Pole & Barn Paradox

1a. A barn is 10 m long and has front and back doors. How fast does a ladder of length 12 m have to move so that it can be entirely in the barn?

b. Suppose the ladder is moving at 0.8c. Draw a spacetime diagram showing worldlines for the ladder and the barn doors. (Make the barn the unprimed frame.)

c. The doors are closed when the ladder is completely in the barn, then opened to let the ladder out. What is the sequence of the following events, according to the ladder?

1. left door closes
2. left door opens
3. right door closes
4. right door opens
5. back end of ladder enters barn
6. back end of ladder leaves barn
7. front end of ladder enters barn
8. front end of ladder leaves barn

Transverse Doppler Shift

According to Ohanian, the transverse Doppler shift results from the slowing of the emitter clock. This means that the emitter and receiver are transverse at the time of emission.

a. Is it possible for the emitter and receiver to disagree about whether the emitter is transverse at the time of emission? In other words, could it be the case that the emitter is transverse at the time of emission, and the receiver is transverse at the time of detection? Why or why not?

b. Suppose the emitter and receiver are transverse at the time of detection. According to the emitter, the receiver clock runs slow. What frequency is detected?

c. Draw the emitter and receiver in space (not spacetime) for the case where the emitter is transverse at the time of emission, and for the case where the receiver is transverse at the time of detection. Draw these in both reference frames (you’ll have four drawings.)

d. Consider the case where the emitter and receiver are transverse at the time of emission, in the emitter frame. If the emission is at a frequency of f, show that, according to the emitter, the receiver is hit by wave crests at a frequency of f’ = (1-v^2/c^2)f. Why is this not the correct Doppler shift? What is missing?