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Twin in a Spaceship

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Special relativity (SR) defines the relativistic mass of an object traveling with a speed υ by $m = m_0/\sqrt{(1-\upsilon^2/c^2)}$ where $1/\sqrt{(1-\upsilon^2/c^2)}$ is the Lorentz factor γ, m_0 is the rest mass of the moving object and c is the speed of light about 3×10^8 m sec^{-1}. The mass of the moving object increases with its (relative) speed.

The relativistic length of the moving is given by $l = l_0\sqrt{(1-\upsilon^2/c^2)}$ where l_o is the rest length of this object. The SR interpretation of this formula is that the length of the moving object contracts in the direction of motion.

The equation for calculating relativistic time is as follows: $t = t_0/\sqrt{(1-\upsilon^2/c^2)}$ where t_0 is the rest time of the moving object. It means that an object in motion experiences time dilation, meaning that when an object is moving it experiences time more slowly than when it is at rest. This dilation is probably the most peculiar aspect of SR.

The twin paradox in physics is a thought experiment of SR involving identical twins. One twin Luke stays on Earth while the other John flies into the Universe in a spaceship at a non-relativistic or relativistic speed then returns realizing that Luke is older than he is.

During his spaceflight, John did not observe the increase in mass of the spaceship or its contraction[1], or find that his time dilated. However, Luke claims that the mass of it increases, its length is shortened and John's time runs slow. However, now the question arises as to how Luke, ground on Earth, established all these SR peculiarities? Not directly but indirectly by applying the known results of the SR theoretical or experimental research. After all, this is a thought experiment.

However, John can also claim that the masses and of the lengths objects around Luke have changed, and Luke's time runs slower than his time. All of this is based on the above theoretical and experimental results. Now the question arises, which of them is right? It is only usually stated that John is younger than Luke. But what about the mass and length of the spaceship? If they are found to be the same as before John's space journey then an intriguing question emerges: γ [$= 1/\sqrt{(1-\upsilon^2/c^2)}$] factor is valid for John's age after his return but then why not for the mass or length of the spaceship? If this factor is valid for the spaceship, then its mass and length have to be changed.

[1] For the sake of clarity, we will focus only on the mass and length of the spaceship.