AKT II – Übung 3

2. 4. 2019

Bsp 0 (Übertrag von UE2)

1.8 Tungsten has a radiation length of $X_0 = 0.35$ cm and a critical energy of $E_c = 7.97$ MeV. Roughly what thickness of tungsten is required to fully contain a 500 GeV electromagnetic shower from an electron?

Bsp 1 & 2

3.4 At a future e^+e^- linear collider operating as a Higgs factory at a centre-of-mass energy of $\sqrt{s} = 250$ GeV, the cross section for the process $e^+e^- \to HZ$ is 250 fb. If the collider has an instantaneous luminosity of 2×10^{34} cm^{-2} s^{-1} and is operational for 50 % of the time, how many Higgs bosons will be produced in five years of running? Note: 1 femtobarn $\equiv 10^{-15}$ b.

3.5 The total $e^+e^- \to \gamma \to \mu^+\mu^-$ annihilation cross section is $\sigma = 4\pi\alpha^2/3s$, where $\alpha \approx 1/137$. Calculate the cross section at $\sqrt{s} = 50$ GeV, expressing your answer in both natural units and in barns (1 barn = 10^{-28} m^2). Compare this to the total pp cross section at $\sqrt{s} = 50$ GeV which is approximately 40 mb and comment on the result.

Bsp 3

- Show that $\delta(f(x)) = \left|\frac{\mathrm{d}f}{\mathrm{d}x}\right|_{x_0}^{-1} \delta(x - x_0)$

  where $\boldsymbol{\delta}$ is the Dirac Delta function.

Bsp 4 & 5

4.6 By considering the three cases $\mu = \nu = 0, \mu = \nu \neq 0$ and $\mu \neq \nu$ show that

$$\gamma^\mu \gamma^\nu + \gamma^\nu \gamma^\mu = 2g^{\mu\nu}.$$

4.7 By operating on the Dirac equation,

$$(i\gamma^\mu \partial_\mu - m)\psi = 0,$$

with $\gamma^\nu \partial_\nu$, prove that the components of ψ satisfy the Klein–Gordon equation,

$$(\partial^\mu \partial_\mu + m^2)\psi = 0.$$

Bsp 6

4.10 Demonstrate that the two relations of Equation (4.45) are consistent by showing that

$$(\boldsymbol{\sigma} \cdot \mathbf{p})^2 = \mathbf{p}^2.$$

$$u_A = \frac{\boldsymbol{\sigma} \cdot \mathbf{p}}{E - m} u_B, \tag{4.45}$$

$$u_B = \frac{\boldsymbol{\sigma} \cdot \mathbf{p}}{E + m} u_A. \tag{4.46}$$