# Velocity Transformation in Reference Frame

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A moving object in one inertial reference frame always moves at a different speed in another inertial reference frame. To determine this different speed, a temporary acceleration is applied to a duplicate of the first inertial reference frame in order to match the second inertial reference frame. The velocity transformation between two inertial reference frames is precisely derived based on the applied acceleration. The result shows that velocity transformation depends solely on the relative motion between inertial reference frames. Velocity transformation is independent of the speed of light.

## I. INTRODUCTION

A moving object in one inertial reference frame will move at a new speed in another inertial reference frame. The new speed clearly depends on the relative motion between two inertial reference frames. It is not clear what other factors also account for this new speed. Lorentz Transformation[1][2] claims that the new speed also depends on the speed of light.

In this paper, the acceleration is used to transform one inertial reference frame to another inertial reference frame. The velocity transformation that relates the speeds of the same object in both inertial reference frames will be precisely derived.

## II. PROOF

Consider one-dimensional motion

### A. Relative Motion

Let an inertial reference frame $F_2$ move at a speed of V relative to another inertial reference frame $F_1$. Let a clock $W_1$ be stationary in $F_1$. Let a clock $W_2$ be stationary in $F_2$.

The speed of $W_1$ in $F_1$ is 0

The speed of $W_2$ in $F_2$ is 0

These two clocks, $W_1$ and $W_2$, are in relative motion to each other in $F_1$.

The speed of $W_1$ in $F_1$ is 0

The speed of $W_2$ in $F_1$ is V

Let a reference frame $F_3$ be stationary relative to $F_1$. Therefore,

The speed of $W_1$ in $F_3$ is 0

The speed of $W_2$ in $F_3$ is V

### B. Acceleration

Put $F_3$ under a constant acceleration A relative to $F_1$ for a duration T. For the relative motion between $F_1$ and $F_3$, this is equivalent to putting $F_1$ under a constant acceleration -A relative to $F_3$ for a duration T.

By the definition of acceleration, this temporary acceleration produces a difference in the relative speed between $F_1$ and $F_3$ and accelerates all clocks in $F_1$ by -A*T in $F_3$.

The speed of $F_1$ relative to $F_3$ is $V_{13}$

$$V_{13} = -A * T \tag{1}$$

The speed of $W_1$ in $F_3$ is $0 + V_{13}$

The speed of $W_2$ in $F_3$ is $V + V_{13}$

The speed of $W_1$ in $F_1$ is 0

The speed of $W_2$ in $F_1$ is V

**Therefore, a moving clock in $F_1$ will move in $F_3$ at a speed equal to the sum of its speed in $F_1$ and the relative speed between $F_1$ and $F_3$. This is the velocity transformation from $F_1$ to $F_3$.**

If v is the speed of a clock in $F_1$ and v' is the speed of this clock in $F_3$ then the velocity transformation between $F_1$ and $F_3$ follows this equation

$$v' = v + V_{13} \tag{2}$$

## III. CONCLUSION

The velocity transformation between two inertial reference frames exclusively depends on the relative speed between two inertial reference frames. It is independent of the speed of light.

For more than a century, there have been speculation that the speed of light is a factor in velocity transformation. This is is clearly incorrect as in the proof of this paper.

Therefore, any proposed velocity transformation that incorporates the speed of light is invalid in physics. One particular example is Lorentz Transformation[1][2] which is based on the assumption that the speed of light is independent of inertial reference frame.

As a result of its incorrect assumption[3], Lorentz Transformation violates Translation Symmetry[4] in physics. Translation Symmetry requires conservation of simultaneity[5], conservation of distance[6], and conservation of time[7]. All three conservations are broken by

Lorentz Transformation. Therefore, Lorentz Transformation is not a proper transformation in physics.

Consequently, any theory based on Lorentz Transformation is incorrect in physics. For example, Special Relativity[4][8]


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