Event Horizon
Artist: Stoyan Dechev
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Anca Poterasu Gallery Leipzig

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How it all started

Nearly 100 years ago astronomers believed that the Universe consisted only of our own Galaxy, the Milky Way. Plenty of colourful, astronomical nebulous objects were catalogued but, at that time, were thought of as other forming Solar systems. Only after Edwin Hubble measured the precise distances to these objects, he realised that they are a lot further away than the known stars, therefore, implying that these are other distant gigantic conglomerations of stars, known as galaxies or "island universes". Hubble did not only measure distances, but he also measured the speed of these objects determining that the most distant ones are receding away from us at the highest velocity. This was the first observational proof of the Big Bang model.

The very basic idea of the Big Bang model is that if galaxies are drifting away from each other, then they must have been closer in the past. So at one point in time, everything was in one infinitesimal space (singularity). Space and time as we study are believed to have been created during this initial "big bang", although our laws of Physics cannot explain this very beginning of time yet. We can measure that it started 13.8 billion years ago and that the extremely hot early Universe was expanding until it cooled enough to form the first atomic particles, predominantly Hydrogen. The Universe kept expanding and cooling when hundreds of millions of years later, giant clouds of gas started collapsing under their own gravity to form the first stars and galaxies. Our detailed observations show that the matter we can see is far from the mass that we need to explain what is going on. We call this missing matter "dark matter".

Latest observations indicate that the Universe is not only expanding but that it continues to do so with an acceleration caused by an unknown "force" called the dark energy. The future of our Universe and whether it will keep expanding forever will be determined by the exact proportion of the dark energy to matter.

The destiny of the stars is also caused by the play of forces that "pull together" and "push away". Since gravitation is caused by mass, the stellar evolution depends mainly on the initial mass of the molecular cloud fragment forming the star. As the gravitational potential energy is released, the gas becomes denser and denser and the temperature increases. Once the conditions in the core are hot and dense enough to start the nuclear fusion processes of the Hydrogen, the star has officially started its life and the energy produced stops the collapse (See more on the topic here and here). The more massive the star is, the quicker it goes through these stages. For very massive stars, some of the details of the formation stages are not completely clear. After burning the fuel in their cores, massive stars may not have enough pressure to resist the gravitational collapse and will inevitably implode to create a stellar-mass black hole.

Black holes are called that way because there is nothing that can escape their gravitational pull, not even light (the "escape velocity" is beyond the speed of light). Black holes deform spacetime and the border of "no escape" is called the event horizon. They can grow by absorbing other matter and merging with other stars, accumulating a mass of thousands, even millions of solar masses. Such supermassive black holes can be found at the centres of most galaxies. Usually, we cannot see the black holes directly, but we can infer about them from their interactions with surrounding objects and matter. For example, some black holes create accretion discs and the infalling matter gets heated to extreme temperatures and strong electromagnetic radiation is emitted as jets. Such is the case with the central black hole in the distant galaxies called quasars, which are among the most energetic objects (read more about them here).

Nowadays, the biggest challenge is to combine Einstein's theory of general relativity (explaining Big Bang and black holes) with the knowledge of quantum mechanics. Currently, these theories are so mathematically complex, that they are impossible to understand by the general public. However, they will hopefully one day provide the answer to the true nature of the world our civilisation lives in.