Column

Explained in 60 Seconds: The First-Ever Image of a Black Hole

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Earlier this year the world was hit with one of the biggest astronomical breakthroughs this decade: the first image of a black hole. Even to astronomers, black holes are one of the most mysterious objects in the Universe. About a century ago, the existence of a black hole was predicted from Einstein's general theory of relativity. Its strong gravity warps the surrounding spacetime and anything nearby, even light, can be absorbed into the black hole. Astronomers now widely theorise that a massive black hole exists at the centre of almost every galaxy.

Although a black hole itself does not shine, the accreting matter surrounding the black hole becomes so hot that it emits intense radiation. As a result, the black hole is expected to be pictured as a dark "shadow" surrounded by the bright ring of emissions. However, the angular extent of the shadow is so tiny on the sky that no direct picture of the black hole shadow had ever been obtained. Even for the nearest supermassive black hole, an angular resolution at least 1000 times better than the Hubble Space Telescope would be required to spatially resolve its shadow.

So this imaging feat required astronomers from around the world to assemble a global network of radio telescopes called the Event Horizon Telescope (EHT). The resulting Earth-sized diametre radio telescope achieved a super-sharp angular resolution to capture the image of the black hole. Initial observations began in April 2017, when the EHT observed the core of M87, a supergiant elliptical galaxy located at 55 million light-years from the Earth.

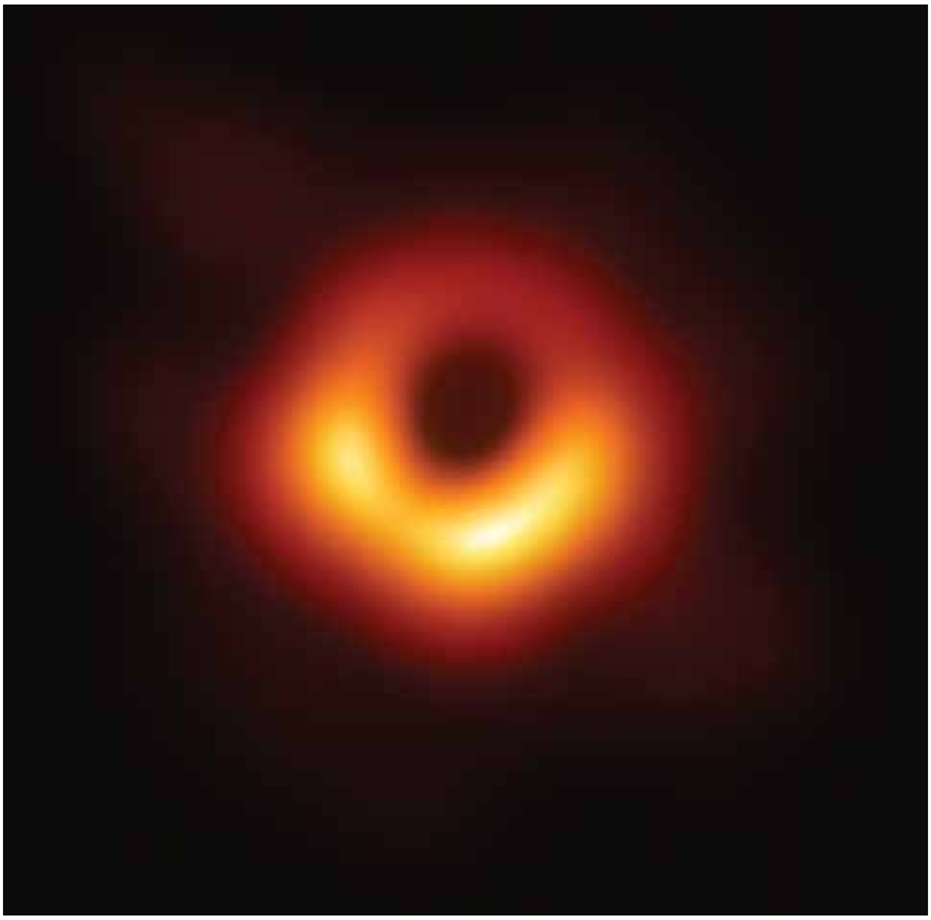

Figure 1. The first image of the shadow of a black hole, located at the centre of galaxy M87. Credit: EHT Collaboration

Following careful data calibration and analysis lasting two years, the team released the first EHT image of M87*, the centre of galaxy Messier 87, in April 2019 (Figure 1). The image reveals a bright circular ring surrounding a dark central area. The observed feature is in beautiful agreement the prediction from Einstein's theory as well as recent state-of-the-art supercomputer simulations. Furthermore, from the observed diameter of the ring, the mass of the central black hole was determined to be 6.5 billion times that of the Sun.

The detection of the dark shadow is the first-ever visual evidence for a black hole and shows the extreme real-life distortion of spacetime just near the event horizon. This image opens a new window for black hole physics and astronomy. The EHT network is still rapidly evolving by adding more stations and enhancing sensitivity. Further EHT observations of M87* and other nearby supermassive black holes will yield higher quality images and the possibility of movies, which will tell us in even greater detail about the physics of black holes and gas dynamics.