The Historical Asymmetry of Acceleration in Special Relativity

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Newton's first law of motion states, "Every body continues in its state of rest, or of uniform motion in a straight line, unless acted on by a force." Special relativity theory assumes such motion. Newton's second law states, "The change of motion from a straight line is caused by acceleration due to a force." Changes in velocities are caused by accelerations. General relativity follows the second law. Modern technology has enabled individual objects to know their velocities using accelerometers that measure increments of acceleration or deceleration and record them. If two or more objects have this capability, each object has an on-board history of its velocity. An historical asymmetry between moving objects can be measured. Consequently, the statement in special relativity that no single object can measure its uniform velocity is not valid anymore. In addition, the principal of relativity that each object can claim to be the fastest is no longer reasonable to assume. Since length contraction, time dilation, and the twin paradox are process changes, all three occur during acceleration or deceleration and are sustained during the ensuing state of uniform motion. The only thing that is special about special relativity is that special relativity applies to point-to-point conditions of uniform motion, rather than processes that occur between the points. It is time to re-examine the role of special relativity in the 21st century paradigm of physics.

Introduction

During the past five years that I have attended meetings of the **Natural Philosophy Alliance (NPA)**, speakers have repeatedly questioned the assumptions Einstein used and the conclusions he obtained from special relativity theory (SRT). I could not understand the logic of their attacks. That may have been because my attention has been focused mostly on the general theory (GRT). During the 14th NPA Conference at the University of Connecticut in 2007, I suddenly understood where other NPA members were coming from. Comments by some of the speakers convinced me that more than a little bit of GRT is hidden within SRT. This paper addresses my suspicions, which are mostly speculative and do not exhibit the mathematical justifications that most of my concepts do.

Assumptions and Definitions

One of the ways to better understand Einstein is to seek out his assumptions and the implied definitions of the terms he uses. It has been my experience that he does a better job of explaining his terms in personal correspondence and in later papers, not in real time in his published papers. Here are some things that Einstein said about relative motion. The statements are numbered for future reference.

1. "The laws of physics by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of coordinates in uniformly transitory motion." [1]
2. "The laws by which the states of physical systems alter are independent of the alternative, to which of two systems of coordinates, in uniform motion of parallel translation relatively to each other, these alterations of state are referred (principle of relativity)." [2]
3. "Only relative uniform motion can be observed." [3]
4. We must have what we call some frame of reference. . . . This frame, to which we refer all our observations, constructed of rigid unchangeable bodies, is called the co-ordinate system CS)." [4]
5. "The laws of nature are the same in all CS moving uniformly relative to each other." [5]

The above quotations are full of terminology that may or may not be defined elsewhere in Einstein's writings. Notice "laws of physics" in the first quotation from Einstein. What laws of physics? Also, he uses the words "state, uniform motion, and rigid bodies" that need more details. Some of these words are defined below and others are deeper within the text. A single source [6] was used for definitions of the words that immediately follow.

- **Mechanics** – A branch of physics that deals with energy and force in their reference to material bodies.
- **Statics** – The branch of mechanics which treats of force and force systems abstracted from matter, and of forces which act on bodies in equilibrium.
- **Kinematics** – The study of the motion of a system of material particles without reference to the forces which act on the system.
- **Dynamics** – That branch of mechanics which deals with the motion of a system of material particles under the influence of forces.
- **State** – The condition of a system which is specified as completely as possible by observations of a specified nature; a minimum set of numbers which contain

enough information about a system's history to enable its future behavior to be computed.

- **Process** – A system or series of continuous or regularly occurring actions taking place in a predetermined or planned manner to produce a desired result.

Another term will be discussed in more detail that will focus more on the point that I am trying to make.

Inertial Guidance

Much of my professional career from 1970 to 2001 was involved with the inertial guidance of weapons systems [7]. My experience causes me to raise questions about SRT. After a brief discussion of inertial guidance, I will address the twin paradox, and suggest a particular experiment to test my conclusions.

Inertial guidance is the control of the trajectory of a missile by means of self-contained instruments that are actuated by changes in the velocity of a missile. In other words, a missile knows the path it is taking and exactly where it is during flight based upon where it was launched and on-board measurements of changes in velocity. Modern day inertial guidance systems are self-contained, not subject to jamming, not detectable, and are operational whether day or night and in adverse whether. No command links or contacts with anyone or anything else are required. Position updates may be obtained from a command center, LORAN, or the Global Positioning System (GPS), but are not necessary.

Inertial guidance systems do need to know where they started (launcher) and where they are going (target). Even the best of inertial guidance systems drift with time and may need updates.

Inertial guidance systems conform with Newton's [8] three laws of motion, which actually determine the system components of an inertial guidance system.

Law I – Gyroscopes: Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change their state by forces impressed upon it.

Law II – Accelerometers: The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.

Law III – Guidance: To every action there is always opposed an equal reaction; or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.

So-called "iron" gyroscopes maintain an angular reference direction by virtue of a rapidly spinning, heavy mass. More sophisticated ring-laser gyroscopes use lasers in three rings corresponding to three axes that detect perturbing forces through interference patterns. An accelerometer measures the magnitudes of perturbing forces. The outputs of gyroscopes and accelerometers are changed from analog to digital signals and processed in a computer. Integration of acceleration over time gives velocity and integration of velocity over time gives distance traveled. Outputs are fed into the guidance system to adjust the missile path if needed. An Earth coordinate reference system is used within range of the Earth. A celestial coordinate system based upon the star Vega is used in space. Random forces in precision inertial guidance systems can sense pressures equivalent to sunlight on your hand.

Historic Asymmetry

Einstein bases his assumptions in special relativity on kinematic principles, that is, in terms of uniform motion states where no forces are involved. Therefore, he is considering point conditions at constant velocity. Dynamic conditions of motion are postponed until work on the general theory. Uniform motion is reflected in Newton's first law as well. However, my point is this, if two objects have different uniform velocities, then one of the two objects has experienced more acceleration. Different uniform motions are somewhat like the sensation of being stopped at a stop light. Out of the corner of your eye, you sense, relative to the car next to you, that you are moving. How can that be? You have just experienced SRT even though you have your foot on the break. If there is a difference in velocities between two objects, one of them is going faster. That would be easy to test with an inertial guidance system on each object. The object could be an elevator, as frequently used by Einstein for his thought experiments, or spaceships, the modern choice for comparison.

If two objects are moving in space, say down an intergalaxy spacelane and they each adjust their velocities to be side-by-side, and then one moves ahead to be going a few zips faster, each spaceship knows which is going faster. But if some crew member who had been in suspended hibernation awoke and took the controls, he or she would not know which spaceship was faster until he or she checked acceleration records and talked with the other ship. Historic asymmetry would determine the fastest.

My other premise that contributes to historic asymmetry concerns time dilation, length contraction, and the twin paradox. I believe that these phenomena are revealed in the point-to-point comparison of objects in uniform motion. Moreover, if these phenomena do occur physically, they are probably caused by the forces of acceleration and deceleration and remain unchanged during uniform motion. They are actually GRT phenomena. I am not alone in pointing out that time dilation is the consequence of acceleration. Sommerfeld [9] made a similar observation. He made comments on time dilation that were appended as "Notes" to Minkowski's 1908 paper on "Space and Time". "On this depends the retardation of the moving clock compared with the clock at rest. This assertion is based, as Einstein pointed out, on the unprovable assumption that the clock in motion actually indicates its own proper time, i.e. that it always gives the time corresponding to the state of velocity, regarded as constant, at any instant. The moving clock must naturally have been moved with acceleration (with changes of speed or direction) in order to be compared with the stationary clock at the world-point P. The retardation of the moving clock does not therefore actually indicate 'motion,' but 'accelerated motion.' Hence this does not contradict the principle of relativity."

I have a third observation about length contraction that might impact time dilation and the twin paradox. Lorentz [10] actually "supposed" in his transformation equations that contraction occurred in the direction of motion. This assumption has caused all sorts of problems for rotating objects that actually experience a relativistic concentration of force at their centers as velocity of rotation increases. I have assumed since the 1960s a three-dimensional contraction during accelerated translation. I reported on this prediction at the 12th NPA [11] in 2005 and

suggested a relativistic translation coupling with quantized rotation as a Lorentz contraction type of answer to quantum-relativity.

Suggested Experiment for the Twin Paradox

It is suggested that radioactive materials with a relatively short half-life be used in testing for historic asymmetry and the twin paradox as related to time dilation. The hypothesis to be tested is: *Time dilation, length contraction and the twin paradox are processes caused by accelerated motion and their rates remain constant during uniform motion.*

- Select a sample of radioactive material and determine its content of decayed material and radioactive material.
- Divide the radioactive test sample into two equal portions. Leave one portion on Earth for a control. Accelerate one sample into orbit.
- Option 1: If measurement of the half-life in orbit is the same as on Earth, both the rate of decay and the rate of clocks have slowed.
- Option 2: If the half-life measured in orbit has changed—new hypothesis needed
- Return to Earth and compare the half-lives of the samples. They should be the same. Also, compare the amount of decayed and undecayed materials. If Option 1 is followed, the sample sent into orbit should contain more undecayed material than the sample retained on Earth.
- Vary tests with longer or more intense periods of acceleration and lengths of time in orbit.

Conclusions

My conclusions for this paper sound like an outline for further work. Two objects, a and b, are moving in uniform motion relative to each other with a velocity difference Δ v.

- Modern technology can independently measure changes in velocity without an external reference.
- The fastest/slowest object can be determined.
- Either object can be used as a kinematic reference frame, but the signs will change.
- Kinematic formulations describe end points not the dynamic changes in process rates.

Static processes and dynamic processes must be distinguished:

- Changes in the rate of phenomenological processes occur during acceleration or deceleration.
- Phenomenological changes occur at a constant rate during uniform motion.
- The twin paradox, time dilation and length contraction involve changes in the rate of dynamic processes, which are GRT and not SRT phenomena.
- A test of radioactive decay is suggested.

References and Notes

[1] A. Einstein. "Electrodynamics of Moving Bodies," Originally published in 1905. **The Principle of Relativity**, New York: Dover Publications, Inc., p. 41 (1923). Statement of relativity postulate/principle in SRT.

[2] A. Einstein. "Does the Inertia of a Body Depend upon its Energy Content?", Originally published in 1905. **The Principle of Relativity**, New York: Dover Publications, Inc., p. 69 (1923). Restatement of relativity principle.

[3] A. Einstein and Leopold Infeld. **The Evolution of Physics**, New York: Simon and Schuster, p. 171 (1961). Only relative motion can be observed.

[4] Ibid, p. 156. Einstein's definition of a coordinate system.

[5] Ibid, p. 177. Laws of nature in uniform motion.

[6] S. P. Parker. **McGraw-Hill Dictionary of Scientific and Technical Terms,** 5th Edition**,** New York: McGraw-Hill, Inc (1994). Definitions of terms related to motion, forces, and matter.

[7] R. J. Heaston and C. W. Smoots. **Introduction to Precision Guided Munitions: A Handbook Providing Tutorial Information and Data on Precision Guided Munitions (PGM**, Vol. 1: Tutorial, GACIAC HB-83-01, Chicago: IIT Research Institute (May 1982). Contains basic information on inertial guidance.

[8] I. Newton. "Mathematical Principles of Natural Philosophy," Originally published in 1687, **Great Books of the Western World**, Vol. 34, pp. 14 (1952). Relationships of Newton's laws of motion to missile guidance and control components.

[9] H. Minkowski. "Space and Time," Originally published in 1908. **The Principle of Relativity**, New York: Dover Publications, Inc., p. 94 (1923). Sommerfeld Notes that say retardation of clocks is an acceleration phenomenon.

[10] H. A. Lorentz. "Electromagnetic Phenomena in a System Moving with any Velocity less than that of Light," Originally published in 1904. **The Principle of Relativity**, New York: Dover Publications, Inc., p. 21 (1923). Lorentz supposition that contraction only occurs in the direction of motion.

[11] R. J. Heaston. "Quantum Gravity and the Structure of the Electron,"12th Annual NPA Conference, 23-27- May 2005, University of Connecticut, Storrs, CT, **Proceedings of the Natural Philosophy Alliance**, ISSN 1555-4775, Vol. 2, No. 1, pp. 58-62 (Spring 2005). Contraction occurs in all three dimensions.

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