MTH 437/537 **HW #1** Spring 2009

1. **VECTORS IN MINKOWSKI SPACE**

Show that a timelike vector cannot be orthogonal to a null vector or to another timelike vector. Show that two null vectors are orthogonal if and only if they are parallel. (Assume these vectors are nonzero.)

Try to do this in 4 spacetime dimensions, rather than 2. A convenient notation is to view a 4-vector $\mathbf{u}$ *as consisting of a timelike component* u^t *and spacelike components making up an ordinary 3-vector* $\vec{\boldsymbol{u}}$*; one often writes*

$$\mathbf{u} = \begin{pmatrix} u^t \\ \vec{\boldsymbol{u}} \end{pmatrix}$$

2. **THE GETAWAY**

This problem is optional, but good practice.

The outlaws are escaping in their getaway car, which goes $\frac{3}{4}c$, chased by the police, moving at only $\frac{1}{2}c$. Realizing they can't catch up, the police attempt to shoot out the tires of the getaway car. Their guns have a muzzle velocity (speed of the bullets relative to the gun) of $\frac{1}{3}c$.

(a) Does the bullet reach its target according to Galileo?

(b) Does the bullet reach its target according to Einstein?

(c) Verify that your answer to part (b) is the same in all four (!) reference frames: ground, police, outlaws, and bullet.