1. Introduction of the Event Horizon and the First Picture of a Black Hole

This essay is formulated as followed. (A)First it will talk about what exactly is a black hole and mainly its properties.(B) This will lead to a technique to take pictures of the black hole called Very Long Baseline Interferometry. This can help understand what exactly is an Event Horizon Telescope and how it works. (C)The reason it works is due to the fact that Einstein's theory of general relativity works with gravitational waves.(D) Until finally to conclude you see the final picture of a black hole and how it's used in recent times.

A. What is a black hole

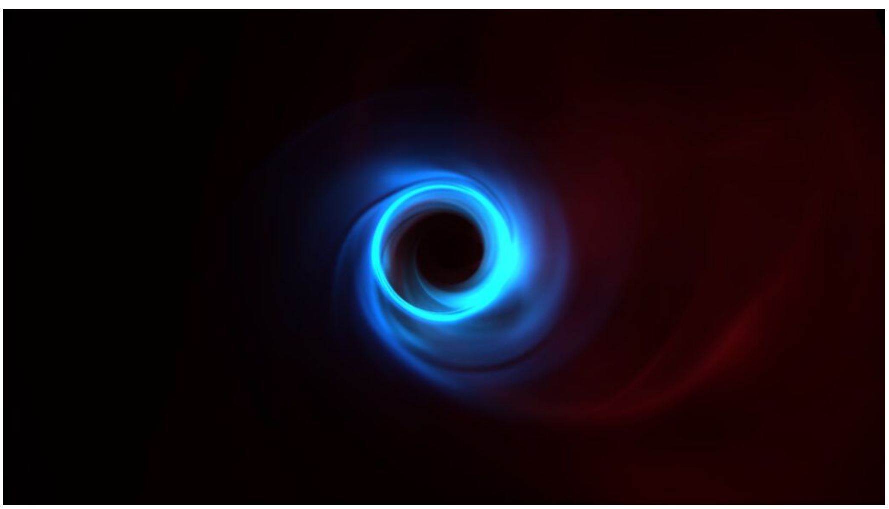
In a galaxy far far away, 53 million light years away to be exact, is a supergiant elliptical galaxy named Messier 87 which has an active supermassive black hole at its core[1]. The black hole creates a hole in space that deforms the fabric of space around it. As this happens whatever material goes inside comes out with no escape making it very difficult to to measure anything inside [2]. It has been an ongoing goal for many scientists to try to precisely observe the immediate atmosphere of a black hole but are capable of three measured physical properties. These include the mass, charge, and angular momentum which are visible from the outside [3]. The density of the black hole makes it difficult to capture pictures as their gravitational waves suck up anything near such as light.These findings could potentially result in photographs of high gravity effects near the black hole, and to a direct identification of dynamics near the black hole as matter orbits at light speeds. Now let's say we wanted to move even closer into the black hole what can we best see? With radio wavelengths if we were to zoom in even closer into the core of the black hole there's a ring of light sitting there due to gravitational lensing of hot plasma causing it to act as a lens for the things that lie behind it.[6] To be able to see these properties NASA would need an earth sized telescope but instead NASA came up with a technique to that does the same effect.

B. Very Long Baseline Interferometry & Event Horizon telescope

This technique is known as the Very Long BaseLine Interferometry (also known as VLBI). It was first Launched in 1967 to take pictures of quasars and to track spacecraft. This technique instead of using one gigantic telescope to take photographs uses eight smaller telescopes linked together simultaneously having the same effect. The eight telescopes are called the Event Horizon Telescopes which each have a distance of 5351 miles, and six are located on earth, in Arizona, Northern Chile, Southern Spain, Hawai'i, Southern Mexico, and the South Pole. The other two telescopes are currently in orbit.[4] As the Earth rotates, the telescopes in the different continents allow the telescopes to cover more in depth of the black hole with low resolution. How it works is pictures are being taken by the massive array, an algorithm sorts the images and organizes them into an approximation of what the object in question might look like such as “puzzle pieces” where you put them together to create a final picture. This potentially opens a new door of opportunity on the study of general theory of relativity within the strong field regime, accretion and outflow processes of black holes, the existence of event horizons.

C. Einstein's general relativity

Through recent discoveries, scientists have discovered ways to use telescopes around the world to work together and produce an image of a black hole. This ability has allowed scientists to understand if Albert Einstein’s theory of relativity stands true at such a grand scale. Einstein's theory of relativity is the law of physics is the same for all non-accelerating observers and speed of light in a vacuum is the same for all observers relative motion and course of light. Shape of the event horizon helps to prove Einstein's Theory of Relativity as he predicted a circular event horizon, while other theories would predict other slightly different shapes. According to Einstein’s theory of relativity this proves the very existence of black holes along with the size of shadow casted on dense objects swirling around.



Simulations of the way light and matter move around the supermassive black hole at the center of galaxy M87, like the one shown here, helped physicists pin down the size of the shadow the black hole casts on surrounding material. That size is crucial in tests of general relativity. [6]

4. The Final Picture

Thanks to the development of getting the first picture of black hole many scientists now believe that this is just the beginning of a whole new breakthrough. They began to see things that only made sense if black holes were real. Like orbits of stars in the Milky Way just moving rapidly around an invisible point [7]. Think, so many things had to go right for this to happen to where if we didn't come up with the Very Long Baseline Interferometry technique they would be in trouble to see what lays beyond the galaxies. This photo proved general relativity as it represented the extreme parts of the universe that probably wouldn't be discoverable as this opened so many doors and opportunities to improve. Maye since we detected a galaxy 55 million light years away we can find one even further away by adding more telescopes to the Event Horizon Telescopes.

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