Science and Technology Class 04

13th July, 2023 at 9:00 AM

CHANDRAYAAN 1 (9:06 AM):

- **Chandrayaan 1** was only an orbital mission- it only orbited the moon and never reached the moon's surface.
- It gave vital information like water is present on the moon's surface.
- The **Magma-Ocean hypothesis** for the origin of the moon was confirmed.
- It held that the entire moon at one point in time was in a molten state.
- It further gave credence to the theory that the moon was once a part of the earth, before some celestial collision.

Chandrayaan 2 (2019):

- It was a totally indigenous mission, unlike Chandrayaan 1 which was done with **NASA** collaboration.
- Chandrayaan 2 had an orbiter, a lander (Vikram), and a rover (Pragyan).
- However, the lander could not be soft-landed, and along with the rover, it got dysfunctional.
- The project is still a partial success because the orbiter is functional and is doing a spectroscopical analysis of the moon's surface.
- It was expected to land at the lunar south pole, which receives no sunlight.
- We expect that the absence of sunlight for millions of years must have done some unforeseen changes to the surface.

Chandrayaan 3:

- The project aims to achieve a soft landing on the south pole of the moon.
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Self-Study for Students:
Students must go through the coverage of Chandrayaan 3 from the February monthly magazine.

- Chandrayan 3 also aims for in-situ analysis through a rover.

The golden foil on launch vehicles & satellites:

It is called Multi-Layer Insulation (MLI).

It protects against large temperature variations.

It is made of polyester with layers of aluminum.

LAYERS OF THE SUN (9:30 AM):

- Photosphere: The visible outermost layer of the sun.
- It is the solar "surface" that we see when we look at the Sun in "white" (i.e. regular, or visible) light
- Chromosphere: It is the irregular layer beyond the photosphere and below the solar transition region.
- Corona: It is the outermost layer of the sun, which can also be considered the “Atmosphere of the Sun”.
- **Aditya Mission** will study Corona, the Chromosphere and Photosphere, and not the core of the sun.
- Nuclear fusion (hydrogen is being converted into helium) happens in the Sun's core which is the source of the Sun's energy
- The mission aims to find the reason behind Corona (above 1 million degrees Celsius), being much hotter than the photosphere (6000 degrees Celsius).
- Corona despite being very hot, is only visible during a total solar eclipse, because it has very low particle density.

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- Corona exists in the **plasma state** due to high temperature.
- Sun is much larger than what we can observe.
- Sun accounts for around 99.5 % of the mass of the solar system(the sun, all planets, satellites, comets, and asteroids combined).
- Out of the rest 0.5 %, 0.4% mass is contributed by Jupiter.

Aditya L1 mission :

- It is India's first dedicated mission to study the sun in the **Halo orbit** around **Lagrangian point 1.**
- Aditya Mission is certainly vulnerable to solar storms, but due to the large size of solar storms, we expect that a very less portion would strike the mission.
- It will carry seven payloads with the following **objectives:**
- I. To study the solar corona, dynamics & origin of Coronal Mass Ejection.
- II. To image the photosphere and chromosphere in ultraviolet light.
- III. To study the variations of solar winds, their composition & energy.
- IV. Heating mechanism of the solar corona.
- V. To measure the magnitude and nature of the interplanetary magnetic field ejected from the solar corona

Corona:

- The Sun’s corona is the outermost part of the Sun’s atmosphere.
- It extends millions of kilometers.
- It is made up of plasma- the fourth state of matter.
- The corona is usually hidden by the bright light of the Sun's surface.

Solar flare:

- It is a sudden release of energy from the sun's atmosphere.
- It causes electromagnetic radiation (travel at the speed of light) of very high intensity.

Coronal Mass Ejection(CME):

- They are eruptions of plasma and magnetic fields.
- When the CME hits the earth's magnetosphere, it leads to geomagnetic storms (Auroras, disruption of electronic systems, etc.)
- They can fry electronic circuits and hamper the functioning of electronic devices.
- Even CME can cause Auroras of stronger intensity.

Solar Wind:

- It is a regular ejection of charged particles from the earth.

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- The earth's magnetic field has been shaped by solar winds over millions of years.
- Initially, the earth's magnetic field and solar winds saw both attraction and repulsion.
- As of now, repulsion is much more prominent, which protects the Earth from solar winds.
- The interaction of the solar winds and the ionosphere of the earth causes bright **Auroras** or **Northern Lights**.
- Auroras are usually associated with poles, but under some circumstances, they can only be observed in rest regions, as we see in Ladakh.
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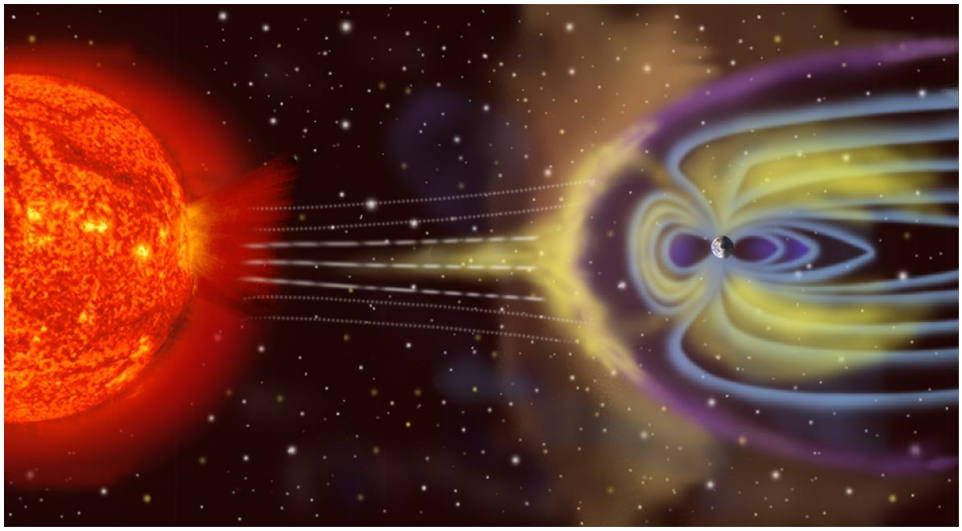
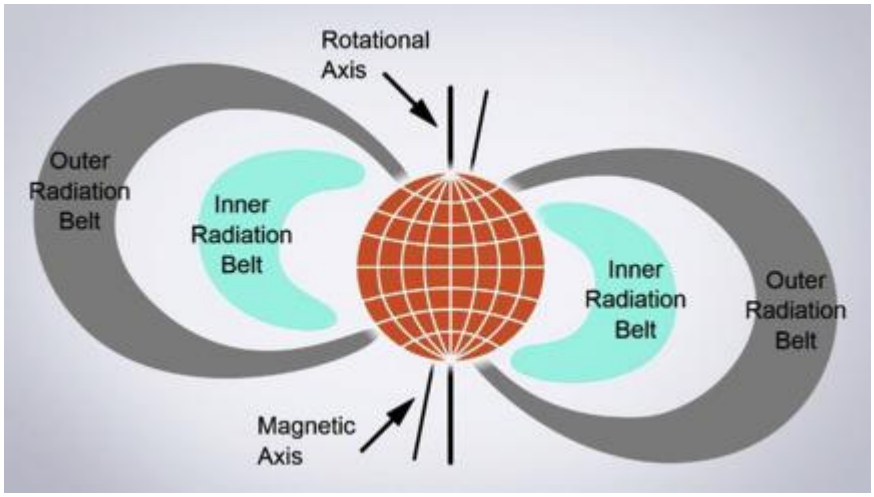
Geomagnetic storms:

- These storms occur because of the interaction of the particles emanating from the sun and the Earth's atmosphere.
- A very powerful geomagnetic storm can cause damage to the functioning of satellites, change their orbit, and can also disrupt the power supply on Earth.

- 

Van Allen Radiation belt:

- It is a zone of energetically charged particles, most of which originate from the solar wind.
- They are captured and held around by the earth's magnetosphere.
- The earth has two such belts and another may be temporarily created.

- 

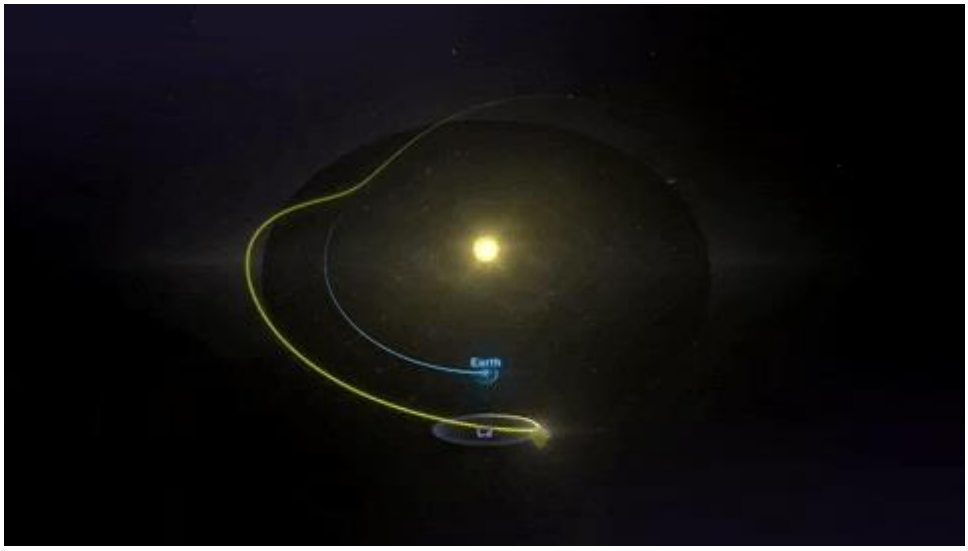
LAGRANGIAN POINTS & HALO ORBITS (10:10 AM):

- Lagrange points are five special points in space where an object with a very small mass can get the required centripetal force from the gravitational pull of two massive objects.
- The combined gravitational forces of two large bodies provide the required centripetal force for a third much smaller body to complete its orbit.
- **For example-** In the Sun-Earth system can have five such points.
- These points can be found by any two bodies gravitationally locked
- Lagrangian point 1 is between the Earth and the sun 1.5 million kilometers away from the Earth.
- It has the advantage of continuously viewing the sun without any eclipse.
- L1 point also has the **Soho Mission of NASA.**
- Similarly, **L2** is 1.5 million kilometers away from the Earth in the opposite direction.
- It is very useful for astronomical observation as it will be observed without the effects of solar and lunar eclipses.
- **For example- the** James Webb Space Telescope(JWST) is placed around L 2 point.
- JWST is a combined effort of NASA and the Canadian Space Agency.
- L2 can monitor the night sky without coming in the shadow of the earth or the moon, and at the same time can continuously send data to earth stations.

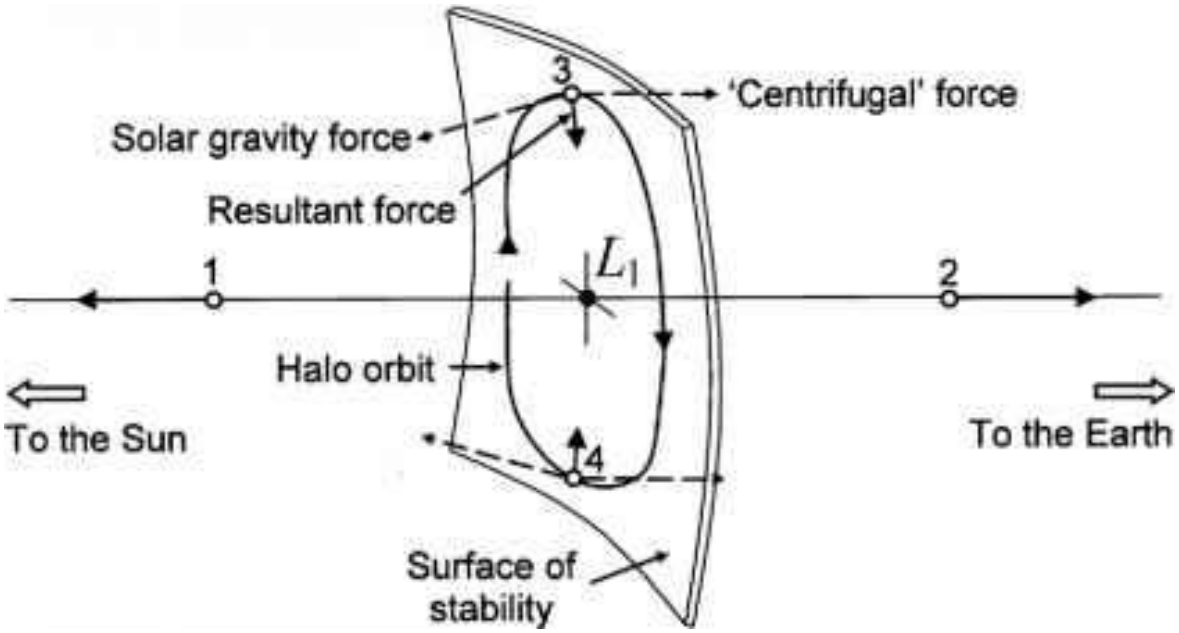
- **James Webb telescope:**
  The orbit of JWST is a halo orbit around the L2 point.

  The sun-shade of JWST protects it from any light from the sun, earth, or moon so that they do not interfere with the observation of the night sky (deep space).

  Because of all these arrangements, JWST can look to the past when the first stars and galaxies were formed in the universe.



- Even though these are points in empty space, their peculiar characteristic is that they can be orbited.
- These orbits are called **halo orbits.**
- Aditya will not be on L1, but it will revolve around L1.
- Just like the fact that JWST is revolving around L2.
- Due to the small size of the satellites, there is very less probability that they get hit by solar flares while orbiting Lagrange points.
- Theoretically, satellites at L1 and L2 would need no fuel.
- Still, the missions to L1 and L2 will have fuel in order to correct any changes in their orbits if the orbits get affected by the gravitational pull of any other body.



- The **L3 point** is not useful because it always remains behind the sun.
- **L4 & L5** points are examples of stable equilibrium, i.e. a stable orbit can be maintained without much effort.
- Even though they are not being used, maybe in the future, they will be used for space stations that can maintain a stable orbit without any fuel.
- In comparison, L1, L2, and L3 are the points of semi-stable equilibrium.
- So if disturbed, the satellites placed on those points will not return to their original position.
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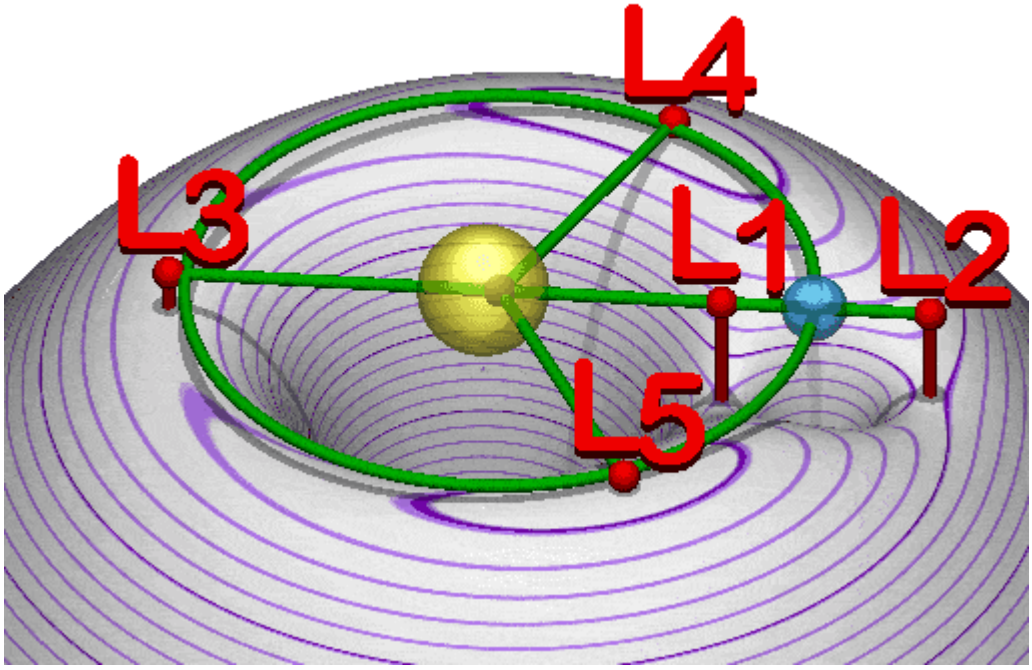


- It is India's first dedicated mission to study the sun in the **Halo orbit** around **Lagrangian point 1.**

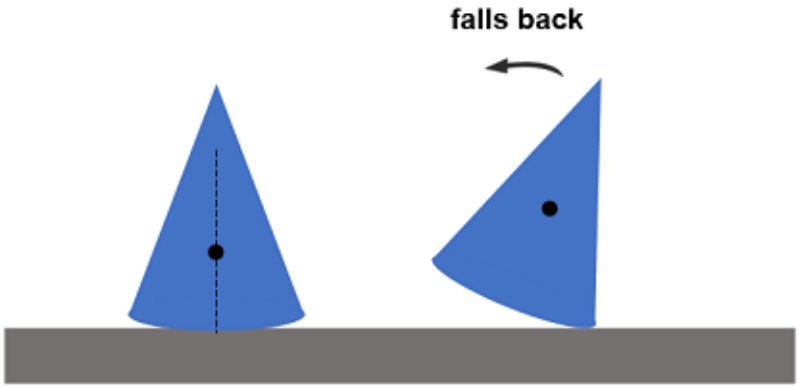
Equilibrium:

If an object is said to be in a state of equilibrium, then all the forces which act upon the object are balanced.

Stable equilibrium:

When a particle is displaced slightly from a position, then a force acting on it brings it back to the initial position, it is said to be in a stable equilibrium position.

For example- A marble placed at the bottom of a hemispherical bowl.



Semi-Stable equilibrium:
It is achieved when displacement on one side of the object will give us motion towards equilibrium, and displacement on another side will give us a motion away from the equilibrium.

For example-: A horse saddle.

TROJAN ASTEROIDS (10:40 AM):

- They are those asteroids that circle the same star as that of the planet in the same path.
- These asteroids are situated at the Lagrange point(s) which is a gravitationally balanced region around the sun and the star.
- In our solar system, they are most prominent for Jupiter.

SPACE DEBRIS (11:20 AM):

- Space debris is the orbital junk that is revolving around the Earth.
- There can be natural sources for the debris like micro-meteorites, but most of the sources are man-made.
- Human beings have been launching space probes for more than 50 years now.
- This has also led to the accumulation of huge amounts of debris, mostly in lower earth orbit.
- Most of this debris travels at a very high speed, fast enough to cause damage to a satellite or even a space station.

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The main sources of debrisare the following:

- Upper stages of rockets.
- The explosion of satellites and rocket bodies.
- Abandoned and old pieces of satellites.
- Anti-Satellite demonstrations like **Mission Shakti of India**.
- **Kessler's syndrome** is a scenario in which the density of objects in low earth orbit is high enough that one collision could cause a cascade.
- Each collision generates space debris that increases the likelihood of further collisions.
- Because of space debris, space launches have become more challenging and expensive

The following steps can be taken to tackle the issue:

- **Space Situational Awareness:**
- This will include monitoring larger pieces of debris with the help of telescopes and dedicated missions in space.
- Space agencies try to save their space assets by investing in space situational awareness.
- The **Project Netra** of ISRO is an example.
- **Inter-Agency Space Debris Coordination Committee(UN-IADC)** is an inter-governmental platform that aims to exchange information on space debris and research activities.
- ISRO is a member of it.
- No separation of the rocket in the lower earth orbit.
- Ban on **Anti-Satellite** demonstrations which will minimize the creation of new debris.
- **A code of conduct** can be followed such as separating the last stage of the rocket at a lower altitude.
- Dedicated missions have been launched to destroy existing pieces of space debris.
- **For example-** The Remove Debris Mission by the University of Surrey, the destruction of debris by LASER, space nets, harpoons, etc.
- However, the technical and economic feasibility of such missions remains a challenge.
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Self Study to be done from basic NCERTs:

Atomic structure.

Components of the atom.

Radioactivity

The topic for the next class is Nuclear Technology.