Schwarzchild Radius Encyclopedia Article

Schwarzchild Radius

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In 1795, French mathematician Pierre Simon de Laplace, armed with a knowledge of Newtonian gravitational theory, asked himself whether a star could be so large that even **light** would be gravitationally bound. He knew that the escape **velocity** (the minimum velocity with which an upwardly moving object would never fall back) is given by, where *M* and *r* are the **mass** and radius of the planet or star, and *G* is the Newtonian gravitational constant. This expression is independent of the projectile's own mass. Thus, by setting the above expression equal to the **speed of light**, *c*, he arrived at an expression for the radius of a body from which nothing, not even light, could escape: *r=2GM/c[sup2]*. This calculation assumes, of course, that the star's entire mass lies within the radius *r*.

But Newtonian theory does not describe **gravity** correctly, although it suffices quite well in describing the **gravitational force** between, for example, people and **planets**. In order to describe very strong gravitational fields correctly, Einstein's general theory of relativity must be employed. In 1916, shortly before he was killed in World War I, German astronomer Karl Schwarzchild found the solution for the **space-time** geometry around a spherical mass. Remarkably, Laplace's naive calculation was borne out, and the radius at which a body becomes a black hole now bears Schwarzchild's name. The Schwarzchild radius for bodies of even astronomical mass is quite small; for example Earth's entire mass would have to be compressed into a sphere 3.7 mi (6 km) in diameter in order for light to be unable to escape its pull.