The Twin's Paradox

Simplified Resolution Without

Frame Switching or Acceleration

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Abstract:

It is shown here that "The Twin's Paradox" of Special Relativity arises from a fundamental misunderstanding of what the Relativity Principle actually means. The asymmetry in the physical conditions that leads to the asymmetrical times is abundantly clear from the outset, but is almost always overlooked. Understanding the root cause of the asymmetry immediately resolves the paradox independently of acceleration or frame switching

Key words: twins paradox, acceleration, frame switching, special relativity

Overview:

Overwhelmingly, all accounts of Special Relativity analyse the Principle of Relativity (POR) from the simplified viewpoint of only considering two observers and alternatingly swapping over which observer is considered at rest and what observer is considered moving. Such a view implicitly ignores the physical reality of the situation that occurs in all practical applications. This leads to a fundamental misunderstanding as to the role of the other objects in the system which are conveniently ignored, that is, the rest of the universe. This view immediately hides any asymmetry in the system by fiat.

Indeed as soon as one mentions "the rest of the universe matters" eyebrows are raised in dismay due to the bias that Relativity only requires the relativity motion between two test objects to be considered. It's an erroneous view hammered into the minds of all students.

Unfortunately, "The rest of the universe" statement, leads to the idea that there is a claim of some background ether, which is not the claim. The claim is simply that one has to acknowledge that, if a single object is swapped as to which one is considered moving, *all* of the objects in the frame of that stationary test object must now be considered moving. If this is not done, the system is not physically equivalent as a matter of fact.

The view is so ingrained that most simply haven't even thought about the problem to understand why such a view cannot be correct.

That this "ignore the rest of the universe" is false, is easily established by returning to Einstein's original core paper on Special Relativity paper

"On the Electrodynamics of Moving bodies".

The key section of this paper that demonstrates a fundamental misunderstanding of Relativity is:

> *"...for if the magnet is in motion and the conductor at rest, there arises in the neighbourhood of the magnet an electric field with a certain definite energy, producing a current at the places where parts of the conductor are situated. But if the magnet is stationary and the conductor in motion, no electric field arises in the neighbourhood of the magnet. In the conductor, however, we find an electromotive force, to which in itself there is no corresponding energy, but which gives rise--assuming equality of relative motion in the two cases discussed--to electric currents of the same path and intensity as those produced by the electric forces in the former case..."*

The problem here, is that the rest of the environment, that is the universe, is simply ignored. The description implies that if either the magnet or the wire moved, the same result will occur.

This statement is clearly false in general.

Locally to this setup, they may well be *other* magnets whose fields also extend to the test magnet and test wire. If only the test magnet or the test wire are moved relative to each other, the results will not be the same because the effect of moving one test magnet is not the same as moving all of the magnets in the region relative to the wire. To maintain the physical equivalence of the situation, all of the magnets must be considered moving.

Unfortunately, Einstein's simplification of the system to highlight a particular point, has been expanded to imply that the external system has no consequences at all.

The literature has almost universally ignored this issue. What this example demonstrates is that the entirety of the universe must be included when one decides to swap what object is considered moving and what object is considered at rest.

That is, Relativity is not simply swapping over what two objects are moving with respect to each other, Relativity requires that what object is moving with respect to all other objects and their interactions with the rest of the universe are accounted for.

In the situation of the Twin's Paradox, one has to actually include, as a minimum, the 3rd object of the system, that is, the location of the Star that the traveller twin is traveling to.

That is, the *point* that the twin is travelling to, must be explicitly included in the analysis. Without accounting for this point, it is impossible to recognise that the systems are intrinsically asymmetrical. The Star location point is required so that one can actually calculate where the twin is traveling to. This point is not an invariant in Special Relativity, different observers attribute different distances to this point, which breaks the symmetry.

Twins Calculation:

The Correct Resolution of the Twins Paradox can be performed by actually ignoring that there is a go and return journey.

It should be noted that the specific description of the Twin's Paradox was made to illustrate a feature of Special Relativity. It is not a requirement to illustrate the feature. The same result can be achieved simply by considering a one way trip, showing that all agree on the asymmetry in times for a one way trip, and double up the time for the return trip.

Neither frame switching nor acceleration are enacted in the system in this scenery.

The root cause of the asymmetry is that the stay at home twin and the star are both in a different frame from the travelling twin, always.

The frames are different because the star always stays in the same frame as the stay at home twin, whatever frame is taken to be at rest.

This means that there is an inherent asymmetry between the twins. Correctly applying the relativity principle means that:

1 When the traveller twin is considered to be moving, he is moving with respect to the non-traveller twin, the star and the rest of the universe.

2 When the traveller is at considered to be at rest, the non-traveller twin, the star and the rest of the universe must be considered to be relatively moving. It's not just one twin or the other moving, the star, and consequently, the rest of the universe must be considered moving or not moving.

So, the stay at home twin never moves with respect to the star and the universe, whether he is considered at rest or not. The traveller twin always relatively moves with respect to the non-traveller twin, star and the universe, whether considered at rest or not.

So, somewhat ironically, the Twins Paradox is resolvable without the explicit inclusion of time dilation at all. One only has to consider the situation from the point of how the Earth Twin, Traveller Twin and Star are perceived from the point of length contraction.

The distance the Earth Twin determines for the distance from the Earth to the Star, is the distance in the rest frame of the Earth Twin and Star:

This distance is always the same for the Earth Twin, independent as to whether the Earth twin, including the Star, is considered at rest or moving. This is because for both conditions, the Earth and Star are in the same frame, whether considered at rest or moving together.

Thus the time the Earth Twin measures for the time the traveller takes from getting from the Earth to the Star is:

Variables:

Twin A = stay at home on Earth twin

Twin B = traveller twin from Earth to the Star

Lorentz contraction factor = γ

L = distance from Earth to Star in the rest frame of the Earth and Star

T1 = time that Twin A observes it takes Twin B to travel from the Earth to the Star

T2 = time that Twin A calculates Twin B's own time takes to travel from the Earth to the Star

T3 = time that Twin B calculates Twin B's own time takes to travel from the Earth to the Star

T4 = time that Twin B observes Twin A and the Star takes to pass by him

T5 = time that Twin B calculates that Twin A and the Star takes to pass by him

Argument:

In the rest frame of the stay at home twin, twin A,

$T1 = L/v$

The distance the Earth Twin determines for the distance from the Earth to the Star for the Traveller Twin is not the same as the Earth Twin as the Traveller Twin is in a different frame. This distance is given by the Lorentz contraction factor $1/\gamma$. Thus the time the Earth Twin concludes the time occurring for the Traveller Twin as:

$T2 = L/v\gamma$

The Traveller Twin is in a different frame than the Earth & Star frame, so the Traveller twin, considered travelling, also considers that the distance from the Earth to the Star is Lorentz contracted, thus incurring a time of travel as:

$T3= L/v\gamma$

The Traveller Twin, considered at rest, views the Earth and Star go by the Traveller Twin at a velocity, thus is Lorentz contracted and concludes a time between the Earth and Star passing as:

$T4 = L/v\gamma$

The distance the Traveller Twin determines for the distance from the Earth to the Star as determined by the Earth Twin, is not Lorentz contracted and thus concludes the time for the Earth Twin for the time between the Earth and Star as:

$T5 = L/v$

The summary is:

Both Twins considers the time it takes to go from the Earth to the Star for the Earth Twin is based on the time of the normal length L.

Both Twins considers the time it takes to go from the Earth to the Star for the Traveller Twin is based on the contracted length L/γ

It’s the difference in effective lengths that are asymmetrical, because the Star and Earth are in one frame, and the Traveller is in another frame. It’s the time to transverse the lengths that matter, not time dilation.

The return journey simply doubles up the time difference.

Summary:

The Twins Paradox is resolvable without acceleration or frame switching.

This analysis highlights that it is not correct to only consider that it is either A or B that can be considered moving, according to the relativity postulate.

A correct application of the relativity postulate requires, as a minimum, a third object C, such that the A and C are always locked together. Without a third object it is impossible to deal with the length aspect of the Lorentz Transform.

The recognition of the requirement for a third object introduces the elephant in the room, almost always ignored. That is, object C can only logically be, the entire universe. Unless the entire universe is considered moving, switching who is moving cannot be an equivalent system.

It should be noted that the Lorentz Transform is only a mathematical, behavioural, calculation machine. It provides no argument as to how or why it accounts for observations.

References:

1 On the Electrodynamics of Moving Bodies – Albert Einstein. 1905. 30 pages. Published in: Annalen Phys. 17 (1905) 891-921