

Particle Physics Phenomenology I

HS 10, Series 1

Due date: 30.09.2010, 1 pm

Exercise 1 Review of Natural Units:

- (i) Express the following in natural units (in GeV): 1 second, 1 centimeter, 1 gramme.
- (ii) Calculate the ratio $a_{\text{Bohr}} : \lambda_{\text{Compton}} : r_0$ for an electron in "natural units" (in cgs units: $a_{\text{Bohr}} = \hbar^2/m_e e^2$, $\lambda_{\text{Compton}} = \hbar/m_e c$, $r_0 = \alpha \hbar/m_e c$, "classical" electron radius, $\alpha = e^2/\hbar c$).
- (iii) Given that the center of mass energy of the LHC will be 14TeV, what is the smallest possible length it will probe in SI units? How does this compare to the planck length?

Exercise 2

A photon γ ($k^2 = 0$) with four-momentum $k^\mu = (E, E, 0, 0)$ is scattered off an electron e at rest ($p_e^\mu = (m_e, 0, 0, 0)$). After the scattering the γ has the four-momentum $k'^\mu = (E', E' \cos \Theta, E' \sin \Theta, 0)$. Show that the energy E' after the scattering is given by

$$E' = \frac{E}{1 + \frac{E}{m_e}(1 - \cos \Theta)}.$$