Title: A Simple Proof that the Thread Doesn't Break in Bell's Spaceship Paradox

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Abstract:

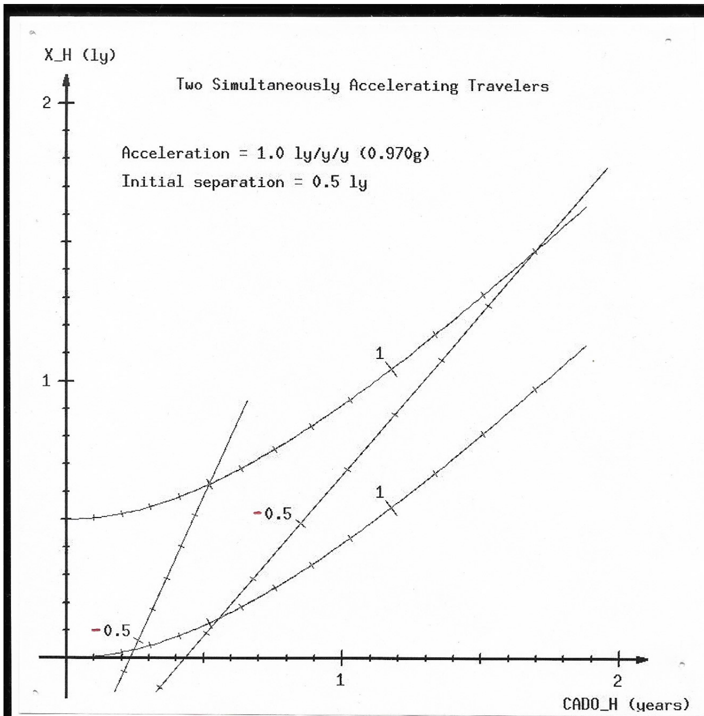
This paper shows that the inertial observers, who are stationary with respect to the accelerating observers immediately before the acceleration begins, conclude that the accelerating observers get closer together as the acceleration proceeds, and that the separation approaches zero as time goes to infinity. Therefore they conclude that the thread doesn't break. The accelerating observers conclude that their separation never changes, and so they also conclude that the thread doesn't break. Although the reasons for their conclusions are different, they must agree about the survival of the thread.

More than 20 years ago, I plotted a chart showing two separated objects undergoing the same constant acceleration "A". (That chart still hangs on the wall above my desk, and I've never questioned it before). The plot supposedly shows the view of things according to an inertial reference frame (the "IRF") that is stationary wrt the two accelerating objects immediately before the acceleration begins. One curve starts from the origin with slope zero at the origin, but then curves upward with a curvature that monotonically decreases as time increases, and asymptotically approaching a slope of "c", the speed of light. I use units where "c" equals 1.0 lightyear/year, so the curve approaches a slope of 1.0 on the chart.

The other curve has exactly the same shape, but starts at some distance "D" above the origin. The two curves are always separated by a vertical distance of "D".

The original idea, I think, was that the two curves must have exactly the same shape because of "the Principle of Relativity" ... i.e., it shouldn't matter where in space you start the curve, the curves should always have the same shape.

But here's the quandary: An observer in the inertial frame "IRF" is told by the chart that the two objects always have the same distance apart. But the length contraction equation ("LCE") of special relativity says that an inertial observer should conclude that a moving yardstick (aligned with the motion) should get shorter and shorter as its speed wrt the inertial observer increases. That seems to contradict what the chart says, and it seems to contradict the Principle of Relativity. The "LCE" seems to require that the two curves get closer together as time increases. Does the upper curve slowly get closer to the lower curve? Or does the lower curve approach the upper curve? Or is there some combination of those two movements? Any of those movements contradicts what the chart says, and it thus seems to contradict the Principle of Relativity.


X_H (ly)
Two Simultaneously Accelerating Travelers
Acceleration = 1.0 ly/y/y (0.970g)
Initial separation = 0.5 ly
2
1
1
1
-0.5
-0.5
1
2
CADO_H (years)

The Length Contraction Equation (LCE) requires that the two curves get closer together as time increases, according to the inertial observers stationary wrt the accelerating observers immediately before they start accelerate. Does the upper curve slowly get closer to the lower curve? Or does the lower curve approach the upper curve? Or both?

I've realized that the bottom curve doesn't move upward, because it already has speeds that approach the speed of light "c", and so its speeds can't be increased any. So all of the decrease in their separation has to come from a lowering of the upper curve.

That is enough information to allow the correct upper curve to be plotted ... just divide the vertical distance between the two curves by the factor "gamma", where

gamma = 1 / { sqrt (1 - v * v) }.

Note that, as "v" approaches 1 ly/y (the speed of light), "gamma" goes to infinity, and the vertical distance between the two curves goes to zero.

The result is that the upper curve gets closer to the lower curve, and the distance between them goes to zero as time goes to infinity. Therefore, according to the inertial observers who are co-located with the accelerating observers immediately before the acceleration starts, the thread DOESN'T break. And the accelerating observers agree that the thread doesn't break, because they say their separation is constant. In fact, they say that the original diagram (without the diagonal lines) shows THEIR perspective.

One thing that diagram DOESN'T show is how the AGES of those two accelerating observers compare. They are NOT ageing at the same rate. The leading person ages faster than the trailing person. The time variable in the chart (the horizontal axis) refers to the age of the trailing observer, not the leading observer. Einstein (in his 1907 paper) said the leading person ages exp(D * A) times faster than the trailing person, but I showed in an earlier paper (https://vixra.org/abs/2109.0076) that that exponential equation is incorrect. I derived the correct equation in https://vixra.org/abs/2201.0015 .

The above process can also be used to define an accelerated array of clocks, yardsticks, and observers that extends throughout all space, which establishes a "NOW-at-a-distance" for an accelerating observer (him). That allows him to determine the current age of a distant person (her), just as an array of inertial clocks, yardsticks, and observers (defined by Einstein) could be used by an inertial observer. That guarantees that simultaneity at a distance for an accelerating observer is fully MEANINGFUL, just as Einstein did for an inertial observer. Such an accelerated array is used in my paper https://vixra.org/abs/2302.0119 .