Universal Specificity Investigation 2: Inducing The Cause of Kinetic Time Dilation

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The results from the previous investigation into the mass model assumed by $E = mc^2$ lead to updating the mass model from $m_0 = \gamma^{-1}m$ being invariant to $m = \gamma^2 m_0$ being invariant, updating the kinetic energy model from $\Delta K = (\gamma - 1)m_0c^2$ to $\Delta K = \frac{1}{2}mv^2$, and updaing the total energy model from $E_T = mc^2$ to $E_T = \frac{1}{2}mc^2$. I now turn to how these changes relate to kinetic time dilation to induce its cause.

The form of kinetic time dilation I wish to use in this paper is as follows:

$$\frac{dt}{dt'} = \sqrt{1 - \frac{v^2}{c^2}} \tag{1}$$

In this form, dt represents the time rate of change for an object traveling in an inertial frame, as measured by some clock in that frame; dt' represents the time rate of change for a stationary object, as measured by an identical clock in its inertial frame; v is the velocity of the traveling object relative to the stationary object; and c is the speed of light. I chose this form because I am focused on inducing what causes this differential to a change.

In my investigation for this cause I have identified two plausible causes posited by others, and one abdication for any need for a cause. The abdication amounts to relying on the Lorentz Transform to predict any time dilation related measurements one can possibly verify, and indeed, this transform does just that. It describes *what* one can expect to observe with regard to time differential effects with exactitude. I aim to go further and discover *why* we observe it.

In addition to the two posited causes, I added two of my own—work done and specific work done—and the compiled list is as follows:

- Relative Velocity
- Acceleration
- Work Done
- Specific Work Done

Just to give a brief description of each: relative velocity is based on the realization that changes in time differentials only occur between two frames when there is a relative velocity between them; acceleration is based on an attempt to resolve the twin paradox by concluding it must be during accelerating where the traveling twin's aging slows down; work done is one of my contributions, and it is based on the realization that velocity, acceleration, and a need for Lorentz Transformation are all caused by work done to an object; specific work done is like my other contribution, but requires work to scale by the mass of an object.

Ruling out Relative Velocity

It might seem reasonable to think velocity is the cause of changes in time differentials between two frames because it is the only variable in Equation (1).

As an extreme counter example, consider what happens when the twin paradox is modified such that both twins travel with the same speed profile, but in the opposite direction. These siblings can have any possible relative velocity with respect to each other; however, neither one ages more than the other, as shown in Figure 1.

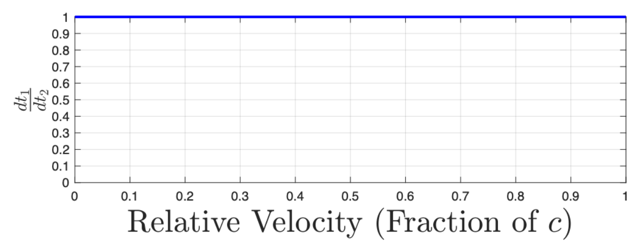

Figure 1. **Velocity changes, but time differential remains unchanged.%%FIX Y-AXIS Label**

Invoking the method of agreement, where the effect remained invariant when the plausible causal factor changed, proves inductively that relative velocity is necessary, but insufficient to cause a change in the time differential between two inertial frames.

Ruling out acceleration

In the twin paradox, one twin accelerated and the other did not, and the accelerated twin ages less—it seems to be the difference that makes the difference. This approach, therefore, concludes that the time differential during acceleration is less than unity, and this is the cause of the differences in aging. Einstein even attempted a twin paradox resolution assuming that gravitational time differential was responsible for the kinetic time differential during acceleration; however, this plausible factor has been disproved in many sources [1][2][3][4].

Ruling out Work and Inducing Specific Work

For the remaining plausible causal factors, the time differential remains constant until work (or specific work) is done, which implies time differentials have an "inertia." This conception of the time differential remaining constant for an inertial frame is termed *inertial time differential* (ITD).

That being said, let's put the remaining two factors to the test. Two simple thought experiments tells us that a change in specific work is the precise cause.

Proof:

First, I evaluate the effects of force applied over some distance.

Case 1: Consider a planet that barley accelerates to some final velocity when some work is done to it versus the same work done to a tiny marble, which causes that marble to zoom to a much higher velocity. Using the Lorentz Transformation reveals that the marble experiences a slower clock than the planet; therefore, invoking the method of difference, where each object experienced a different effect than the other, while having the same work done, proves inductively that work cannot be the cause of changes in ITD.

Now, I evaluate effects of specific work.

Case 2: Consider the same two objects as before, but now they have the same specific work applied to them. Using the Lorentz Transformation reveals the same time differential between the two; therefore, invoking the method of agreement, where each object experienced the same effect, while having the same specific work applied, proves inductively that specific work applied causes the change in ITD ■.

It has been inductively proven that an object undergoing a non-zero net force applied over some distance causes its ITD to change (inversely proportional to its mass). Knowing this, I can now derive a precise math model for changes in kinetic ITD in terms of the precise causal factor.

Deriving The Causal Math Model

From my previous investigation I was able to establish that the relative mass model is as shown in Equation (2), and that the total energy model is as shown in Equation (3).

$$m = \frac{m_0}{1 - \frac{v^2}{c^2}} = invariant \tag{2}$$

$$\frac{1}{2}mc^2 = \frac{1}{2}m_0c^2 + \frac{1}{2}mv^2 \tag{3}$$

From these models, the time differential between an initial inertial frame and a change in that inertial frame can be related to specific work required to make this transition, as shown in Equation (4d).

$$\frac{1}{2}mc^2 = \frac{1}{2}m_0c^2 + \frac{1}{2}mv^2 \tag{4a}$$

$$\frac{m_0}{m} = 1 - \frac{\frac{1}{2}mv^2}{\frac{1}{2}mc^2} = 1 - \frac{\Delta K}{E_T} \tag{4b}$$

$$\frac{dt^2}{dt'^2} \Longleftarrow 1 - \frac{v^2}{c^2} = 1 - \frac{\Delta e_K}{e_T} \tag{4c}$$

$$\therefore \frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_K}{e_T}} = \sqrt{1 - \frac{w}{e_T}} \blacksquare \tag{4d}$$

Equation (4d) relates ITD changes with the induced causal factor, specific work done. It also relates it to its equivalent, change in specific kinetic energy. I use work done and change in kinetic energy interchangeably as representing reciprocals of the same causal phenomenon—a non-zero net force causes a change in kinetic energy, and changing the kinetic energy (e.g., a rocket engine sending hot gas away very fast) creates a force.

References

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