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Increase of Mass in a Gravitational Field

Mohammadreza Tabatabaei

contact@ki2100.net

As we know, force multiplied by distance equals energy:

E=F.d

E represents energy; **F** represents force and **d** is distance. Also the gravitational force between two masses is calculated by the following equation:

$$F = \frac{GMm}{r^2}$$

Where **G** equals the global constant of gravity and **M** is the first mass (celestial substance), **m** represents the second mass of a material and **r** is the distance between two centers. So gravitational potential energy is obtained in the following ways:

$$E = F \times d$$

$$d = r \Rightarrow E = F \times r \Rightarrow F = \frac{E}{r}$$

$$\frac{E}{r} = \frac{GMm}{r^2} \Rightarrow E = \frac{GMm}{r} = U$$

U represents gravitational potential energy that equals and is equivalent to the corresponding mass, and it will increase the mass. Now we calculate the amount of masst:

$$U = \frac{GMm_0}{r}$$

$$E = mc^2$$

$$E = U$$

$$\Delta m = \frac{E}{c^2} = \frac{U}{c^2} = \frac{\frac{GMm_0}{r}}{c^2} = \frac{GMm_0}{rc^2}$$

$$m = m_0 + \Delta m = m_0 + \frac{GMm_0}{rc^2}$$

$$m = \frac{m_0 rc^2 + GMm_0}{rc^2} = \frac{m_0\left(rc^2 + GM\right)}{rc^2}$$

m_0 is the initial mass of a material, **c** is the speed of light, **Δm** is increase in mass of the material in a gravitational field and **m** is its final mass in a gravitational field.

Hence, we calculate 1kg mass of material on the sun's surface:

$$m = \frac{m_0\left(rc^2 + GM\right)}{rc^2} = \frac{1 \times \left(6.96 \times 10^8 \times 9 \times 10^{16} + 6.672 \times 10^{-11} \times 1.99 \times 10^{30}\right)}{6.96 \times 10^8 \times 9 \times 10^{16}} = 1.000002$$