PHYSICS 489/1489

REVIEW

NEXT TIME

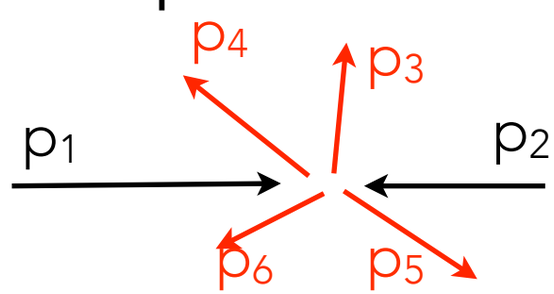
- Midterm:
  - Pencil, calculator
  - Material includes:
    - drawing Feynman diagrams for EM, weak, strong interactions. Allowed/forbidden interactions
    - special relativity, relativistic kinematics
    - Phase space
- There will be no detailed calculations . . . ..
  - necessary detailed equations will be provided.

RELATIVISTIC KINEMATICS:

- Consider the center-of-mass collision:
  - $a + a \rightarrow b + c$
  - where each *a* particles has energy E
- What is the momentum of the outgoing particle b in terms of the energy of the incoming particles and the masses of the particles?

PHASE SPACE:

- Phase space expression for scattering of two particles



$$\sigma = \frac{S}{4\sqrt{(p_1 \cdot p_2)^2 - (m_1 m_2)^2}} \times \int |\mathcal{M}|^2 \times (2\pi)^4 \delta^4(p_1^\mu + p_2^\mu - \sum_f p_f^\mu)$$

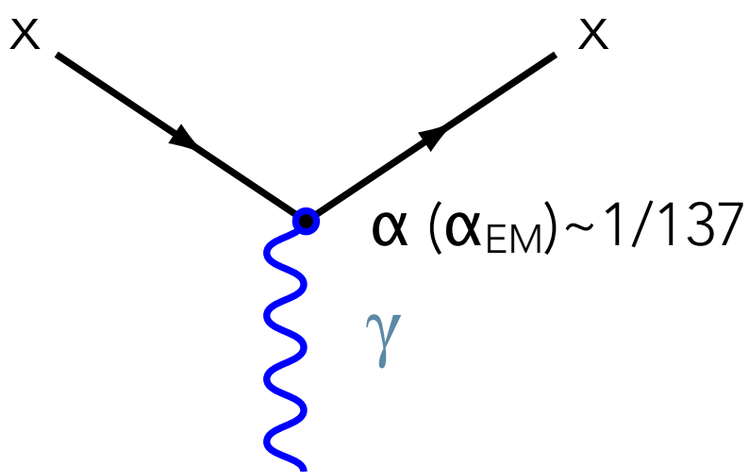
$$\times \prod_{j=3}^{N} 2\pi\, \delta(p_j^2 - m_j^2)\, \Theta(p_j^0)\, \frac{d^4 p_j}{(2\pi)^4}$$

INTERACTIONS

(Problem 1.1)

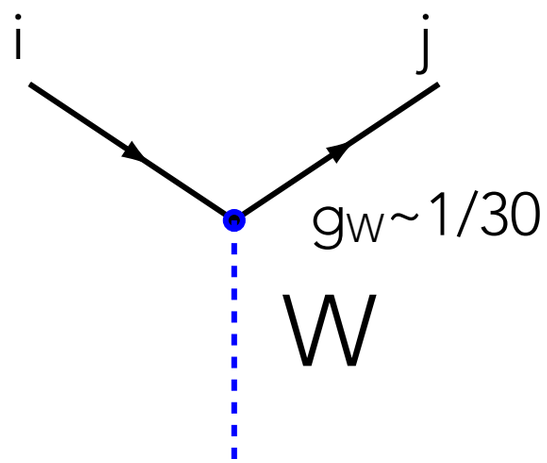
- Fundamental building block of an interaction is the "vertex"

electromagnetism
"quantum electrodynamics"



x is any charged particle

weak charged current

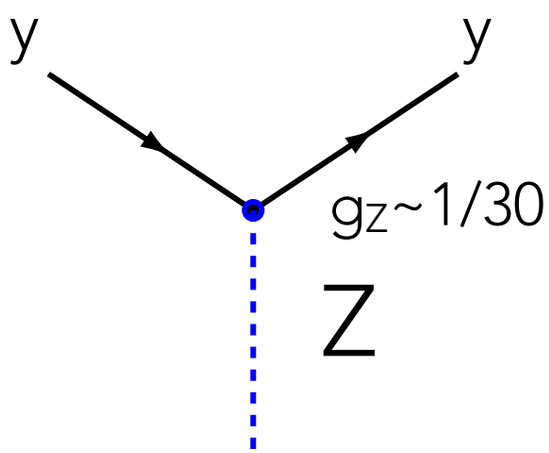


i:+2/3 quark, j: -1/3 quark

or

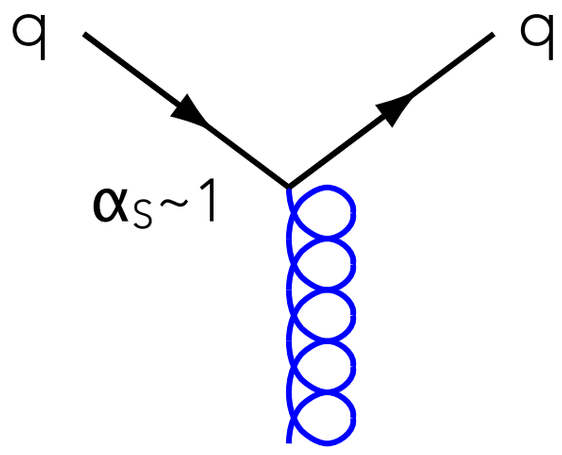
i: ν_l, j: l^-

weak neutral current



y is quark or lepton

strong interaction
"quantum chromodynamics"



q is any quark (colored object)

- arrows: direction matters!
  - backward arrow means "antiparticle" (opposite charges)
  - don't mix up arrow and label
- same letter means same particle
- vertex factor "coupling constant"
  - not part of diagram but indicates "strength" of interaction

FEYNMAN DIAGRAMS:

- Write the lowest order Feynman diagrams for the processes;
  - $e^+ + e^- \rightarrow \nu_e + \bar{\nu}_e$
  - $e^+ + e^- \rightarrow B^+ (\bar{b}u) + B^- (b\bar{u})$
  - $e^+ + e^- \rightarrow e^+ + e^- + \gamma$
  - $\nu_e + n\ (udd) \rightarrow e^- + \Lambda\ (uds) + K^+ (\bar{s}u)$
  - $B^0 (\bar{b}d) \rightarrow D^- (\bar{c}d) + \mu^+ + \nu_\mu$
  - $B^0 (\bar{b}d) \rightarrow \rho^- (\bar{u}d) + \mu^+ + \nu_\mu$
  - $B^0 (\bar{b}d) \rightarrow K^+(\bar{s}u) + \pi^-(ud)$
  - $\Lambda\ (uds) \rightarrow p\ (uud) + \pi^- (\bar{u}d)$