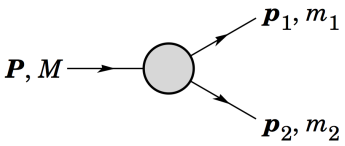
Experimental Particle Physics

ESIPAP 2018

Homework 1

1 2-body decay



For a 2-body decay we proved in class that, in the CM framework of the decaying particle:

$$E_1 = \frac{M^2 - m_2^2 + m_1^2}{2M} \tag{1}$$

Compute what is $|p_1| = |p_2|$ in the CM framework of the decaying particle.

2 Fixed target vs. collider experiments

How much energy E_{fix} should a fixed target experiment have to equal the center of mass energy E_{col} of two colliding beams? Prove that:

$$E_{\text{fix}} = 2\frac{E_{\text{fix}}^2}{m} - m \tag{2}$$

assuming both the beam(s) and the target are composed by particles of mass $m = m_1 = m_2$. Hint: define the center of mass energy in both cases, then equal them.

3 Accelerating electrons

How much energy did electrons and positrons of E = 50 GeV and 100 GeV loose in one round at LEP (L = 27 km)? Remember that:

$$\Delta E = \frac{4\pi}{3}\frac{1}{4\pi\varepsilon_0}\left(\frac{e^2\beta^3\gamma^4}{R}\right) \tag{3}$$

Hint: remember that $\frac{e^2}{4\pi\varepsilon_0\hbar c} = \alpha$.

4 Muon lifetime and acceleration

How long would the muon lifetime be in a muon beam of 200 GeV momentum?

If we inject 10^{10} of such muons in a storage ring of R = 100 m, how many rounds would they do before beam intensity get reduced by a 10^6 factor?