Particle Physics

Weak Interactions

Problem Set 3

Due: Thursday, June 1, 2000

Problem 1 – Fermion coupling constants

From the definition of the Z current, derive the couplings of the Z to the various fermions (neutrinos, charged leptons, u-type quarks and d-type quarks).

Problem 2 – Z_0 width

Assuming the standard model show that

$$\Gamma(Z \to \nu_e \bar{\nu}_e) = \frac{g^2}{96\pi \cos^2 \theta_W} M_z$$

Problem 3 – $Z_0 - \gamma$ Interference

Calculate the cross section for $e^+e^- \to \mu^+\mu^-$ including both the photon and the Z_0. Then calculate the two separately, add them together and subtract from this actual cross section. The result is the effect of the interference term. Plot the difference in the vicinity of the Z_0 mass.

Problem 4 – Z_0 total cross section

Calculate the total cross section for Z_0 iron scattering. Assume the valence quark distribution has the shape of

$$f(x) = 20x(1-x)^3.$$

Ignore the sea quarks and the Q^2 dependence.