

# Homework 4

September 6, 2011

**Explain the following apparent paradoxes as briefly and as completely as possible. Follow Einstein's advice: "Things should be as simple as possible, but not simpler."**

1. At rest, a spear is too long to fit into a barn. But when a spear thrower runs with it (at a significant fraction of the speed of light), the spear Lorentz contracts enough to fit inside the barn. To make sure it does fit in the barn, the barn hands ask the runner to run through the barn. Once the spear is in the barn, they plan to *first* close the entry door after the spear passes through it and *then* open the exit door. But from the spear thrower's perspective, the barn is even smaller now. Therefore, would the spear not hit the exit door if the barn hands wait for the spear to pass through the entry door before taking any action?
2. Two identical rockets are tied together with a rope that is stretched to its limit. Two astronauts on board, by working in a completely synchronized manner, carefully accelerate the rockets so that they reach cruising speed ( $v$ ) together. Because their motions are synchronized both rockets would have advanced by the same distance from their respective starting points on earth by the time they reach speed  $v$ . Therefore, we on earth expect the distance between rockets to stay constant. In this picture, the rope starts to Lorentz contract and eventually breaks because the rockets do not get closer. But, if you think of the rockets and the rope as one unit moving at speed  $v$ , wouldn't the whole unit contract - making the distance between the rockets smaller for observers on earth. So, which viewpoint is correct? In other words, does the rope break or stay intact.
3. Read about the twin paradox in section 2.8 of the text book and explain it in terms of what you learned in class on Tuesday Sept 6 (the relativity of simultaneity).