

## Geography Class 05

### REVISION OF THE PREVIOUS CLASS (9:10 AM):

#### Indian Standard Meridian:

- The Indian Standard Meridian passes through 82.5 degrees east- Mirzapur, Uttar Pradesh.
- India used to have three time zones till 1906- Bombay, Madras, and Calcutta time zones.
- India also had a local **Chai Bagan Time** in Assam.

#### International Date Line(IDL):

- It is an imaginary line of demarcation running from the North Pole to the South Pole.
- It demarcates the change of calendar day.
- When a traveler crosses it from East to West, a day is lost- it means that a day is added to the calendar.
- When a traveler crosses it from West to East, a day is gained- it means a day is removed from the calendar.

#### Daylight Saving Time:

- The clocks are forwarded in summer for better use of natural light and conservation of energy, particularly during the evening.
- It is mainly practiced in temperate countries with a sufficient variation of day length between summer and winter.
- The main issue is to streamline our **Circadian Rhythms**- a timely and regular sleep-wake cycle.

### **Milankovitch Cycles:**

- The cyclical changes observed during the earth's circumnavigation around the sun are called Milankovitch cycles.
- It involves variations in :
  - I. **Eccentricity:** Shape of the earth's orbit around the sun.
  - It is visible after around 1 lakh years.
  - II. **Obliquity:** Inclination of the earth's axis.
  - It is visible after around 41 thousand years.
  - III. **Precession:** Earth's slow wobble during its spinning motion.
  - It is visible after around 26 thousand years.

### **Universe:**

- The universe is the limitless expanse of all of space, and all the matter around us.
- It consists of the solar system, stars, galaxies, dark matter, dark energy, etc.
- **There have been many theories regarding the origin of the universe:**

### **Steady State Theory:**

- It was proposed by **Fred Hoyle**.
- The theory says that the overall size and mass of the universe remain constant at any point in time.

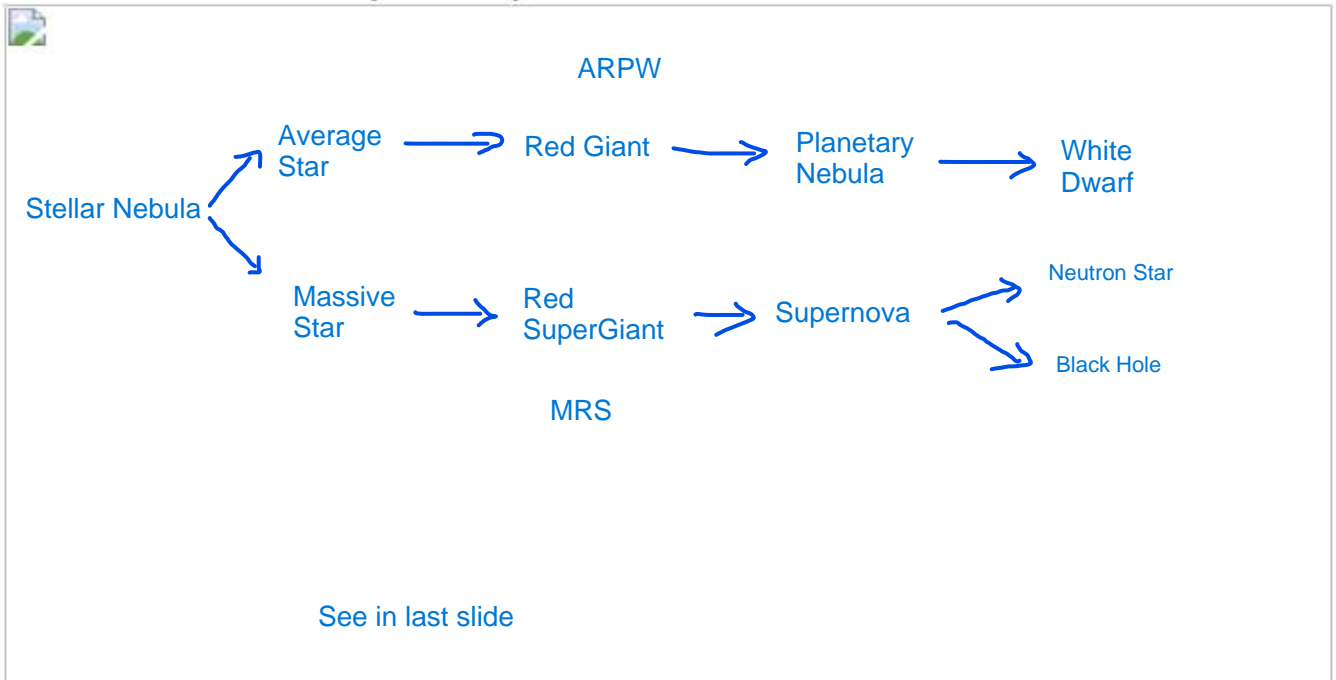
### **Pulsating Theory:**

- It was proposed by **Arthur Eddington**.
- The theory suggests that the universe expands and contracts alternatively.
- Even this theory, along with the Steady State theory suggests that the universe has no beginning and no end.

### **Big Bang theory:**

- It was first proposed by **Georges Lemaitre in 1927**.
- The universe started as a very hot and dense point known as the **singularity**.
- 13.7 billion years ago, a cosmic explosion called the **big bang** happened.
- The **Red Shift** observed by **Hubble** proved that the faraway galaxies and stars are still moving farther.

## LIFE CYCLE OF A STAR (9:25 AM):



### Stellar Nebula:

- It is a giant cloud of gas and dust which is mainly made up of hydrogen.
- The gaseous particles collide due to gravity and the entire nebula starts to spin.

### Protostar:

- It is the spinning gaseous mass with a hot core due to the heat released during the collision of gaseous particles.

### Star:

- When the temperature of the protostar core crosses 14 million degrees Celsius, the **Nuclear Fusion** reaction begins at the center.
- This results in the birth of a star.
- Our Sun is right now in the phase of **Average Star**.
- Our sun is around 4.8 billion years old.
- Our Sun is expected to continue for 7 billion years more in the average star stage.
- After then, our sun will become a Red Giant.
- When our sun becomes the Red Giant, it is expected to engulf Mercury and Venus into itself.

### Red Giant:

- When the supply of hydrogen runs out, the core starts to contract and simultaneously the outer shell expands resulting in the formation of a red giant.

### Planetary Nebula:

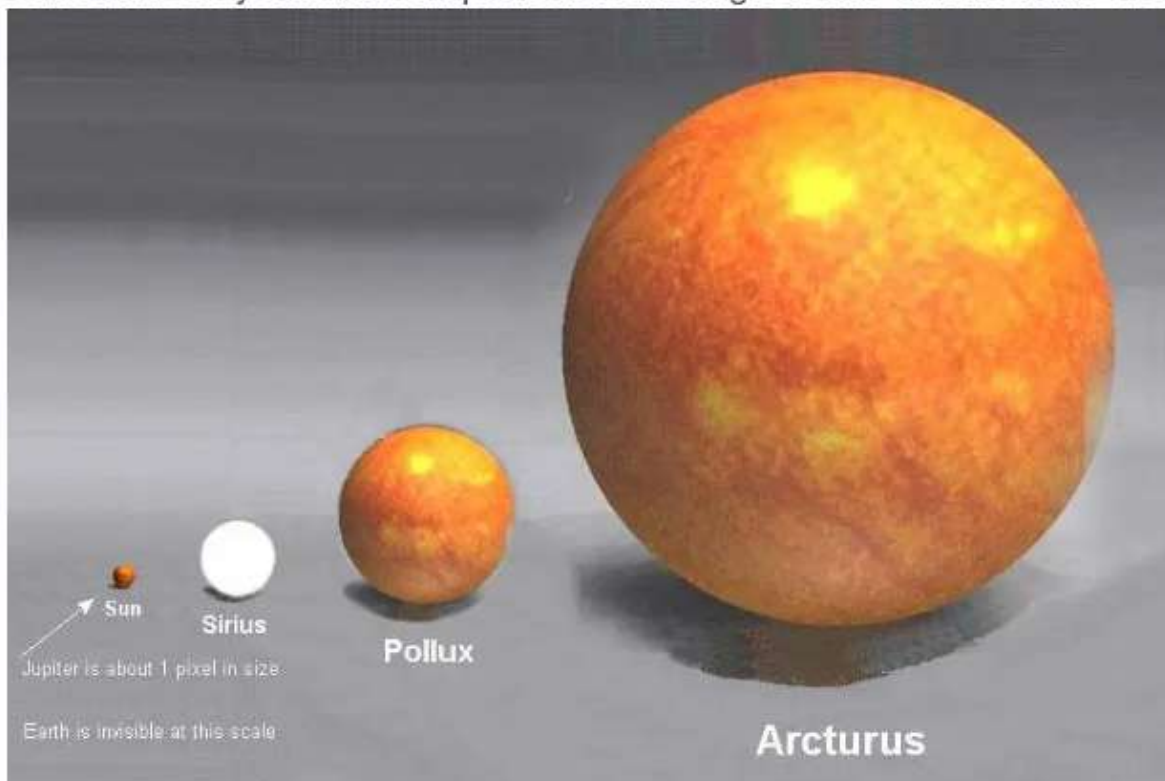
- When a low-mass star with less than ten times the mass of our sun becomes a red giant, its core collapses leading to the formation of a planetary nebula.
- A planetary nebula is a spherical shell of gases.
- Planetary Nebula has nothing to do with planet formation.

### White Dwarf:

- A planetary nebula will be gradually left with the core inside the shell, which is called a white dwarf.
- A white dwarf is theorized to become a **black dwarf**.
- But we have not observed a black dwarf till now.

### OUR SUN (10:00 AM):

- Our Sun is very small in comparison to the largest stars that we have observed.





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- If a star is 10 times the mass of our sun, it will follow the life cycle- Massive Star- Red Supergiant-Supernova-Blackhole/Neutron Star.
  - A supernova explosion is so strong that it will wipe out life within 10 light-years of its vicinity.
  - There are no massive stars within 50,000 light-years

### **Red Supergiant:**

- If the mass of the star is more than ten times the mass of the sun, it results in the formation of a Red Super Giant.
- A red supergiant gradually leads to a supernova explosion, which is a very violent explosion of the star.
- It results in the release of a huge amount of energy.

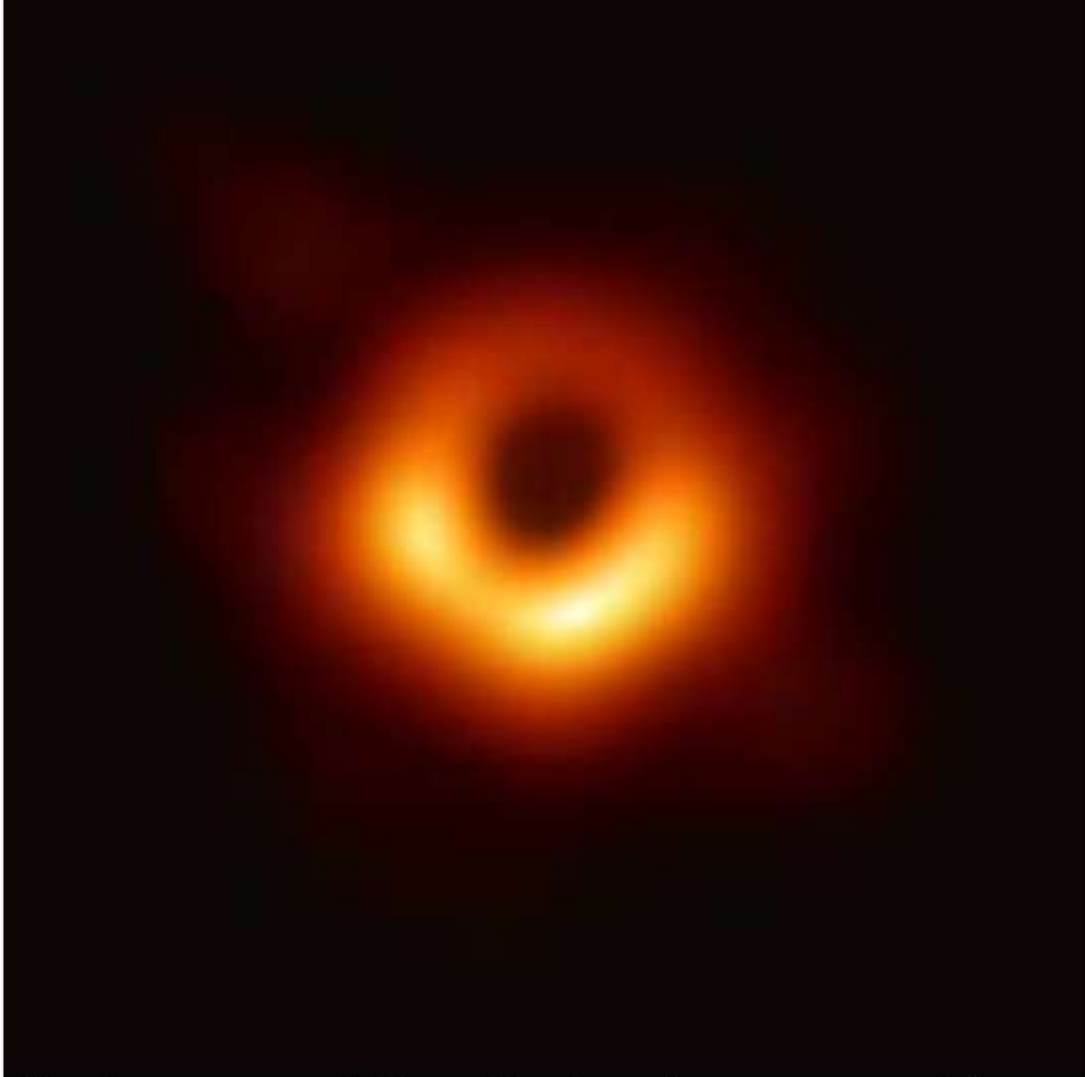
### **Neutron Stars:**

- Some stars are so large that even after a supernova explosion, some mass of the remnant core remains.
- If the leftover part is 1.44-3 times the mass of the sun, we will get a neutron star.
- A neutron star is a body made up of closely packed neutrons of very high intensity.
- Neutron star gives a faint light.
- 1 spoon of matter from neutron star is equal to 500 billion kilograms.

### **Blackhole:**

- If the leftover part/remnant core after the supernova explosion is more than 3 times the mass of the sun, it collapses under its own gravity to be a black hole.
- Its gravitational pull is so large that it does not even let light pass across it.
- The central point/Core of the black hole is also called **Singularity**.
- This singularity has infinite gravity and density.
- Blackholes can also collide with each other.
- We were recently able to generate a photo of a black hole named M87.

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- This photo was not similar to the photo that we capture daily.
- The image was generated after processing large amounts of data from gravitational telescopes

## **GALAXIES & STARS (10:25 AM):**

- Galaxy is a sprawling system of gas, dust, dark matter, dark energy, stars, etc. which are held together by gravity.
- At the center of every galaxy, there will be a **supermassive black hole** to hold the galaxy together.
- **Sagittarius A** is at the center of the **Milky Way** galaxy.

### **Types of Galaxy:**

- **Spiral Galaxy:**
- It has spiral arms.
- They are relatively flat-disked with a central bulge.



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### **Elliptical Galaxy:**

- Spherical or oval-shaped with stars distributed uniformly throughout.



### **Irregular Galaxy:**

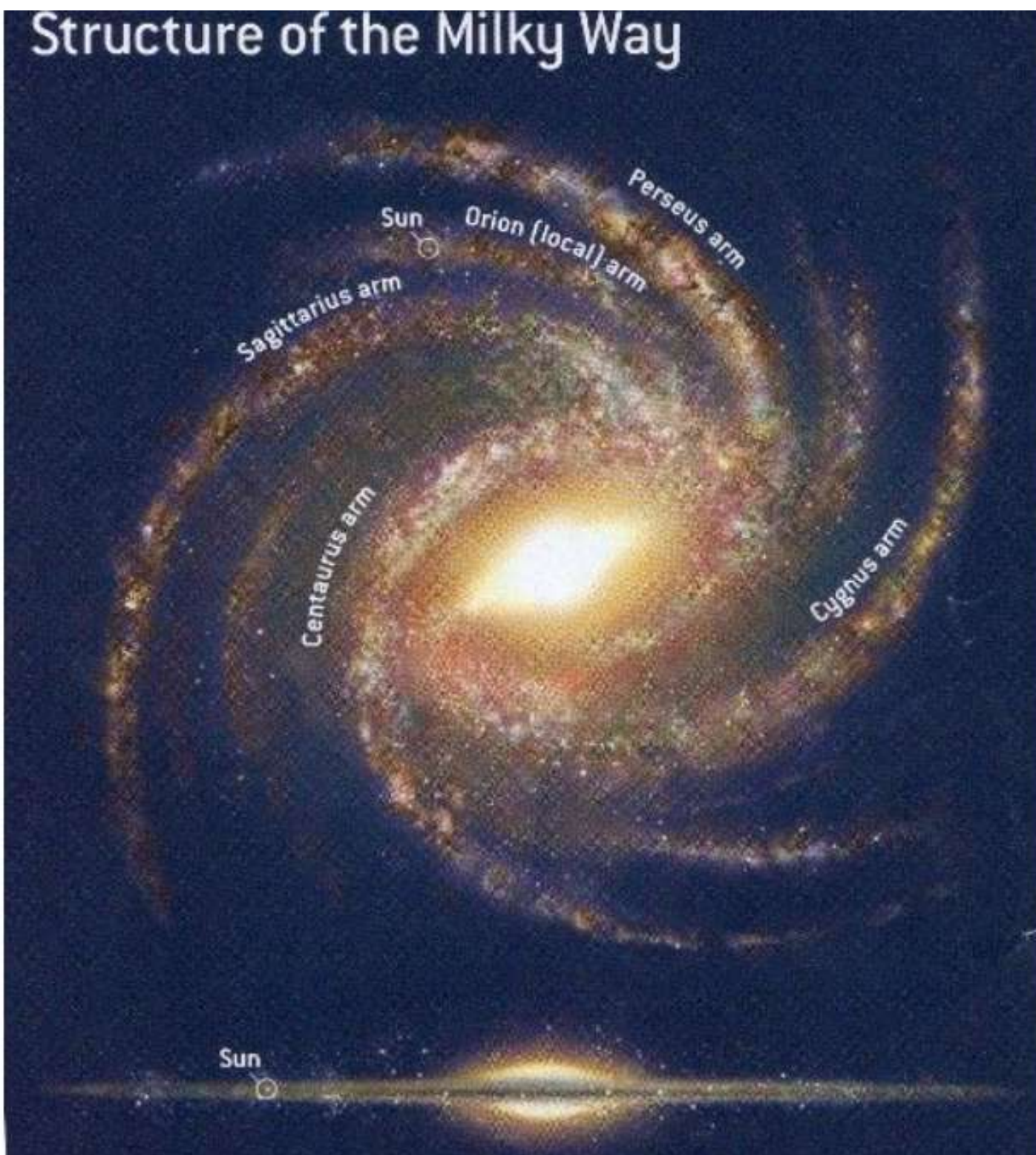
- It has no definite shape/structure.

### **Our Galaxy:**

- Our milky way galaxy s a spiral galaxy with Sun located at the **Orion** Arm.



# Structure of the Milky Way



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- **Proxima Centauri** is the closest star to our Sun which is 4.3 light years away.
  - The brightest star in the night sky other than the sun is **Sirius**.
  - Sirius is 8.6 light years away from the sun.
  - **Andromeda** is the nearest galaxy to the Milky Way.
  - Andromeda is approaching the Milky Way galaxy and a collision is expected in a few billion years.
  - Even if the two galaxies collide, due to the large space within the galaxies, we do not expect any collision of stars.
  - Despite the fact that the universe is expanding, we see these two galaxies coming closer because there is also a gravitational force at play.
  - The expansion is happening due to the energy released by the big bang, but in between all large celestial bodies, even gravitational force works.
  - Wherever the gravitational force is higher than the expansion force, we will see such an event.

### **Stargazing:**

- If the conditions are favorable, both the Milky Way and the Andromeda galaxies are visible from the Earth.
  - **Hanle** in Ladakh is a very favorable location for stargazing.
  - It has been declared as the **Dark Sky Reserve** of India.
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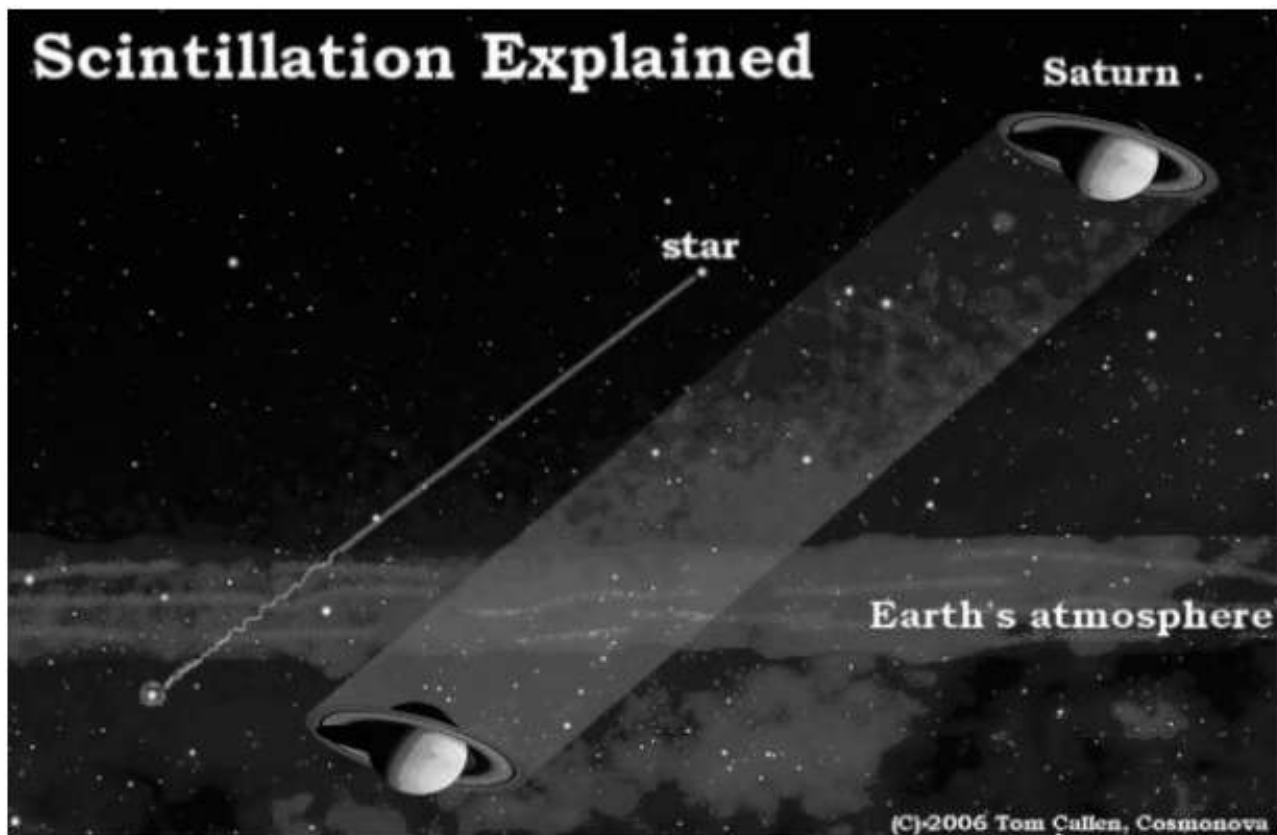
- Even **Spiti Valley** Himachal Pradesh is very good for stargazing.

#### **STARS (11:07 AM):**

##### **The twinkling/scintillation of stars:**

- The stars appear to twinkle, while the planets do not appear to twinkle.
  - The main reason behind this phenomenon is that atmospheric turbulence cause the light from distant star gets deflected more.
  - Stars are so far that they are practically a point source of light for the Earth.
  - However, light coming from a nearby planet or satellite does not twinkle because they are not a point source.
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## Scintillation Explained

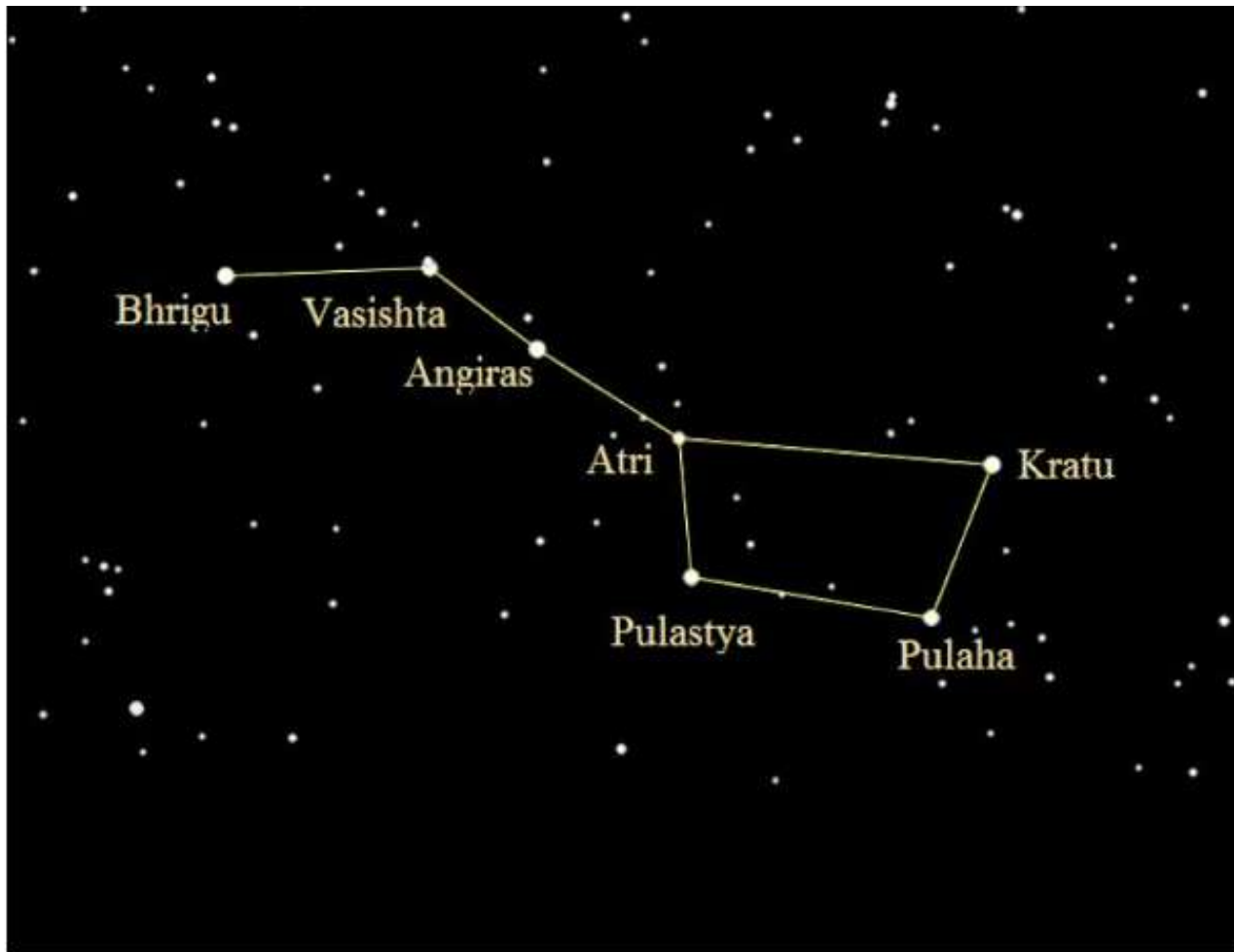


- The twinkling phenomenon is only observable from the surface of the earth under the influence of the atmosphere.

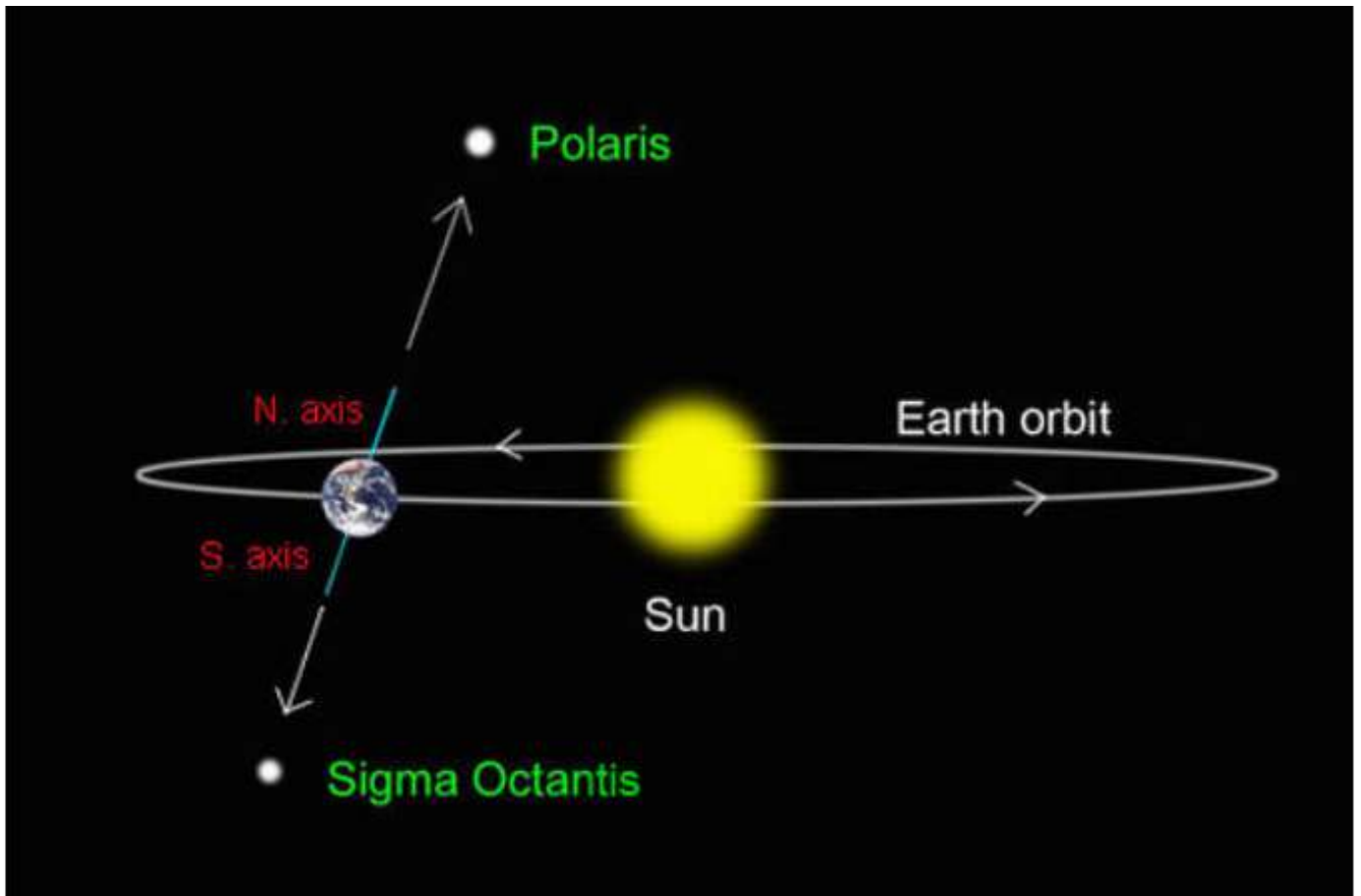
### Constellation:

- It refers to a group of stars forming a recognizable pattern in the sky.
- **For example-** the Big Dipper, or the Saptarishi Mandal.





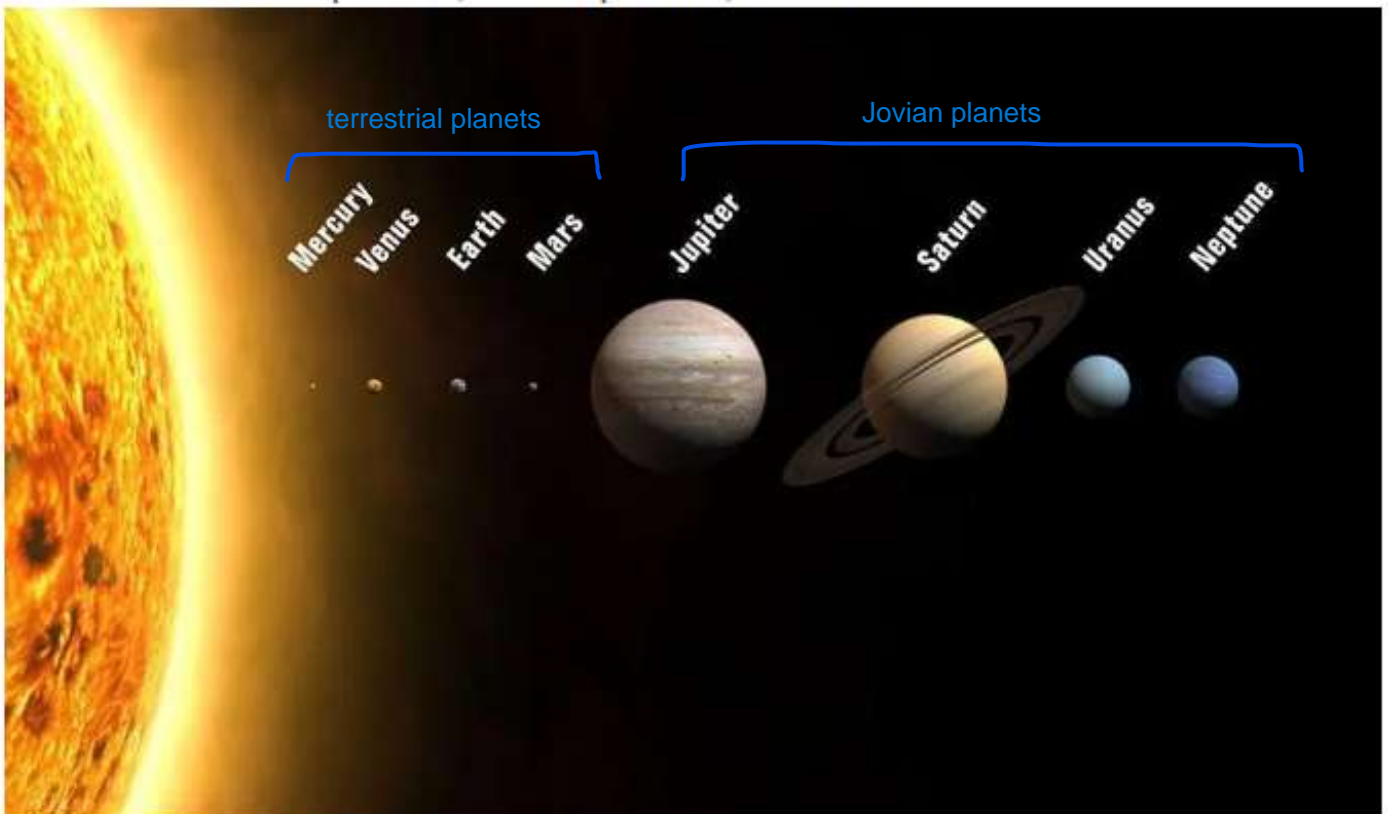
- The ~~star~~ star which is aligned to the axis of rotation of the earth is the Pole Star.
- It is **Polaris** in the Northern Hemisphere.
- It is **Sigma Octantis** in the Southern Hemisphere.



- The pole star is always fixed in the sky.
- We can locate the Pole star by extending the line which joins the Pulaha and the Kratu stars
- The angle at which the polestar is visible varies with the latitude.
- It is visible at 90 degrees from the poles, and the angles decreased to zero degrees at the equator.
- So neither of the pole stars is visible from the equator.
- The pole star also changes due to changes in obliquity as per the Milankovitch cycle.
- Due to the large distance, there is no effect of the earth's rotation in the location or observation of the polestar.

## SOLAR SYSTEM (11:35 AM):

- It is impossible to put the solar system on paper due to the large size differential between terrestrial planets, Jovian planets, and the sun.



## Origin theories of the Solar System:

- **Evolutionary Theories:**
- They hold that the sun and the earth are of the same age.
- The material of the solar system condensed into the sun and planets simultaneously as isolated masses of matter from a single mass of gas.

## I. Nebular Hypothesis:

- The solar system started as a gaseous cloud.
- It was first proposed by **Laplace**.
- The most widely accepted theory regarding the origin of the solar system is the nebular hypothesis.
- A pre-existing nebula was there in a rotating state.
- With gradual cooling, the nebula shrank which led to more spinning and gradually resulted in the formation of a flat disk with a central bulge.
- Sun originated at the center of this disk.
- The other matter got separated as rings due to centrifugal force.
- The matter within each of the rings condensed and collided to form **protoplanets/planetesimals**.
- Laplace did not use the word planetesimal though.
- The protoplanets gradually merged to form bigger planets.

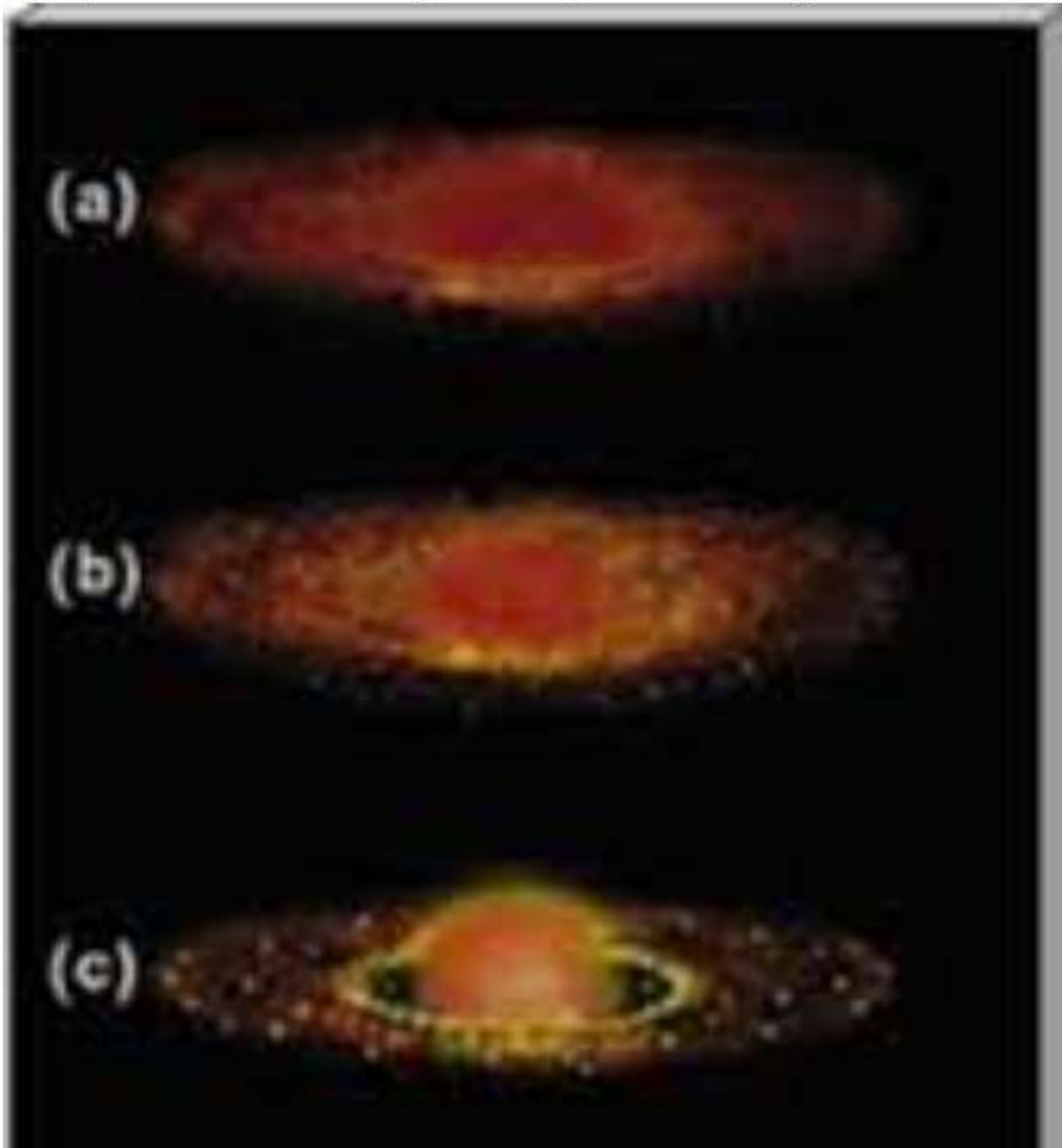


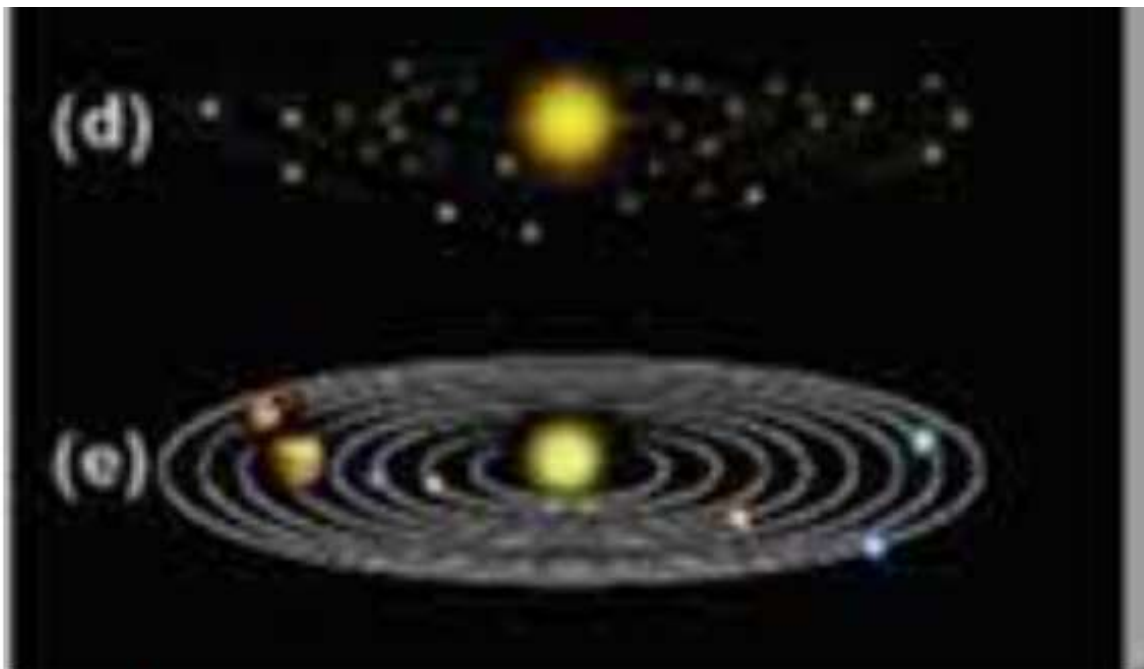
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## II. Gaseous Hypothesis:

- It was given by **Immanuel Kant**.
- It was the earliest theory of the solar system's origin.
- It proposes that the solar system originated from a gaseous cloud.



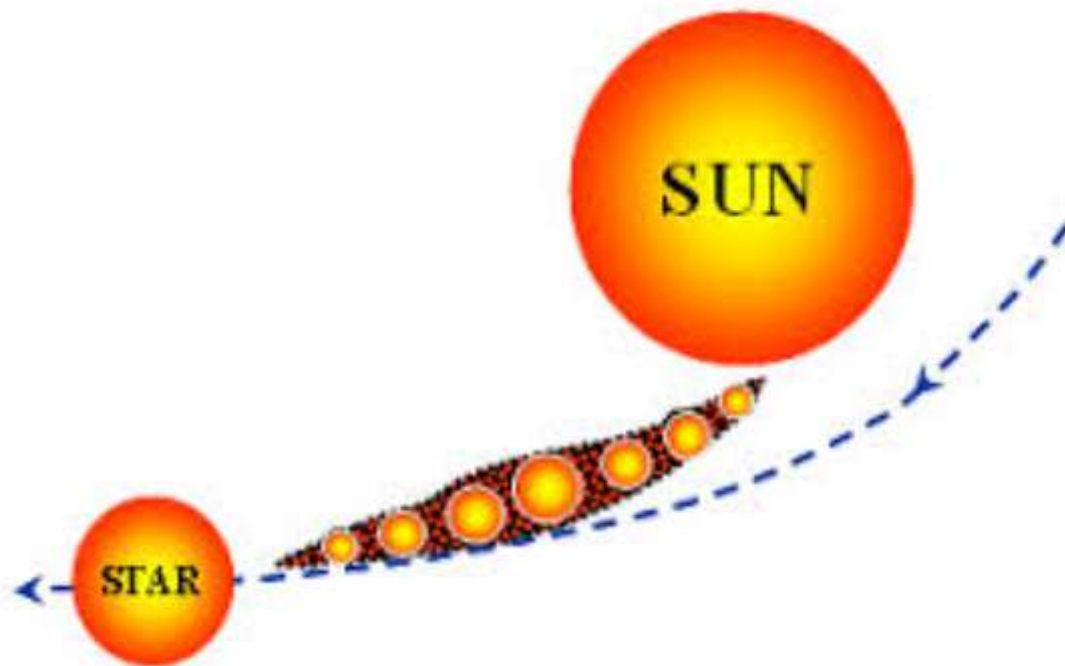


### Catastrophic theories:

- They hold that the sun was formed earlier than Earth and other planets.
- Due to some catastrophic events, some material was removed from the sun and we got the planets.
- This matter cooled down and condensed to form planets.
- So the sun and the planets are not of the same age.
- **Two major theories are:**

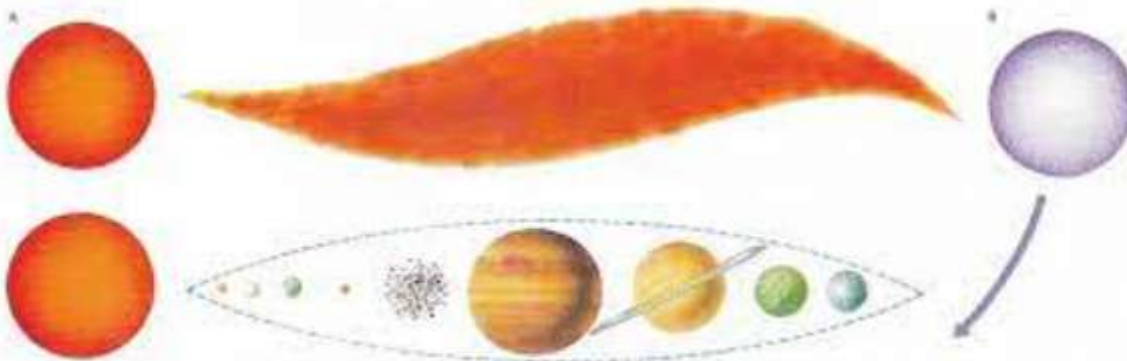
#### I. Planetesimal theory(Chamberlain & Moulton):

- The matter from the sun got ejected due to the companion star of the sun which has moved away from the sun.



## II. Tidal hypothesis (Jeanes & Jeffrey):

- The matter from the sun got ejected in the form of huge tides by another intruding star.

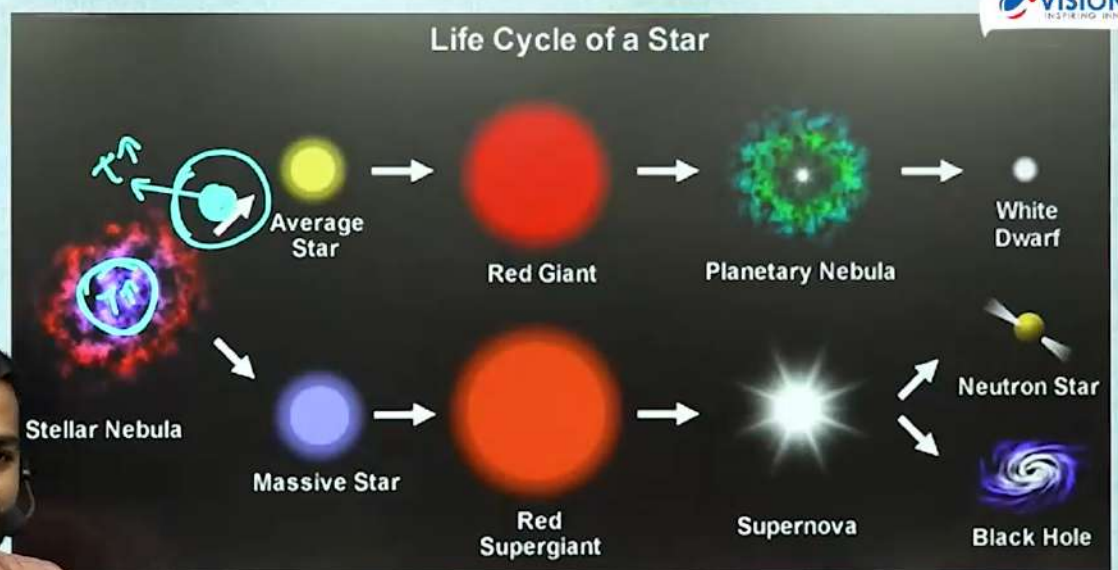


### Sources for self-study:

- First Chapter of G C Leong.
- A related chapter from NCERT class 6.

**The topic for the next class is the continuation of solar systems.**

## Life cycle of a star





Evolutionary  
Theories

- Gaseous hypothesis
- Nebular hypothesis

Catastrophic  
theories

- Planetesimal theory
- Tidal hypothesis

→ chamberlin & moulton

→ Jeans & Jeffreys

