Intermediate-Mass Black Hole

Why in News

Analysis of signals from gravitational waves detected in 2019 at the **Laser Interferometer Gravitational-Wave Observatory (LIGO), the USA** and the detector **Virgo, Italy** have indicated a black hole with unusual mass

> These waves were a result of a collision between two **black holes** billions of years ago.

Key Points

- The signal has been named **GW190521** and likely represented the instant that the two black holes merged.
  - It **lasted less than one-tenth of a second.**
  - It was calculated to have **come from roughly 17 billion light-years away,** a **time when the universe was about half its age.**
- Out of the two, the **larger black hole was of 85 solar masses** and the **smaller black hole was of 66 solar masses.** Post-merger they created a **new black hole of about 142 solar masses** and **energy equivalent to 8 solar masses** was released in the form of gravitational waves, leading to the **strongest ever wave detected** by scientists so far.
  - A **solar mass** is the mass of the sun or more precisely, it is **1.989×10^{30} kilograms,** which is equivalent to about 333,000 Earths.
  - Astronomers use a solar mass as a **basic unit of mass.**

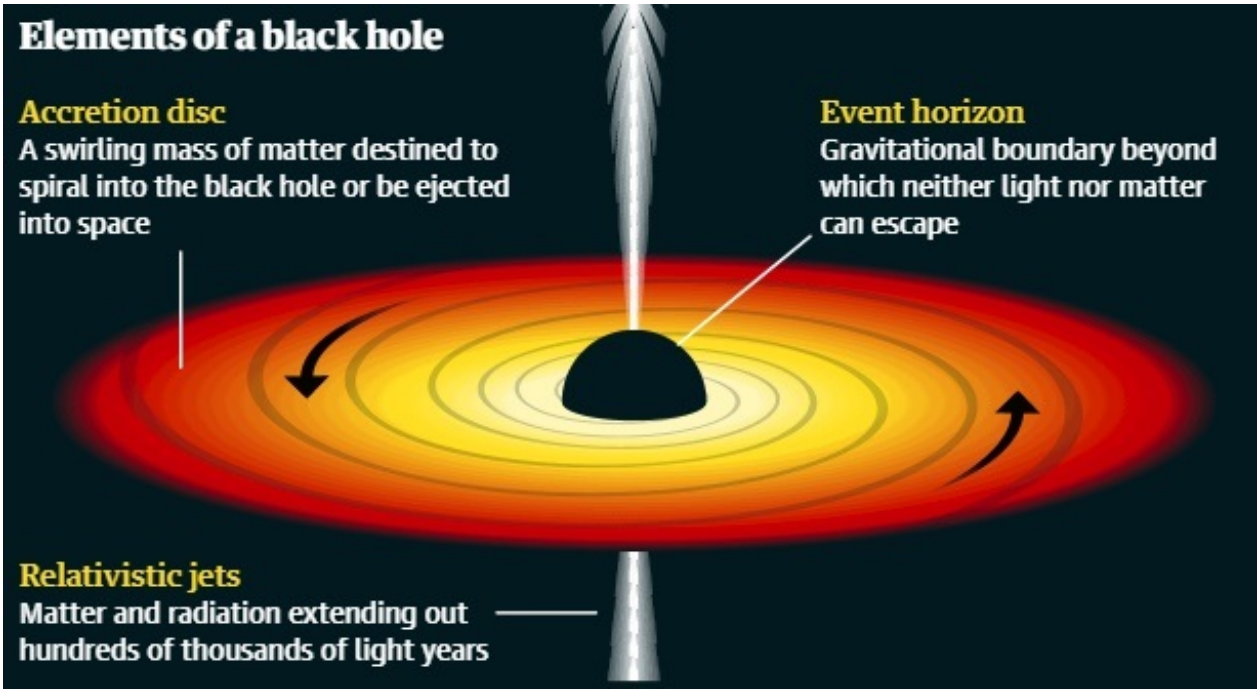
- **Unusual Mass Category:**
    - The black hole with 85 solar masses falls in an **"intermediate-mass" range (first-ever to be observed) and it defies the traditional knowledge** of how black holes are formed.
    - According to traditional knowledge, stars that could give birth to black holes **between 65 and 120 solar masses** do not do so because they **blow themselves apart when they die, without collapsing into a black hole.**
    - In the merger leading to the GW190521 signal, the **larger black hole was well within the unexpected range,** known as the **pair-instability mass gap.**
- **Suggested Reasons for Unusual Mass:**

    The researchers suggest that the larger 85-solar-mass black hole **was not the product of a collapsing star but was itself the result of a previous merger.**

Black Hole

- It refers to a point in space where the **matter is so compressed as to create a gravity field from which even light cannot escape.**
- The concept was **theorized by Albert Einstein in 1915** and the **term 'black hole'** was coined in the **mid-1960s by American physicist John Archibald Wheeler.**
- All the black holes observed so far belong to **two categories:**
    - One category **ranges between a few solar masses and tens of solar masses.** These are thought to form when massive stars die.
    - The other category is of **supermassive black holes.** These range from **hundreds of thousands to billions of times that of the sun** from the Solar system to which Earth belongs.
- In April 2019, the scientists at the **Event Horizon Telescope Project** released the **first-ever image of a Black Hole** (more precisely, of its shadow).

    The image was made possible by the **Event Horizon Telescope** which is a **group of 8 radio telescopes** (used to detect radio waves from space) located in different parts of the world.
- **Gravitational waves are created when two black holes orbit each other and merge.**



Gravitational Waves

- These are **invisible ripples that form when:**
  - A star explodes in a **supernova**.
  - Two big stars orbit each other.
  - Two black holes merge.
- They **travel at the speed of light and squeeze and stretch anything in their path.**

  As a gravitational wave travels through space-time, it causes it to stretch in one direction and compress in the other, Any object that occupies that region of space-time also stretches and compresses as the wave passes over them, though very slightly, which can only be detected by specialized devices like LIGO.
- Gravitational Waves are a **relatively new field of discovery.**
  - These were proposed by Albert Einstein in his **General Theory of Relativity,** over a century ago.
  - However, the **first gravitational wave was actually detected by LIGO only in 2015.**

Source: IE