

# 8.701

Introduction to Nuclear  
and Particle Physics

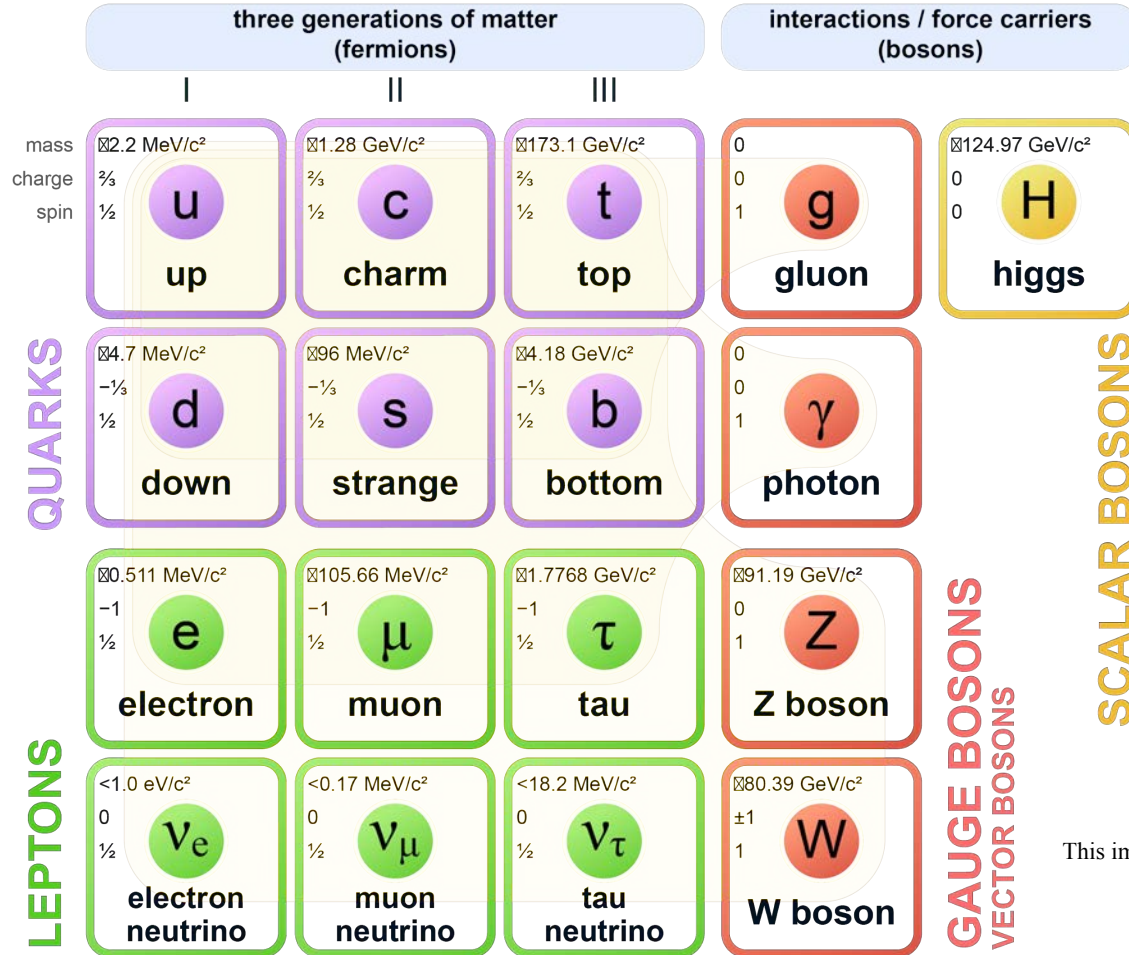
Markus Klute - MIT

6. Weak Interaction

6.1 Feynman rules



# Standard Model of Elementary Particles



This image is in the public domain.

# Feynman Rules

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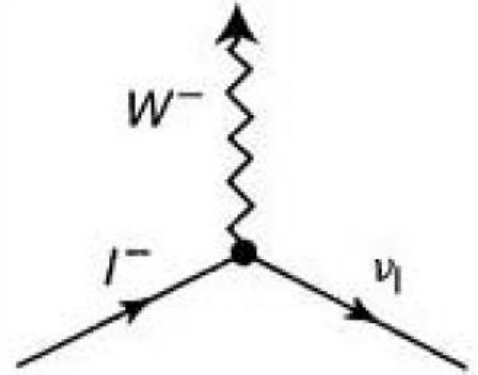
Propagator for W and Z bosons

$$\frac{-i(g_{\mu\nu} - q_{\mu}q_{\nu}/M^2c^2)}{q^2 - M^2c^2}$$

Weak vertex factor

$$\frac{-ig_w}{2\sqrt{2}}\gamma^{\mu}(1 - \gamma^5) \quad (W^{\pm} \text{ vertex factor})$$

$$\frac{-ig_z}{2}\gamma^{\mu}(c_V^f - c_A^f\gamma^5) \quad (Z^0 \text{ vertex factor})$$



# Feynman Rules

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Neutral vector and axial vector couplings

$$\frac{-ig_Z}{2} \gamma^\mu (c_V^f - c_A^f \gamma^5) \quad (Z^0 \text{ vertex factor})$$

$f$	$c_V$	$c_A$
$\nu_e, \nu_\mu, \nu_\tau$	$\frac{1}{2}$	$\frac{1}{2}$
$e^-, \mu^-, \tau^-$	$-\frac{1}{2} + 2\sin^2\theta_w$	$-\frac{1}{2}$
$u, c, t$	$\frac{1}{2} - \frac{4}{3}\sin^2\theta_w$	$\frac{1}{2}$
$d, s, b$	$-\frac{1}{2} + \frac{2}{3}\sin^2\theta_w$	$-\frac{1}{2}$

$$\theta_w = 28.75^\circ$$

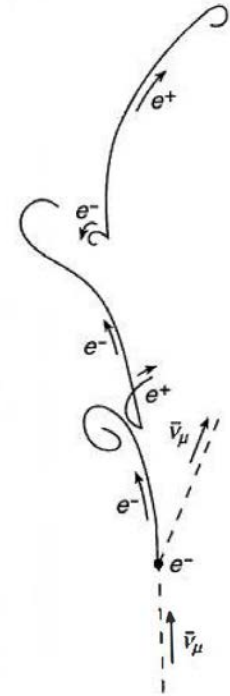
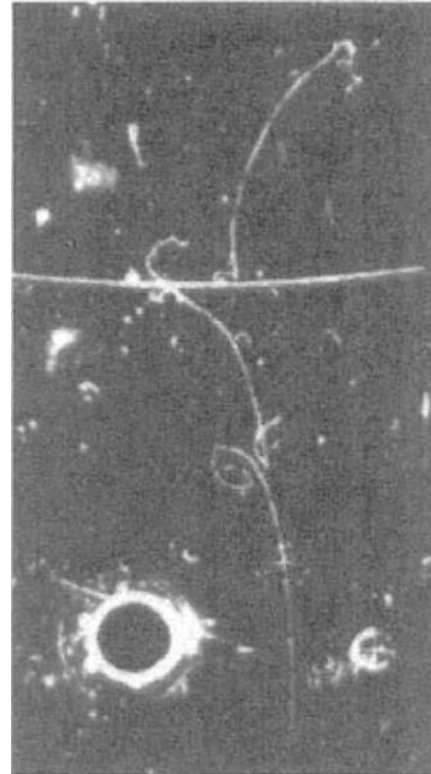
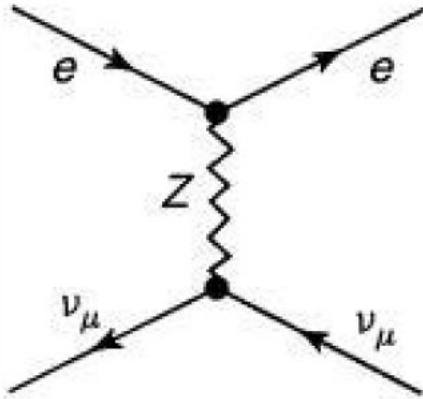
$$(\sin^2 \theta_w = 0.2314)$$

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# Discovery of the Neutral Current

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Gargamelle bubble chamber at  
CERN in 1973



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