1 Relativistic Spies

Two clocks located at the spatial origins of the K and K' systems (which have a relative speed of V between them) are synchronized when the origins coincide. After a time $T_{detected}$, an observer at the spatial origin of the K system observes the K' clock by means of a telescope (meaning, a photon has traveled from the K' clock to the observer).

(a) Draw a spacetime diagram for this situation. Label the worldlines for all objects and the spacetime coordinates for the important events.

(b) What time does the observer read on the K' clock (in terms of the given $T_{detected}$)?

2 All Velocity Components Transform

In Galilean relativity, only the component of velocity that is in the direction of the relative motion of reference frames transforms between the two frames. For example, if the relative motion between frames is x-direction, the x-component of the velocity transforms but not the y-component:

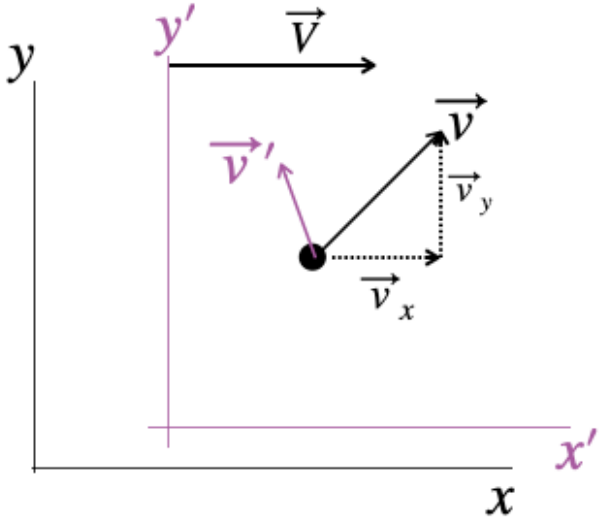
If $\vec{V} = V\hat{x}$

Then Galilean boost:

$$v'_x = v_x - V$$
$$v'_y = v_y$$

I have shown that for a similar situation in special relativity (where the relative velocity is in the x-direction), the x-component of velocity transforms:

$$v'_x = \frac{v_x - V}{1 - \frac{v_x V}{c^2}}$$



Show that, in special relativity, the vertical component also transforms (i.e., find the equation of the transformation).

3 Velocity Addition

(*Taylor 15.22*)

A rocket is traveling at speed 0.9c along the x axis of frame S. It shoots a bullet whose velocity v' (measured in the rocket's rest frame S') is 0.9c along the y' axis. What is the bullet's velocity (magnitude and direction) as measured in S?