

Css : 2018 (Qs).

Q) What are black holes? Explain their origin and properties.

Introduction:

Black holes represent one of the most fascinating and mysterious phenomena in the universe. They are formed from the remnants of massive stars and have such a strong gravitational pull that not even light can escape. Understanding black holes are crucial in modern astrophysics and cosmology.

Black holes:

According to NASA,

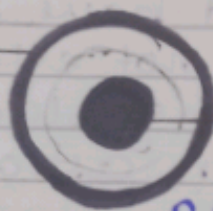
"A black hole is a place in space where gravity pulls so much that even light cannot get out. The gravity is so strong because matter has been squeezed into a tiny space."

A black hole is a region in space where the gravitational field is so intense that nothing can escape from it. This makes it invisible to direct observation, and its presence is detected by how it affects nearby matter and radiation.

- The boundary beyond which nothing can escape is known as the event horizon.

- The center of a black hole is a singularity, a point of infinite density where known laws of physics break down.

event horizon



singularity

Types of Black Hole

There are three

• Black hole

types of black hole.

- Stellar Black holes:

formed by star collapse (3-10 solar mass)

- Supermassive black hole:

found at galaxy centers (million to billions of solar masses).

- Primordial black holes:

Formed shortly after the Big Bang.

Origin of Black Holes:

Black holes typically originate from gravitational collapse of massive stars. The stages include:

1- Main Sequence star:

A massive star burns hydrogen in its core.

2. Red Supergiant:

After exhausting nuclear fuel, it expands.

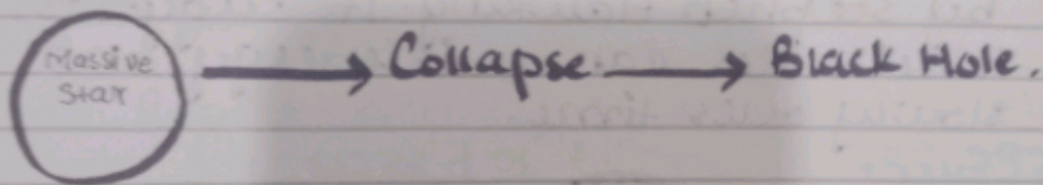
3. Supernova Explosion:

The outer layers explode outward.

4. Core Collapse:

The remaining core collapse under its gravity.

• If the core's mass is more than ~ 3 solar masses, it forms a black hole.



Properties of Black hole:

Properties of Black hole are:

1. Event Horizon:

"The point of no return". Any matter crossing it cannot escape. It marks the boundary of black hole.

2. Singularity:

Located at the center, where mass is compressed into infinite density. Time and space lose their meaning here.

3. Accretion Disk:

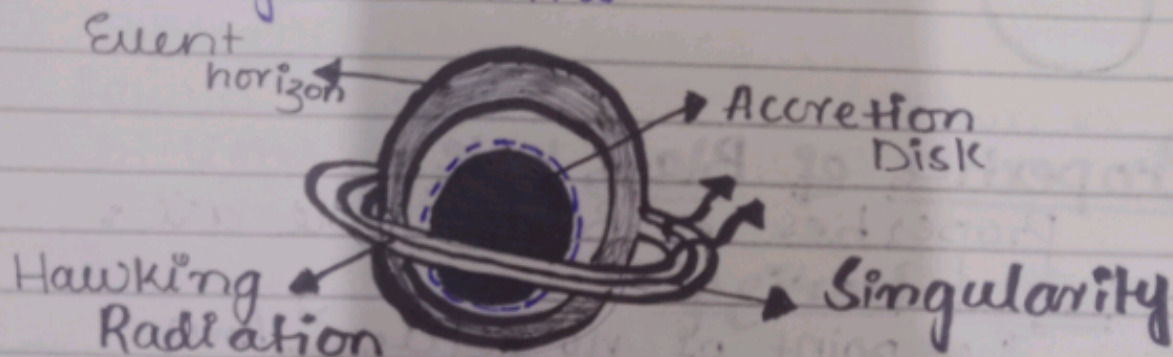
Gas and dust spiral into the black hole, forming a hot, glowing disk around it. This is often visible in X-ray astronomy.

4. Gravitational Time Dilation:

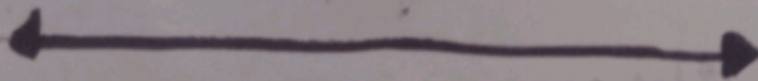
Time slows down near black hole due to their extreme gravitational fields - predicted by General Relativity.

5. Hawking Radiation:

Theoretical radiation predicted by Stephen Hawking. It suggests black holes can emit energy and slowly over time.



• Properties of Black hole.



Css 2017 :

Q. Explain the concept of light year.
How is it used in measuring astronomical distances?

Introduction :

The universe is vast beyond imagination, and ordinary units like kilometers or miles become impractical when measuring distances between celestial objects. To overcome this, astronomers use a larger unit known as the light year.

Light year :

A light year is the distance that light travels in vacuum in one year. The speed of light is $299,792$ kilometers per second (approx.

$3 \times 10^5 \text{ km/s}$). 1 light year is about 5.8×10^{12} miles or $63,240 \text{ AU}$ or 9.46053×10^{12} Kilometers. It is unit of distance.

Significance of light year :

- Astronomers use light year to measure vast distances that are extremely far from earth. It makes these distances manageable and comprehensible.

- It helps convey the immense size of

of the universe. The Milky Way Galaxy itself is about 100,000 light years in diameter.

- It is used widely in scientific literature and calculations involving interstellar and intergalactic distances.

Conclusion:

The light year is essential astronomical unit that provides meaningful way to express and understand the vast distances in the universe.

CSS - 2016

Q. Differentiate between a Comet, meteor, and asteroid with examples.

Asteroids:

Asteroids are rocky, non-planetary and non-lunar objects in the solar system. Most of them orbit between the orbits of Mars and Jupiter. The word 'asteroid' means 'star-like'. They are also called minor planets or planetoids. There are ~~at~~ several thousands of them in asteroid belt i.e. 140.

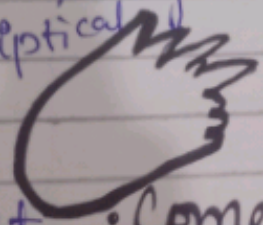
* They generally are irregular in shape. million. The origin of asteroid is partly connected to the remains of planet that fell apart. Some asteroid wander closer to the sun sometimes passing near the Earth. These are called Earth-Grosser or Apollo-asteroids.

Example: Ceres asteroid was first to be discovered in 1801 and is also largest (680 miles and 950 km).

2. Comet :

Comet are bodies made up of the ice and dust that move around the sun. As comet approaches the sun, a somewhat transparent envelope and dust called coma appears around the small compact icy nucleus. The nucleus and coma comprise of head. If the comet comes within astronomical unit of the sun, it may, develop a luminous tail. The head may be as large as 500,00 miles across and tail 250 km long. Comet revolve in three ^{types} orbits elliptical, parabolic or hyperbolic.

Comet are visible when near to sun. When comet are farthest from sun, they are



called dirty snow ball.

Example:

Halley's Comet named after Edmund Halley, the first British astronomer to calculate its orbit in 1705. It visit the sun after 75 years. It was last seen in 1986 and will be next seen in the year 2061.

Meteoroids:

A meteoroid is a small body travelling through space. A meteor typically originates from comet and asteroid. It is also called falling star (streak of light you can see in the night sky). A meteor will burn up or vaporise as it reaches ^{earth's} atmosphere. Most meteors burn up before they reach the ground. If they do reach the ground, they become meteoroids.

Example:

A burning meteor is popularly referred to as a shooting star.



Meteoroid