Universal Specificity Investigation 5: A Time Dilation Gradient Implies an Energy Gradient

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Prior investigations into universal specificity (or specificity for short) found that time properly conceptualized is the interval over which change occurs, and is not a property of the Universe apart from physical changes to things in the Universe; which led to the proper conception of time dilation as a common change in the interval over which change occurs to things. In addition, it was found that a universally stationary frame (USF) must exist; which led to discovering the cause of kinetic time dilation, shown in Equation (1); which led to deriving a relativistic specific energy model, shown in Equation (2).

$$\frac{dt'}{dt} = \frac{c_0}{c} = \sqrt{1 - \frac{\Delta e_K}{e_T}} = \sqrt{1 - \frac{w}{e_T}} = \frac{1}{\gamma_K} \tag{1}$$

$$e_T = \frac{1}{2}c^2 = e_I + \Delta e_K = \frac{1}{2}c_0^2 + \frac{1}{2}v^2 \tag{2}$$

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 stationary in the USF; c_0 is the average effective speed of light in the objects reference frame in motion relative to the USF; c is the speed of light in the USF in a vacuum not under any gravity potential; Δe_K is the traveling object's change in specific kinetic energy in the USF; w is the specific work done to the object in the USF; e_T is the traveling object's total specific energy, $\frac{1}{2}c^2$; and e_I is the specific internal energy of an object, $\frac{1}{2}c_0^2$. The ratio of time derivatives is termed *inertial time differential* (ITD), which remains constant for any object until specific work, w, is done where specific work done is conservative in the USF.

Given this basis, we now investigate the implications of a time dilation gradient.

1. Gravitational Time Dilation

According to the Schwarzschild Metric, which is a good description of how time dilation is measured within a gravitational field for a spherical body stationary in the USF, the ITD measured within a gravitational field at zero velocity in the USF is given by Equation (3).

$$\frac{dt'}{dt} = \sqrt{1 - \frac{GM/r}{e_T}} \tag{3}$$

Where :

GM/r is the Newtonian gravitational potential

The relationship between ITDs and specific work done continue past kinetic ITDs given in Equation (1) and into gravitational ITDs shown in Equation (3). GM/r is the specific work done by the gravitational field to the object as it travels from a point infinitely far away to a distance r from the center of mass given by: $\int_\infty^r g(r)dr$. If one replaces this specific work in Equation (3), you get:

$$\begin{aligned}\frac{dt'}{dt} &= \sqrt{1 - \frac{\int_\infty^r g(r)dr}{e_T}} = \sqrt{1 - \frac{w}{e_T}} \\ &= \sqrt{1 - \frac{\Delta e_P}{e_T}} = \frac{1}{\gamma_P}\end{aligned} \tag{4}$$

Given this relationship between gravitational ITDs and specific work done, and the cause of kinetic time dilation fundamentally being the reduction of the average effective speed of light, c_0, it stands to reason that gravitational time dilation might be fundamentally caused by the same mechanism—a reduction in c_0.

The proof is relatively straight forward. Suppose you wanted to estimate the total time dilation given a velocity within a gravitational field, as shown in Figure 1.

Ultimately, we want to calculate the overall ITD, $\frac{dt'_2}{dt}$, for the moving object within the gravitational field. What we know from relativity is that $\frac{dt'_1}{dt}$ and $\frac{dt'_2}{dt'_1}$ can be measured. Both ITDs are relatable to the total effective ITD, $\frac{dt'_2}{dt}$, via the chain rule, as shown in Equation (5).

$$\frac{dt'_2}{dt} = \frac{dt'_2}{dt'_1}\frac{dt'_1}{dt} = \sqrt{1 - \frac{\Delta e_{K2|P1}}{e_T}}\sqrt{1 - \frac{\Delta e_{P1}}{e_T}} \tag{5}$$

$\Delta e_{K2|P1}$ is the proper change of specific kinetic energy, as measured in the gravitation field using miscalibrated instruments, and will be different than the absolute change in

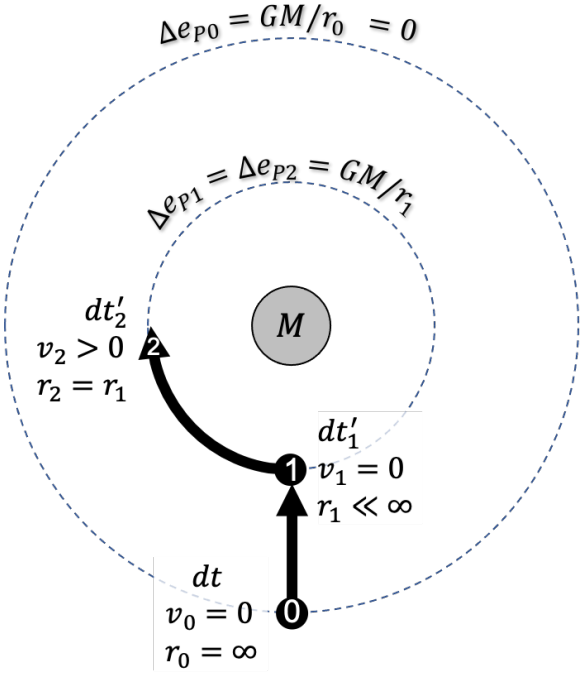

Figure 1. **Total effective time differential example.**

specific kinetic energy, $e_K 2$, as measured at a point in the USF infinitely far from any gravitational potential or with calibrated instruments. This fact becomes evident when we simplify Equation (5) in the following way:

$$\frac{1}{\gamma_T} = \sqrt{1 - \frac{\gamma_{P1}^{-2}\Delta e_{K2|P1} + \Delta e_{P2}}{e_T}} = \sqrt{1 - \frac{\Delta e_{K2} + \Delta e_{P1}}{e_T}} = \sqrt{1 - \frac{\Delta e_t}{e_T}} \tag{6}$$

The full term, $\gamma_{P1}^{-2}\Delta e_{K2|P1} + \Delta e_{P2}$, is properly interpreted as the change in total specific energy, Δe_t. The $\gamma_{P1}^{-2}\Delta e_{K2|P1}$ term is properly interpreted as the absolute change in specific kinetic energy, Δe_{K2}. Notice that $\Delta e_{K2} < \Delta e_{K2|P1}$ by a factor of γ_{P1}^{-2}, which can be generalized to the following: velocities of entities slow down within a gravitational field by a factor of γ_{P1}^{-1}, including light. QED.

Additionally, according to the Schwarzschild metric the coordinate radial speed of light, c_r', is $\gamma_P^{-2}c$, while the coordinate transverse speed of light, c_t', is $\gamma_P^{-1}c$. This is akin to the kinetic situation where the moving frame two-way average speed of light along the velocity dimension, $c_{||}'$, is $\gamma_K^{-2}c$, while the two-way average speed of light perpendicular to the velocity dimension, $c_\perp'$, is $\gamma_K^{-1}c$. The reason why the average effective speed of light, c_0, is $\gamma_K^{-1}c$ in all directions for the kinetic case is because of length contraction, where $L_{||}\gamma_K = L_\perp = L'$, since the slower traveling light along the velocity direction is perfectly offset by the reduction in its distance traveled. According the Schwarzschild metric, the same is true for the gravitational case, where $L_r\gamma_P = L_t = L'$, because the slower traveling light along the radial direction is perfectly offset by the reduction in its distance traveled; therefore, c_0 is $\gamma_P^{-1}c$ in all directions for the gravitational case.[2] QED.

This fact implies refraction governs gravitational effects and prior work in this area demonstrated "the equations of motion for [refracted] light are formally identical to those predicted by general relativity" [1]. Additionally, time dilation gradients being a gradient in the average effective speed of light, c_0, implies a specific energy gradient is the cause of gravity as is shown in the next section.

2. Time Dilation Gradient

Given that observations for gravitational ITDs match that of Equation (3), it means that a TDG exists around physical objects, and is defined by Equation (7).

$$\nabla\frac{dt'}{dt} \triangleq \frac{d\left(\frac{dt'}{dt}\right)}{dr} = \frac{\gamma_g}{2e_T}\frac{GM}{r^2} \tag{7}$$

Where :

$\nabla\frac{dt'}{dt}$ is the time dilation gradient

$\frac{dt'}{dt}$ is the ITD in the gravitational field.

We can immediately see the connection between TDG and the specific force of gravity, since $-\frac{GM}{r^2} = g(r)$; however, this relationship is only correlated, not causal. To establish the causal relationship we need a specific energy gradient (SEG), which the time dilation gradient implies. This is derived as follows:

$$\text{given : } \frac{\mathrm{dt}'}{\mathrm{dt}} = \frac{c_0}{c} \tag{8}$$

$$\text{and given : } \frac{\mathrm{e_I}}{\mathrm{e_T}} = \frac{\frac{1}{2}c_0^2}{\frac{1}{2}c^2} = \frac{c_0^2}{c^2} \tag{9}$$

$$\begin{aligned} \therefore -\nabla e_I &= -e_T\nabla\frac{e_I}{e_T} = -e_T\nabla\frac{dt'^2}{dt^2} \\ &= -e_T\frac{d\left(\frac{dt'^2}{dt^2}\right)}{dr} = -\frac{GM}{r^2}\hat{r} \\ &= \vec{g}(r)\ \blacksquare \end{aligned} \tag{10}$$

Equation (3) and Equation (10) for any generic gravitational field described by the Schwarzschild metric is shown in Figure 2, where r is in units of the Schwarzschild Radius, r_s, and $\nabla\frac{e_I}{e_T}$ is in units of $\frac{1}{r_s}$.

Given that TDGs implies SEGs, then it is easy to show that the equivalence principle is falsifiable under this new paradigm. As in, free falling is not equivalent to floating

[2]The full integration of kinetic and gravitational time dilation will have to wain until the next investigation in this series when we discuss total time dilation.

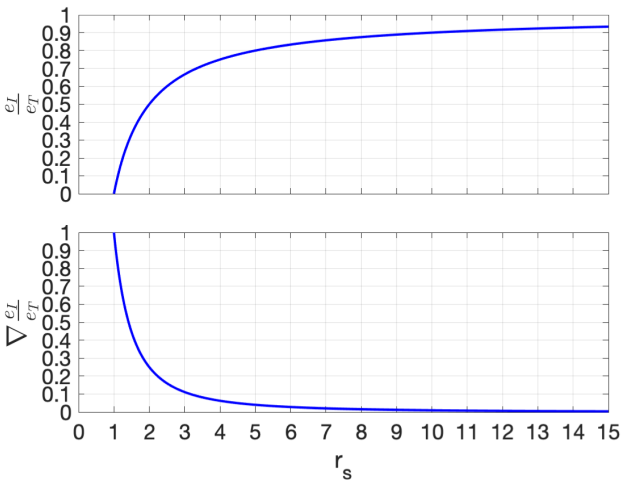

Figure 2. ITD^2 and SEG in units of r_s.

in empty space, and sitting on earth is not equivalent to accelerating in empty space.

The difference is that SEGs exist around earth, but not in empty space. The same was said about tidal force existing around earth and not in empty space, but the response to tidal forces has been that the equivalence principle is accepted as *approximately* true since for infinitesimally small points tidal forces vanish [2]. The argument has been that tidal forces approaches zero for infinitesimal points near earth, just like they are zero in empty space; however, this argument does not apply to SEGs because, as we can see in Figure 2, SEGs do converge to a non-zero value for infinitesimal points. Therefore, the equivalence principle must be rejected on the grounds that non-zero SEGs have significant consequences– they cause a specific force to be applied to objects.

Not only is the equivalence principle falsifiable, it was shown in the last section that, in terms to what happens to c_0, it is the exact opposite—free falling towards earth is akin to accelerating in empty space and sitting on earth is akin to floating in empty space. In the kinetic case, a change in the object's specific energy state causes a reduction in c_0, while in the gravitational case, the change c_0 along the radial direction causes a change in the object's energy state. They are reciprocal phenomena in this way, where a change in either c_0 or specific energy state causes a change in the other.

To summarize, TDGs around massed objects are due to the slowing of the average effective speed of light. This means for objects wihtin a TDG, the specific internal energy within them forms a gradient, where the specific internal energy of the object is lower on the end closer to the massed object, and higher on the end farther away from the massed object. This imbalance of specific internal energy within the object causes the specific force we call gravity.

3. Historical Context

I am not the first to suggest that the speed of light varies around massed objects, commonly called *spatially variable speed of light* (spatially-VSL), and that spatially-VSL is somehow tied to gravity. Einstein actually mentioned spatially-VSL in several papers leading up to deriving his general theory of relativity [3][4][5][6][7][8][9], and he continued to write about spatially-VSL even after he developed the general theory of relativity [10][11].

Dicke was the first to formalize the spatially-VSL approach in a manner that matched general relativity predictive power because he took into account length contraction implied by the Schwarzschild metric [12], which was missed earlier. After Dicke it was known how much the speed of light must vary around massed objects. For example, Shapiro predicted the time delay of a radar return off of Mercury when traveling near the sun due to the changing velocity of light [14], and his prediction was later confirmed by experiments [15].

The causal mechanism within the spatially-VSL model perfectly well explains the motion of light within a gravitational field via refraction. As far as explaining the motion of massed objects within a gravitational field, however, the causal mechanism within the spatially-VSL is completely absent. Dicke explains how the spatially-VSL correlates to the gravitational potential, and this potential describes the motion of massed objects just as well as general relativity [12], but as far as any content inducing the cause of this correlation—nothing. I have now provided that missing causal mechanism within the spatially-VSL model, which is the internal specific energy gradient within objects caused by spatially-VSL.

4. Possible Implications

Discovering that an energy gradient internal to objects causes the specific force of gravity is the next logical step after Newton's in understanding a more fundamental cause of gravity.[3] To Newton, gravity was an action at a distance, where one object affected another without physical contact (or rather contact through a distant invisible field). According to specificity, however, it is a local action caused by an object's specific internal energy gradient. This gradient is caused by the speed of light being slower on one end of the object vs the other.

While this discovery is one step closer to understanding gravity as a local phenomena, the question directing the logical next step after this one becomes: what about objects causes the permittivity and/or permeability of free space around them to change? A complete answer to this question will have to wait for a different investigation, but perhaps the path starts with further investigations into the nature of Neutrinos, where experimenters are seeing if neutrinos can affect time dilation [16].

While we lack the tools to induce a more fundamental cause of gravity than what has been presented in this investigation, it is interesting that gravity, which is thought to be a fundamental force, involves light, which is responsible for the electromagnetic force. Equally interesting, electromagnetism is a force orthogonal to light's velocity, while gravity acts parallel to its velocity; in other words, in all three dimensions of light, a different force exists—electrical, magnetic, and gravitational—one force for each dimension. It may turn out that gravity needs to be coupled with electromagnetism (EM) to form *electromagnetgravitism* (EMG).

If EMGs are a true coupling, then one really needs to consider

[3]This demonstrated causal mechanism governing gravitation is only valid in the local frame, the frame within gravitational potential not accounting for miscalibrated instruments, and this is why Newton's gravitational law came out as it did—it too was derived within the local frame. To get the proper calibration to the USF coordinate frame, see here [13].

the possibility that light is the only force carrier in existence and that the other known forces—the week and strong nuclear forces—might really be just an aspect of EMG. Meaning EMG might be the only force in existence, where the strong/week nuclear forces are simply a manifestation of the never before considered couplings of electrogravitism (EG) and magneticgravitism (MG)? That is EG would be a form of EMG with the magnitic component neutralized, and MG is a form of EMG with the electric component neutralized, just like EM is a form of EMG with the gravitational component neutralized.

Einstein had looked into a unified field theory coupling gravity with electromagnetism [17][18][19][20][21][22], but he lacked the concepts and the newly discovered causal link between gravity and electromagnetism that we now possess. The possibility of EMG being the only force in existence would be an interesting question to look into, and we are better prepared to investigate this now than ever before, but it will have to wait for a future investigation.

5. Conclusion

In conclusion, it was discovered that gravitational ITDs follow the same relationship to specific work done in the USF as does kinetic ITDs. Additionally, it was shown that the speed of light slows down within a gravitational field, and this is responsible for time dilation within a gravitational field. The existence of TDGs implies the existence of SEGs internal to objects within TDGs, which causes a specific force to be applied to those objects, which we call gravity.

The next investigation will look to integrate gravitational and kinetic ITDs fully into total ITD. In addition, the next investigation will integrate changes in specific potential energy into the total specific energy model, which tacitly assumed that no specific work was done by specific internal energy gradients.

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