Physics 3922H Physics Colloquium Thur. 4.28.2016 Exercise Set 13 Due Tue May.03

Read Unit 3 (*SRQM by Ruler&Compass*) thru page 50. Study Lecture 25-30

This is just a continuation of Ex. 12

H*ow long does it take to get to* α*-Centauri in 6 months?*

1. Suppose we define a velocity we will call $v_{ignorant}$ as that speed that someone ignorant of relativity would say a spaceship had to go to get to a distant star in a given time. For example, if we ask how fast a ship would have to go to get to α-Centauri (~4 light years away) in 6 months then the "ignorant" person would say it had to go $v_{ignorant} = 8c$, that is, eight times the speed of light. So if super-luminal travel is prohibited, then 6 months seems too short.

But the relativity expert says that there is a speed v_{expert} which will get the ship to α-Centauri in 6 months according to the ship's passengers, who, after all, are the ones really counting their time.

(a) Compute v_{expert} for α-Centauri trip and derive general algebraic relations giving v_{expert} in terms of $v_{ignorant}$ and vice-versa.

(b) How long does it really take to get to α-Centauri in 6 months? (Lighthouse time.)

2. Consider a more realistic project discussed recently in the New York Times.
This involves sending a package that would get to α-Centauri in 16 years (its time) by blasting it up to necessary speed with powerful lasers. This one can be plotted on a Minkowski graph such as can be made using the Relawavity website.
Do a plot and make an event table involving departure and arrival space-time events. Find $v_{ignorant}$ and v_{expert}.
If upon arrival the package sends a message back, when should we expect to hear from it if we had sent it out today?

http://www.uark.edu/ua/modphys/markup/RelaWavityWeb.html?plotType=8l8&velocity=-0.25

The cost of ignorance::NASA goes for broke

3. Use the velocity $v_{ignorant}$ defined in a preceding exercise (**1.**) and results concerning the "6-month" α-*Centaur* voyage.

(a) Relativistic momentum of particle of rest mass M can be nicely expressed using $v_{ignorant}$. How?

(b) Redo ex.1 using Epstein space-proper time and plot it onto a protractor graph provided in class and onsite.
Check calculation of stellar angle σ =______° using the graph.

(b) Given the proposed journey to α-Centauri in "6 months" work up a budget estimate. How many GNPU (*1GNPUnit = 10^{12}=$1 Trillion*) will it cost to get a ship of mass 10^6 *kg (1,100 tons)* up to speed at a prevailing rate of power: *$0.10/ kWHr.* ? (*1 kWHr = 3600x10*^{3} *J*) *Note:* Don't count the rest mass energy of the ship in your cost. We may.assume NASA (*i.e.*, you, the taxpayer) has already bought that stuff. Bottom line: Cost= $________________

(c) If you express this as a factor of the ship rest energy, what do you get? ________________