Universal Specificity Investigation 5: The Effect of a Time Dilation Gradient

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Prior investigations into the theory of universal specificity found a proper conception of time missed in common practice; which led to the realization that a universally stationary (USF) frame must exist; which led to discovering the cause of kinetic time dilation, shown in Equation (1); which finally led to deriving a relativistic specific kinetic energy and total specific energy model—where the total specific is $e_T = \frac{1}{2}c^2$, and the specific kinetic energy model is $\Delta e_K = \frac{1}{2}v^2$.

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

dt' is the time rate of change measured by a clock traveling with an object in an inertial frame; dt represents the time rate of change measured by an identical clock in the USF; Δe_K is the traveling object's change in specific kinetic energy in the USF; 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 specific work, w, is done.

1. Time Dilation Gradient

I can now take these concepts and turn to the question: what happens to an object 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).

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

Where :

∇dt is the time derivative gradient

dt is the time derivative of a stationary point further away from the gravitational source

dt' is the time derivative of a stationary point closer to the gravitational source

Δr is distance between time derivatives

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

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.

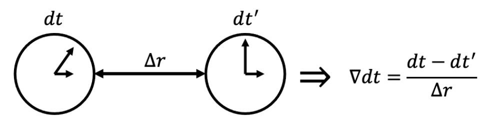

Figure 1. **Single dimension TDG measuring instrument.**

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 infinitesimally small spaces [1]. For example, around earth $dt' - dt$ approaches 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 Δr, meaning TDGs can (and do) converge to a non-zero value as $\lim_{\Delta r \to 0}$. 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:

$$\nabla dt = \frac{dt - dt'}{\Delta r} = \frac{dt - dt\sqrt{1 - \frac{w}{e_T}}}{\Delta r}$$

$$\sqrt{1 - \frac{w}{e_T}} = 1 - \nabla dt \frac{\Delta r}{dt}$$

$$w = e_T \left(1 - \left(1 - \nabla dt \frac{\Delta r}{dt}\right)^2\right)$$

$$\text{Let} : \nabla \tau^2 = \frac{\left(1 - \left(1 - \nabla dt \frac{\Delta r}{dt}\right)^2\right)}{\Delta r}$$

$$\nabla \tau^2 = \frac{\left(1 - \left(\frac{dt'}{dt}\right)^2\right)}{\Delta r} = \frac{\tau^2}{\Delta r}$$

$$w = \int_r^{r - \Delta r} g(r) dr = e_T \nabla \tau^2 \Delta r$$

$$\frac{\int_r^{r-\Delta r} g(r) dr}{\int_r^{r-\Delta r} dr} = \bar{g} = \frac{e_T \nabla \tau^2 \Delta r}{\int_r^{r-\Delta r} dr} = -e_T \nabla \tau^2$$

$$\lim_{\Delta r \to 0} \frac{\int_r^{r-\Delta r} g(r) dr}{\int_r^{r-\Delta r} dr} = g(r) = \lim_{\Delta r \to 0} -e_T \nabla \tau^2 \blacksquare \tag{3}$$

Note, as $\lim_{\Delta r \to 0}$, 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 conservative [2] 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, which is caused by the existence of a TDG.[3]

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 specific energy, 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.

2. ITD Changes within TDGs

Now, I present how to measure a change in the ITD between two objects at two different locations within a TDG. This change must be consistent with Equation (1), meaning however much specific work is done by the gravitational field between two points is causally related to the change in ITD between those points.

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

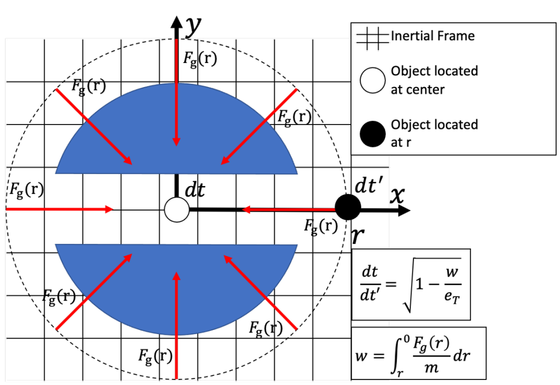

Figure 2. Example of specific work done by TDG.

As another example, the ITD for a stationary object at some altitude, r_a, away from a gravitational source, relative to another stationary object infinitely far away is equal the ITD 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 this current investigation.

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

3. Conclusion

In conclusion, it was discovered that ITDs change with changes in specific potential energy, just as ITDs change with changes in specific kinetic energy. The next investigation will look to integrate these two causes of change in ITD into the cause of total time dilation. In addition, it will integrate changes in specific potential energy into the total specific energy model, which tacitly assumed no specific work was done by gravitational specific forces.

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 $-e_T \nabla \tau$.

$$\begin{aligned}
\frac{\int_r^{r-\Delta r} g(r) dr}{\int_r^{r-\Delta r} dr} &= \bar{g} = -e_T \nabla \tau^2 \\
\frac{\int_r^{r-\Delta r} \frac{-GM}{r^2} dr}{(r-\Delta r) - r} &= \bar{g} = -e_T \nabla \tau^2 \\
GM \frac{\int_r^{r-\Delta r} \frac{-1}{r^2} dr}{(r-\Delta r) - r} &= \bar{g} = -e_T \nabla \tau^2 \\
GM \frac{\frac{1}{r-\Delta r} - \frac{1}{r}}{(r-\Delta r) - r} &= \bar{g} = -e_T \nabla \tau^2 \\
GM \frac{\frac{-((r-\Delta r)-r)}{r(r-\Delta r)}}{(r-\Delta r) - r} &= \bar{g} = -e_T \nabla \tau^2 \\
-\frac{GM}{r(r-\Delta r)} &= \bar{g} = -e_T \nabla \tau^2 \\
-\sqrt{g(r) g(r-\Delta r)} &= \bar{g} = -e_T \nabla \tau^2 \; \blacksquare
\end{aligned} \tag{6}$$

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

[3] What causes a TDG? That remains to be determined and would be a great topic to investigate in the future. Perhaps it will turn out to be neutrinos [3]. If not, then something else must cause it. Research into this question could easily be on the path towards a valid quantum theory of gravity.

The Earth's TDG Example

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

$$\begin{aligned}
&\text{Let} : r - \Delta r = 6371000\ [m] \\
&\text{Let} : G = 6.6744 \times 10^{-11}\ [m^3 kg^{-1} s^{-1}] \\
&\text{Let} : M_{Earth} = 5.97219 \times 10^{24}\ [kg] \\
&\frac{dt'}{dt} = \sqrt{1 - \frac{\Delta e_P}{e_{\max}}} = \sqrt{1 - \frac{\int_r^{r-\Delta r} \frac{-GM_{Earth}}{r^2} dr}{e_{\max}}} \\
&\frac{dt'}{dt} = \sqrt{1 - \frac{9.81 \times 10^3}{e_{\max}}} = 1 - 1.0925 \times 10^{-13}
\end{aligned} \tag{7}$$

The resulting TDG is given in Equation (8).

$$\begin{aligned}
\text{Let} : \text{dt} = 1 &\implies dt' = 1 - 1.0925 \times 10^{-13} \\
\nabla dt &\triangleq \frac{dt - dt'}{\Delta r} \\
\nabla dt &\triangleq \frac{1.0925 \times 10^{-13}}{1000} = 1.0925 \times 10^{-16}
\end{aligned} \tag{8}$$

Using Equation (6), I solve for the resulting specific force as show in Equation (9):

$$\begin{aligned}
\bar{g} &= -\frac{e_T}{\Delta r}\left(1 - \left(1 - \nabla dt \frac{\Delta r}{dt}\right)^2\right) \\
\bar{g} &= -9.8185\ [N/kg]
\end{aligned} \tag{9}$$

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 a million):

$$\begin{aligned}
\bar{g} &= -9.8185 \\
-\sqrt{g(r - \Delta r) g(r)} &= -9.8185 \\
-\sqrt{(9.8204)(9.8174)} &\approx -9.8185 \\
-9.8189 &\approx -9.8185 \blacksquare
\end{aligned} \tag{10}$$

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, $r - \Delta r$, whose distance is earth's mean orbital radius, and another location, r, where Δr is a half light second. The resulting ITD is shown in Equation (11):

$$\begin{aligned}
&\text{Let} : r - \Delta r = 1.5203 \times 10^{11}\ [m] \\
&\text{Let} : G = 6.6744 \times 10^{-11}\ [m^3 kg^{-1} s^{-1}] \\
&\text{Let} : M_{Sun} = 1.9887 \times 10^{30}\ [kg] \\
&\frac{dt'}{dt} = \sqrt{1 - \frac{\Delta e_P}{e_{\max}}} = \sqrt{1 - \frac{\int_r^{r-\Delta r} \frac{-GM_{Sun}}{r^2} dr}{e_{\max}}} \\
&\frac{dt'}{dt} = \sqrt{1 - \frac{8.7352 \times 10^8}{e_{\max}}} = 1 - 9.7192 \times 10^{-9}
\end{aligned} \tag{11}$$

The resulting TDG is given in Equation (12).

$$\begin{aligned}
\text{Let} : \text{dt} = 1 &\implies dt' = 1 - 9.7192 \times 10^{-9} \\
\nabla dt &\triangleq \frac{dt - dt'}{\Delta r} \\
\nabla dt &\triangleq \frac{9.7192 \times 10^{-9}}{\frac{c}{2}} = 2.1628 \times 10^{-25}
\end{aligned} \tag{12}$$

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

$$\begin{aligned}
\bar{g} &= -\frac{e_T}{\Delta r}\left(1 - \left(1 - \nabla dt \frac{\Delta r}{dt}\right)^2\right) \\
\bar{g} &= -1.9438 \times 10^{-8}\ [N/kg]
\end{aligned} \tag{13}$$

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 a million):

$$\begin{aligned}
\bar{g} &= -1.9438 \times 10^{-8} \\
-\sqrt{g(r - \Delta r) g(r)} &= -1.9438 \times 10^{-8} \\
-\sqrt{(0.0057)(6.573 \times 10^{-14})} &\approx -1.9438 \times 10^{-8} \\
-1.9429 \times 10^{-8} &\approx -1.9438 \times 10^{-8} \blacksquare
\end{aligned} \tag{14}$$

References

[1] E. R. HARRISON, *General Relativity*,in Cosmology: The science of the universe, 2nd ed., CAMBRIDGE UNIV PRESS, 2000.

[2] *Conservative Force* Wikipedia, 10-May-2022. [Online]. Available: https://en.wikipedia.org/wiki /Conservative_force. [Accessed: 26-Sep-2022].

[3] *Neutrinos from Ansto might break time dilation rules*, Spaceaustralia. [Online]. Available: https://spaceaustralia.com/news/neutrinos-ansto-might-break-time-dilation-rules. [Accessed: 23-Feb-2023].