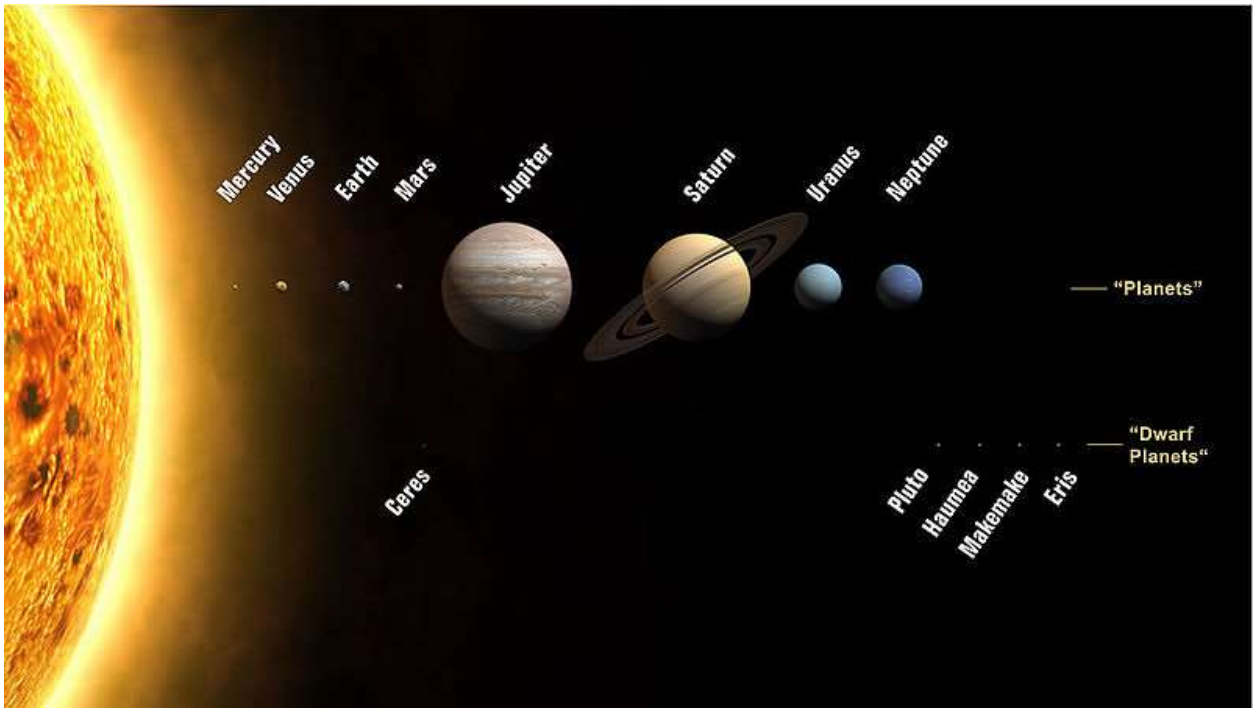
Summary Notes - Topic 11: Exploring the Solar System Part 1

11.1 The Solar System’s Structure

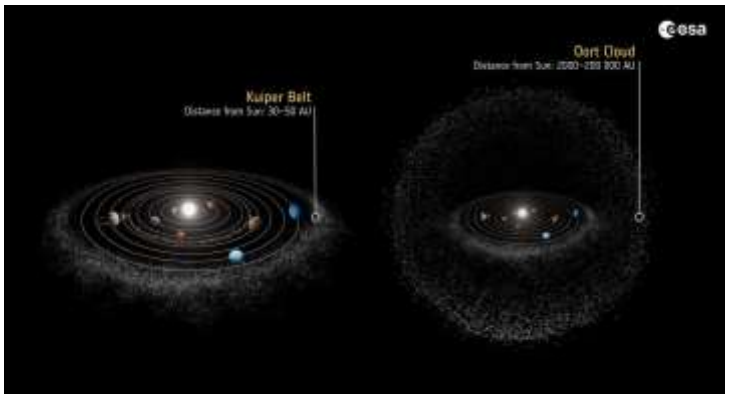
The Solar System consists of various celestial bodies:

- **Planets** – Orbit the Sun and are large enough to be spherical.
- **Dwarf Planets** – Similar to planets but haven't cleared their orbits (e.g., Pluto, Ceres).
- **Small Solar System Objects (SSSOs)** – Includes asteroids, meteoroids, and comets.

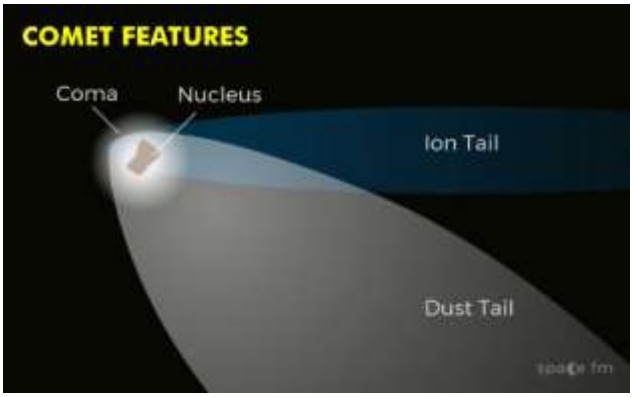


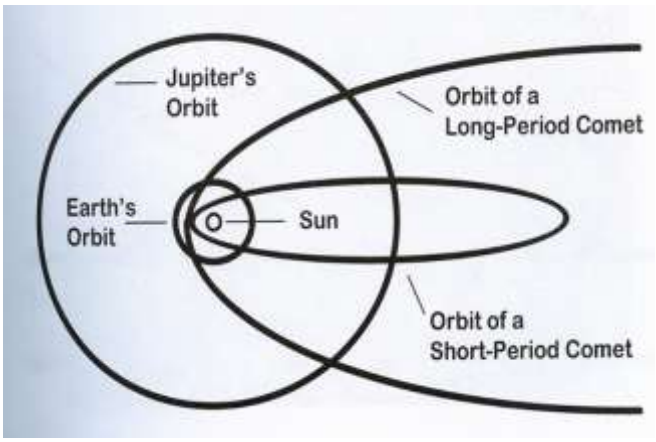
11.2–11.5 &11.11 Elliptic, Comets and the Outer Solar System

- **Ecliptic Plane** – Most Solar System objects orbit the Sun in a nearly flat disk
- **Kuiper Belt -** region of the Solar System outside the orbit of Neptune. It is thought to extend several times the orbit of Pluto, possibly between 100 to 1000 AU.
- **Oort cloud -** spherical region at between 10,000 to 20,000 AU
- **Heliosphere -** It is a 'bubble' surrounding the solar system, created by the solar wind. It is thought to be 'cigar-shaped' as it is shaped by the Sun's movement.



- **Comets -** are ice and rock bodies. Comets have a highly elliptical inclined orbit, can have retrograde motion. Some comets have open orbits.
- **Comet Structure** – Made of a **nucleus, coma, and tails** (ion tail points away from the Sun).
    - **Nucleus –** Solid ice and rock, typically no larger than an average asteroid.
    - **Coma –** Spherical region around the nucleus formed by evaporation of ice as the comet approaches the sun
    - **Dust tail -** A curved dust tail forms and can be up to several millions of kilometres long. This tail forms because of radiation pressure from the Sun.
    - **Ion tail -** Particles from the solar wind hit the comet and an ion tail is produced which is more coloured but straighter than the dust tail.





- **Short-period comets** – Originate in the **Kuiper Belt**, taking less than 200 years to orbit.
- **Long-period comets** – Originate in the **Oort Cloud**, taking thousands of years to orbit.

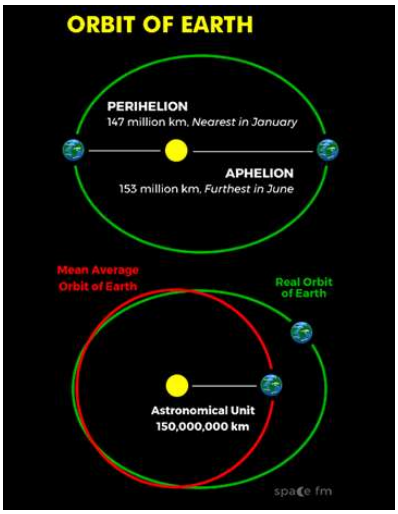
11.6 Planetary Characteristics

Planets vary in:

- **Relative size and mass** – Gas giants (Jupiter, Saturn) vs. rocky planets (Earth, Mars).
- **Surface temperature** – Hotter planets are closer to the Sun.
- **Atmospheric composition** – Gas giants have thick atmospheres, terrestrial planets have thinner ones.
- **Satellites & rings** – Gas giants have **multiple moons and ring systems**.

Name	Type of body	Mean distance from Sun/AU	Sidereal period/ Earth year	Mean temperature /°C	Diameter /1000 km	Mass/ Earth mass	Ring systems	Moons
Mercury	planet	0.38	0.24	170	4.9	0.055	no	none
Venus	planet	0.72	0.62	470	12.1	0.82	no	none
Earth	planet	1.0	1.0	15	12.8	1.00	no	1: the Moon
Mars	planet	1.5	1.9	−50	6.9	0.11	no	2 small moons: Deimos and Phobos
Ceres	dwarf planet	2.8	4.6	−105	0.95	1.5×10^{-4}	no	none
Jupiter	planet	5.2	11.9	−150	143	318	yes	4 major moons: Ganymede, Callisto, Europa, Io >60 others
Saturn	planet	9.5	29.5	−180	121	95	yes	5 major moons: including Titan, Iapetus >55 others
Uranus	planet	19.1	84.0	−210	51	15	yes	5 major moons: including Titania, Oberon >20 others
Neptune	planet	30.0	165	−220	50	17	yes	1 major: Triton >12 others
Pluto	dwarf planet	39.5	248	−230	2.4	2.2×10^{-3}	no	1 major: Charon >4 other moons
Haumea	dwarf planet	43.1	283	−241	1.4	6.7×10^{-4}	no	2
Eris	dwarf planet	67.8	557	−230	2.3	2.8×10^{-3}	no	at least 1

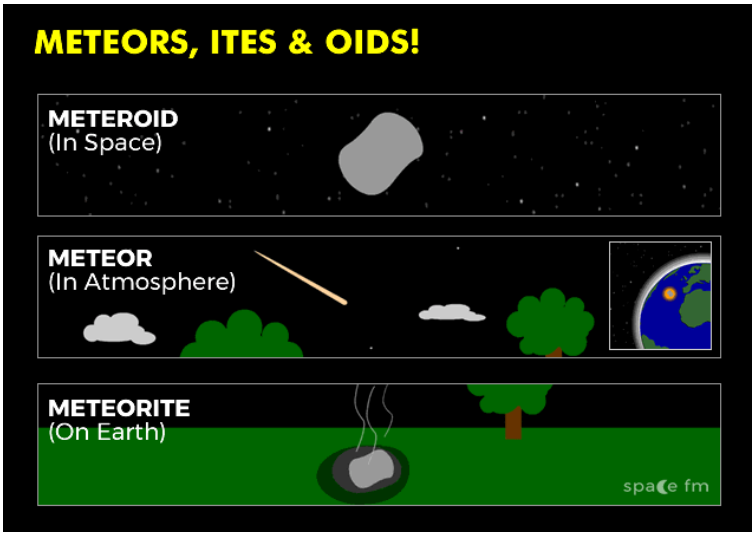
11.7 Gas Giant Formation Theories (covered in next topic)



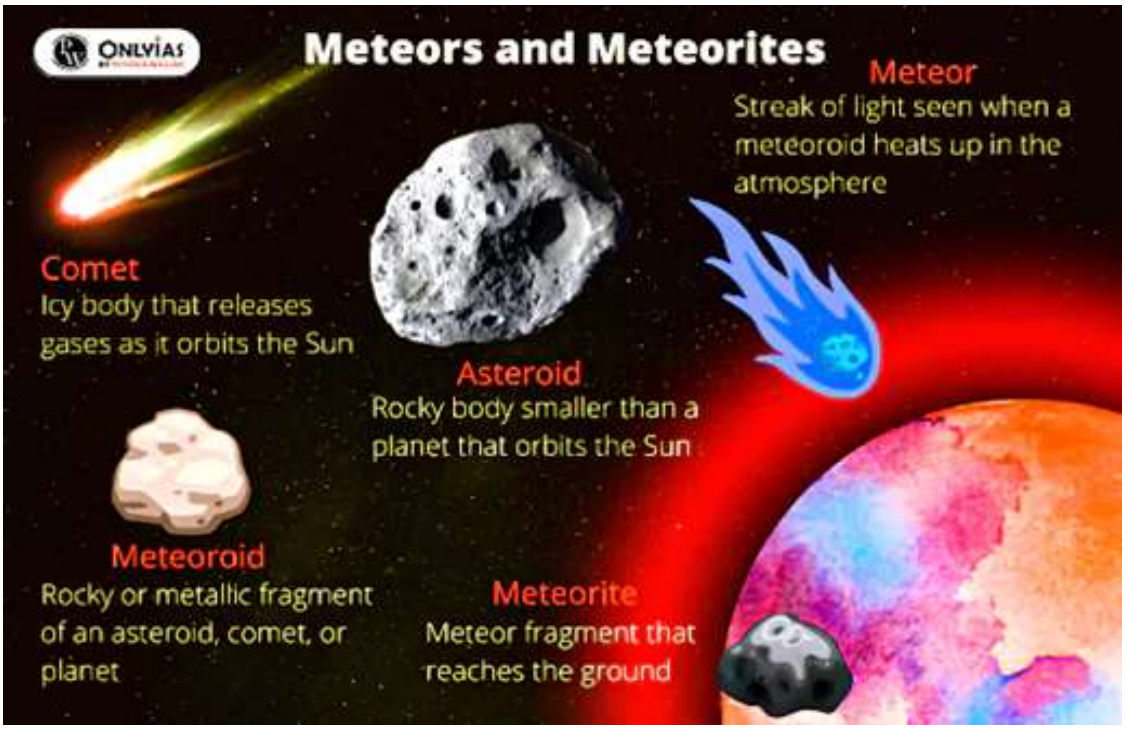
11.8–11.9 Measuring the Solar System

- **Astronomical Unit (AU)** – Mean distance from Earth to the Sun (1 AU = 1.5 × 10^8 km).
- **Light Year (l.y.)** – Distance light travels in one year.
- **Parsec (pc)** – Equal to 3.26 light-years, used for measuring greater distances.

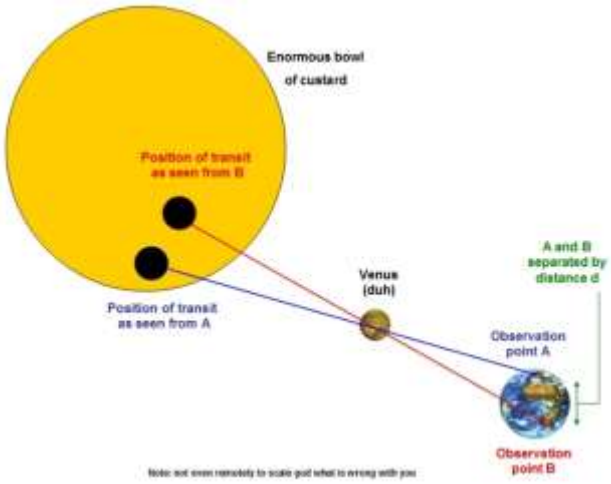
11.10–11.11 Meteoroids & Orbits



- **Meteoroids** – object in space, possibly similar to an asteroid that will eventually become a meteor.
    - **Cometary meteoroids** - small particles shed by comets
    - **Asteroidal meteoroids** - particles fallen off or chipped off asteroids
- **Meteors** – When meteoroids burn up in Earth's atmosphere.
- **Meteorites** – When meteoroids reach Earth's surface. About 10% of meteors survive to hit Earth's surface and land as meteorites, having not been burnt up by Earth's atmosphere (not all meteorites are observed).



11.12 Transits of Venus & Measuring the Solar System



- **Transits of Venus** – Used to calculate the Astronomical Unit (AU).

- **Edmond Halley's Method** – Edmund Halley was Astronomer Royal and proposed for the next transits in 1761 and 1769 that astronomers observe the transit, take measurements and share their data using a highly precise method of measurement based on work by James Gregory. Accurate results can be made using transits by multiple observers recording their precise location and exact paths timings of durations of the event especially ingress and egress points (the moments a body starts and ends its transit). With this information astronomers were able to arrive at a good measurement of the astronomical unit.

11.13 Theories on the Origin of Water on Earth

Two main theories suggest how Earth got its water:

- **Cometary Theory** – It is thought that Earth was heavily bombarded by comets and other bodies early in its evolution and the Moon bears evidence of this. Comets contain large amounts of ice and this would have fed our oceans on impact. This theory is controversial as it would have taken an enormous amount of water to cover 71% of the surface and most scientists have difficulty with the theory. The Rosetta probe was launched by the European Space Agency in 2004 to understand the origin and evolution of the Solar System. Rosetta and its lander Philae detected water-rich carbons in the comet and took numerous water detecting measurements of the comet 67P/Churyumov–Gerasimenko.
- **Outgassing Theory** – This theory says that water was part of Earth's body when it formed. As the Earth cooled, water leaked from rocks and the atmosphere condensed the water into liquid form.