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# CHAPTER -1

# ORIGIN OF EARTH AND ITS POSITION IN SPACE

**Gaseous Theory (1755)**

- By Imanuel Kant (German)
- Primordial matter was evenly distributed in shape of small & cold particles from which our earth & other planets of solar system formed

**Nebular Hypothesis (1796)**

- By Laplace (French)
- Primordial matter existed in form of intensely hot & rotating gaseous mass (Nebula), Which cooled with time
- This resulted in decrease of its volume & increase in its rotational speed, which in turn increased its centrifugal force
- The centrifugal force when exceeded gravitational force, a ring shape deformed from nebula & many other rings formed out of its breaking.
- These rings on cooling became planets & satellites & remaining part of nebula is sun

**Planesimal Hypothesis (1900)**

- By Chamberlain & Moulton
- A wandering star approached the sun & exerted its gravitational pull on the sun, which resulted in separation of cigar shaped material from the sun.
- As star moved away from the sun, material separated from the sun started revolving around the sun & condensed into planets at later stage.

**Tidal Hypothesis**

- By Sir James Jeans (British) & Harold Jeffrey
- Sun was a gaseous mass; another star several times larger than sun accidentally came close to it & pulled gaseous mass away from the sun due to its gravitational pull.
- Giant tongue of matter came out from the sun & planets were formed

**Big Bang Theory (1929)**

- By Edwin Hubble (American)
- Everything in the world emerged from a point known as singularity (of indefinite mass & indefinite density) about 13.7 billion years ago.
- As galaxies moved away, space between them expanded (Red shift).
- As the universe expanded, hot radiation in original firewall cooled down, which led to formation of different galaxies which further broke into stars & finally stars broke to form planets.

## PLACE OF THE EARTH IN THE UNIVERSE

The universe is commonly defined as everything that exists, including all physical matter and energy, the planets, stars, galaxies, and the contents of intergalactic space. The term universe may be used in slightly different contextual senses, denoting such concepts as the cosmos, the world, or nature.

In the ancient times, the knowledge about the universe was vague and confined to mystery and religious perceptions. In 140 AD, **Ptolemy** propounded the theory that the earth was the centre of the universe and sun and not the earth was the centre of the universe. However, he still equated the universe with the solar system. **Kepler** supported Copernicus but said that the sun was in the centre of the solar system and not the universe. In 1805, Hershel made it clear that the solar system was a part of the much larger system of stars called galaxy.

**Edwin Hubble** in 1924 first demonstrated existence of galaxies beyond Milky Way. He proved that these galaxies are flying away from each other and that the farther they are, the faster they fly. This means that the universe is expanding like a ballon that is being blown up.

Our galaxy is **Milky Way Galaxy** (or the **Akash Ganga**). It is spiral in shape. It consists of over a 100 billion stars rotating and revolving about its centre. Nearest galaxy to ours is Andromeda.

**POSITION, SHAPE AND SIZE**

- The shape of the earth is oblate spheroid or oblate ellipsoid (i.e. almost spherical, flattened a little at the poles with a slight bulge at the centre)
- This hypothetical surface, called a geoid, is a reference surface from which topographic height and ocean dept are measured.
- Geodesy also named geodetics a branch of earth sciences, is the scientific discipline that derals with the measurement and representation of the earth.

**PROOF OF THE EARTH'S SPHERICITY**

- **Ship's visibility** → When a ship appears over the distant horizon, top of the mast is seen before the hull & vice a versa.
- **Sunrise & Sunset** → Sun rises & sets at different times in different places. As earth rotates from west to east, places in east see sun earlier than those in the west.
- **Lunar eclipse** → Shadow cast by earth on the moon during the lunar eclipse is always circular

**Driving poles on level ground on curved earth**

- Engineers while driving poles of equal length at regular intervals on the ground have found that they do not give a perfect horizontal level.
- Centre pole normally projects slightly above the poles at either end because of curvature of the Earth
- Hence they have to make certain corrections for this inevitable curvature i.e. 8" to a mile

**Aerial Photographs**

- Pictures taken from high altitudes by rockets & satellites show clearly the curved edge of the earth.
- This is perhaps the most convincing & up to date proof of earth's sphericity

# CHAPTER-2
# SOLAR SYSTEM

**The Star Formation**

**Stars are self-luminous bodies** that account for 98 per cent of the material in the galaxy. The rest 2 percent consists of interstellar or galactic gas and dust in an attenuated form. Stars are formed by gravitational contractions from these vast clouds of galactic gas and dust. Star forming clouds are thousands of times denser than the normal interstellar gas. Star forming matter is richer in hydrogen and helium.

A star's **colour indicates the temperature** of its surface. Blue colour denotes maximum temperature. Then comes yellow, then red, etc.

The life of a star is spread over billions of years. It begins to form by compression of galactic gas and dust. Compression generates heat which in turn causes hydrogen to be converted into helium **nuclear fusion**, thereby emitting large amount of heat and light.

Continued nuclear fusion over a period of time starts depletion of hydrogen and the helium core becomes increasingly heavy, resulting into swelling and reddening of outer regions. Such starts of gigantic dimensions are termed as **Red Giants.**

If the star is of sun's size, it becomes a **White Dwarf**. Their density can reach up to 10· grams per cubic cm. If the star is bigger than the sun but not more than twice as big, it will turn into a **Neutron Star or Pulsar**. Their central density is $10^{14}$ grams per cubic cm. They are formed due to **Novae** or **Super Novae** explosion.

Stars having mass greater than three times that of the sun, because of their great gravitational power, have contracted so much that they have developed super density of 1016 grams per cubic cm. It is so dense that nothing, not even light, can escape from its gravity and hence called **'Black Hole'.**

Brightest star outside our Solar System is **Sirius,** also called **Dog Star.**

Closest star of Solar System is **Proxima Centauri** (4.2 light years away). Then come **Alpha Centauri** (4.3 light years away) and **Barnard's Star** (5.9 light years away)

Measurement Units of space are:

| | |
|---|---|
| Light Year | It is the distance covered by light in one year in vacuum at a speed of 3· $10^5$ km/s A light year is a measure of distance and not of time. Light travels at a speed of 300,000 km/second. Considering this, the distances the light will travel in one year is taken to be one light year. This equals to 9.461×1012 km. The mean distance between the sun and the earth is 149,598,000 km. In terms of light years, it is 8.311 minutes of a year. |

| | |
|---|---|
| Astronomial Unit (A.U.) | It is the mean distance between the earth and the sun. one light year is equal to 60,000 A.U. |
| Parsec | It represents the distance at which the mean radius of earth's orbit subtends an angle of one second of an arc. |

**Universe and Solar System**

In the vastness of the Universe, the Earth, the Sun and planets are tiny dots. The Sun is a single star in a Galaxy comprising 100,000 million stars.

The Solar System is centered on the Sun. It consists of a star called the Sun and all the objects that travel around it. The Solar System includes : **8 planets** (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune) along with the numerous satellites that travel around most of them; planet-like objects called **asteroids** (hundreds of asteroids); chunks of iron and stone called meteoroids; bodies of dust and foreign gases called **comets** (thousands of comets); and drifting particles called interplanetary dust and electrically charged gas called plasma that together make up the interplanetary medium.

The whole solar system by volume appears to be an empty void. This vacuum of 'space' comprises the interplanetary medium. The speed of the solar wind is about 400 kilometer per second in the vicinity of Earths' orbit.

The Solar System originated in a primitive solar nebula–a rotating disc of gas and dust. It is from this rotating disc that the planets and the rest of the Solar System evolved. The Solar System is also tucked away in a corner of the Milky Way at a distance of about 30,000 to 33,000 light years from the centre of the galaxy.

**The Sun contains 99.85% of all the matter in the Solar System**. The planets which condensed out of the same disk of material that formed the Sun, contains only 0.135% of the mass of the Solar System.

Jupiter contains more them twice the matter of all the other planets combined. Satellites of the planets, comets, asteroids, meteoroids, and the interplanetary medium constitute the remaining 0.015%.

Our solar system consists of a **Star** (sun), 8 **Planets, 5 Dwarf Planets** and countless fragments of left-over called asteroids, meteors comets, and satellites of the planets **(Called small solar system Bodies).**

**THE SUN**

**SUN SOME FACTS**

| | |
|---|---|
| Average distance from Earth | 14,95,98,900 km |
| Diameter | 13,91,980 km |
| Temperature of Core | 1,50,00,000 c |
| Temperature of Photosphate | 5,760 c |
| Rotation period | 25 days (at equator, 33 days (at poles) |
| Chemical Composition | Hydrogen-70%, Other-2% |
| Age | 4.6 billion years (approx.) |
| Expected Life | 10 billion years (approx.) |
| Time Taken by light to reach from Sun to Earth | 8 min 16.6 sec. |
| Velocity of light (in vacuum) | 3,00,000 km/sec |
| Gravitational Pull | 28 times than that of Earth |

**STRUCTURE OF SUN**

The structure of the Sun can be divided into several different layers as follows:

**Core**

- The core of the Sun has the highest temperature and pressure among all layers.
- The temperature of the core is around 15 million degree Celsius – is in ionized state called plasma
- The solar energy is produced in the core by controlled nuclear fusion process.

The high temperature in the core helps in removing the electrons from hydrogen atoms and in creating numerous electrons and protons for nuclear fusion.

**Radiative Zone**

- The Sun's radiative zone is the section of the solar interior between the innermost core and the outer convective zone.
- In the radiative zone, energy generated by nuclear fusion in the core moves outward as electromagnetic radiation.

**Convective zone**

- In this zone the density of plasma is low.
- This zone transports hot and light density fluids from the core region of high energy & temperature to the outer region of low energy & temperature.

**Photosphere**

- This is the first visible layer of the Sun.
- The temperature here is around 6000 degree Kelvin (5370 degree Celsius).
- The solar spots are formed on this layer. The temperature of a solar spot is around 4500 degrees.

**Solar spots** → Temporary dark spots formed when the magnetic field bursts through the surface. It can slow down the flow of energy from the inside of the Sun – that's what makes the sun spots cooler & darker than the surrounding photosphere.

**Chromosphere**

- Chromosphere literally mean as 'sphere of colour'.
- This layer is dominated by emission lines.

**Corona**

- This is the outermost layer of the Sun.
- High temperature in this region gives it an unusual spectral feature of a highly ionised ion.
- Chromosphere & corona are visible only during formation of Diamond Ring during Solar eclipse.

**THE PLANETS**

The 2006 redefinition of "Planet" by the International Astronomical Union (IAU) states that, in the solar system, a planet is a celestial body that:

- Is in orbit around the Sun.
- Has sufficient mass so that it assumes a hydrostatic equilibrium (nearly round) shape
- Has "cleared the neighborhood" around its orbit.
- A non-satellite body fulfilling the first two of these criteria is classified as a **Dwarf Planet,** whilst a non-satellite body fulfilling only the first criterion is termed a **Small Solar System Body (SSSB).**

According to the definition, there are currently eight planets and five dwarf planets known in the solar system. Planets are divided into two groups: large, low-density gas giants and smaller, rocky terrestrials.

Under IAU definitions, there are 8 planets in the Solar System-Mercury, Venus, Earth, Mars (called Terrestrial Planets), Jupiter, Saturn, Uranus, Neptune (called Jovian Planets). Planets according to size: Jupiter, Saturn, Uranus, Neptune, Earth, Venus, Mars and Mercury. **The 5 dwarf planets are Pluto, Ceres, Eris, Makemake and Haumea.**

**MERCURY**

Rotation: 58.65 days.
Revolution: 88 days (Fastest revolution in Solar System). Maximum diurnal range of temperature. Its days are scorching hot and nights frigid. It has no atmosphere and no satellite.

**VENUS**
Also called **Earth's Twin,** because it is slightly smaller than earth (500 km less in diameter).Popularly known as **Evening star** and **Morning Star**. It is seen in the eat in the morning and in the west in the evening. It is not possible to see it all over the night. Brightest object after sun and moon (because of 70 allbedo, the reflecting power). Closest planet to earth. It is the hottest planet in Solar System. It is because of the Green house effect as its atmosphere contains 90-95% carbon dioxide. The night and day temperatures are almost the same. Rotates backward (clockwise) unlike others. It has no satellite. Slowest rotation in Solar System (257 days). Almost equal rotation and revolution (224.7 days).

**EARTH**
Earth is also called **Blue Planet**. It is the densest of all planets. Circumference: 40,232 km. Area: 510 million sq. km. Average distance from sun: 149 million-km.
The energy of sun comes from the fusion of hydrogen into helium. **Sunlight takes 8 mins; 16.6 sec to reach earth**. Ecliptic is an imaginary annual path of Sun across the sky. Its age is 5 billion years and the total life is 10 billion years.

**MARS**
Also called **Red Planet.**
Revolution: 687 days Rotation: 24.6 hrs (almost equal to Earth). It has a thin atmosphere comprising of nitrogen and argon. It is marked with dormant volcanoes and deep chasms where once water flowed. Recent explorations have thrown light on the possibilities of existence of life here. The highest mountain here is named 'Nix Olympia', which is three times higher than Mount Everest. It has 2 satellites-**Pheibos and Deimos**.

**JUPITER**
Largest of all planets (71% of the total mass of all planets). Called **Lord of the Heavens.** It is about eleven times larger than the earth. Its volume is one and half times the volume of all the planets combined together .Jupiter appears to have stopped halfway to becoming a star. It was too massive to solidify as a planet but not massive enough to develop 'nuclear fusion and become a star. It gives off more energy than it receives from the sun, because of the heat inside. Its atmosphere contains hydrogen, helium, methane and ammonia.

A great **red spot** is detected on it. It has the fastest rotation time (9.8 hr) in the Solar System. Revolution: 12 years. It has 63 satellites (Prominent are Europa, Gannymede & Callisto). Gannymede is the largest satellite of Solar System.

**SATURN**
Saturn is an outer planet visible to the naked eye. Second in size to Jupiter, it is the least dense of all the planets. Revolution: 29 yrs. Rotation: 10.3 hrs. Least density of all (30 times less dense than earth). Unique feature is its system of rings (3 well defined). These are separate particles that move independently of circular orbits. 61 satellites (Prominent is Titan).The space probe, Cassini, is on Saturn these days.

**URANUS**
Identified as a planet in 1781 by William Hershel. Seems to rotate from north to south as it is inclined at an angle of 98· to its orbit. Revolution: 84 yrs. Rotation: 10.8 hrs. Surrounded by a system of 9 faint rings. Has 27 satellites (prominent are Miranda, Airtel, etc.)

**NEPTUNE**
Appears as 'Greenish Star' Revolution: 165 yrs. Rotation: 15.7 days. Has 5 faint rings. Discovered by JG Galle of Berlin in 1846.13 satellites (prominent are Triton and Nereid).

**PLUTO**
Pluto is the second largest known Dwarf Planet in the Solar System. Since its discovery by Clyde Tombaugh in 1930, Pluto was considered the ninth planet from the Sun. in August, 2006, the International Astronomical Union (IAU) redefined the term 'Planet', and classified Pluto, Ceres, Eris, Makemake and Haumea as Dwarf Planets. Now, Pluto has been given the number 134340.

**PLANETS: IN FIGURES**

| **Planet** | **Distance from Sun (in million km)** | **Diameter (in km)** | **No. of Satellites** | **Rotation period** | **Revolution Period** |
|---|---|---|---|---|---|
| Mercury | 5.79 | 4878 | 0 | 58.65 days | 88 days |
| Venus | 10.82 | 12102 | 0 | 257 days | 225 days |
| Earth | 14.96 | 12755 | 1 | 23 hrs, 56 min,40.91 sec | 365 days, 5hrs 48 min, 45.51 sec |
| Mars | 22.79 | 6787 | 2 | Almost 24hrs | 687 days |
| Jupiter | 77.83 | 142800 | 63 | 9 hrs | 12 years |
| Saturn | 142.70 | 120500 | 61 | 10.3 hrs | 29 years |
| Uranus | 287.96 | 51400 | 27 | 10.8 days | 84 years |
| Neptune | 497.06 | 48600 | 13 | 15.7 days | 165 years |

**SOLAR SYSTEM: SOME FACTS**

| | |
|---|---|
| Biggest Planet | Jupiter |
| Smallest Planet | Mercury |
| Nearest Planet | Mercury |
| Farthest Planet from Sun | Neptune |
| Nearest Planet to Earth | Venus |
| Brightest Planet | Venus |
| Brightest star after Sun | Sirius |
| Planet with maximum satellites | Jupiter |
| Coldest Planet | Neptune |
| Hottest Planet | Venus |
| Heaviest Planet | Jupiter |
| Red Planet | Mars |
| Biggest Satellite | Gannymede |
| Smallest Satellite | Deimos |
| Blue Planet | Earth |
| Morning/Evening Star | Venus |
| Earth's Twin | Venus |
| Green Planet | Neptune |
| Planet with a big red spot | Jupiter |
| Lord of the Heavens | Jupiter |
| Greatest Diurnal Temperatures | Mercury |

**SATELLITES**

Satellite are bodies which revolve around the planets. All planets have one or more satellites, except Mercury and Venus. The moon is the earth's natural satellite. In August 1989, the US Space probes Voyager-1 and Voyager-2 revealed six new satellites around Neptune which was earlier believed to have only two satellites.

**Earth's Natural Satellite (Moon)**

The moon is the earth's natural satellite and is its nearest neighbour in space. It revolves around the earth while rotating on its own axis. Only 59% of its surface is directly visible from the earth. Of all satellites in the solar system, the moon is the largest in proportion to its primary body, that is, the earth. All other satellites have sizes below 1/8 the size of the mother planet. The moon is about 1/4 the size of its mother planet, the earth. It takes about 1.3 seconds for moonlight to reach the earth, whereas sunlight takes about 8 minutes and 16.6 seconds to reach the earth.

The moon takes 27 days 7 hours 43 minutes and 11.47 seconds to complete one revolution of the earth. It rotates on its axis in exactly the same time. Hence, we see only one side of the moon.

Circumference: 11,000 km. Diameter: 3475 km/ Gravitational pull: $1/6^{th}$ of Earth. Its orbit around earth is elliptical. The maximum distance (Apogee) of the moon from the earth is 406,000 km and the minimum distance (Perigee) is 364,000 km. the average distance is 3,82,200 km.

Sidereal Month:- Moon completes 1 rotation in 27 days 7 hrs & 43 min approx. wrt earth

Synoptic Month:- Moon completes 1 rotation in 29 days 12 hrs & 44 min approx. wrt sun

All **other satellites** (except Charon) have sizes below 1/8 the the size of mother planets. But moon is about $1/4^{th}$ the size of earth.

To our unaided vision, moon seems to be made up of bright and dark patches. The bright parts are the mountains and highlands, while the darker patches are low-lying planes. The highest mountains on moon are Liebnitz Mountains, which are 10,600 m high. They are situated at moon's South Pole.

Moon has no atmosphere, no twilight and no sound. Moonlight takes 1.3 sec to reach earth. It has a low albebo (amount of sunlight reflected). It reflects only 7% and the rest is absorbed (Earth: 30%, Venus: 70%) .

**Neil Armstrong and Buzz Aldrin** reached moon on July 20, 1969 on Apollo XI and set the foot on July 21, 1969 (landing spot is called **Sea of tranquility**).