

(Bonus) I recently received an email from an amateur physicist who believes that he can disprove special relativity. Here is his thought experiment:

In the Earth frame of reference, imagine a spacecraft one light-year from Earth traveling toward Earth at nearly the speed of light and a photon in the same direction two light-years away also traveling toward Earth. In our frame of reference, the spacecraft will arrive at Earth in about one light-year, and the photon will arrive in two light-years.

Now consider the spacecraft frame of reference. It sees Earth traveling toward it at nearly the speed of light. Since relativity requires that light is seen traveling at the constant speed of light in all frames of reference, the spacecraft sees the photon traveling toward it at the speed of light. In the spacecraft frame of reference, the Earth and the photon meet at the spacecraft at the same time. This result contradicts the result seen in the Earth frame of reference.

To me, this simply shows that relativity is false. How would Einstein explain it?

How would Einstein explain it? Please explain in two sentences or less. (5 points)

There are a number of points here that are indeed correct: According to an observer on earth (OE) the space ship arrives after approximately one year, and the photon after two years. It is also correct that according to an observer on the spacecraft (OS) the photon travels at the speed of light. This implies that for OS the relative velocities spacecraft-photon and spacecraft-earth are indeed the same. It is also true that OS measures the distances photon source-spacecraft origin and spacecraft origin-earth to be the same.

The writer concludes that the photon must arrive at the spacecraft at the same time that the space craft arrives on earth. This would indeed be paradoxical: Simultaneity is relative, but simultaneity at a single point (the earth) must be absolute.

The reason the conclusion is wrong is that the simultaneity of the launch times is relative. For OE the photon and the spacecraft leave at the same time, but to OS the photon is emitted after the spacecraft is launched, and that is why the photon catches up with the spaceship long after the spaceship reaches earth.