Special Relativity Kinematics Problems 1

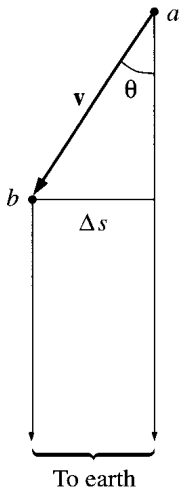
Will Bunting

October 5, 2010

1 Stars observed moving faster than light?

A star moves across the sky toward us at an angle (Figure 1). What is the star's apparent speed across the sky, that is $\Delta s/\Delta t$. What angle θ gives the maximum apparent speed.

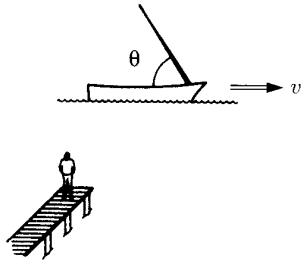
[*D. Griffiths: Introduction to Electrodynamics*]



2 Sailboat's Mast Problem

In a boats reference frame the angle the mast makes with the deck is θ an observer on a dock sees the boat go by with speed v (Figure 2). What does the observer perceive the angle to be?

[*D. Griffiths: Introduction to Electrodynamics*]



3 Velocity Addition a la Einstein

3.1 2 frames

Frame S is moving with respect to frame $\tilde{S}$ with velocity v. In S a particle is observed to have a velocity $u = \frac{dx}{dt}$ what is then its observed velocity in $\tilde{S}$, $\tilde{u} = \frac{d\tilde{x}}{d\tilde{t}}$?

3.2 N frames

For simplicity (we want to drop all the c's) we set $\beta_i = v_i/c$. An object moves with speed β_1 with respect to S_1, and S_1 moves with speed β_2 with respect to S_2, and so on for S_{N-1} moves at speed β_N with respect to S_N (Figure 3.2). Show that the formula for the speed of the object with respect to S_n can be written as:

$$\beta_{(N)} = \frac{P_N^+ - P_N^-}{P_N^+ + P_N^-}$$

where

$$P_N^+ = \prod_{i=1}^{N}(1+\beta_i) \qquad \text{and} \qquad P_N^- = \prod_{i=1}^{N}(1-\beta_i)$$

[*D. Morin: Introduction to Classical Mechanics*]