Elementary Particle Physics
from the context of the courses
PHY 493: Elementary Particle Physics

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Contents

0.1   The SI System

In physics it's often important to have precisely defined units for the purposes of making very accurate measurements or simply having a coherent unit system. It's possible to derive all necessary units from five measurements of **length, mass, time, current, and temperature**. The standard SI units for these properties are listed bellow:

Type	Unit	Definition
Length	Meter(m)	Length of distance light in a vacuum travels in $\frac{1}{299792458}$ seconds
Mass	Kilogram(kg)	Defined by fixing the Planck's constant $h = 6.62607015 \times 10^{-34} kg\ m^2 s^{-1}$
Time	Second(s)	Defined by fixing the ground-state hyperfine transition frequency of the caesium-133 atom, to be $9192631770 s^{-1}$
Current	Ampere(A)	Defined by fixing the charge of an electron as $1.602176634 \times 10^{-19} A \cdot s$
Temperature	Kelvin(K)	Defined by fixing the value of the Boltzmann constant k to $1.380649 \times 10^{-23} kg \cdot m^2 s^{-2} K^{-1}$

Common prefixes are listed bellow:

Prefix	Symbol	Definition
mega	M	10^6
kilo	k	10^3
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Additionally, the following are defined constants:

Symbol	Definition
$\hbar$	$\hbar = \frac{h}{2\pi} \approx 1.0546 \times 10^{-34} kg\ m^2 s^{-1}$

Chapter 1

Fundamental Particles

1.1 Fermions and Bosons

Definition 1.1.1. A **fermion** is a particle with half integer spin.

Definition 1.1.2. The **color** of a particle is a quantum number that can be in 7 possibles states: colorless, red, green, blue, anti-red, anti-green, and anti-blue.

Definition 1.1.3. A **quark** is a fermion with color charge.

Definition 1.1.4. An **anti-quark** is a fermion with anti color charge.

Table 1.1.5. Quarks and Anti-Quarks Table of quarks and anti-quarks and there corresponding properties.

Name	Sym.	S	Q	B_a	T_3	I_3	C	S	T	B_o	Mass (MeV/c^2)
Up	u	1/2	2/3	1/3	1/2	1/2	0	0	0	0	2.3
Anti-Up	$\overline{u}$	1/2	−2/3	−1/3	−1/2	−1/2	0	0	0	0	2.3
Down	d	1/2	−1/3	1/3	−1/2	−1/2	0	0	0	0	4.8
Anti-Down	$\overline{d}$	1/2	1/3	−1/3	1/2	1/2	0	0	0	0	4.8
Charm	c	1/2	2/3	1/3	1/2	0	1	0	0	0	1.275×10^3
Anti-Charm	$\overline{c}$	1/2	−2/3	−1/3	−1/2	0	−1	0	0	0	1.275×10^3

S is spin ($\hbar$), Q is electric charge (e), B_a is baryon number, I_3 is strong isospin, T_3 is weak isospin, C is charmness, S is strangeness, T is topness, B_o is bottomness.

Definition 1.1.6. a **lepton** or an **anti-lepton** is a fermion with no color charge.

Table 1.1.7. Leptons and Anti-Leptons Table of leptons and anti-leptons and their corresponding properties.

Definition 1.1.8. A **Boson** is a particle with integer spin.

Table 1.1.9. Bosons Table of bosons and their corresponding properties.

1.2 Feynman Diagrams

Definition 1.2.1. A **feynmann diagram** is a pictorial representation of and interaction between particles.