EP 328 Particle Physics – List of Particles and Interactions

Table 1: The four fundamental Interactions

Interaction	Particles affected	Range	Relative Strength	Particles Exchanged	Role in Universe
Strong	Quarks	10^{-15} m	1	Gluons (*g*)	Holds quarks together to form nucleons
	Hadrons			Mesons	Holds nucleons together to form atomic nuclei
Electro-magnetic	Charged particles	∞	10^{-2}	Photons (γ)	Determines the structure of atoms, molecules, solids and liquids, is important factor in astronomical universe, is responsible for frictional force
Weak	Quarks and Leptons	10^{-18} m	10^{-5}	Intermediate bosons (*W*, *Z*)	Mediates transformations of quarks and leptons, helps determine compositions of atomic nuclei
Gravitational	All	∞	10^{-39}	Gravitons (*G*) (*not seen as yet*)	Assembles matter into planets, stars, galaxies.

Table 2: List of Leptons (B = 0)

Name	Symbol	Antiparticle	Mass (MeV/c^2)	Mean life time (s)	Charge (e)	Spin
Electron	e^-	e^+	0.511	stable	−1	½
e-neutrino	ν_e	$\overline{\nu_e}$	< 2.2×10^{-6}	Stable	0	½
Muon	μ^-	μ^+	106	2.2×10^{-6}	−1	½
μ-neutrino	ν_μ	$\overline{\nu_\mu}$	< 0.17	Stable	0	½
Tau	τ^-	τ^+	1777	2.9×10^{-23}	−1	½
τ-neutrino	ν_τ	$\overline{\nu_\tau}$	< 15.5	Stable	0	½

Table 3: List of Quarks. B, S, C, Bt, T stands for the baryon, strangeness, charm-ness, bottom-ness, top-ness numbers, respectively. Note that, for anti-quarks, each quantum number and charge must be multiplied by −1.

Name	Symbol	Antiparticle	Mass (MeV/c^2)	Charge (e)	Spin	(B, S, Bt, C, T)
up	u	$\bar{u}$	1.5 − 3.3	+⅔	½	$(+\frac{1}{3}, 0, 0, 0, 0)$
down	d	$\bar{d}$	3.5 − 6.0	−⅓	½	$(+\frac{1}{3}, 0, 0, 0, 0)$
charm	c	$\bar{c}$	1.16 −1.34	+⅔	½	$(+\frac{1}{3}, 0, 0, 1, 0)$
strange	s	$\bar{s}$	70 − 130	−⅓	½	$(+\frac{1}{3}, -1, 0, 0, 0)$
bottom	b	$\bar{b}$	4.13 − 4.37	−⅓	½	$(+\frac{1}{3}, 0, 1, 0, 0)$
top	t	$\bar{t}$	169.1 −173.3	+⅔	½	$(+\frac{1}{3}, 0, 0, 0, 1)$

Table 4: List of Bosons (L=B=0)

Name	Symbol	Antiparticle	Mass (MeV/c^2)	Mean life time (s)	Charge (e)	Spin	Interaction mediated
Photon	γ	self	0	stable	0	1	EM
W boson	W^-	W^+	80.4	3.0×10^{-25}	−1	1	Weak
Z boson	Z	self	91.2	3.0×10^{-25}	0	1	Weak
Gluon	g	self	0	stable	0	1	Strong
Higgsboson*	H	self?	> 114	?	0	0	None
Graviton*	G	self	0	stable	0	2	Gravitation

* The existence of this particle is unconfirmed.

Table 5: List of some Hadrons (L=0). The symbol S stands for the strangeness number. Note that, for anti-particles S must be multiplied by −1.

Class	Name	Particle Symbol	Antiparticle	Particle Quark Content	Mass (MeV/c^2)	Mean life time (s)	Spin	S
Mesons	Pion	π^-	π^+	$u\bar{d}$	140	2.6×10^{-8}	0	0
		π^0	self	$\frac{u\bar{u}-d\bar{d}}{\sqrt{2}}$	135	8.7×10^{-17}		
	Kaon	K^+	K^-	$u\bar{s}$	494	1.2×10^{-8}	0	+1
		K_s^0	self	$\frac{d\bar{s}-s\bar{d}}{\sqrt{2}}$	498	8.9×10^{-11}		
		K_L^0	self	$\frac{d\bar{s}+s\bar{d}}{\sqrt{2}}$	498	5.2×10^{-8}		
	Eta	η^0	self	$\frac{u\bar{u}+d\bar{d}-2s\bar{s}}{\sqrt{6}}$	549	5.0×10^{-19}	0	0
		η'	self	$\frac{u\bar{u}+d\bar{d}+s\bar{s}}{\sqrt{3}}$	958	2.6×10^{-21}		
	Rho	ρ^+	ρ^-	$u\bar{d}$	775	4.5×10^{-24}	1	0
		ρ^0	self	$\frac{u\bar{u}-d\bar{d}}{\sqrt{2}}$	775	4.5×10^{-24}	1	0
Baryons	Nucleon	p	$\bar{p}$	uud	938.3	stable	½	0
		n	$\bar{n}$	udd	939.6	889	½	0
	Lambda	Λ^0	$\overline{\Lambda^0}$	uds	1116	2.6×10^{-10}	½	−1
	Sigma	Σ^+	$\overline{\Sigma^+}$	uus	1189	8.0×10^{-11}	½	−1
		Σ^0	$\overline{\Sigma^0}$	uds	1193	6.0×10^{-20}		
		Σ^-	$\overline{\Sigma^-}$	dds	1197	1.5×10^{-10}		
	Xi	Ξ^-	Ξ^+	dss	1321	1.6×10^{-10}	½	−2
		Ξ^0	$\overline{\Xi^0}$	uss	1315	2.9×10^{-10}		
	Omega	Ω^-	Ω^+	sss	1672	8.2×10^{-11}	½	−3