General Relativity (PHYS 325) PS 4

Spring 2024 v1.0

This fourth problem set has a bit on 4-vector notation, particle kinematics, and vector differentiation.

Reading:
Schutz Chapter 3

Problems: Solutions due by noon on Friday, February 16
All numbered problems are from Schutz.

(1) 2.22 Working with 4-momentum

(2) 2.30 part (b) only: Finding observed energy

(3) Hot Potato-Cold Potato: Suppose you have two identical 0.52 kg potatoes. You put one in the oven to give it 150 J of energy (it is now Hot). Before eating the hot potato, you accelerate the two potatoes with identical forces. Do the potatoes accelerate at the same rate? If so, find the ratio of potato accelerations. If not, explain how the thermal energy remains free of inertia.

(4) 3.10 A Checking that the derivative form or the Lorentz transformations, equation 3.18, makes sense

(5) 3.30 parts (a) - (e) Practice with 4-vectors and derivatives.

(6) A pion π^+ decays at rest into an (anti)muon μ^+ and a massless neutrino ν_μ,

$$\pi^+ \to \mu^+ + \nu_\mu.$$

The muon has a mass of $m_\mu = 106$ MeV and the pion has a mass of $m_\pi = 140$ MeV. Use conservation of 4-momentum to

(a) Find the energy of the muon in terms of the rest masses m_μ and m_π.
(b) Find the speed of the muon in the original frame. You can find this with $|p_\mu|/E_\mu$.