Reflection Symmetry and Time

Eric Su
eric.su.mobile@gmail.com
(Dated: April 14, 2017)

Two identical stopwatches moving at the same speed will elapse the same time after moving the same distance. Start one stopwatch later than the other stopwatch. The time difference between these two stopwatches will remain constant after both stopwatches have elapsed the same time. Such time difference will remain constant while both stopwatches are under identical acceleration. Therefore, the elapsed time in an accelerating reference frame is identical to the elapsed time in a stationary reference frame. Consequently, a physical system that exhibits Reflection Symmetry in its motion demonstrates that the time of a moving clock is independent of the relative motion between the clock and its observer.

I. INTRODUCTION

In 1887, Woldemar Voigt was working on an elastic theory of light. Voigt[1] proposed a time transformation for a moving system. In 1900, Joseph Larmor[2] found a space-time transformation different from Voigt's time transformation and proposed that time runs differently in different reference frame.

As early as 1895, Hendrik Lorentz[3] also independently proposed a space-time transformation similar to Voigt's time transformation. Based on the hypothesis of length contraction, Lorentz eventually developed his space-time transformation into Lorentz Transformation which was presented in modern form by Henri Poincare[4] in 1905.

Lorentz Transformation claims that time in a moving reference frame elapses differently from time in a stationary reference frame. In this paper, Reflection Symmetry will be the primary tool in a rigorous examination on time in a moving reference frame.

II. PROOF

Consider one-dimensional motion.

A. Difference In Time

A stopwatch moving at a constant speed will elapse certain time after moving a certain distance. Two identical stopwatches moving at the same speed will elapse the same time after moving the same distance.

Let the first stopwatch W1 start N seconds earlier than the second stopwatch W2. After moving an identical distance, both W1 and W2 elapse the same time. Therefore, the time difference between W1 and W2 is still N seconds. The time difference between W1 and W2 is independent of the distance they have travelled.

Put both W1 and W2 under identical acceleration at the same time. After moving an identical distance, both W1 and W2 will elapse the same time.

Proof 1. **Therefore, the time difference between W1 and W2 is always N seconds which is independent of the distance travelled and of the speed of both W1 and W2.**

B. Reference Frame

Consider two reference frames moving relative to each other. Let both W1 and W2 be stationary in one reference frame F1. Let the observer be stationary in the other reference frame F2.

Let F1 be stationary relative to F2. Start W1 N seconds earlier than W2. The time difference between W1 and W2 is N seconds in both F1 and F2.

Put F1 under acceleration relative to F2.

As stated in *Proof 1*, the time difference between W1 and W2 is N seconds in F2. The time difference between W1 and W2 is always N seconds in F1 because both W1 and W2 are stationary in F1.

Proof 2. **Therefore, the time difference between W1 and W2 is N seconds in both F1 and F2, independent of the relative motion between F1 and F2.**

C. Time in different reference frames

Let F1 be stationary relative to F2. Let both W1 and W2 be stationary in F1. Start W1. The time of W1 is T1 in both F1 and F2. Wait N seconds to start W2. The time of W2 is T2 in both F1 and F2.

$$T1 - T2 = N \tag{1}$$

Put F1 under acceleration relative to F2. The time of W1 is T1 in F1 and is T3 in F2. The time of W2 is T2 in F1 and is T4 in F2.

As stated in *Proof 2*, the time difference between W1 and W2 is always N seconds in both F1 and F2.

$$T1 - T2 = N = T3 - T4. \tag{2}$$

Rearrange variables in equation (2) to get

$$T4 - T2 = T3 - T1 = C \tag{3}$$

The time of W2 in F1 differs from the time of W2 in F2 by a number C.

$$T4 = T2 + C \tag{4}$$

N is an arbitrary number. Therefore, C has to be constant in time during acceleration.

Put F1 under deacceleration relative to F2. At the moment when F1 becomes stationary relative to F2, the time of W2 in F1 is identical to the time of W2 in F2.

$$T2 = T4 \tag{5}$$

D. Reflection Symmetry

Let W2 be stationary in F1. Let F1 be stationary relative to F2. Reset and start W2. At the same time, put F1 under constant acceleration A relative to F2. After F1 has moved a distance D relative to F2, the time of W2 is T6 in F1 and is T8 in F2. From equation (4), The time of W2 in F1 differs from the time of W2 in F2 by C.

$$T8 = T6 + C \tag{6}$$

Put F1 under constant acceleration -A relative to F2. After F1 has moved another distance D relative to F2, F1 becomes stationary relative to F2. At this moment, the time of W2 in F1 is identical to the time of W2 in F2. The time of W2 is T2 in F1 and is T4 in F2.

$$T2 = T4 \tag{7}$$

T8 is the time of W2 in F2 when F1 has moved half of the total distance 2D relative to F2. Reflection Symmetry requires that

$$T8 = \frac{T4}{2} \tag{8}$$

T6 is the time of W2 in F1 when F1 has moved half of the total distance 2D relative to F2. Reflection Symmetry requires that

$$T6 = \frac{T2}{2} \tag{9}$$

Derive from equation (6), (8) and (9) to get

$$\frac{T4}{2} = \frac{T2}{2} + C \tag{10}$$

Derive from equation (7) and (10) to get

$$C = 0 \tag{11}$$

The time of a moving stopwatch in F2 is identical to its time in F1 at any moment.

Therefore, the time of a clock is unique to all reference frames.

III. CONCLUSION

The elapsed time in a moving physical system is identical to the elapsed time in a stationary physical system. The relative motion between these two physical systems is irrelevant to the elapsed time in both systems.

The time of a moving clock to an observer at rest is identical to its time to an observer in motion. The time of a clock is independent of the relative motion between the clock and the observer.

For more than a century, the speed of light has been a mystery to physicists. Some of them, such as Voigt and Lorentz, proposed several time transformations to explain the constant speed of light. This paper presents a rigorous proof that all these transformations are invalid for physics. Although mathematically consistent, Lorentz Transformation describes the reality and time incorrectly.

For one-dimensional motion, time elapses in exactly the same rate in all physical systems.

[1] Voigt, W. (1888), "Theorie des Lichts fr bewegte Medien", Annalen der Physik, 35: 370396, 524551

[2] Larmor, J.: Aether and Matter. Cambridge University Press, Cambridge (1900), 174.

[3] Lorentz, H. A.: De relatieve beweging van de aarde en den aether. Zittingsverlag Akad. v. Wet. 1, 74 (1892), English trans. The relative motion of the earth and the aether. In: Zeeman, P., Fokker, A. D. (eds.) Collected Papers. Nijho, The Hague (1937)

[4] Poincar, Henri (1904), "The Principles of Mathematical Physics", The Foundations of Science (The Value of Science), New York: Science Press, pp. 297320

[5] H. A. L. Lorentz (1899) Simplified Theory of Electrical and Optical Phenomena in Moving Systems, Koninklijke Akademie van Wetenschappen te Amsterdam, Section of Sciences, Proceedings 1, 427442.

[6] B. J. Hunt (1988), The Origins of the FitzGerald Contraction, British Journal for the History of Science 21, 6176.

[7] H. R. Brown (2001), The origin of length contraction: 1. The FitzGeraldLorentz deformation hypothesis, American Journal of Physics 69, 1044 1054. E-prints: gr-qc/0104032; PITT-PHIL-SCI00000218.

[8] J. M. Bennett, D. T. McAllister and G. M. Cabe (1973), Albert A. Michelson, Dean of American OpticsLife, Contributions to Science, and Influence on Modern-Day

Physics, Applied Optics 12, 22532279.

[9] S. G. Brush (1967), Note on the History of the FitzGerald-Lorentz Contraction, Isis 58, 230232.

[10] Reignier, J.: The birth of special relativity - "One more essay on the subject". arXiv:physics/0008229 (2000) Relativity, the FitzGerald-Lorentz Contraction, and Quantum Theory

[11] W. F. G. Swann (1941), Relativity, the FitzGerald-Lorentz Contraction, and Quantum Theory, Reviews of Modern Physics 13, 197202.

[12] A. A. Michelson and E. W. Morley (1887), On the Relative Motion of the Earth and the Luminiferous Ether, American Journal of Science 34,