C Gravitation

(This Appendix is part of the Universal System of Units Standard.)

C.1 The gravitational constant and the gravity field equations

When representing the mass of a celestial body by means of the Universal System of Units Standard, the gravitational radius (half the Schwarzshild radius) is used rather than using mass directly. Because the accuracy of measuring the Newton constant is poor, representing the mass of a celestial body directly in terms of mass results in poor accuracy, but the gravitational radius can be measured to an accuracy of more than 10 decimal places. The reason for the poor accuracy of measuring the Newton constant is that the quantities that are required for astronomical calculations almost always appear in the form of the product of the Newton constant and mass and the Newton constant seldom appears alone, so it is difficult to construct observations and experiments for measuring the bare Newton constant with high accuracy. The gravitational radius has an appropriate scale and so is convenient.[(13)]

If we define a quantity that has the dimension 'force' as 'the gravitational constant', there is a good chance that the geometrical parts can be separated from the coefficients in the formula. Make the gravitational constant $N_G = c_0^4 G^{-1} = \frac{c_0 \hbar}{4\alpha l_P^2} = 2\mathrm{A.B33B} \times 10^{34}_{(12)} \mathrm{N}_u$, then

$$\begin{aligned}
\text{gravitational radius } r_m &= \frac{Gm}{c_0^2} = \frac{mc_0^2}{N_G} (\text{ half the Schwarzschild radius}) &(32)\\
\text{gravitational force } f &= N_G \frac{r_m r_{m'}}{r^2} = c_0^2 \frac{r_m m'}{r^2} &(33)\\
\text{gravitational acceleration } g &= c_0^2 \frac{r_m}{r^2} = \frac{r_m}{(r/c_0)^2} &(34)\\
\text{gravity field equation } T_{ik} &= \frac{N_G}{2\Omega_2}(R_{ik} - \frac{1}{2}\delta_{ik} R) &(35)
\end{aligned}$$

In the gravity field equation (35), because R is the curvature tensor, it has the dimension of solid angle/area. T, on the other hand, is the energy-momentum tensor, and so has the dimension of energy density. Therefore, the denominator of the coefficient $\dfrac{N_G}{2\Omega_2}$ must be the dimension of solid angle (It is interesting to compare this to the equation for the energy density of an electromagnetic field).

C.2 The Planck length

The Planck length, a distinguishing feature of superstring theory, can also be represented in well-bounded form in the Universal System of Units Standard.

That is to say, half the value of the Planck length is

$$\frac{1}{2}\sqrt{\frac{G\hbar}{c_0^3}} = 1.022031 \times 10^{-28}_{(12)} \mathrm{m}_u \tag{36}$$

In order to represent the tensile force in a superstring, half the value of the Planck length, l_P, adjusted by the fine structure constant, α,[(2)] becomes

$$l_P = \frac{1}{2}\sqrt{\frac{G\hbar}{c_0^3 \alpha}} = 0.\mathrm{BA70BB} \times 10^{-27}_{(12)} \mathrm{m}_u \tag{37}$$