Physics 130 General Relativity Seminar Week-2 Fall 2008

Readings: Woodhouse - Special Relativity
Chapter 4 - Einstein's Special Relativity
Chapter 5 - Lorentz transformations in 4D
Chapter 6 - Relative Motion

Present Ideas and Lead Discussion:

Chapter 4 __Sam_____
Chapter 5 __Ben P____
Chapter 6 __Erin_____

Present Problems:

4.2 - Is it a Lorentz transformation __Eric_____
4.3 - Pole and Barn
4.4 - Photon separation

5.6 - Future pointing vectors __Robert____
5.7 - Vector sums
5.9 - Displacement vector

5.11 - Plane waves __Margaret__
6.3 - Three observers
6.4 - Motion in straight line

6.5 - Two accelerating rockets __Emma_____
6.6 - Independent of the motion

EP4. __Ben G____

A particle (in special relativity) moves in uniform circular motion, that is(with $c=1$),

$$x^{\mu} = (t, r\cos\omega t, r\sin\omega t, 0)$$

(a) Write down its worldline according to an observer moving with velocity v along the y-axis. You will need to use the old time t as a parameter. Hint: this follows directly from the Lorentz transformation.

(b) If the particle at rest decays with half-life $\tau_{1/2}$, what is its observed half-life?

(c) Show that the proper acceleration α is given by

$$\alpha = \frac{r\omega^2}{1 - r^2\omega^2}$$

EP5. __Chris____

(a) Consider a particle moving along the x-axis with velocity u' and acceleration a', as measured in frame S'. S' moves relative to S with velocity v along the same axis. Show that

$$\frac{du}{dt} = \frac{1}{\gamma^3}\frac{1}{(1+u'v)^3}a'$$

where a′=du′/dt′.

(b) Suppose that S′ is chosen to be the instantaneous rest frame of the particle and a′=9.806 m/s^2. That is, u′=0, a′=g, and u=v. Using the result from part (a), derive expressions for u (velocity as measured in S) and x as a function of time. Write x as a function of τ, the proper time as measured along the particle's worldline, and evaluate for τ = 20 yrs. Discuss the significance of this result for space travel. You can use $dt/d\tau = \gamma$ to derive an expression for τ as a function of t.

EP6. __Markus_____

Consider a pair of twins that are born somewhere in spacetime. One of the twins decides to explore the universe. She leaves her twin brother behind and begins to travel in the x-direction with constant acceleration $a = 10\, m/s^2$ as measured in her rocket frame. After 10 years according to her watch, she reverses the thrusters and begins to accelerate with a constant $-a$ for a while.

(a) At what time on her watch should she again reverse her thrusters so she ends up home at rest?

(b) According to her twin brother left behind, what was the most distant point on her trip?

(c) When the sister returns, who is older, and by how much?