



# Challenging Big Bang Theory

[Source: TH](#)

## Why in News?

Recent observations from the [James Webb Space Telescope \(JWST\)](#) have revealed the **existence of massive, fully-formed galaxies** and **black holes** as early as **400-650 million years** after the **Big Bang**.

- This challenges the [Big Bang Theory's](#) standard model, which posits that galaxies took **billions of years** to form after the universe's creation.

## What are Key Highlights of the Study?

- **Challenge to Big Bang Theory: NASA's JWST** has discovered a surprising number of massive, fully-formed galaxies **just 400-650 million years after** the Big Bang. This challenges the Big Bang Theory, which states that the universe started as an extremely **hot and dense point (singularity) 13.8 billion years ago**, and galaxies were thought to form much later, over billions of years.
  - These early, mature galaxies don't fit with the current understanding of how the universe evolved.
- **Black Holes as Indicators: Black holes** (referred as little red dots), especially supermassive ones at the centres of galaxies, serve as **key indicators** of a galaxy's formation and evolution.
  - The amount of heat and light emitted by the blackhole helps in accurately **measuring the mass of stars** in galaxies.
- **Reason for Massive Galaxies in Early Universe:** One possible explanation for a larger number of massive galaxies in the early universe is that these galaxies **manufactured stars more efficiently** than the galaxies of today.
- **Role of JWST:** It has a **6.5 m** wide primary mirror and is specifically designed for **infrared observations** with a focus on studying the **early universe**.
  - Observations in the [infrared spectrum](#) allows researchers to **detect light** from the **earliest galaxies** and see through **dust clouds** and identify **celestial objects** that are otherwise **obscured**.

## Big Bang Theory

- **Origin of the Universe:** Proposed by **Georges Lemaître** in 1927, the **Big Bang Theory** explains how the universe began as a **single, infinitely small and hot point** that expanded and stretched to create the vast universe.
- **Evidence and Confirmation: Edwin Hubble** later confirmed this idea by observing galaxies **moving away from us**, indicating that the universe is still expanding.
  - **Visible and ultraviolet light** from distant galaxies shift to the [infrared wavelengths](#) as the universe expands.
- **Formation of Celestial Bodies:** As the universe expanded, it **cooled**, allowing particles to form atoms, which then combined to create celestial bodies such as **planets, asteroids, comets, and black hole**.

# BLACK HOLES

## ABOUT

- A place in space with **extremely high gravity pull**; even light can't escape (hence, **invisible**)
- The strong gravity is due to matter being squeezed into a tiny space

The term 'black hole' was coined in the mid-1960s by American physicist John Archibald Wheeler

## Albert Einstein and Black Hole

- First predicted their existences in **Theory of General Relativity**
- It showed that when a massive star dies, it leaves behind a small, dense remnant core

India's first dedicated satellite, AstroSat observed for the very first-time rapid variability of high energy X-ray emission from a black hole system

## DETECTION

- By seeing how stars very close to black holes act differently than other stars
- In April 2019, scientists at the **Event Horizon Telescope Project** released the first-ever image of a Black Hole (shadow, more precisely)

## TYPES

- **Miniature (Hypothetical):**
  - The smallest; size of just 1 atom
  - Mass: varies from 1/100th of a milligram to the mass of a large mountain
  - **Believed to be formed** when universe began
- **Stellar:**
  - Mass: **20x the mass of sun**
  - **Believed to be formed due to Supernovae explosion**

Supernova is an exploding star that has reached the end of its life

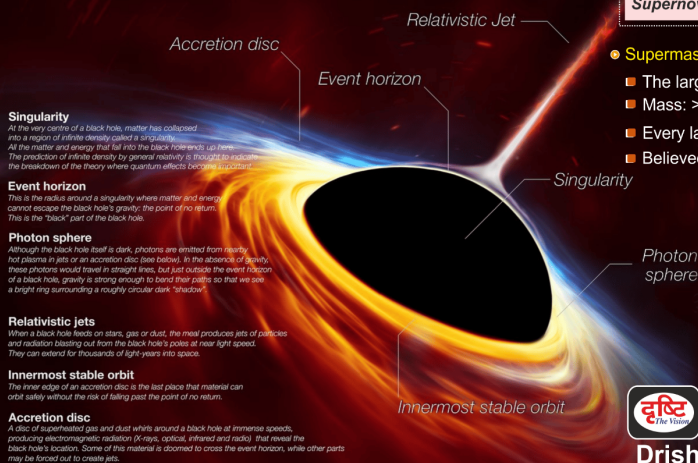
- **Supermassive**
  - The largest
  - Mass: >1 million suns together
  - Every large galaxy has a supermassive black hole at its centre
  - Believed to be made at the same time as their home galaxy

Sagittarius A is the supermassive black hole at the centre of Milky Way (mass: ~about 4 mn suns)

The Sun will never turn into a black hole as it is not big enough to make a black hole



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## UPSC Civil Services Examination, Previous Year Question (PYQ)

### Prelims:

Q.The terms 'Event Horizon', 'Singularity', 'String Theory' and 'Standard Model' are sometimes seen in the news in the context of (2017)

- (a) Observation and understanding of the Universe
- (b) Study of the solar and the lunar eclipses
- (c) Placing satellites in the orbit of the Earth
- (d) Origin and evolution of living organisms on the Earth

**Ans: (a)**

**Q. Which of the following is/are cited by the scientists as evidence/evidences for the continued expansion of universe? (2012)**

1. Detection of microwaves in space
2. Observation of redshift phenomenon in space
3. Movement of asteroids in space
4. Occurrence of supernova explosions in space

**Select the correct answer using the codes given below:**

- (a) 1 and 2
- (b) 2 only
- (c) 1, 3 and 4
- (d) None of the above can be cited as evidence

**Ans: (a)**

**Q. Which of the following pairs is/are correctly matched? (2008)**

| Theory/Law                 | Associated Scientist |
|----------------------------|----------------------|
| 1. Continental Drift :     | Edwin Hubble         |
| 2. Expansion of Universe : | Alfred Wegener       |
| 3. Photoelectric Effect :  | Albert Einstein      |

**Select the correct answer using the code given below:**

**Code:**

- (a) 2 and 3 only
- (b) 3 only
- (c) 2 only
- (d) 1 only

**Ans: (b)**