

THE FASCINATION OF BLACK HOLES

Chapter 2

Black Holes – What We Know About Them

Nowadays, we can observe black holes using space telescopes and computer-based calculations. Yet they remain one of most fundamental mysteries of the universe.

What we do know is that the formation of smaller black holes is linked to the evolution of stars.

A star burns hydrogen continuously; once all the hydrogen is used up, the pressure from the star's own gravity becomes so great that an explosion, a supernova, occurs. The core of the star collapses and its mass is compressed under great pressure. Larger black holes are thought to be formed by the direct collapse of gigantic masses of gas.

Whatever is causing the collapse is so massive that it rips a hole into spacetime. But how can we picture this?

Let's consider Albert Einstein's theory of relativity. The theory of relativity contradicts our basic understanding of time and space. Albert Einstein thought of space in terms of length, width, and height, with time being the fourth dimension. This spacetime structure can be altered by gravity.

According to Einstein's theory, a heavy object can bend space and slow time. A very heavy, that is, a supermassive object, such as a black hole, can bend spacetime so much that it creates a funnel. At the bottom of this funnel, there is a point where matter is squeezed under high pressure into the smallest space. At this point, gravity is infinite, and time stands still. The dimensions of space and time merge in this so-called singularity. We cannot picture this because it has no surface and no volume – everything is in the void.

At the outer edge of the funnel, we find a region referred to as the event horizon. In 1916, long before black holes could be detected empirically, Karl Schwarzschild described this area mathematically in the context of general relativity. Beyond the event horizon, gravity is so strong that not even light can escape. If you were to enter this region, you would immediately become invisible from the outside. Spinning, you would sink deeper and deeper into the funnel. Your head and feet would be accelerated at such different rates that you would be stretched out. Astrophysicist Stephen Hawking called this effect "spaghettification". You would not survive this process. And even if you did, the gravitational pull would be so strong that you wouldn't be able to get out again.

So, do we need to worry that there is a supermassive black hole at the centre of the Milky Way?