Relationship between the Gravitational and Planck constants

The universal gravitational constant G in the gravity equation

$$F = G\frac{m1 * m2}{r^2} \qquad kg\frac{m}{s^2} = \frac{m^3}{kg * s^2} * \frac{kg^2}{m^2}$$

$$G = 6.67428 * 10^{-11}\frac{m^3}{kg * s^2} \quad \text{or} \quad N\left(\frac{m}{kg}\right)^2$$

The Gravitational constant G is related to the Planck values in the following way:

$$G = \frac{Planck\,length^3}{Planck\,mass * Planck\,time} \quad \text{or} \quad G = \frac{l_p^3}{m_p * t_p}$$

Planck constant h

- Describes the size of quanta.
- The proportional constant between the energy of a photon and the frequency of the associated electro-magnetic wave.

$$E = h * v = \frac{h * c}{\lambda}$$

Planck length l_p

- Smallest dimension by which any 3D substance can be known.
- Length by which the structure of space-time becomes dominated by quantum effects.
- The only length that can be formed from the constants c, G, and h:

$$l_p = \sqrt{\frac{\hbar G}{c^3}}$$

Planck time t_p

Is the time for light to travel in a vacuum a distance of 1 Planck length

$$t_p = \sqrt{\frac{\hbar G}{c^5}}$$

Planck mass p_m

The Compton Wavelength $\lambda_c = \frac{h}{mc}$ is the wavelength where quantum effects become important for a particle.

The Schwarzschild radius $r_s = \frac{2G * m}{c^2}$ is the radius of a particle in which its mass becomes a black hole.

If the mass of a particle becomes heavy enough so that its Compton wavelength and SchwarzSchild radius are roughly equal, it will be strongly affected by quantum gravity. This mass is approximately the Planck mass.

Author: Dirk Bertels, Hobart June 2009