



## Black Holes & Dark Matter

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An international research team has ruled out the possibility that **primordial black holes** (formed in the early age of the universe) **might be the primary source of dark matter.**

The theory that **primordial black holes are a source of dark matter was proposed by Professor Stephen Hawking.**

### Dark Matter

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- **Dark matter, though never detected, is believed to be present in the entire universe, its existence presumed because a number of observable celestial phenomena could not be possible if the universe did not have much more matter in it than is seen.**
- It is believed to make up more than **95% of all universe.**
- Its gravitational force prevents stars in our Milky Way from flying apart.
- However, attempts to detect such dark matter particles using underground experiments, or accelerator experiments including the world's largest accelerator, the Large Hadron Collider (LHC), have failed so far.

### Dark Matter Presence in Universe

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- In the solar system, Mercury, the planet closest to the Sun, takes just 88 days to make one revolution around the sun, while Neptune, the farthest one, takes 165 years to make one round.
- Laws of gravity expect us to see stars closer to the center of galaxies rotating faster than the stars on the edge.
- However, in most galaxies, **the stars closer to the center and the stars at the edge of the galaxies take almost the same time to make one revolution.**
- **This implied that something invisible and enveloping the galaxies was giving an extra push to the outer stars, speeding them up.**

- This entity has remained as one of the unresolved puzzles in cosmology since the 1930s. It is named as `Dark Matter'.]
- **The material is considered to be a 'matter' since it has gravitational attraction and it is 'dark' because it does not seem to interact with light (or any part of the electromagnetic spectrum).**

## Black Holes

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- It is a **region of space having a gravitational field so intense that no matter or radiation can escape.**
- **Primordial Black Holes**
  - When the big bang hypothesis was proposed, two Soviet physicists, Yakov Borisovich Zel'dovich and Igor Dmitriyevich Novikov, showed that at the initial instant of the big bang, the densities would have been very high at many points, resulting in the formation of small black holes.
  - They were named `primordial black holes'.
  - Stephen Hawking investigated them in 1971. He computed that the mass of the primordial black holes could range from as low as one-hundredth of a milligram to as high as more than the mass of Thousand Suns.

## Gravitational lensing

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- **When the black hole is in alignment with a distant star, due to gravitational attraction, light rays are bent inwards like a lens, making the star appear brighter. This is called `gravitational lensing'.**
- This rare phenomenon can occur only when the star, the black hole and the observer on the Earth are aligned in a straight line.
- This phenomenon was first proposed in Albert Einstein's General Theory of Relativity.