Phy 523
PARTICLE PHYSICS
Problem sheet IX

21st March 2009

28th March 2009(due date)

41. Consider the S- matrix element of Compton scattering $\gamma(k_1)+e(p_1) \rightarrow \gamma(k_2)+e(p_2)$ in the form

$$N\epsilon^{\mu}(k_1)\epsilon^{*\nu}(k_2)M_{\mu\nu}(2\pi)^4\delta^4(k_1+p_1-k_2-p_2)$$

. where N is the normalisation constant.

Show that $k_1^{\mu}\epsilon^{*\nu}M_{\mu\nu} = k_2^{\nu}\epsilon^{\mu}M_{\mu\nu} = 0$. (This proves the amplitude is gauge invariant: In momentum space, $\epsilon^{\mu}(k)$ changes to $\epsilon^{\mu}+\alpha k^{\mu}$ under a gauge transformation. Here α is the gauge parameter.)

42. Write the matrix element for $\tau^- + \mu^+ \rightarrow \tau^- + \mu^+$ assuming only electromagnetic interaction for τ-lepton and muon.

43. τ-lepton has a mass of about 1.8 GeV. τ^- can decay to $\pi + \nu_{\tau}$. Using the expression of $\pi^- \rightarrow \mu^- + \bar{\nu}_{\mu}$ decay write the matrix element for $\tau^- \rightarrow \pi + \nu_{\tau}$decay.

44. Calculate the decay rate for the τ-decay in the problem 43.

45. Write possible leptonic decays of τ-lepton and the corresponding matrix element assuming the interaction is of the current-current form.