# Simultaneity and Translational Symmetry

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Two identical stopwatches moving at the same speed will elapse the same time after moving the same distance. If both stopwatches were started at the same time, there will be no time difference between these two stopwatches after both stopwatches have elapsed the same time. Both stopwatches will continue to show no time difference under identical acceleration. Therefore, both stopwatches show identical time in an accelerating reference frame if both stopwatches were restarted at the same time in a stationary reference frame. Consequently, a physical system that exhibits Translational Symmetry in its motion demonstrates that two simultaneous events in one reference frame should be simultaneous in another reference frame.

## I. INTRODUCTION

Two simultaneous events in one reference frame may be simultaneous in another reference frame in motion. Lorentz Transformation[1] claims that this is impossible. However, Translational Symmetry indicates that it is possible and should exist in reality.

In this paper, Translational Symmetry will be the primary tool in a rigorous examination on time in a moving reference frame.

## II. PROOF

Consider one-dimensional motion.

### A. Identical 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.

According to Translational Symmetry, the elapsed time is independent of the starting location of the stopwatch.

Let a stopwatch $W_1$ be adjacent to another identical stopwatch $W_2$. Let both $W_1$ and $W_2$ move at the same speed. Both will elapse the same time after moving the same distance.

### B. Acceleration

Let both $W_1$ and $W_2$ be stationary and restart both $W_1$ and $W_2$ at the same time.

Put both $W_1$ and $W_2$ under identical acceleration at the same time.

After moving an identical distance, both $W_1$ and $W_2$ will elapse the same time. The elapsed time is independent of the starting location of the stopwatch according to Translational Symmetry.

***Proof 1.*****Therefore, there is no time difference between $W_1$ and $W_2$ during acceleration. Both $W_1$ and $W_2$ show identical time at any distance travelled and at any speed.**

### C. Reference Frame

Consider two reference frames moving relative to each other. Let both $W_1$ and $W_2$ be stationary in one reference frame $F_1$. Let the observer be stationary in the other reference frame $F_2$.

Let $F_1$ be stationary relative to $F_2$. Place $W_1$ next to $W_2$ and restart both $W_1$ and $W_2$ at the same time The time of $W_1$ is identical to the time of $W_2$ in both $F_1$ and $F_2$.

Put $F_1$ under acceleration relative to $F_2$.

As stated in *Proof 1*, there is no time difference between $W_1$ and $W_2$ in $F_2$. The time of $W_1$ is always identical to the time of $W_2$ in $F_2$.

***Proof 2.*****Therefore, the time of $W_1$ is identical to the time of $W_2$ in both $F_1$ and $F_2$. This property of simultaneity is independent of the relative motion between $F_1$ and $F_2$.**

## III. CONCLUSION

Two identical stopwatches, if restarted at the same time, always show the same time regardless of their motion and seperation. This is a direct property of Translational Symmetry.

Two simultaneous events in one reference frame are simultaneous in another reference frame if the relative motion between two reference frames is linear.

For more than a century, Lorentz Transformation has claimed that simultaneous events in one reference frame can not be simultaneous in another reference frame if there is relative motion between two reference frames. This paper presents a rigorous proof that such claim is false.

Lorentz Transformation is invalid for physics[2][3] but valid in mathematics.

[1] 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
[2] Eric Su: Reflection Symmetry and Time. viXra: Relativity and Cosmology/1704.0187 (2017), http://vixra.org/pdf/1704.0187v1.pdf
[3] Eric Su: Translational Symmetry and FitzGerald-Lorentz Contraction. viXra: Relativity and Cosmology/1703.0169 (2017), http://vixra.org/pdf/1703.0169v2.pdf