Physics 6H Freshman Seminar Fall 2004

Assignment #5

Readings:

- Moore - Chapter 10
- Moore - Chapter 11

Supplemental

- Boccio - Relativity 6 - P6
- Boccio - Relativity 7 - P6

Summary: This week we develop a extend the mathematical formalism for special relativity, which is also useful in many other areas of theoretical physics.

We will continue to study the concept of a 4-vector. We will use 4-vectors to study properties of the spacetime interval, energy and momentum. We will apply the 4-vector formalism to particle physics.

We also take our first look at the causal structure of spacetime as expressed by light cones.

Everyone Problems:

M10-1 An elastic collision
M10-4 We're under attack
M11-6 The decay of the π^0 meson
EP-13 Center of mass frame
EP-17+M11-11(a and b only) Threshhold energies

Individual Problems:

M10-2 An ineleastic collision
M10-5 Emergency procedures
M10-9 Light pressure
M11-1 Finding the four-momentum
M11-3 Finding the mass
M11-8 The decay of the π^- meson
M11-10 Interactions of fictitious particles (error - photon $\rightarrow +x$)
EP-14 Proton-proton collision
EP-15 Energy in another frame
EP-16 The decay of the π^0 meson again

Presentations:

(1) Energy-Momentum Diagrams
(2) Matter-Antimatter rocket
(3) Kaon Decay
(4) Compton Scattering
(5) Pair Production
(6) Threshold energy (Boccio notes)
(7) Big accelerators vs. colliding beams (Boccio notes)

Seminar Break:

Extra Problems:

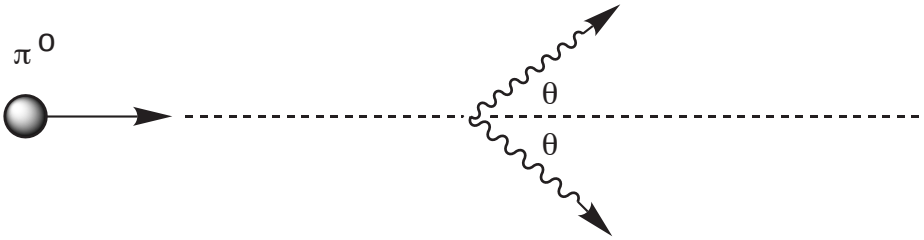
EP-13 In the laboratory frame a particle of rest mass m_0 and a speed v is moving towards a particle of rest mass m_0 that is at rest. What is the speed of the inertial frame in which the total momentum of the system is zero? This frame is called the **center of mass** or **zero momentum** frame.

EP-14 A proton with a kinetic energy of $10^{10} eV$ collides with a proton at rest. Find

(a) the velocity of the center of mass
(b) the total momentum and total energy in the laboratory frame
(c) the kinetic energy of the particles in center of mass frame

EP-15 Two particles of rest mass m_0 approach each other with equal and opposite velocity v in the laboratory frame. What is the total energy of one particle as measured in the rest frame of the other?

EP-16 A π^0 particle of rest mass 135 MeV, decays symmetrically (as shown below) into two photons while moving at high speed. The energy of each photon in the laboratory system is 100 MeV.



(a) Find the meson's speed v.
(b) Find the angle θ in the laboratory between the momentum of each photon and the initial line of motion of the meson.

EP-17 Determine the **threshold energy** for the reaction

$$\pi^- + p \rightarrow \Sigma^- + K^+$$

Assume that the negative pi-meson is the incident particle and the proton is initially at rest.