equal parts, each part is about 13 degrees and 20 minutes. A *nakshatra* is known from the brightest star that it contains. This brightest star is called the *yogatara*. Which *nakshatra* we can see during a sky watch depends upon the position of the earth along its orbit.



Always remember –

1. The place for sky watching should be away from the city and, as far as possible, it should be a new moon night.
2. Binoculars or telescopes should be used for sky watching.
3. Identifying the Pole Star in the north makes the sky watch easier. Hence, the Pole Star should be used as a reference point for sky watch.
4. As the stars in the west set early, sky watching should begin with stars in the west.
5. As in geographical maps, the east and west are shown to the right and left respectively in a sky map.
6. On a sky map, the north and south are towards the bottom and top of the map respectively. This is because the sky map is to be held overhead. Hold the sky map in such way that the direction we face is at the bottom side.



Find out.

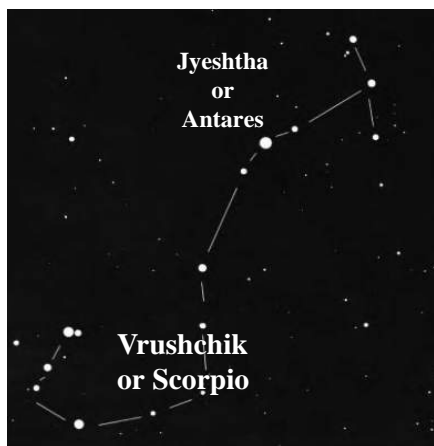
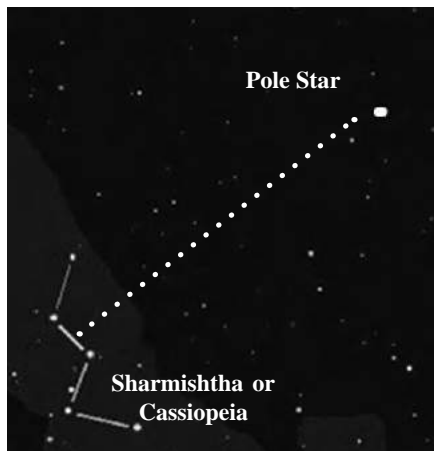
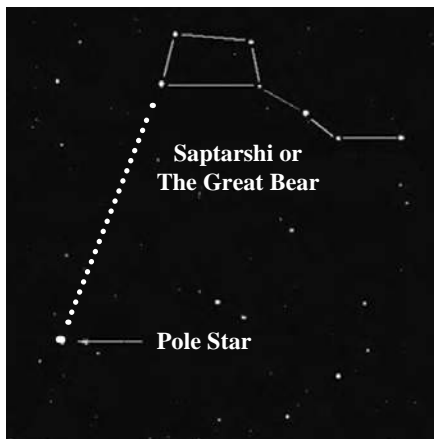
Using a Marathi calendar, collect information about the 27 *nakshatras* and divide them into the following three categories:

| | |
|---------------------------|--|
| Monsoon <i>nakshatras</i> | |
| Winter <i>nakshatras</i> | |
| Summer <i>nakshatras</i> | |



Use your brain power !

One zodiac sign = *nakshatras*.



20.3 Some constellations

Getting to know some constellations

1. During summer nights one can see a particular arrangement of seven stars. We call them Saptarshi. In the month of February, this constellation rises around 8 pm in the north-east. It is on the meridian in the month of April and in the month of October, it sets around 8 pm. As the name suggests, Saptarshi is a group of seven bright stars. It is in the shape of a quadrangle with a tail made up of three stars. It thus resembles a kite and can be easily recognized. If we extend one side of the quadrangle, it reaches the Pole Star or Polaris as shown in figure 20.3. Different countries have different names for this constellation. In English it is called the Great Bear.

2. The constellations of Saptarshi and Sharmishtha or Cassiopeia are useful in locating the Pole Star. Sharmishtha is made up of five bright stars which are distributed along the figure of the letter M. The perpendicular bisector of the line joining the third and fourth stars in Sharmishtha goes towards the Pole Star. (See figure.) The Pole Star has Saptarshi on one side and Sharmishtha on the other. As Sharmishtha sets, Saptarshi rises. Thus, we can always use either one or the other as a reference point on any given night.

3. Mrug *nakshatra* or Orion has very bright stars. On winter nights, they can be easily identified. It has seven-eight stars of which four are at the corners of a quadrangle. The line passing through the three middle stars of the constellation, when extended, meets a very bright star. This is Vyadh or Sirius. During the month of December, Mruga *nakshatra* rises at 8 pm on the eastern horizon. It is on the meridian during February and in June, it sets around 8 pm.

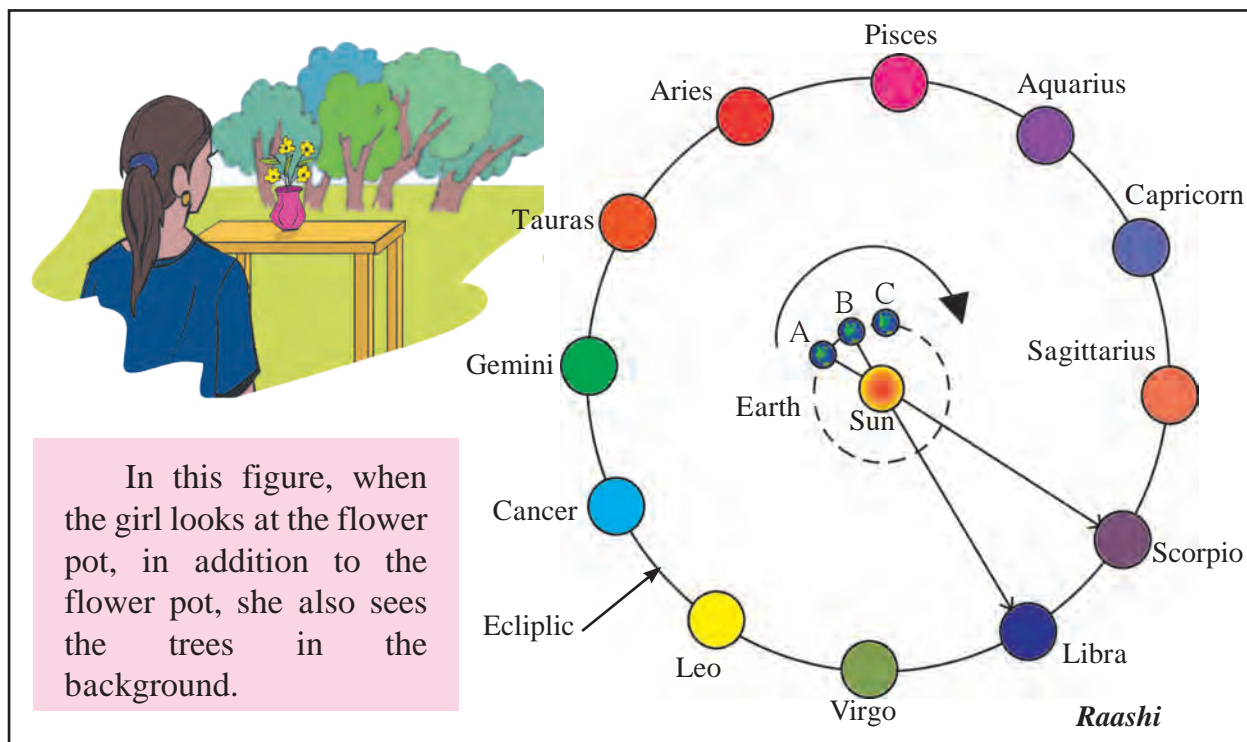
4. Vrushchik or Scorpio is a constellation with 10 to 12 stars. Jyeshtha or Antares is the brightest among them. This constellation is below the equator, in the sky of the southern hemisphere. In the third week of April, it can be seen in the eastern sky a few hours after sunset.

1. Why is the Pole Star important for sky watch?
2. What is the relation between the Pole Star and the constellations Saptarshi and Sharmishtha?



With the help of your friends, draw a big circle on the ground as shown in figure 20.4. Ask twelve of your friends to stand at equal distances along the circle, each holding a placard with the name of one zodiac sign in proper order.

Make one friend stand as the sun at the centre of the circle. Now, move along a smaller circle around the sun, as if you are the earth, facing the sun all the time. What do you notice as you move along this circular orbit? Ask your friends to take turns to do the same. Discuss what everybody sees.



20.4 Diagram of the experiment

The observer looking at the sun sees not only the sun but also a constellation behind the sun. The constellation cannot be seen in bright sunlight, but it is indeed present behind the sun. As the earth changes its position, a different constellation or zodiac sign or *raashi* appears behind the sun. This is what we express when we say that the sun enters a particular zodiac sign or *raashi*. For example, on Makar Sankranti we say that the sun enters Makar *raashi* (Capricorn zodiac sign).

When the earth is at A, for an observer on the earth, the sun appears to be in the Scorpio zodiac sign. When the earth moves from A to B, the observer will say that the sun has entered Libra. In reality, the sun does not move, but we perceive it as moving due to the motion of the earth around it. This motion of the sun is called its **apparent motion** and its path is called the **apparent path**. The rising of the sun in the east and its setting in the west is also an apparent motion. You might have heard some elders saying that a particular *nakshatra* is in the rising and now prevails. It means that, at that time, if you look at the sun from the earth, that particular *nakshatra* is behind the sun and gives you an idea about the position of the earth revolving around the sun.

National Institutions

IUCAA (Inter University Centre for Astronomy and Astrophysics) in Pune carries out fundamental research in astronomy.

In India, planetariums named after Pandit Jawaharlal Nehru have been established at New Delhi, Bangaluru, Allahabad, Mumbai and at New English School in Pune. They present a virtual projection of various stars and constellations as if it were a sky watch. Do visit these places during a school tour or whenever possible.



Layout of a planetarium

Website : www.taralaya.org



Always remember –

Science has proved that the constituents of the solar system e.g. planets, satellites and comets as also distant stars and constellations do not have any influence on human life. Man stepped on the moon in the twentieth century. He will conquer Mars in the twenty-first century. Hence, in this age of science, holding on to beliefs which have been proved to be wrong through numerous scientific tests, is an unnecessary waste of one's time, energy and money. It is necessary to consider all these issues with a scientific frame of mind.

Books, my friends !

'Aakashashi Jadale Naate', 'Chhand Aakashadarshanachaa', 'Vedh Nakshatrancha', and 'Taarakanchya Vishvat' are a few books which you may read to get more information on constellations and sky watching.

Exercise

- Write the proper words in the blanks.** (meridian, horizon, twelve, nine, apparent, celestial, ecliptic)
 - When seen from a great distance, the sky seems to be touching the ground along a circle. This circle is called the
 - The is used while defining the zodiac signs.
 - Classified according to seasons, one season will have *nakshatras*.
 - The rising of the sun in the east and its setting in the west is the motion of the sun.
 - A star rises at 8 pm tonight. At what time will it rise after a month? Why?**
 - What is meant by 'The sun enters a *nakshatra*'? It is said that in the rainy season the sun enters the *Mrug nakshatra*. What does it mean?**
 - Answer the following questions.**
 - What is a constellation?
 - What points should be considered before a sky watch?
 - Is it wrong to say that the planets, stars and *nakshatras* affect human life? Why?
 - Write a paragraph on the birth and lifecycle of stars using figure 20.1**
- Project :** Visit a planetarium, collect information and present it in your school on Science day. ♦ ♦ ♦