Exercise Sheet 7 – Particle Physics – Summer 2016

N. Berger, A. Kozlinskiy

hand in: Mo 18.07. (in the lecture)

7.1 τ-lepton decay ratios (3 points)

Explain the following observed τ-lepton decay ratios:

$$\mathrm{Br}(\tau^- \to e^- \bar{\nu}_e \nu_\tau) : \mathrm{Br}(\tau^- \to \mu^- \bar{\nu}_\mu \nu_\tau) : \mathrm{Br}(\tau^- \to \mathrm{hadrons} + \nu_\tau) \approx 1 : 1 : 3. \tag{1}$$

7.2 Neutrino *CC* cross-section (3 points)

Show that in the rest frame of electron the charged-current scattering cross-section (through exchange of W) of the process $\nu_e e \to \nu_e e$ is proportional to the energy of the incoming neutrino

$$\sigma_{CC} \approx G_F^2 m_e E_\nu. \tag{2}$$

7.3 Neutrino oscillations (4 points)

Calculate the appearance probability $P(\nu_\mu \to \nu_\tau)$ for 17 GeV muon neutrinos at a distance of 730 km. Estimate the contamination by tau-neutrinos produced in the transition $\nu_e \to \nu_\tau$ if the initial beam contains 1% of electron neutrinos.