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## **BLACK HOLES, WORMHOLES**

**Ken Tapping, 16<sup>th</sup> August, 2016**

Isaac Newton regarded gravity as a force. However, Albert Einstein proposed it was something else entirely. If we were in a space capsule with no windows, we could not feel any difference between floating in empty space and plummeting downwards to Earth. In both cases we would feel weightless, like astronauts in the International Space Station, as they fall around the Earth. This is very different from what we feel when on an aircraft accelerating during takeoff.

Einstein proposed that gravity is actually a bending of the fabric of spacetime by a mass. Just as in the case of putting a mass on a rubber sheet, the stretching is increased by having more mass, or by concentrating that mass in a smaller lump, for example a 10kg ball of aluminium or a 10kg ball of lead. A 10kg ball of lead would distort the rubber sheet far more than the larger, 10kg aluminium ball. Einstein showed that if a mass is large enough or is sufficiently concentrated, the fabric of spacetime can be so distorted that nothing can get out, not even light. We have a black hole. This can be achieved in two ways. We can just keep adding more and more material, so that the overlying weight crushes the material in the middle, or as in an exploding star, shockwaves can compress the core to the point where it becomes a black hole...

Beyond this point we do not know much. Most of our physical knowledge has been built over centuries of observing the world around us and beyond, and doing experiments in the laboratory. To turn our Earth, which has a diameter of 12,756 km, into a black hole would require compressing it to a diameter of 1.7cm. Under conditions this bizarre our physics knowledge gets unreliable. This has triggered the imaginations of scientists, and led to the exchange of all sorts of ideas. Some of them are really exotic. One idea is that some black holes are actually wormholes.

A black hole is a one-way portal to some other place – a dead end. However, Albert Einstein and fellow physicist Nathan Rosen showed that if the

fabric of spacetime is bent and folded the right way a black hole could link through to another part of the universe, like a hollow tube. These are now known as Einstein-Rosen Bridges. Most of us call them wormholes: tubes connecting different places and times in the universe.

The fastest spacecraft we can currently build would take many thousands of years to get to the nearest star, and even at the speed of light it would take over four years. However, as we approach the speed of light, time is distorted, so for the astronauts the journey might take a tolerable time, but they would arrive home to find centuries or millennia have passed. So, in science fiction and the more imaginative areas of science, there is an ongoing quest for some way to deal with what seem to be impossible distances. Going through a wormhole could in principle get you to the other side of the universe instantaneously. In the movie *Contact*, Jodie Foster went through what looked very much like some kind of wormhole.

However, whether or not wormholes exist, it is not clear how we could use naturally-occurring ones for transportation. The gravitational forces holding the portals open would tear us apart as we approach, while we are at the same time being fried by the X-rays and heat emitted by everything being sucked in along with us. It has been suggested we actually live inside a black hole.

Providing our ideas lead to possible observations or experiments to test them, all of them, no matter how exotic, are scientifically valuable. Arthur Eddington was probably right in saying "The universe is not only stranger than we imagine; it is stranger than we can imagine".

Mars and Saturn lie low in the southwest after dark. Saturn is to the left of Mars and fainter. The Moon will be Full on the 18<sup>th</sup>.

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