An Introduction to Fundamental Particles and Interactions

Shahid Beheshti University

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Outline

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Fundamental Particles

$$\text{Leptons } (\text{spin}\tfrac{1}{2}) \quad \begin{matrix}\text{Q=0}\\ \text{Q=-1}\end{matrix} \quad \begin{pmatrix} \nu_e\ (0.01\text{ev}) \\ \text{e}\ (511\text{kev}) \end{pmatrix}, \begin{pmatrix} \nu_\mu\ (0.01\text{ev}) \\ \mu\ (106\text{Mev}) \end{pmatrix}, \begin{pmatrix} \nu_\tau\ (0.01\text{ev}) \\ \tau\ (1.77\text{Gev}) \end{pmatrix}$$

$$\text{Quarks } (\text{spin}\tfrac{1}{2}) \quad \begin{matrix}\text{Q=}\frac{2}{3}\\ \text{Q=}\frac{-1}{3}\end{matrix} \quad \begin{pmatrix} \text{u}\ (3\text{Mev}) \\ \text{d}\ (6\text{kev}) \end{pmatrix}_{\text{RGB}}, \begin{pmatrix} \text{c}\ (1.3\text{Gev}) \\ \text{s}\ (0.1\text{Gev}) \end{pmatrix}_{\text{RGB}}, \begin{pmatrix} \text{t}\ (175\text{Gev}) \\ \text{b}\ (4.3\text{Gev}) \end{pmatrix}_{\text{RGB}}$$

Higgs (125Gev)
(spin 0)

+Antiparticles

Fundamental Interactions

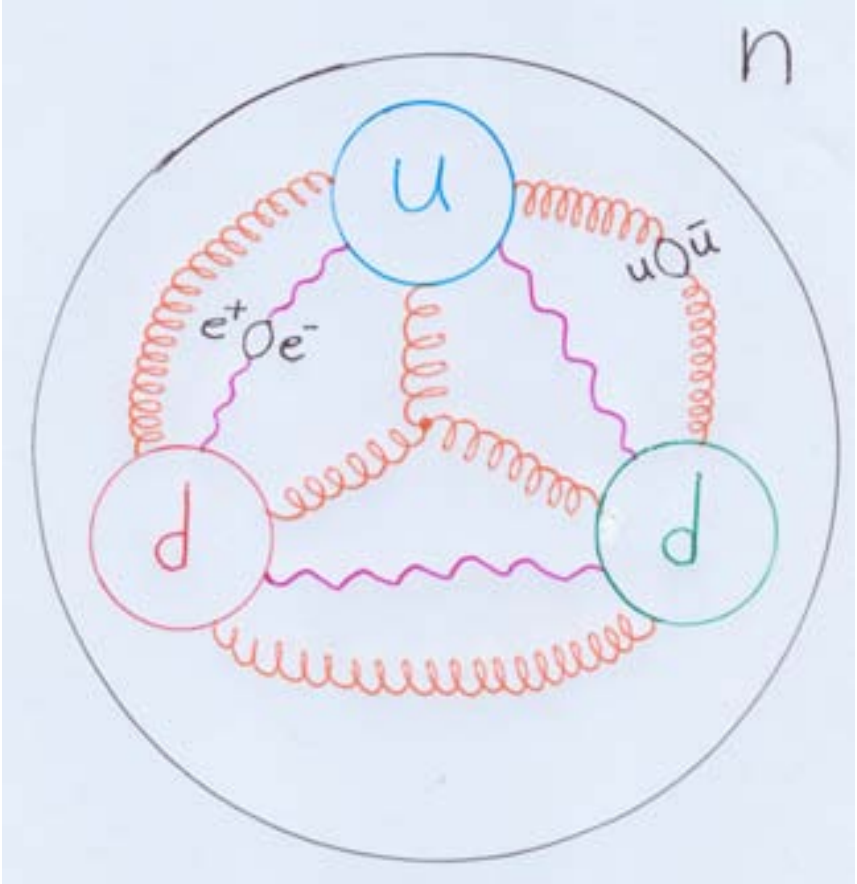
Interactions	Mediator	Effective Range
Gravitation	Gravitons $m =?$	∞
Electromagnetic	Photon $m_\gamma = 0$	∞
Weak	$m_W = 80.4$ Gev, $m_Z = 91.2$ Gev	0.01 fm
Strong	Gluons $m_g = 0$	1 fm

Hadrons and Nuclear Matter

1. Baryons: $p, n, \Lambda \ldots$
2. Mesons: $\pi^{\pm}, \pi^{0} \ldots$

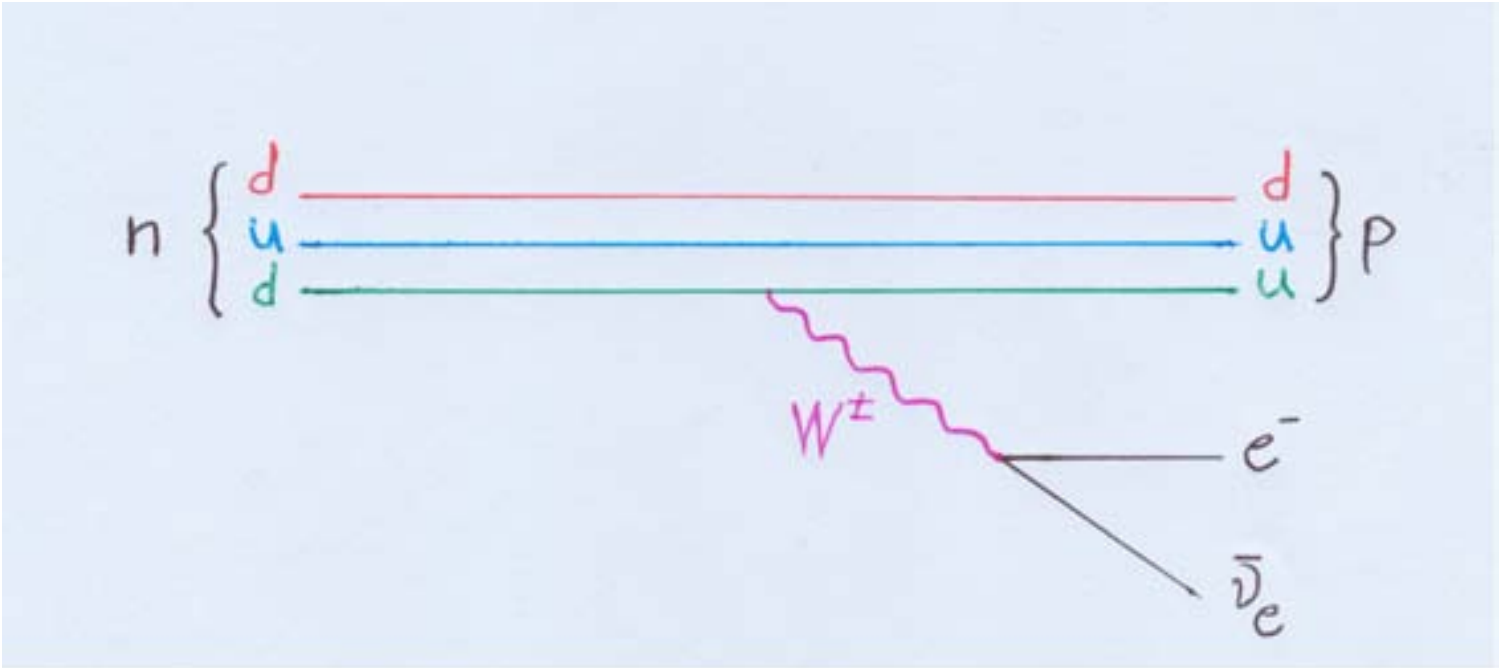
Neutrons and Strong Interaction

- Color confinement
- Asymptotic freedom



Neutrons and Weak Interaction

$$n \rightarrow p + e^- + \bar{\nu}_e$$



Open Problems

- Structure of Hadrons
- CP Violation
- Particle-Antiparticle Asymmetry in the Universe
- Extensions of the Standard Model
- Supersymmetry
- Multi-Higgs Sector

Thanks for your attention