FY3403 Particle physics

Problemset 6

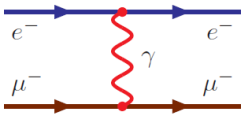
NTNU

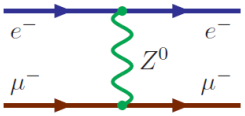
Institutt for fysikk

SUGGESTED SOLUTION

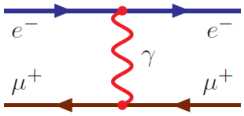
Problem 1

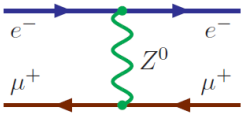
a) $e^- + \mu^- \longrightarrow e^- + \mu^-$





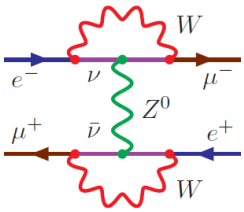
b) $e^- + \mu^+ \longrightarrow e^- + \mu^+$





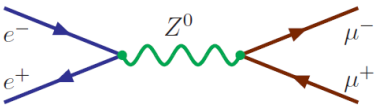
c) $e^- + \mu^+ \longrightarrow e^+ + \mu^-$

It is essentially correct to say that this process is impossible, due to conservation of electron and muon numbers. However, with the possibility of neutrino oscillations there should be an exceedingly tiny amplitude for the process to occur through radiative corrections

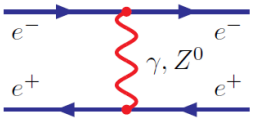


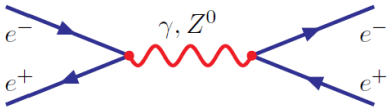
An educated guess is that this amplitude is of order $\left(\Delta m^2_{21}/M^2_W\right)^2$ relative to the amplitude for the amplitude for $\nu + \bar{\nu} \rightarrow \nu + \bar{\nu}$ scattering, and thus that the cross section is of order $\left(\Delta m^2_{21}/M^2_W\right)^4 \approx 10^{-52}$ relative to the $\nu\bar{\nu}$ scattering cross section (which is already very small). Not much chance of observing this process during the lifetime of our universe!

d) $e^- + e^+ \longrightarrow \mu^+ + \mu^-$



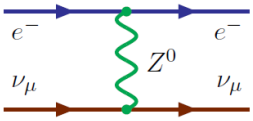
e) $e^- + e^+ \longrightarrow e^+ + e^-$



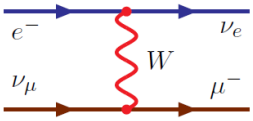


The notation indicates that there are actually four diagrams, two with γ exchange and two with Z^0 exchange.

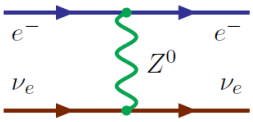
f) $e^- + \nu_\mu \longrightarrow e^- + \nu_\mu$

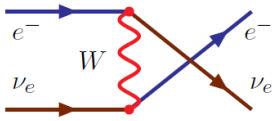


g) $e^- + \nu_\mu \longrightarrow \nu_e + \mu^-$

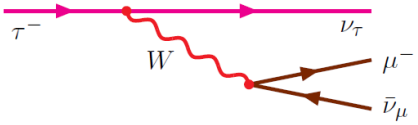


h) $e^- + \nu_e \longrightarrow e^- + \nu_e$





i) $\tau^- \longrightarrow \mu^- + x$ (replace x by some possible set of particles)



j) $\nu_e + \nu_\mu \longrightarrow \nu_\mu + \nu_e$