First Image of a Black Hole

Why in news?

- The Event Horizon Telescope (EHT) collaboration recently showed the world the very first image of a black hole.
- The first-ever black hole to be photographed has been named "Powehi", meaning embellished dark source of unending creation.

What is a black hole?

- A Black Hole is a region of space which is of immense gravity that nothing, not even light, can escape from it.
- Black holes form at the end of some stars' lives, stars that are many times the mass of our sun.
- The energy that held the star together disappears and it collapses in on itself producing a magnificent explosion.
- All the material left over from the explosion falls into an infinitely small point.
- Large black holes can have tens to millions of times the mass of our sun trapped in a point smaller than the tip of a pin.

What was EHT based on?

- If immersed in a bright region, like a disc of glowing gas, the Black Hole could be seen as a dark region similar to a shadow.
- This was something predicted by Einstein's general theory of relativity.
- It predicts that the heated material will illuminate the extremely warped space-time, making a dark shadow visible.
- This is what was attempted through the Event Horizon Telescope.

What was it composed of?

- **EHT** - The Event Horizon Telescope (EHT) operates a planet-scale array of eight ground-based radio telescopes that are linked together.
- Over time, the EHT recruited new radio observatories.
- By 2017, there were eight observing stations in North America, Hawaii, Europe, South America and the South Pole.
- Among the newcomers was the Atacama Large Millimeter/submillimeter Array, or ALMA, located on a high plateau in northern Chile.

- With a combined dish area larger than an American football field, ALMA collects far more radio waves than other observatories.
- **VLBI** - The EHT observations use a technique called very-long-baseline interferometry (VLBI).
- The VLBI technique linked the radio dishes of telescopes across the world to produce a virtual telescope the size of the earth.
- This was needed to obtain the high resolution required for the measurement.
- In this way, VLBI allows the EHT to achieve an angular resolution of 20 micro-arcseconds.

How was it executed?

- The EHT set out to image two candidate supermassive black holes:

1. Sagittarius A* which is 26,000 light years from the earth, at the centre of the Milky Way
2. another black hole which is 55 million light years away at the centre of the Messier 87 galaxy in the Virgo galaxy cluster

- But the first image released was of the more distant one.

- The black hole itself cannot be seen, because light cannot escape its intense gravitational attraction.
- The so-called event horizon that envelops the black hole is the point of no return and any object transgressing this boundary is lost.
- Just outside of it is a region where a photon (light quantum) can orbit the black hole without falling in.
- This is called the ‘last photon ring’, and this is what the EHT imaged, seeing in effect the silhouette of a black hole.
- The challenges included making each of the eight telescopes observe the same broad range of wavelengths around 1.3 mm.
- Another challenge was having precise atomic clocks at each location, so the data could be combined.

How has black hole understanding evolved?

- About a hundred years ago, the black hole made its way into physics through Albert Einstein’s general theory of relativity.
- Few years back from now, the LIGO collaboration first directly observed the gravitational waves made by the merging of two black holes.
- The Higgs boson was detected 50 years after it had been postulated.

- Now, the visual proof of the existence of black holes marks an important milestone.
- It helps understanding the fundamental processes that determine the formation and evolution of galaxies.

Source: Indian Express, The Hindu

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