

Fundamental Forces and the Standard Model

Four Fundamental Forces

- 1. STRONG. rel. strength 1. range 10^{-15} m
- 2. ELECTROMAGNETIC. rel. strength 10^{-2} . Range proportional to $1/r^2$
- 3. WEAK. rel. strength 10^{-6} . Range $<10^{-18}$ m
- 4. GRAVITATIONAL. rel. strength 10^{-38} . Range proportional to $1/r^2$.

Standard Model/Classification of Matter

- Hadrons consist of quarks. Hadrons act through/held together by strong force.
- Baryons are hadrons that consist of three quarks (Example: proton, neutron).
- Mesons are hadrons that consist of a quark and an anti-quark.
- Leptons do NOT contain quarks. Leptons do NOT act through strong force. Six different types of leptons (as is the case with six different types of quarks). Examples: electron, neutrino, positron

Example of Baryon Hadron

- Proton has charge of +1
- Proton is a baryon as it consists of three quarks: uud.
- $U = 2/3$; $u = 2/3$; $d = -1/3$
- The sum of the quark charges equals +1.

Antiparticle

- An antiparticle is a particle having the same mass, lifetime, and spin as the associated particle but with charge of opposite sign (if charged).
- Antiparticle is denoted with a bar over the associated particle.
- Antimatter is material consisting of atoms that are composed of antiprotons, antineutrons, and positrons.

Antiparticles

- Produced in nuclear reactions when there is sufficient energy available.
- Very short lifetime.
- If a particle encounters its antiparticle, they annihilate each other. The energy of their vanished masses, plus any KE they possessed, is converted to the energy of gamma rays or of other particles.