Physics 570 Homework 2

Due September 20, 2017

Problem 1 (20 points)

   Problem 1.1 of Thomson

Problem 2 (20 points)

   Problem 1.6 of Thomson

Problem 3 (10 points)

   Problem 2.12 of Thomson

Problem 4 (30 points)

Of the following processes, state which are allowed or forbidden according to the Standard Model (in a reaction A + B → C + D, assume that the beam energy is above the threshold for producing the particles in the final state). If they are allowed, state which interaction is primarily responsible (strong, electromagnetic, or weak). If they are forbidden, give the reason why.

a) $\Lambda \rightarrow \Sigma^- + \pi^+$

b) $\pi^\circ \rightarrow \gamma + \gamma$

c) $\gamma + e^- \rightarrow e^-$

d) $p + \bar{p} \rightarrow \Lambda + \bar{\Lambda}$

e) $n \rightarrow p + e^-$

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

g) $\Lambda \rightarrow \pi^+ + e^-$

h) $e^+ + e^- \rightarrow \nu_\mu + \bar{\nu}_\mu$

i) $K^- + p \rightarrow K^+ + \Xi^-$

j) $\pi^- + p \rightarrow \pi^\circ + \Lambda$

Some properties of the particles:

Λ: baryon, quarks content: uds, mass: 1115.7 MeV

Σ^-: baryon, quarks content: dds, mass: 1197.4 MeV

p: baryon, quarks content: uud, mass: 938.3 MeV

n: baryon, quarks content: udd, mass: 939.6 MeV

Ξ^-: baryon, quarks content: dss, mass: 1321.3 MeV

K^+: meson, quarks content: $u\bar{s}$, mass: 493.7 MeV

π^+: meson, quarks content: $u\bar{d}$, mass: 139.6 MeV

π°: meson, quarks content: $u\bar{u}(d\bar{d})$, mass: 135.0 MeV

Problem 5 (20 points)

Draw the Feynman diagrams (at the quark level if hadrons are involved) for the following decays:

a) $\pi^+ \to e^+ + \nu_e$

b) $K^- \to \pi^- + \pi^0$

c) $\Delta^{++} \to p + \pi^+$

d) $n \to p + e^- + \bar{\nu}_e$

e) $\Lambda \to n + \pi^0$

(Note that the quark contents of the mesons and baryons can be found in Appendix C, page 523 of Thomson.)