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BLACK HOLE, WORMHOLE

Ken Tapping, 27th May, 2014

Thanks to science fiction movies and TV series, most of us have heard of black holes and wormholes. The former are things to stay away from, and the latter are presented as a means to travel rapidly to other parts of the universe, or even to other universes. These days we are pretty sure most galaxies host large black holes in their cores, and although we have yet to identify a wormhole, the science that describes black holes also suggests wormholes should exist.

Isaac Newton gave us a “comfortable” view of the universe, where space and time are immutable and experienced identically by everybody. Einstein and others showed this is not the case. Each of us has a unique experience of space and time, depending upon our local circumstances and how we are moving. Fortunately under “everyday conditions”, Newton’s ideas work well enough. However, a range of experiments conducted in laboratories, aircraft, satellites and space show Einstein’s picture to be the more accurate one.

Gravity is described as a distortion in space-time produced by mass, just like dropping weights onto a rubber sheet. Two things dictate how deep the depression produced in the rubber sheet will be: the mass of the object and how big it is. A 10kg lead ball will make a deeper, narrower depression than a 10kg wooden ball. The depth and steepness of the distortion is analogous to gravity.

You will not have noticed this, but clocks run more slowly on the surface of the Earth than they do in space, well away from the Earth’s gravity. For a planet the size and mass of the Earth the effect is tiny. However, if we were to compress the Earth down to a very small size, the increased gravitational attraction at its surface would make the effect bigger. If we crunch the Earth down to less than a millimetre in diameter, the distortion of time becomes total. Time inside would pass infinitely slowly compared with time on the outside. You might be inside, happily climbing the escape ladder, but each second of your time would be the

equivalent on the outside of millions or billions of years, or even eternity. Nobody will ever see you emerge. Not even light will be able to escape. The Earth has become a black hole.

Mother Nature makes black holes two different ways. An explosion in the outer envelope of a large star (a few times the mass of the Sun) can compress the core region to a point where it may form a black hole a few kilometres in diameter. The other way is to keep adding more and more material. If something is located where it can pull in material from its surroundings, it may eventually collect enough to compress itself into a black hole. This is probably why we have huge black holes in the cores of many galaxies, where there is lots of material to gobble up. We have observed the black hole in the centre of our galaxy gulping down gas, dust, stars, and probably planets.

According to our current understanding, if enough material is swallowed by black holes the compressional force can become irresistible. Nothing can stop it. It implies something can be compressed down to zero size. One suggestion is that the material is “squeezed out” altogether, reemerging somewhere else in the universe, making our black hole one end of a wormhole.

Such a wormhole would not be a useful cosmic transporter. Diving into it would produce the same fatal results as falling into a black hole. As we approach, intense gravitational fields will tear us apart, until we enter as individual atoms. We would not survive to see what the inside of a black hole looks like, or admire the scenery in some distant part of the universe. We would emerge at the other end as a blast of radiation and particles, no doubt puzzling an alien astronomer or two.

Jupiter sets soon after sunset, leaving Saturn and Mars in the southern sky. Venus lies low in the dawn twilight. The Moon will be New on the 28th.

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