

6.1: Prelude to the Fundamental Forces

The fundamental forces are normally divided in four groups, of the four so-called “fundamental” forces. These are often naturally classified with respect to a dimensionless measure of their strength. To set these dimensions we use \hbar , c and the mass of the proton, m_p . The natural classification is then given in Table 6.1.1. Another important property is their range: the distance to which the interaction can be felt, and the type of quantity they couple to. Let me look a little closer at each of these in turn.

Table 6.1.1: A summary of the four fundamental forces

Force	Range	Strength	Acts on
Gravity	∞	$G_N \approx 6 \cdot 10^{-39}$	All particles (mass and energy)
Weak Force	$< 10^{-18} \text{ m}$	$G_F \approx 1 \cdot 10^{-5}$	Leptons, Hadrons
Electromagnetism	∞	$\alpha \approx 1/137$	All charged particles
Strong Force	$\approx 10^{-15} \text{ m}$	$g^2 \approx 1$	Hadrons

In order to set the scale we need to express everything in a natural set of units. Three scales are provided by \hbar and c and e – actually one usually works in units where these two quantities are 1 in high energy physics. For the scale of mass we use the mass of the proton. In summary (for $e = 1$ we use electron volt as natural unit of energy)

$$\begin{aligned}\hbar &= 6.58 \times 10^{-22} \text{ MeV s} \\ \hbar c &= 1.97 \times 10^{-13} \text{ MeV m} \\ m_p &= 938 \text{ MeV}/c^2\end{aligned}$$

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