Universal Specificity Investigation 3: The Effect of a Time Dilation Gradient

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The results from previous investigations have lead to updating the total energy model from $E_T = mc^2$ to $E_T = \frac{1}{2}mc^2$, updating the kinetic energy model from $\Delta K = (\gamma - 1)m_0c^2$ to $\Delta K = \frac{1}{2}mv^2$, and inducing their causal relationship to time dilation. Equation (1) shows this newly induced causal model, where dt is 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; Δe_K is the traveling object's change in specific kinetic energy relative to the stationary frame; and e_T is the traveling object's total specific energy, $\frac{1}{2}c^2$. The ratio of time derivatives is termed *inertial time differential* (ITD), which remains constant for any object until work is done to it.

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta K}{E_T}} = \sqrt{1 - \frac{\Delta e_K}{e_T}} = \sqrt{1 - \frac{w}{e_T}} \;\blacksquare \tag{1}$$

I can now take these concepts and turn to the question: what happens to a body that exists within a time dilation gradient, or what is termed here a *time derivative gradient* (TDG)? Observation reveals that a TDG exists around physical objects, and is defined by Equation (2).

$$\nabla dt \triangleq \frac{dt' - dt}{dr'} \tag{2}$$

Where :

∇dt is the time derivative gradient

dt' is the time derivative of an object further away from the gravitational source

dt is the time derivative of an object closer to the gravitational source

dr' is distance between time derivatives

An example instrument that can measure a single TDG dimension is shown in Figure 1.

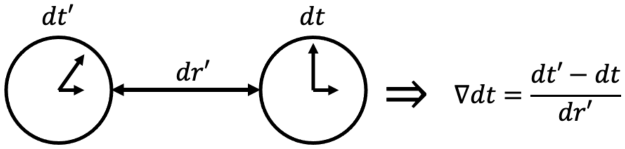

Figure 1. **Single dimension TDG measuring instrument.**

Armed with the cause of ITDs, the existence of TDGs implies that the equivalency principle is falsifiable. As in, free falling is not equivalent to floating in empty space, and sitting on earth is not equivalent to accelerating in empty space.

The difference is that TDGs do not exist in empty space and they do around earth. This breach of equivalence is well known, yet this principle is accepted as *approximately* true. For example, within a TDG $dt - dt'$ is almost zero for really small distances, just like they are zero in empty space; however, what this approach does not take into account is that TDGs are also scaled by inverse dr', meaning TDGs converge to a non-zero value as the limit of dr' approaches zero. Therefore, I am rejecting the equivalence principle since non-zero TDGs have significant consequences, as will be demonstrated shortly.

Since the equivalency principle is being rejected, a new accounting of gravity is required apart from general relativity. Given the ITD causal model shown in Equation (1) and the definition of TDGs in Equation (2), I now deduce the TDG's causal relationship to specific force, $g(r)$, where r is the distance from the gravitational source's center of mass:

$$\nabla dt = \frac{dt' - dt}{dr'} = \frac{dt' - dt'\sqrt{1 - \frac{w}{e_T}}}{dr'} \tag{3a}$$

$$\sqrt{1 - \frac{w}{e_T}} = 1 - \nabla dt \frac{dr'}{dt'} \tag{3b}$$

$$w = e_T \left(1 - \left(1 - \nabla dt \frac{dr'}{dt'}\right)^2\right) \tag{3c}$$

$$\text{Let} : \nabla\tau^2 = \frac{1}{dr'} \left(1 - \left(1 - \nabla dt \frac{dr'}{dt'}\right)^2\right) \tag{3d}$$

$$\nabla\tau^2 = \frac{1}{dr'} \left(1 - \left(\frac{dt}{dt'}\right)^2\right) \tag{3e}$$

$$\nabla\tau^2 = \frac{1}{dr'} \left(1 - \frac{1}{\gamma^2}\right) = \frac{\tau^2}{dr'} \tag{3f}$$

$$w = \int_{r'}^{r'-dr'} g(r)dr = e_T \nabla\tau^2 dr' \tag{3g}$$

$$\frac{\int_{r'}^{r'-dr'} g(r)dr}{\int_{r'}^{r'-dr'} dr} = \bar{g} = \frac{e_T \nabla\tau^2 dr'}{\int_{r'}^{r'-dr'} dr} = -e_T \nabla\tau^2 \tag{3h}$$

$$\lim_{dr' \to 0} \frac{\int_{r'}^{r'-dr'} g(r)dr}{\int_{r'}^{r'-dr'} dr} = g(r') = \lim_{dr' \to 0} -e_T \nabla\tau^2 \;\blacksquare \tag{3i}$$

Note, as dr' approaches zero, the value, $-e_T\nabla\tau^2$, approaches $g(r')$, which is the reason why the equivalence principle is untenable, even as "approximately true." Also, note that $g(r)$ is measuring unit specific force (e.g., Newton per kilogram).[2]

A non-zero TDG induces a specific force we call gravity—a force proportional to mass. This is also why everything falls at the same rate, because the gravitational force scales with mass—as in, the TDG affects every particle to the same degree. All of this is why gravity is indeed a real (specific) force.

A new understanding emerges from the derivation shown in Equation (3): the relationship between changes in specific energy and changes in ITDs are part of the same reciprocal causal phenomenon—changes in one causes changes in the other. Given that a TDG induces a change in energy (proportional to mass), an object existing within this gradient is said to have specific potential energy. It has the potential to achieve some specific kinetic energy state caused by this gradient.

Now, I present how to measure a change in the ITD between two objects at two different radial distances from a gravitational source. These changes must be consistent with Equation (1), meaning it is caused by a change in their specific potential energy between the two states. Essentially, however much specific work is done by the gravitational field when moving from the outer point to the inner point is causally related to the change in ITD.

For example, the IDT for an object at the center of mass of a hollow gravitational source relative to another object some distance away is equal the IDT created by the specific work done when traversing from the outer point to the inner point, as shown in Figure 2.

As another example, the IDT for an object at some altitude, r_a, away from a gravitational source, relative to another object infinitely far away is equal the IDT created by the specific work done when traversing from the outer point to the inner point, and is given by Equation (4):

$$\frac{dt}{dt'} = \sqrt{1 - \frac{\int_{\infty}^{r_a} \frac{-GM}{r^2} dr}{e_T}} = \sqrt{1 - \frac{GM/r_a}{e_T}} \tag{4}$$

Adjusting Equation (4) to be in its more general form, in terms of specific work done or change in specific potential energy, Δe_P, gives us Equation (5), which concludes my current investigation.

$$\frac{dt}{dt'} = \sqrt{1 - \frac{w}{e_T}} = \sqrt{1 - \frac{\int_{r'}^{r'-dr'} g(r)dr}{e_T}} = \sqrt{1 - \frac{\Delta e_P}{e_T}} \tag{5}$$

Appendix

Two examples are provided to show how the TDG relates to gravitational acceleration. The first example involves the earth's TDG and its respective gravitational acceleration at its surface; and the second example involves the Sun's TDG and its respective gravitational acceleration at a distance of one astronomical unit.

Before getting into these examples, let $g(r) = -GM/r^2$ so we can solve for $\bar{g}$ in relation to $-e_T \nabla \tau$.

$$\frac{\int_{r'}^{r'-dr'} g(r)dr}{\int_{r'}^{r'-dr'} dr} = \bar{g} = -e_T \nabla \tau^2 \tag{6a}$$

$$\frac{\int_{r'}^{r'-dr'} \frac{-GM}{r^2} dr}{(r'-dr') - r'} = \bar{g} = -e_T \nabla \tau^2 \tag{6b}$$

$$GM \frac{\int_{r'}^{r'-dr'} \frac{-1}{r^2} dr}{(r'-dr') - r'} = \bar{g} = -e_T \nabla \tau^2 \tag{6c}$$

$$GM \frac{\frac{1}{r'-dr'} - \frac{1}{r'}}{(r'-dr') - r'} = \bar{g} = -e_T \nabla \tau^2 \tag{6d}$$

$$GM \frac{\frac{-((r'-dr')-r')}{r'(r'-dr')}}{(r'-dr') - r'} = \bar{g} = -e_T \nabla \tau^2 \tag{6e}$$

$$-\frac{GM}{r'(r'-dr')} = \bar{g} = -e_T \nabla \tau^2 \tag{6f}$$

$$-\sqrt{g(r')g(r'-dr')} = \bar{g} = -e_T \nabla \tau^2 \blacksquare \tag{6g}$$

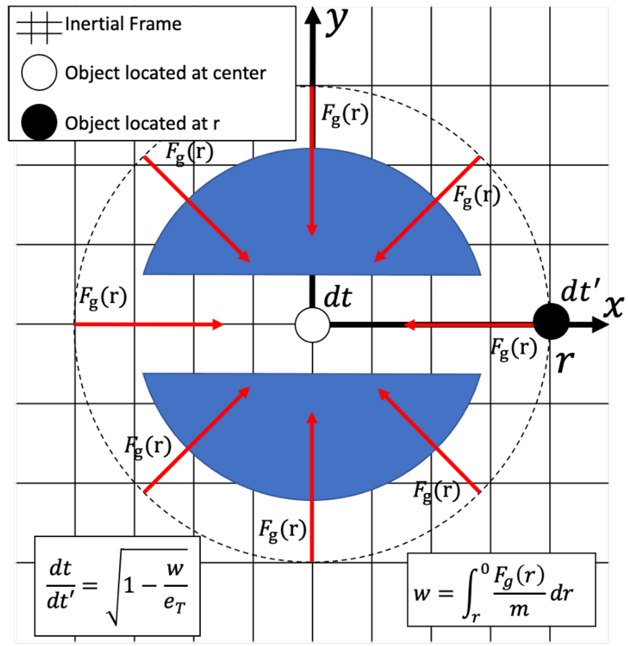

Figure 2. Example of specific work done by TDG.

[2]Concrete examples using Equation (3) for single dimension cases are given in the Appendix.

The Earth's TDG Example

In this example, I form a TDG estimate between a location, $r' - dr'$, on the earth's surface and another location, r', where $dr' = 1000$ meters. The resulting ITD is shown in Equation (7):

$$\text{Let}: r' - dr' = 6371000\ [m]$$
$$\text{Let}: G = 6.6744 \times 10^{-11}\ [m^3 kg^{-1} s^{-1}]$$
$$\text{Let}: M_{Earth} = 5.97219 \times 10^{24}\ [kg]$$
$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_P}{e_{\max}}} = \sqrt{1 - \frac{\int_{r'}^{r'-dr'} \frac{-GM_{Earth}}{r^2} dr}{e_{\max}}} \quad (7a)$$
$$\frac{dt}{dt'} = \sqrt{1 - \frac{9.81 \times 10^3}{e_{\max}}} = 1 - 1.0925 \times 10^{-13} \quad (7b)$$

The resulting TDG is given in Equation (8).

$$\text{Let}: \mathrm{dt}' = 1 \implies dt = 1 - 1.0925 \times 10^{-13}$$
$$\nabla dt \triangleq \frac{dt' - dt}{dr'} \quad (8a)$$
$$\nabla dt \triangleq \frac{1.0925 \times 10^{-13}}{1000} = 1.0925 \times 10^{-16} \quad (8b)$$

Using Equation (6), the resulting acceleration is show in Equation (9):

$$\bar{g} = -\frac{e_T}{dr'} \left(1 - \left(1 - \nabla dt \frac{dr'}{dt'}\right)^2\right) \quad (9a)$$
$$\bar{g} = -9.8185[{}^{m}/_{s}] \quad (9b)$$

Comparing results from Equation (9) to the result of using the geometric mean of known gravitational acceleration values, is shown in Equation (10). The results show that errors are within limits of precision of the machine used to do the calculation (percent error is 0.0036% or 36 in million):

$$\bar{g} = -9.8185 \quad (10a)$$
$$-\sqrt{g(r' - dr')g(r')} = -9.8185 \quad (10b)$$
$$-\sqrt{(9.8204)(9.8174)} \approx -9.8185 \quad (10c)$$
$$-9.8189 \approx -9.8185 \ \blacksquare \quad (10d)$$

The Sun's TDG Example

What about when the distances are really far apart when measuring the TDG? In this example, I use the sun's TDG estimated between a location, $r' - dr'$, whose distance is earth's mean orbital radius, and another location, r', where dr' is a half light second. The resulting ITD is shown in Equation (11):

$$\text{Let}: r' - dr' = 1.5203 \times 10^{11}\ [m]$$
$$\text{Let}: G = 6.6744 \times 10^{-11}\ [m^3 kg^{-1} s^{-1}]$$
$$\text{Let}: M_{Sun} = 1.9887 \times 10^{30}\ [kg]$$
$$\frac{dt}{dt'} = \sqrt{1 - \frac{\Delta e_P}{e_{\max}}} = \sqrt{1 - \frac{\int_{r'}^{r'-dr'} \frac{-GM_{Sun}}{r^2} dr}{e_{\max}}} \quad (11a)$$
$$\frac{dt}{dt'} = \sqrt{1 - \frac{8.7352 \times 10^8}{e_{\max}}} = 1 - 9.7192 \times 10^{-9} \quad (11b)$$

The resulting TDG is given in Equation (12).

$$\text{Let}: \mathrm{dt}' = 1 \implies dt = 1 - 9.7192 \times 10^{-9}$$
$$\nabla dt \triangleq \frac{dt' - dt}{dr'} \quad (12a)$$
$$\nabla dt \triangleq \frac{9.7192 \times 10^{-9}}{\frac{c}{2}} = 2.1628 \times 10^{-25} \quad (12b)$$

Using Equation (6), I solve for the resulting acceleration as show in Equation (13):

$$\bar{g} = -\frac{e_T}{dr'} \left(1 - \left(1 - \nabla dt \frac{dr'}{dt'}\right)^2\right) \quad (13a)$$
$$\bar{g} = -1.9438 \times 10^{-8}[{}^{m}/_{s}] \quad (13b)$$

Comparing results from Equation (13) to the result of using the geometric mean of known gravitational acceleration values is shown in Equation (14). The results show that errors are within limits of precision of the machine used to do the calculation (percent error is 0.049% or 490 in million):

$$\bar{g} = -1.9438 \times 10^{-8} \quad (14a)$$
$$-\sqrt{g(r' - dr')g(r')} = -1.9438 \times 10^{-8} \quad (14b)$$
$$-\sqrt{(0.0057)(6.573 \times 10^{-14})} \approx -1.9438 \times 10^{-8} \quad (14c)$$
$$-1.9429 \times 10^{-8} \approx -1.9438 \times 10^{-8} \ \blacksquare \quad (14d)$$

TDG Examples Takeaway

The key takeaway with these two examples, with both near and far estimates of TDG, is that the causal model relating the TDG to a specific force matches observation.