Physics 221 – Test 2 – Fall 2009

One-page reminder sheet allowed. *Show all work – no credit given if work not shown!* Redraw needed figures on your test paper. The speed of light in SI units is 3×10^8 m s^{-1}.

1. You are flying from San Francisco to Seattle when a giant flashbulb goes off in each city precisely at noon local time. (The two cities are in the same time zone.)

   (a) In your reference frame do you reckon that Seattle's flash occurs before, after, or at the same time as the San Francisco flash? Explain your reasoning using a spacetime diagram.

   (b) Explain how the lag between *seeing* the flashes from the airliner differs from reckoning of when they actually occur relative to the aircraft reference frame. Your spacetime diagram may come in handy here as well.

2. A star 4 ly distant at our time $t = 0$ is moving toward the earth at a speed of 100 m s^{-1}.

   (a) Compute the speed of the star in light years per year.

   (b) Draw a spacetime diagram in which we are at rest at the origin, showing the world line and a line of simultaneity of the distant star. Label these lines.

   (c) Compute the number of years according to an earth observer before the star reaches us.

   (d) Compute the number of years before the star reaches the earth according to an observer moving with the star. Take *our time* $t = 0$ as the start of this interval.

3. Sketch the wave fronts and central wave 4-vector in a spacetime diagram for a relativistic matter wave with zero group velocity.

4. Two spaceships are moving toward the earth from opposite directions, each with speed V relative to the earth.

   (a) If one of the spaceships sends out a laser beam with frequency ω, what is the frequency of this beam as measured on the earth?

   (b) What is the frequency of the laser beam as measured by the other spaceship?

   (c) What approach speed does each spaceship determine the other to have?