Physics 234
Homework 6 (Due Wednesday, March 2)
Lorentz Transformations

Problem 1.
The mean lifetime of a muon in its rest frame is $2.2\mu s$. The mean lifetimes of high speed muons in a burst of cosmic rays observed from the earth is measured to be $16\mu s$. Find the speed of these cosmic ray muons. You can express your answer in terms of $\beta = v/c$.

Problem 2.
You are tired of the present, and want to jump into the future. You do this by riding in a space ship for one year your time. That is, you travel 6 months at a constant velocity (in a straight line). Then you return with this same velocity for 6 months back to earth. If you want to find the earth 1000 years into the future when you return, how fast must you travel? You can express your answer in terms of $\beta = v/c$.

Problem 3.
The distance to the nearest start, Alpha Centuri, is 4.2 light years. You want to travel there, but only spend a month in the space ship. How fast must you travel to reach Alpha Centuri in one month of "space ship" time? You can express your answer in terms of $\beta = v/c$.

Problem 4.
Inertial frame S' moves at a speed of $0.60c$ with respect to frame S. Two events are recorded. In frame S, event 1 occurs at the origin at time $t = 0$, and event 2 occurs at $x = 3\ km$ and at $t = 4\mu s$. What times of occurance does observer S' record for these same events? Explain the difference in the time order.

Problem 5. An observer S sees a flash of red light at the origin in his frame, and a flash of blue light at $x = +720\ m$. He measures the time interval between the occurence of the flashes to be $5.00\ \mu s$, the red flash occuring first.

a) What is the relative velocity of a second observer S' who would record these flashes as occuring in the same place?

b) From the point of view of S', what is the time interval between the flashes, and

which flash occurs first?

Problem 6.
Galaxy A is reported to be receding from us with a speed of $0.35c$. Galaxy B, located in the opposite direction is also found to be receding away from us at this same speed. What recessional speed would an observer on Galaxy A find

a) for our Galaxy?
b) for Galaxy B?

Problem 7.
A spaceship moving away from the earth at a speed of $0.90c$ reports back by transmitting on a frequency (measured in the spaceship frame) of 100 MHz. To what frequency must earth receivers be tuned to receive these signals?

Problem 8.
A spaceship is receding from the earth at a speed of $0.20c$. A light on the rear of the ship appears blue ($\lambda = 450\ nm$) to passengers on the ship. What color would it appear to an observer on earth?