Physics 139
Spring 2014
Homework 3
Due Friday, February 14, 2014

Reading Assignment: Hartle, pp. 70–73, 77-89; lecture notes for Feb. 6.

1. Problem 4.18, p. 75. Also, show that in the case of a time-like interval, all observers agree on the time ordering of the two events.

2. Problem 5.4, p. 100. Be careful not to confuse the spatial part of the 4-acceleration **a** with the ordinary 3-acceleration.

3. Problem 5.7, p. 100. Here is where you would find uniform acceleration in the rest frame of a particle: a charged particle in a uniform electric field; or a rocket ship whose engines are adjusted so that the passengers always feel an effective gravitational acceleration of g (for their comfort).

I think this is the easiest way to do this problem. Use the results of problem 2 above. Specialize to a $1+1$ model (x and t coordinates only). Find the components of the world acceleration of a particle (any particle) in its own rest frame, in terms of the ordinary acceleration d^2x/dt^2 in the same frame. Require that in the rest frame the ordinary acceleration have instantaneously the value g. Notice that Newton's law $F = ma$ is valid at low velocities, in fact it should be exact when $v = 0$. But in the rest frame, we do have $v = 0$, so if the ordinary acceleration in the rest frame is g then the passengers feel a force mg (m is the mass of the passenger). This is just what we want. Transform the world acceleration from the rest frame to the lab frame. Do the same for the world velocity. Find and solve differential equations for the world position, velocity and acceleration as a function of proper time.

There are other ways to do this problem. Perhaps you will find one.

4. Problem 5.13, p. 101.

5. Problem 5.22, p. 102.