

# Black Holes:

The Event Horizon Telescope revealed the first ever photograph of the shadow of a black hole.

## Black Hole:

- A black hole is a region of space-time, which exhibits the property of extremely intense gravitational force, which is so strong, that nothing, not even light, can escape it.
- Black holes were predicted by the Einstein's theory of general relativity, which showed that when a massive star dies, it leaves behind a small, dense remnant core.

## Formation:

- If the core's mass is more than about three times the mass of the Sun, the force of gravity overwhelms all other forces and produces a black hole.
- The density of the black holes is so great or denser that nothing, not even light can escape from its gravity.

## Structure:

- Black holes cannot be directly observed because they themselves do not emit or radiate light, or any other electromagnetic waves that can be detected by instruments built by human beings.
- But the area just outside the boundary of the black hole (Event Horizon), which has vast amounts of gas, clouds and plasma swirling violently, emit all kinds of radiations, including even visible light. Hence,

the presence of black holes can be inferred by detecting their effect on other matter nearby them.

- Now, the Event Horizon Telescope has captured the just outside region of a black hole, located 55 million light-years from Earth, at the centre of a galaxy named Messier 87.
- The image shows a photon can orbit the black hole without falling in. This is called the 'last photon ring'

### **Types:**

- Stellar black holes: According to the astronomer's, this types of black holes are formed by the compression of the collapse of the larger star.
- Supermassive black holes: According to the astronomer's, this types of black holes are formed by the merger of the hundreds or thousands of tiny black holes through the ongoing gravitational collapse which resultant the spheroid region of space from which nothing can escape.
- Intermediate black holes: According to the astronomer's, black holes which are more bigger than Stellar Black holes but less than supermassive black holes is called intermediate black holes.

### **Significance:**

- For centuries, the concept of black hole has only been theorized, without any actual evidence of it. This is a remarkable confirmation of more than a century of theoretical work.
- The black hole is very small as compared to other celestial bodies and the light has to pass through all sorts of gases and material of the space and the Earth's atmosphere.
- The telescopes of EHT also have to synchronize in a perfect manner to be able to make simultaneous recordings of the radiations coming in from the black hole region.

- Scientists can compare the actual image with computer-simulated images used earlier to ascertain the differences, which could be explained by instrumentation, observation or other errors.
- This can provide a test for existing theories of the universe, and lead to a better understanding of black holes and the nature of the universe itself.
- Enhances the understanding of gravitational force- which can be useful for the Global Positioning Satellites in order to make them accurate to more than a few metres.

### **Locations of Black Holes:**

- Supermassive black holes are found at the centre of most galaxies, including our own Milky Way.
- The one in our galaxy is called Sagittarius A\* and is one of those the Event Horizon Telescope has been attempting to photograph.
- Sagittarius A\* isn't the only black hole in our galaxy, though. Earlier this year, astronomers discovered another 12 within three light-years of it, suggesting there could be upwards of 10,000 black holes around the galactic centre.

### **Event Horizon:**

- A long-standing goal in astrophysics is to directly observe the immediate environment of a black hole.
- The 'event horizon' is the boundary defining the region of space around a black hole from which nothing can escape.

### **ETH:**

- The EHT is an international collaboration to continue the progress in achieving this goal, using the technique of Very Long Baseline interferometry (VLBI) at short wavelengths.
- A network of 8 groundbased radio telescopes have been linked and exploit the rotation of our planet to form one virtual Earth-size telescope observing at a wavelength of 1.3 mm.

### **Wormholes and Cosmic Strings**

- Wormholes and cosmic strings are theoretical imperfections in space-time.
- While a Black hole has one point of singularity, the wormhole may have two points – one where matter can only enter and another where matter can only exit. No worm hole has been detected so far, so they are only in theory and science fiction.
- A cosmic string is a theoretical, vibrating strand that is like a black hole but instead of being a point or sphere, it is a long but very thin crease left in otherwise smooth universe.
- Cosmic string is also theoretical and no such string has been detected so far.