PHY 6246 October 7, 2019

Assignment #8

Reading: Complete Chapter 7 in *Goldstein*.

Problems: Due by the start of class on Monday, 10/14/19.

(1) A famous physics limerick runs:

There was a young woman named Bright.
whose speed was much faster than light.
She left home one day,
in a relative way,
and returned on the previous night.

Suppose Bright has the ability to move at 10 times the speed of light in *any* inertial frame, and that she can stop and start instantly. In this problem we will follow her journey into the past.

(a) Suppose that Bright begins moving to the right in the unprimed frame at $10c$. What is her worldline $x(t)$ in the unprimed frame?

(b) What is Bright's worldline $x'(t')$ in the primed frame of an observer moving to the right at $\frac{4}{5}c$?

(c) At time $t = T$ Bright turns around and begins moving back at $10c$ in the primed frame. What is her worldline $x'(t')$?

(d) What is the worldline $x(t)$ of Bright's return trip in the unprimed frame?

(e) At what unprimed time does Bright reach the origin?

(f) What must the turn-around time T be in order for Bright to return 12 hours before her departure?

(2) A particle of mass M at rest decays into two identical particles.

(a) If each fragment moves at $\frac{4}{5}c$, what is the mass of each fragment?

(b) If the mass of each fragment is $0.48M$, what is the speed of each fragment?

(c) Suppose that the original particle can also decay into *three* identical particles of mass $0.32M$. What must be their speeds?

(3) Consider a particle of mass m moving in one spatial dimension whose Lagrangian is,

$$L = -mc\sqrt{c^2 - \dot{x}^2} + max \ .$$

(a) What is the Euler-Lagrange equation?

(b) What is the general initial value solution?

(c) If the particle starts at rest from the origin, what is the last time that a photon released from the origin can catch the particle?