Black Holes and Quantum Mechanics

Source: PIB

Why in News?

Recently, research conducted by a team of scientists from **S.N. Bose National Centre for Basic Sciences**, an **autonomous institute of the Department of Science and Technology,** has delved into the intriguing **realm of** black holes **and their interaction with** quantum mechanics.

- This exploration holds the potential to provide valuable insights into the unification of two significant scientific theories: **quantum mechanics and the general theory of relativity, propounded by Einstein.**
- The study focuses on **atoms freely falling into a black hole** and the novel quantum effects on the radiation emitted in this process.

Note:

- **General Theory of Relativity:** Albert Einstein's theory explains how objects move around massive ones. A fundamental consequence of the general theory of relativity is the existence of a black hole.
- **Quantum Theory:** The study of tiny particles' behavior, like atoms, at the smallest level.
- **Einstein's Principle of Equivalence:** The idea that nature's laws are the same in a small region with gravity as without it.
- **Hawking Radiation:** It is a theoretical concept proposed by Stephen Hawking, which suggests that **black holes can emit radiation due to quantum effects** near the event horizon known as Hawking radiation.

What are the Key Highlights of Study?

- Radiation from atoms falling into **black holes exhibits similarities to Hawking radiation**.
- The investigation reveals that the **radiation is generated from two-level atoms, unlike the radiation emitted by black holes** as predicted by Hawking.
- The study introduces the **concept of "horizon brightened acceleration radiation entropy" (HBAR entropy)** to quantify the **amount of disorder in the emitted radiation.**
    - The HBAR entropy follows the area law with logarithmic leading order area corrections and inverse order of area subleading corrections.
- The findings **uphold Einstein's Principle of Equivalence in a general setting**, providing valuable insights into the **interplay of quantum mechanics and general relativity in black hole scenarios.**
- The study adds to our understanding of the mysterious world of quantum effects in black holes.

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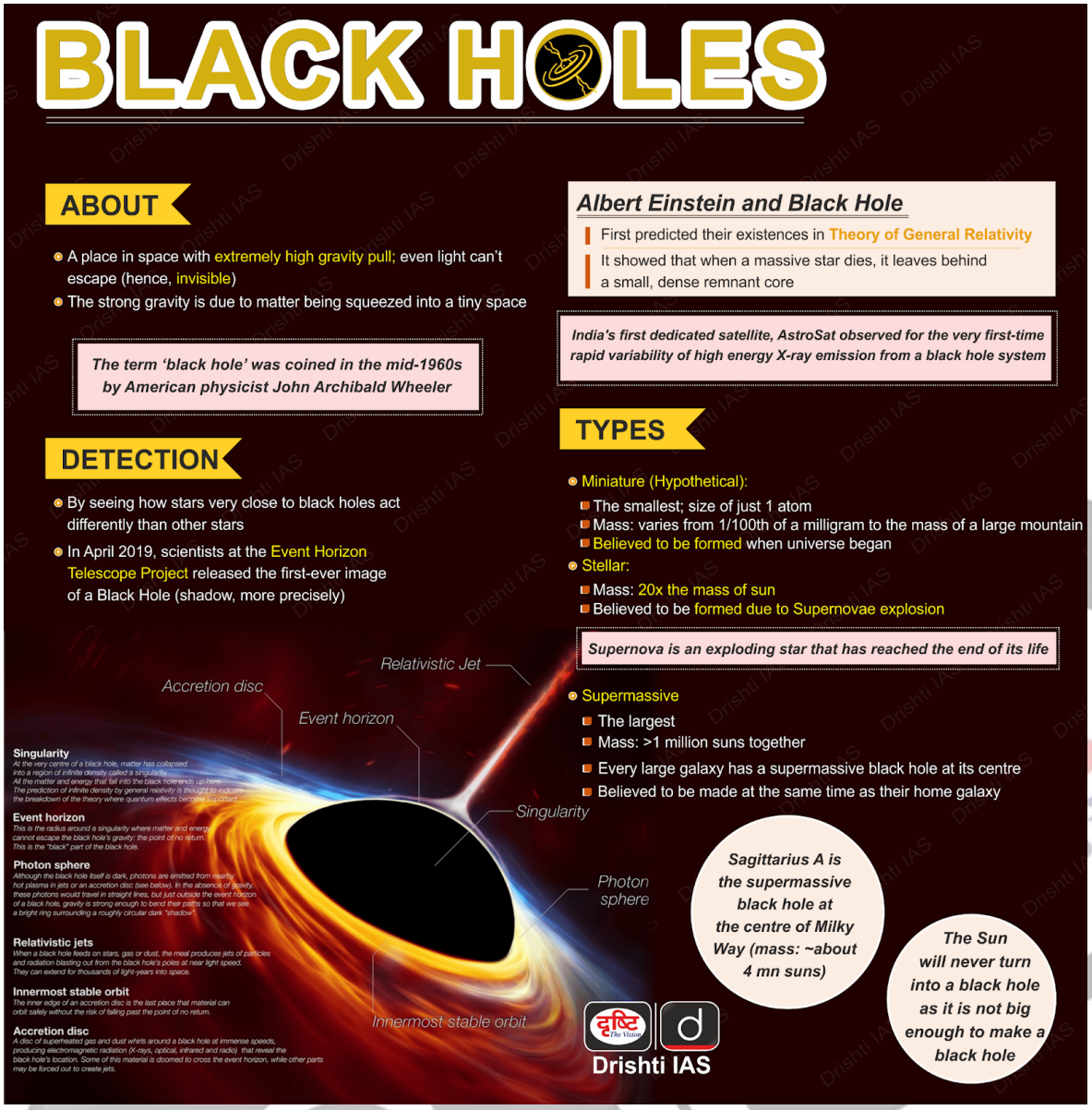

UPSC Civil Services Examination, Previous Year Question (PYQ)

Q. Consider the following phenomena: (2018)

1. Light is affected by gravity.
2. The Universe is constantly expanding.
3. Matter warps its surrounding space-time.

Which of the above is/are the prediction/predictions of Albert Einstein's General Theory of Relativity, often discussed in media?

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

Ans: (d)