Inducing the Cause of Total Time Dilation and Total Energy's Relation to Potential Energy

Daniel Harris
Northrop Grumman
Huntsville, USA
daniel.harris2@ngc.com

The results from previous investigations have lead to the following causal relationship: changes in inertial time differentials (IDTs) are related to work done, either changes in specific kinetic or specific potential energy. These relationships are summarized in Equation (1).

$$\frac{dt}{dt'} = \sqrt{1 - \frac{w}{e_T}} \tag{1a}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_K}{e_T}} \tag{1b}$$

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_P}{e_T}} \tag{1c}$$

Additionally, previous investigations revealed an update to the relativistic mass, kinetic energy and total energy models, as summarized in Equation (2).

$$m = \frac{m_0}{1 - \frac{v^2}{c^2}} = \text{Invariant} \tag{2a}$$

$$\Delta K = \frac{1}{2} m v^2 \tag{2b}$$

$$E = \frac{1}{2} m c^2 = \frac{1}{2} m_0 c^2 + \frac{1}{2} m v^2 \tag{2c}$$

I now relate changes in IDTs to changes in total specific energy, and then I will update the total energy model to include potential energy.

Changes in specific kinetic or potential energy are related to changes in ITDs, but this is only half of the picture because we tacitly assumed all else remained equal. Now we test what if all else does not remain equal to discover a more precise cause to changes in ITDs.

In reviewing Equation (1), simple analysis reveals that transferring some amount of specific kinetic energy to some amount of specific potential energy (or vice versa) would not cause an overall change in the ITD. As proof, consider an object that has some amount of specific potential energy, who then transfers to a state with equal specific kinetic energy, but without potential. Equation (3) proves that the two IDTs in each state are equivalent.

$$\text{Proof :}$$
$$\text{Let } \mathrm{e_P} > 0.$$

$$\text{Let } \frac{1}{\gamma} = \frac{dt}{dt'} \tag{3a}$$

$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta e_P}{e_T} \tag{3b}$$

$$1 - \frac{1}{\gamma_P^2} = \frac{\Delta e_P}{e_T} \tag{3c}$$

$$\left(1 - \frac{1}{\gamma_P^2}\right) e_T = \Delta e_P = \Delta e_K \tag{3d}$$

$$\left(1 - \frac{1}{\gamma_P^2}\right) e_T = \Delta e_K \tag{3e}$$

$$1 - \frac{1}{\gamma_P^2} = \frac{\Delta e_K}{e_T} \tag{3f}$$

$$\frac{1}{\gamma_P^2} = 1 - \frac{\Delta e_K}{e_T} \tag{3g}$$

$$\frac{1}{\gamma_P^2} = \frac{1}{\gamma_K^2} \ \blacksquare \tag{3h}$$

Invoking the method of agreement: observing that changes in specific potential energy and changes in specific kinetic energy induced no changes in ITD, proves inductively that they are not the fundamental causes to changes in ITDs—they each play half a role.

The same change in total specific energy caused the same change in ITDs proves inductively, via method of agreement, that changes in ITD are caused by a change in total specific energy, and vice versa.

Next, I derive the change in total specific energy's relationship to change in ITD. This derivation begins by trying to solve the effective IDT for an object stationary within a gravitational field, and determining how a change in kinetic energy, as measured from the stationary position within the gravitational field, affects the IDT. This situation is shown in Figure 1.

The desire is to measure total effective IDT. The IDT from the initial inertial frame to the stationary point inside a gravitational potential can be measured. Additionally, the IDT between this stationary frame and the moving frame within the gravity potential can be measured. These two ITDs are relatable to the total effective IDT using the chain rule, as shown in Equation (4).

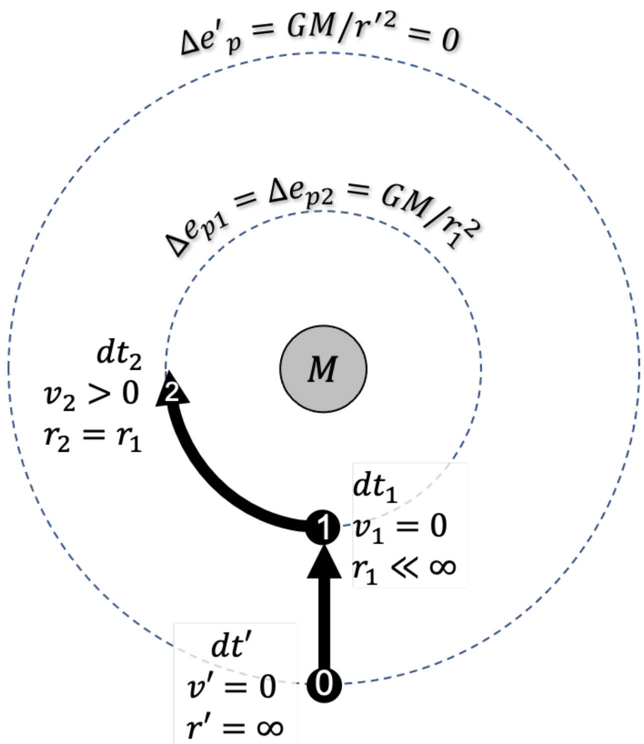

Figure 1. **Total time differential effects example.**

$$\frac{dt_1}{dt'} = \sqrt{1 - \frac{\Delta e_{P1}}{e_T}} \tag{4a}$$

$$\frac{dt_2}{dt_1} = \sqrt{1 - \frac{\Delta e_{K2}}{e_T}} \tag{4b}$$

$$\frac{dt_2}{dt'} = \frac{dt_1}{dt'}\frac{dt_2}{dt_1} = \sqrt{1 - \frac{\Delta e_{P1}}{e_T}}\sqrt{1 - \frac{\Delta e_{K2}}{e_T}} \tag{4c}$$

This can be generalized to any condition where an object inside a gravity potential gains some kinetic energy as measured inside that potential, as shown in Equation (5).

$$\text{Let}: \frac{1}{\gamma_P} = \frac{dt_P}{dt'} = \sqrt{1 - \frac{\Delta e_P}{e_T}} \tag{5a}$$

$$\text{Let}: \frac{1}{\gamma_K} = \frac{dt_K}{dt_P} = \sqrt{1 - \frac{\Delta e_{K/P}}{e_T}} \tag{5b}$$

$$\frac{1}{\gamma_T} = \frac{1}{\gamma_P}\frac{1}{\gamma_K} = \sqrt{1 - \frac{\Delta e_P}{e_T}}\sqrt{1 - \frac{\Delta e_{K/P}}{e_T}} \tag{5c}$$

$$\frac{1}{\gamma_T} = \sqrt{1 - \frac{\Delta e_P + (1 - \frac{\Delta e_P}{e_T})\Delta e_{K/P}}{e_T}} \tag{5d}$$

$$\frac{1}{\gamma_T} = \sqrt{1 - \frac{\Delta e_P + \frac{1}{\gamma_P^2}\Delta e_{K/P}}{e_T}} \tag{5e}$$

$$\frac{1}{\gamma_T} = \sqrt{1 - \frac{\Delta e_P + \Delta e_K}{e_T}} = \sqrt{1 - \frac{\Delta e_T}{e_T}} \blacksquare \tag{5f}$$

Lastly, I can now use these tools to update the total energy model in Equation (2) to include an external potential energy term, along with the other terms—internal potential energy and a kinetic energy—as shown in Equation (6).

$$\frac{1}{\gamma_T} = \sqrt{1 - \frac{\Delta e_T}{e_T}} \tag{6a}$$

$$\frac{1}{\gamma_T^2} = 1 - \frac{\Delta e_T}{e_T} \tag{6b}$$

$$e_T = \frac{1}{\gamma_T^2} e_T - \Delta e_T \tag{6c}$$

$$E_T = \frac{1}{\gamma_T^2} E_T + \Delta E_T \tag{6d}$$

$$\frac{1}{2}mc^2 = \frac{1}{\gamma_T^2}\frac{1}{2}mc^2 + \Delta E_P + \Delta E_K \tag{6e}$$

$$\frac{1}{2}mc^2 = \frac{1}{2}m_0c^2 + \Delta E_P + \frac{1}{2}mv^2 \blacksquare \tag{6f}$$