7th Science Lesson 13 Notes in English

13] Universe And Space

Introduction:

"My goal is simple. It is a complete understanding of the universe, why it is as it is and why it exists at all." — **Stephen Hawking**

Starry night sky is a wonder which has fascinated humans from time immemorial. Our ancestors have observed and documented the objects seen in the night sky. The field of study of the universe is called astronomy. We know that there are billions and billions of stars in the universe, although only about 2000 or so are visible to naked eye. Have you ever think of the size of our universe? The universe is unimaginably and infinitely big. Universe is commonly defined as the totality of everything that exists or is known to exist. Even

though the spatial size of the entire universe is still unknown, it is possible to measure the observable universe.

The universe consists of galaxies, planets, stars, meteorites, satellites and all other forms of matter and energy. And it is a world of wonder. Let us move into this world of wonder to know more interesting facts about the place of residence of our solar system.

GEO Centric Theory:

Sky is a wonder. Sun, Moon, stars all appear to rise in the East and move towards the west, giving us an impression that all these objects are going around the Earth. Just as in a moving bus the distant mountains and trees appear to move backwards, perhaps really Earth is spinning and that is why Sun, Moon and stars appear to

go around the Earth. Does the Earth revolve around the Sun, or the Sun revolves around the Earth? How do you know about it?

When you look at the night sky you can see lot of twinkling objects. But a few of them differ from the others. They don't twinkle and while the other stars hold a fixed pattern from night to night, these drift. They wander across the sky, moving against the backdrop of stars. These are called planets. Our ancestors observed this and they imagined a universe with the Earth at the center, the stars in the distant background, and Sun, Moon and the planets orbiting around us.

Two observations supported the idea that Earth was the center of the Universe. First, from anywhere on the Earth, the Sun appears to revolve around the Earth once in a day. While the Moon and the planets have their own motions, they also appear to revolve around the Earth about once per day. Even the celestial sphere studded with stars appears to rise and set in the evening, and make one complete rotation in a year. Second, the Earth seems to be unmoving from the perspective of an earthbound observer; it feels stationary.


As civilization progressed the early astronomers found two types of motion of celestial objects. Let us take the case of Moon. On a daily basis Moon appears to rise in the east and set in the west. Thus, one can say that Moon is going around the Earth with a period of one day. But for a careful observer, it was clear that the Moon was also exhibiting another motion. Suppose, the Moon is appearing in the sky today near the star Asvini, tomorrow we will observe that the Moon is near the star Bharani, a star east of Asvini. And the next day it will be near the star Kartikai, east of Bharani. After 27 days, moving little by little eastwards, the Moon again

stations itself near asvini. Thus, everyday Moon appears to move from east to west in one day where as it appears to go in a circle from west to east in the background of stars in about 27 days.

These two motions were puzzling. Very soon astronomers like Aryabhata said that Earth is spinning in its axis that is the cause of apparent daily motion from East to West. Whereas the eastward motion of Moon in the celestial sphere with a period of about 27 days, was seen as the 'actual' motion of the celestial objects.

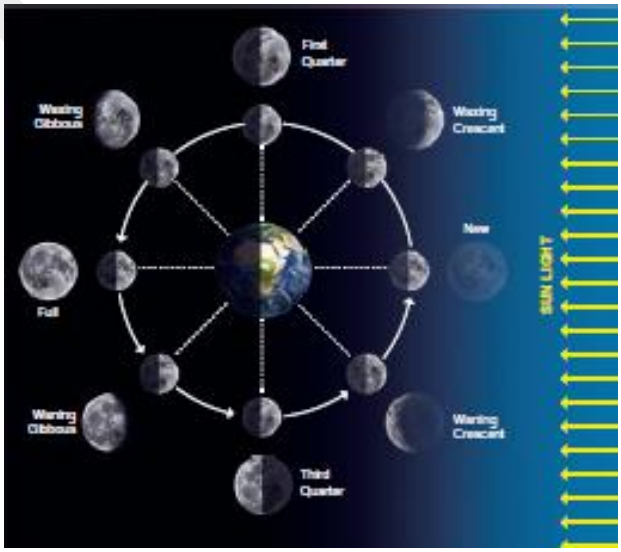
Thus, the geocentric model (also known as geocentrism), that is a description of the Universe with spherical and spinning Earth at the center and the Sun, Moon, stars, and planets all orbits the Earth emerged in various cultures. In Greece, this model was put forth by the Greek philosopher Plato and his disciple Aristotle in 6th century B.C. It was standardized by a Greeco Roman mathematician Ptolemy in the 2nd Century A.D. A similar model is seen in the Siddhanthic astronomy in India like Aryabhateeyam of Aryabhata.

How moon exhibit phases:

Astronomers in ancient times also observed certain facts. The Puranануru (65) of Sangam literature, the poet Poet Kalathalaiyar singing in appreciation of Cheraman Peruncheralathan says"

On the day when the full moon appears, the sun and moon look at each other with their bright light. In the evening time, one sphere hides behind the mountains."

On the full moon day, when the Sun is setting in the west, precisely at the same time, Moon rises at the East. That is both Sun and Moon are in the opposite side. Likewise when it is waning half moon, the Moon is rises when it is midnight and the waxing half moon rises during noon. From such observations and modelling ancient astronomers could explain why we have waxing and waning of moon.



It is probably easier to understand the waxing and waning of Moon in the order of new moon & full moon and then how the first and third quarter moon (half moon) appear and then the phases in between.

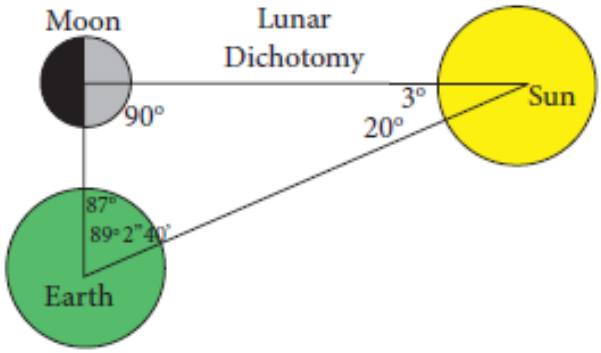
Sun is the source of light. Sun light falls on the spherical earth, but only on the side facing Sun. The opposite side of Earth is without sunlight. As the Earth spins day and night follows as different parts of Earth appear before the Sun. That is at all times one half of Earth is illuminated by Sun and one half is in darkness.

Likewise at all times one half of Moon is illuminated by Sun and the opposite side is shroud in darkness.

As shown in the above diagram, when the moon is positioned between the earth and sun, notice all the illuminated part of Moon is away from Earth. Hence we cannot see any part of the illuminated side of the Moon. Only the dark side of Moon is towards Earth. When the moon is in this position, we have new moon.

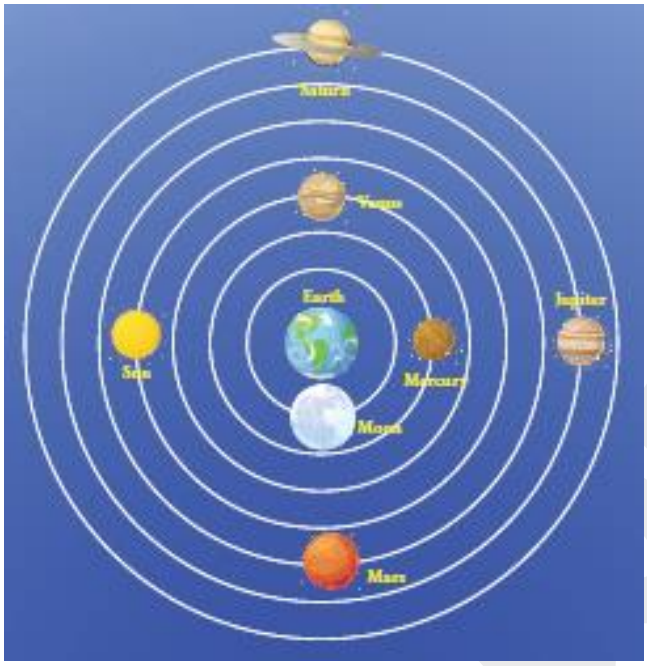
Now look at the moon when it is behind the Earth. Now the portion of the moon illuminated by sun is totally towards Earth. The dark side is away from the Earth. This means the moon will appear to be round in the sky. This is full moon.

When the Sun, Earth and Moon are in 90 degree angle how will the moon appear to a person on the surface of the Earth? Now if you look at the portion of moon facing Earth, we will see half if it illuminated and half is dark side. Thus, the moon will appear as half moon. The half moon during the waxing period is called as first quarter and the half moon during the waning period is called as third quarter. (figure sun moon and earth are at right angles)



Once we understand those four key moon phases, the phases between them should be fairly easy to visualize.

The word crescent refers to the phases where the moon is less than half illuminated. The word gibbous refers to phases where the moon is more than half illuminated. Waxing essentially means “growing” or expanding in illumination, and waning means “shrinking” or decreasing in illumination. Note all so that these discoveries could be made with naked eye. You do not need telescope or any modern equipment.



Epicycles:

Moon going around Earth with 27 day period nicely explained its motion. However astronomers in ancient times faced problem in explaining the motion of the then known five planets-Mercury, Venus, Mars, Jupiter and Saturn.

Moon in the background of stars moved everyday eastwards nicely. However for example, if we were observing the motion of Mars from January, it would appear to move eastward in the background stars. That is the position of mars today will be near a star which is east of the star near which it was yesterday. However on June 28, we will see a change. From that date the Mars would appear to move west rather than its normal eastward motion. This reversal of direction of planets is called as 'retrograde motion'. If we continue to observe, on August 28 once again the Mars would appear to reverse the direction and again on its usual eastward motion in the celestial sphere. Usually Jupiter is brighter than Mars, however, around the period of retrograde motion the Mars was much bright than other times; even brighter than Jupiter.

Other planets also exhibited number of puzzling behaviours. Venus and Mercury always appeared very close to Sun, and hence never appeared in the midnight sky. The brightness of Jupiter also varied again when it exhibited retrograde motion. For example in 2018, Jupiter reversed its direction of motion on March 9, 2018 and again resumed its normal eastward motion on July 11, 2018.

The simple geocentric model, where planets go around the Earth could not explain why the brightness of the planets changed, and why they reversed their directions. Change in brightness and retrograde motion would be impossible if we assumed that the planets were at the same distance at all times from Earth.

To explain the puzzling phenomena astronomers in early times proposed a change in the simple geocentric model. This is called as epicycle model.

Ptolemy (2nd cent) in Greece, Aryabhatta in India and others used the epicycle model to explain the motion of the celestial objects. Their models were improved by generation of astronomers like Tycho Brahe and Neelakanta Somayaji.

Although, the model explained many phenomena there were number of mismatches. The model was becoming messy.

Arrival of telescope:

Telescope was invented by Hans Lippershey but Galilio used it for studying the sky for the first time. The telescope showed more universes was than visible to naked eye. With his simple telescope matching toy telescopes of today, Galileo was able to see mountains on the Moon, small dim stars invisible to naked eye, sunspots on the face of Sun. He was able to demonstrate that the milkyway, an hazy bright patch in the sky is nothing but thousands of stars huddled together, Jupiter had moons going around it and Saturn had mysterious appendage which we now know as rings.

One of the most startling observations he made was related to telescopic observation of Venus. This convinced him to accept the theory of the Polish Astronomer Nicolus Copernicus, that it is not Sun, planets and Stars that go around Earth, but it is Earth and other planets that go around the Sun- heliocentric theory.

Heliocentric model:

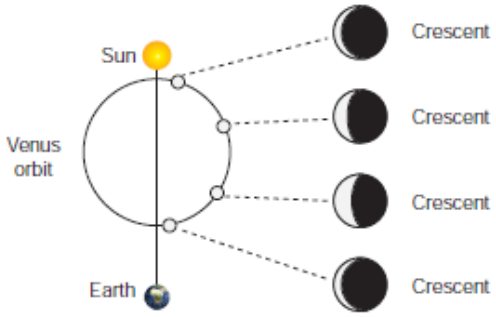
Dissatisfied with the messy epicycle model Nicolus Copernicus, radically proposed that the model will become simple if we assume Sun is at the center and all planets, including Earth, go around it.

Suppose, Earth and Mars are on the two sides of the Sun, then Mars would be far and appear dim, compared to when they are on the same side. Earth orbit around Sun in 365 days, whereas Mars takes 687 days. This implies at times Earth will overtake Mars. When the Earth is approaching and overtaking Mars, the Mars would appear to exhibit retrograde motion. In short all the observed phenomena could be explained in a simple way.

However how do we know that actually Sun is at the center or not?

Galileo found that his observation of Venus gave the observational evidence to support the heliocentric theory. Galileo observed Venus in 1610-1611 with a telescope. To naked eye, Venus is just a gleaming bright spot. However, through a telescope, the shape of the planet can be seen. Galileo was startled to find like Moon

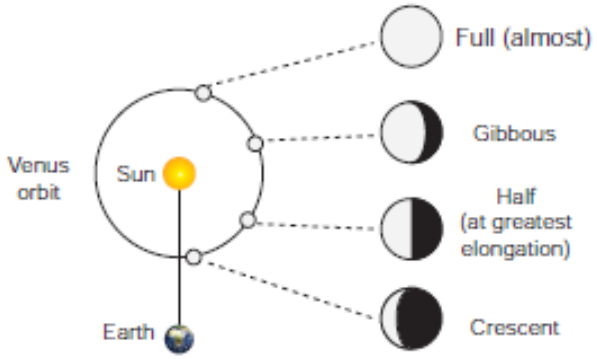
Venus too exhibited phases. The shape varied from crescent to gibbous. Also, the size of the planet varied. When the planet was in gibbous phase the size was small, and when it was thin crescent the size was many folds higher.



As the Venus went around the epicycle, as shown in the diagram Venus would exhibit phases. Also at times the planet would be nearer, making the apparent size grow bigger and at

times far making the apparent size smaller. Thus, the variation in the brightness can also be explained.

It became clear to Galileo that the geocentric epicycle model will not help in accounting for the observed phases of the Venus.



Look at the above diagram. If the Venus was going around the Sun, and its orbit is inside that of Earth, Venus would appear always near the Sun in the sky. It can never be seen in the midnight sky. Two when it is near the Earth, it would be brighter and bigger compared to when it is on the other side of the Sun. Thirdly only if the Venus is revolving around the Sun, it can exhibit gibbous phase, and the size of the gibbous phase smaller than the crescent phase. If the Venus was revolving around the Earth, we can never see the gibbous phase of the Venus and it would be seen only if it is orbiting the Sun. This clinching observational evidence proved that at the least Venus orbited around the Sun. Further evidences collected by astronomers using telescope and other advanced modern instruments gave enough evidence that all planets revolve around the Sun.

If Galileo were around today, he would surely be amazed at exploration of our solar system and beyond by ISRO, NASA, Russian space agency and others.

Now we can observe planets orbiting around other stars (called exo-planets), proving that not only planets orbit around the Sun in solar system, but all around the universe such planetary systems exist. Who knows, in some of there could be life and in rare cases intelligent life, like humans wondering and exploring universe. Imagine a future time when such life meet us; how exciting and momentous it would be!

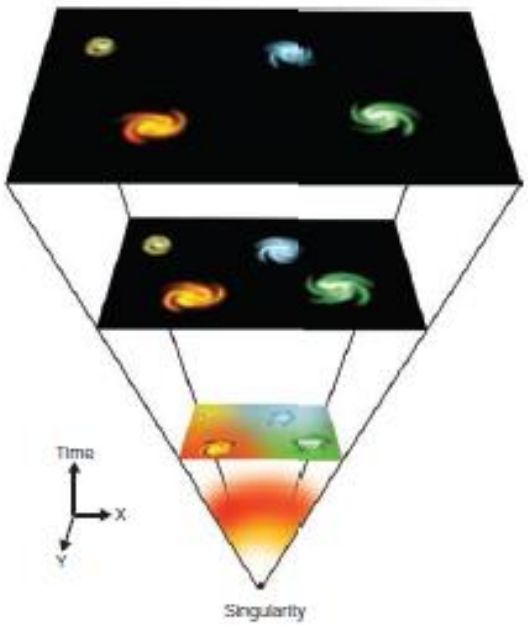
Origin of the Universe:

You are a student who belongs to a particular class studying in VII std. In your school, there might me many section for VII std. Likewise, there are VI std class, VIII std class and so on. All of them together make the school. Likewise, our Sun is a star with a planetary system. Billions of such stars constitute a system called as galaxy. The name of our galaxy is, Milky Way. Like Milky Way, there are at least hundreds of billions of galaxies in the Universe.

How did all these come about? Where they in existence always or was there a beginning?

When we observed other galaxies we found a strange behaviour. All the galaxies were appearing to move away from us. Further, farther they are faster they appear to move. Cosmologists , scientists who study the structure and evolution of universe that is cosmos, reason that this imply at one point of time in the past all matter was confined in a single point and since then it has started to expand.

The event when the matter confined in a single point and began to expand is called 'big bang'. This is considered as the origin of our universe as we know it.



The Big Bang Theory is the prevailing model of the evolution of the Universe. Under this theory, space and time emerged together about 14 billions of years ago. At that time, the entire Universe was inside a bubble that was thousands of times smaller than a pinhead. It was hotter and denser than anything we can imagine. Then it suddenly expanded. The present Universe emerged .Time, space and matter all began with the Big Bang.

In a fraction of a second, the Universe grew from smaller than a single atom to bigger than a galaxy. And it kept on growing at a fantastic rate. It is still expanding today. Over the next three minutes, the temperature dropped below 1 billion degrees Celsius. After 300 000 years, the Universe had cooled to about 3000 degrees. Atomic nuclei could finally capture electrons to form atoms. At that stage of the evolution of the

Universe, it was filled with clouds of hydrogen and helium gas. Giant clouds of hydrogen and helium were gradually drawn to the places where dark matter was most dense, forming the first galaxies, stars, and everything else seen today.

We cannot see anything that happened during the first 300000 years of the Universe. Scientists try to work it out from their knowledge of atomic particles and from computer models. The only direct evidence of the Big Bang itself is a faint glow in space, called cosmic microwave background.

As millions of years passed, the dense areas pulled in material because they had more gravity. Finally, about 100 million years after the Big Bang, the gas became hot and dense enough

for the first stars to form. New stars were being born at a rate 10 times higher than in the present-day Universe. Large clusters of stars soon became the first galaxies.

Building Blocks Of Universe:

As stated above universe is constituted of galaxies, just as lot of houses in our locality constitute a village or a city. We have lot of things such as rooms, furniture etc. in our homes. Likewise lot of stellar objects such as stars, planets, asteroids and meteors are the building blocks of our universe.

Galaxies:

A galaxy is a large collection of stars or cluster of stars and celestial bodies held together by gravitational attraction. There are about billions of galaxies in the universe. Most galaxies range from thousand to ten thousand parsec in diameter. As we have different types of houses in a locality, the galaxies are also of different types.

Types of galaxies:

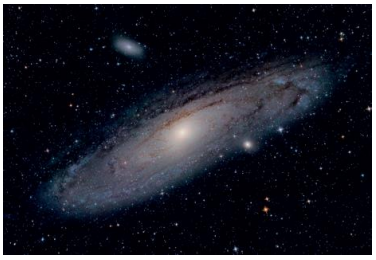
There are various types of galaxies such as spiral, elliptical, barred spiral and irregular.

Spiral Galaxy:

Spiral galaxies consist of a flat, rotating disk containing stars, gas and dust, and a central concentration of stars known as the bulge. These are often surrounded by a much fainter halo of stars. Spiral galaxies are named by their spiral structures that extend from the center into the galactic disc. The spiral arms are sites of ongoing star formation and are brighter than the surrounding disc because of the young, hot stars that inhabit them.

Elliptical Galaxy:

An elliptical galaxy is a type of galaxy having an approximately ellipsoidal shape and a smooth image. Unlike flat spiral galaxies with organization and structure, elliptical galaxies are three-dimensional, without much structure, and their stars are in somewhat random orbits around the center. Interestingly Stars found inside of elliptical galaxies are on an average much older than stars found in spiral galaxies. Elliptical galaxies tend to be surrounded by large numbers of globular clusters.



Irregular Galaxy:

An irregular galaxy is a galaxy that does not have a distinct regular shape, unlike a spiral or an elliptical galaxy; they are often chaotic in appearance, with neither a nuclear bulge nor any trace of spiral arm structure. About one forth of the galaxies found so far are of this type.

Cosmologists say that some irregular galaxies were once spiral or elliptical galaxies but were deformed by an uneven external gravitational force. Irregular galaxies may contain abundant amounts of gas and dust.

Barred Spiral:

A barred spiral galaxy is a spiral galaxy with a central bar-shaped structure composed of Stars. Bars are found in approximately in two-thirds to one third of all spiral galaxies. The Milky Way Galaxy, where our own Solar System is located, is classified as a barred spiral galaxy.

Milky Way:

The Milky Way is the galaxy in which our solar system is located. The diameter of Milky Way is over

100,000 light years. The Milky Way includes stars smaller than our Sun as well as many other stars that are thousands of times bigger than the Sun. It includes many other celestial bodies of gases, clouds of dust, dead stars, newly born stars, etc. It is also thought to contain at least 100 billion stars. The galaxy that is closest to our Milky Way is Andromeda. The descriptive “milky” is derived from the appearance from Earth of the galaxy – a band of light seen in the night sky formed from stars that cannot be individually distinguished by the naked eye. In Indian mythology, this patch called as Akasha Ganga. From the Earth, the Milky Way appears as a band because its disk-shaped structure is viewed from within. Galileo Galili first resolved the band of light into individual stars with his telescope in 1610. Until the early 1920s, most astronomers thought that the Milky Way contained all the stars in the Universe. Observations by Edwin Hubble showed that the Milky Way is just one of many galaxies.

The Milky Way does not sit still, but is constantly rotating. Our solar system is located within the disk of the galaxy, about 27,000 light years away from the centre of the galaxy. The solar system

travels at an average speed of 828,000 km/h. Even at this rapid speed, the solar system would take about 230 million years

to travel all the way around the Milky Way. When the solar system was in the same spot as it is now, there were no humans, no Himalayan mountain on Earth and the dinosaurs were roaming around the Earth.

Tucked inside the very center of the galaxy is a monstrous black hole, billions of times as massive as the sun. Although, black holes cannot be directly viewed, scientists can see their gravitational effects as they change and distort the paths of the material around it, most galaxies, like our milky way, are thought to have

a black hole in their heart.

Constellation:

A constellation is a recognizable pattern of stars in the night sky when viewed from the Earth. International Astronomical Union has classified 88 constellations to cover the entire celestial sphere. Many of the old constellations have Greek or Latin names and are often named after mythological characters.

Ursa Major (Saptha Rishi Mandalam) is a large constellation and it covers a large part of the sky. The most striking feature of this constellation is a group of seven bright stars known as big dipper (seven Sages in Indian astronomy).

Ursa Minor in Lattin means 'the little bear' it lies in the northern sky. The Pole star – Polaris (Dhrua) lies within this constellation. The main group, 'little dipper', consists of seven stars and is quite similar to that found in Ursa Major.

Orion was a hunter in Greek mythology. The constellation comprises around 81 stars out of which all but 10 are too faint to be seen with naked eye.

Different constellations become visible in the sky at different times in the year. This happens due to the revolution of the Earth around the Sun.

Unlike galaxy, constellations are mere optical appearance and not real objects. In galaxy stars are bound by gravity and constitute a system. In a constellation, one star may be near and another very very far, but because they are in the same direction appear to be near to each other in the sky.

Name of Constellations:

Indian Name	English Name
Mesham	Aeries
Rishabham	Taurus

Midhunam	Gemini
Kadakam	Cancer
Simmam	Leo
Kanni	Virgo
Thulam	Libra
Vrischikam	Scorpio
Dhanusu	Sagittarius
Makaram	Capricorn
Kumbam	Aquarius
Meenam	Pisces

Stars:

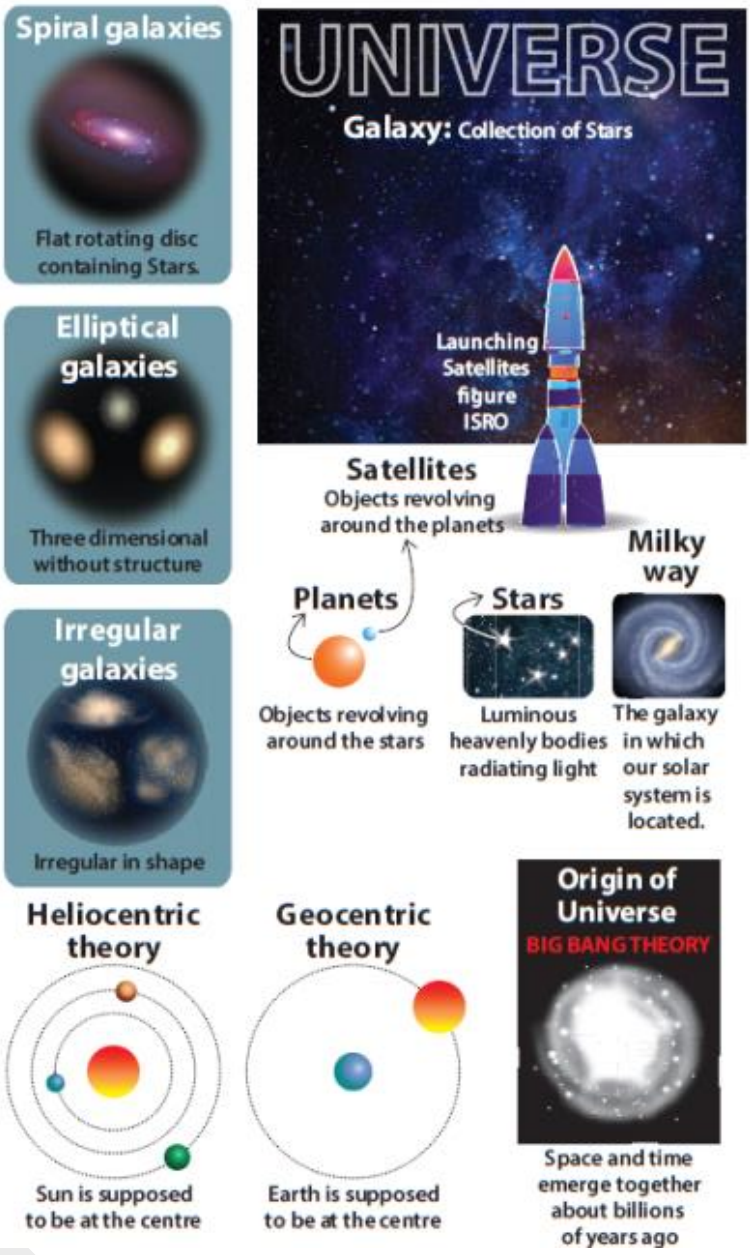
A Star is a luminous heavenly body that radiate energy. With naked eyes, we can see nearly 3000 stars in the night sky and many more with the help of a telescope. The stars are remotely located and appear as tiny dots of light. Their light travels long distances to reach us. The atmosphere disturbances do not allow light to reach us in a straight line path. Because of this the stars appear to twinkle. The Sun is the nearest star to the Earth. The next nearest star is Alpha Centauri.

Satellites:

An object that revolves around a planet in a stable and consistent orbit is called a satellite. Satellites can be classified into two categories – natural and artificial.

Natural satellites:

All natural objects revolving around a planet are natural satellites. They are also called moons. Most moons are spherical, the ones that are not usually asteroids or meteors that were captured by the strong gravity of a planet. All planets except mercury and Venus in our solar system have moons. Earth has only one moon- whereas planets like Jupiter and Saturn have more than 60 moons.



Artificial satellites:

Artificial satellites are man-made objects placed in an obit to rotate around a planet – usually the Earth. The world's first artificial satellite launched was Sputnik-1 by Russia, Aryabhatta was the first satellite launched by India. These satellites are used in television and radio transmission, studying agriculture yield, locating mineral resources, weather forecasting, locate different places on earth.

ISRO:

The Indian Space Research Organisation (ISRO) is the space agency of the Government of India headquartered in the city of Bangalore. Its vision is to "harness space technology for national development while pursuing space science research and planetary exploration."

Formed in 1969, ISRO superseded the erstwhile Indian National Committee for Space Research (INCOSPAR) established in 1962 by the Scientist Vikram Sarabhai. The establishment of ISRO thus institutionalized space activities in India. It is managed by the Department of Space, which reports to the Prime Minister of India.

ISRO built India's first satellite, Aryabhatta, which was launched by the Soviet Union on 19 April 1975. It was named after the Indian astronomer Aryabhata. In 1980, Rohini became the first satellite to be placed in orbit by an Indian-made launch vehicle, SLV-3. ISRO subsequently developed two other rockets: the Polar Satellite Launch Vehicle (PSLV) for launching satellites into polar orbits and the Geosynchronous Satellite Launch Vehicle (GSLV) for placing satellites into geostationary orbits. These rockets have launched numerous communication satellites and earth observation satellites. Satellite navigation systems like GAGAN and IRNSS have been deployed. In January 2014, ISRO used an indigenous cryogenic engine in a GSLV-D5 launch of the GSAT-14.

ISRO sent a lunar orbiter, Chandrayan -1, on 22 October 2008 and a Mars orbiter, Mars Orbiter Mission, on 5 November 2013, which entered Mars orbit on 24 September 2014, making India the first nation to succeed on its first attempt to Mars, and ISRO the fourth space agency in the world as well as the first space agency in Asia to reach Mars orbit. On 18 June 2016 ISRO set a record with a launch of 20 satellites in a single payload. On 15 February 2017, ISRO launched 104 satellites in a single rocket (PSLV-C37) and created a world record. ISRO launched its heaviest rocket, Geosynchronous Satellite Launch Vehicle- Mark III (GSLV-Mk III), on 5 June 2017 and placed a communications satellite GSAT-19 in orbit. With this launch, ISRO became capable of launching 4 ton heavy satellites.

ISRO launched Chandran 2 on July 22, 2019, Geosynchronous Satellite Launch Vehicle (GSLV-Mk III). It entered the Moon's orbit on August 20, 2019 and its lander landed on the Moon on September 7.

Points to Remember:

- The field of study of the universe is called astronomy.
- The universe consists of galaxies, planets, stars, meteorites, satellites and all other forms of matter and energy.
- The half moon during the waxing period is called as first quarter and the half moon during the waning period is called as third quarter.
- The word crescent refers to the phases where the moon is less than half illuminated. The word gibbous refers to phases where the moon is more than half illuminated.
- The reversal of direction of planets is called as 'retrograde motion'.

- The geocentric theory followed by the ancient people proposed that the Earth is at the centre and the sun and other planets revolve around it.
- The helio-centric theory states that the sun I at the centre and the planets revolve around it.
- Galileo gave the observational evidence to support the heliocentric theory.
- There are at least hundreds of billions of galaxies in the Universe.
- A galaxy is a large collection of stars or cluster of stars and celestial bodies held together by gravitational attraction.
- A constellation is a recognizable pattern of stars in the night sky when viewed from the Earth.
- An object that revolves around a planet in a stable and consistent orbit is called a satellite.
- The Indian Space Research Organization (ISRO) is the space agency of the Government of India headquartered in the city of Bangalore.


The Missile Man Of India
A.P.J. Abdul Kalam (1931-2015)
Abdul Kalam started his school education in Government school at Rameswaram. He was very much interested in science and mathematics during his school days
He assisted his relative, a news paper agent during his childhood to meet his educational expenditure
During childhood in his school days, Kalam wondered about the flying of birds and clarified his doubts from his teachers. This incident acted as an impetus for him to become a scientist and an aircraft engineer
He got graduate degree in Physics in 1954. Then, in 1955, he joined MIT, Chennai to pursue his course on Aerospace Engineering
After completing his studies at MIT, he designed an aircraft named 'Nandhi' using indigenous materials with the help of indigenous technologists. He operated that flight himself
He took charge as the Director of Indian Defence Research Development Organisation and the scientific advisor to the Defence Ministry of India in 1983

More to know:

The Hubble Space Telescope and powerful ground-based telescopes are now beginning to find galaxies that were created about one billion years after the Big Bang. These small galaxies were much closer together than galaxies are today. Collisions were common. Like two flames moving towards each other, they merged into bigger galaxies. Our Milky Way galaxy came together in this way.

Astronomical unit: The average distance between the Earth and the Sun is called an astronomical unit. It is denoted by 'au'.

1 au = 1.496×10^8 km

Light year: The distance travelled by light in one year is called a light year. It is denoted by 'ly'.

1 ly = 9.4607×10^{12} km

Parsec: A parsec is defined as the distance at which one astronomical unit subtends an angle of one arc second. It is denoted by 'pc'.

1 pc = 3.2615 ly = 3.09×10^{13} km

Subrahmanyan Chandrasekhar (19 October 1910 – 21 August 1995) was an Indian Americanastrophysicist who spent his professional life in the United States. He was awarded the 1983 Nobel Prize for Physics with William A Fowler. His mathematical treatment of stellar evolution yielded many of the best current theoretical models of the later evolutionary stages of massive stars and black holes. The Chandrasekhar limit is named after him. Chandrasekhar worked on a wide variety of physical problems in his lifetime.

In 1989, Galileo Galilei was memorialized with the launch of a Jupiter-bound space probe bearing his name. During its 14-year voyage, the Galileo space probe and its detachable mini-probe, visited Venus, the asteroid Gaspra, observed the impact of Comet Shoemaker-Levy 9 on Jupiter, Europa, Callisto, IO, and Amalthea.

In order to avoid the possible contamination of one of Jupiter's moons, the Galileo space probe was purposely crashed into Jupiter at the end of its mission in September 2003.