

A Pilot Wave Model of the Invariant Speed of Light and Apparent Time Dilation

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Abstract

Special relativity, general relativity, and de Broglie-Bohm (pilot wave) theory are explanations of fundamental aspects of nature. For the most part, special and general relativity concern observations at large scale, whereas pilot wave theory addresses atomic processes. A feature that is unique to relativity is time dilation, the slowing of time with; a) relative movement in an inertial reference frame, and b) the effect of a gravitational field. At present, time dilation remains a difficult notion to intuitively understand, although it can be derived from general principles and characterized by straightforward mathematics. Canonical pilot wave theory is less well known than relativity and does not address time dilation; however, the theory can be conceptually expanded to cover additional phenomena. Described here is a modified pilot wave model based on classical principles that proposes time dilation does not occur in nature, but rather the slowing of clocks or other objects is due to a mechanical change in atomic efficiency. In other words, atoms, structures composed of atoms, and emergent properties of objects operate more slowly with motion or gravity due to a functional decrease in the effect of pilot waves, but time always elapses at a constant rate for all observers. An idealized and expanded mechanical pilot wave model and an idealized standing wave model are used to explain the invariant speed of light and the apparent slowing of time due to motion or gravity.

Keywords: Pilot Wave, Mechanical Pilot Wave Theory, Invariant Speed of Light, Time Dilation, Special Relativity, General Relativity, Classical Physics

1. Introduction

1.1. Overview – Special and General Relativity

In 1905 Albert Einstein proposed the theory of special relativity (SR) [1-7]. The two major postulates are:

1. The laws of physics are identical in all inertial frames of reference.
2. The speed of light in a vacuum, designated as c , is the same for all observers regardless of the motion of the light source or observer.

Einstein then went on to invent and publish the concept of general relativity (GR) in 1915 based on his musings on reference frames, curved surfaces, and acceleration [8-11]. Later, GR produced slightly more accurate experimental measurements of gravity than the prevailing theories of Einstein's time, including the classical physics of Isaac Newton and others.

Both SR and GR predict time will slow in certain circumstances involving motion or gravity [12-24]. The concept of time dilation has a strong theoretical underpinning and is useful

for mathematical calculations; however, the real-world mechanism remains an enigma and there are many critics who are skeptical of the theories or who offer alternative views on the matter [15-17]. Time dilation can become lost in the day-to-day world of equations, calculations, and focused investigations, but one should not lose sight of the astounding implications for the functioning of the universe, namely that time itself is purported to slow down. Irrespective of viewpoints on the strengths and weaknesses of relativity, it's important to critically examine SR and GR and to evaluate propositions that challenge the theories, including the notion that time slows. The goal here is to present a mechanical pilot wave-based model based on classical principles that asserts time never dilates, but only appears to slow due to the effect of pilot waves.

1.2. Time and Time Dilation – Definitions

A definition of time as defined by the Merriam Webster dictionary is; a) the measured or measurable period during which an action, process, or condition exists or continues, or b) a nonspatial continuum that is measured in terms of events which succeed one another from past through present to future. A definition of the measurement of time, according

to the US National Institute of Science and Technology, is explained as; “The answer to how we measure time may seem obvious. We do so with clocks. However, when we say we’re measuring time, we are speaking loosely. Time has no physical properties to measure. What we are really measuring is time intervals, the duration separating two events. We measure time intervals – the duration between two events – most accurately with atomic clocks.” Alternatively, one can state the definition of time measurement is monitoring the transition of a certain atomic state, such as the ammonia molecule. A general definition of time dilation is the relative difference in elapsed time between two clocks. Specifically for SR and GR, this is the slowing down of a clock as determined by an observer who is in relative motion with respect to that clock, or the slowing of a clock in a gravitational field relative to a clock in a weaker or no field. A meaning of proper time is; the time measured by an observer between two events in a reference frame where the events stay in the same position and the clock is attached locally to an observer. A definition of coordinate time is; a grid of synchronized clocks traceable to an ideal clock at a predetermined point in space.

1.3. Time Dilation – Equations

In SR, time dilation is related to the gamma (Lorentz) factor as shown below:

$$\gamma = 1 / \sqrt{1 - (v/c)^2}$$

Time dilation is described as $\Delta t' = \gamma \Delta t$.

Where:

$\Delta t' = \gamma \Delta t$ is the change in time for an inertial reference frame moving relative to another one

$\Delta t'$ = coordinate time (dilated time)

Δt = proper time

c is the speed of light

v is the velocity of the object in motion

The fact that clocks slow with movement was first verified in 1938 and many times since, using a variety of different experimental setups, including decay of atomic particles as well as atomic clocks placed aboard fast moving airplanes [18-24]. All studies to date indicate that events slow for an object in motion.

Time dilation with gravity occurs in the vicinity of an object with mass and is based on the following equation, with the assumption the object is spherically symmetrical and observers are in a weak field such as occurs in the vicinity of earth:

$$T_o / T_f = \sqrt{1 - 2GM/r_o c^2} / \sqrt{1 - 2GM/r_f c^2}$$

Where:

T_o is the proper time between two events for an observer close to a massive object and T_f is the coordinate time between the

events for an observer at an arbitrarily large distance from the object

G is the gravitational constant

M is the mass of the object creating the gravitational field

r_o and r_f are the distance from the center of the object

c is the speed of light

The slowing of clocks due to gravity was also experimentally verified many times, and in fact must be considered when designing systems such as global positioning satellites or other technologies that involve a gravitational field [25-28].

1.4. Pilot Wave Theory – Louis de Broglie, David Bohm

Pilot wave theory differs markedly from Newtonian physics, relativity, standard quantum mechanics (QM) such as the Copenhagen Interpretation, and other explanations of nature [29-38]. The concept was first proposed in 1918 by Louis de Broglie, a French graduate student in physics who is best known for his fundamental contribution to the early development of QM; namely, that electrons exhibit dual particle and wave features [39]. However, de Broglie also proposed a nascent version of pilot wave theory, consisting of an underlying wave-based structure to the universe that had explanatory and predictive power for several observations in the newly developing field of atomic physics. The theory was then taken up and significantly advanced by David Bohm in the mid-1900s who published an article in 1952 entitled, A suggested interpretation of the quantum theory in terms of “hidden” variables [40-46]. Bohm’s version is a less unusual and more intuitive explanation of atomic physics data than QM and was intended to solve some of the problems associated with the Copenhagen Interpretation.

Pilot wave theory includes complete mathematical formalism that describes and predicts atomic behavior equally as well as standard quantum mechanics. According to Bohm, atoms and particles are guided by pilot waves based on two key equations. The first one is analogous to the Schrodinger equation, which describes the wavefunction, and the second is called the Guiding equation, which describes and predicts how particles move on the waves. Pilot wave theory is deterministic, non-local, asserts that particles exist in nature with a definite location irrespective of measurement, and includes hidden variables. Bohm himself was circumspect and uncertain as to whether pilot waves actually existed in nature, or if they were only mathematically useful constructs. Today, the physical nature of pilot waves, if they exist, remains an open question and a subject of theoretical development and experimental testing. To be sure, though, the impressive mathematical formalism of Bohm in the quantum realm makes expansion of pilot wave theory into areas beyond atomic behavior a serious and legitimate undertaking. For additional information and to fully appreciate the richness of de Broglie’s and Bohm’s work, one should read their original papers and subsequent follow-up and related articles (40-46). Additionally, for a recent review see the article by C. Dewdney [29].

1.5. Idealized Models – Standing Waves, Pilot Waves, and the Invariant Speed of Light

1.5.1. Standing Waves

Standing waves are components of many physical processes and defined by in-phase, multi-directional oscillations that retain the spatial location of moving and stationary components; characteristic nodes (minimal movement) and

antinodes (maximal movement) [47-54]. Standing waves can exist in many media, including air, water, non-aqueous fluids, and importantly, the model proposed for electron orbitals to explain quantization [55-58]. The properties of standing waves are based on the physical medium, characteristics of the system, and external forces the wave is subjected to. A representative example of a standing wave is illustrated in Figure 1.

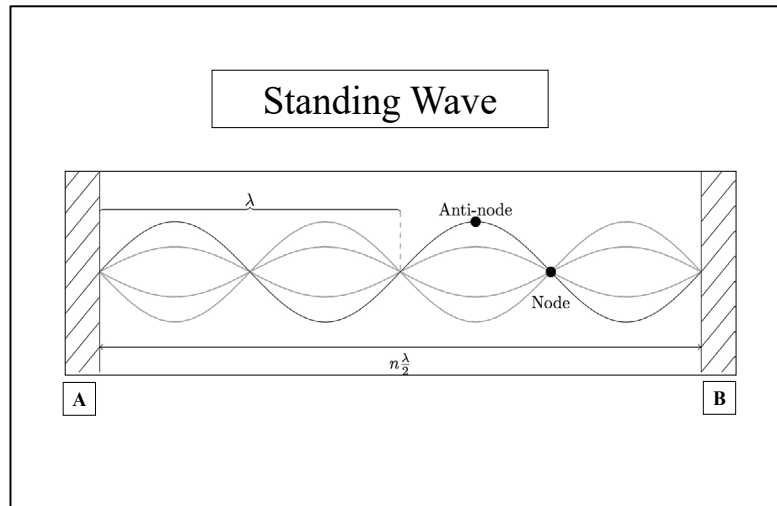


Figure 1: Schematic image of a standing wave created by two traveling waves moving in opposite directions between points A and B. The peaks and troughs of the standing wave are antinodes while the stationary components are nodes. The wavelength is shown in the upper left of the Figure. (Attribution - CC-BY-SA-3.0; Author-Vegar Ottesen)

For this report, a simple, idealized, fixed-end standing wave was selected as the model, which can be described using the following conventions:

At time = 0, there is a cord with fixed ends at locations (A) and (B) that is not moving and has negligible tension. Movement of fixed end (A) slightly upward induces a traveling wave that moves to (B), followed by return of the cord to its original position. The traveling wave moves with an amplitude and wavelength defined by the parameters of the system; the composition, characteristics, and dampening effects of the cord. The wave reflects back at fixed end (B) and returns to fixed end (A). Eventually a steady state is created where traveling waves in each direction are in synch and a characteristic standing wave is created. If no additional movement of fixed end (A) occurs a dampening effect will cause the amplitude of the standing wave to grow smaller over time and then to extinguish. Alternatively, repeat application of movement at (A) that matches the dampening effect will maintain the standing wave indefinitely. The equation below describes a standing wave that is subject to boundary conditions where $y = 0$ at (A) and (B) because the cord is fixed at both ends.

The value of y at the two ends prior to the addition of external force is:

1. $y(A,t) = 0$
2. $y(B,t) = 2y_{max} \sin(2D) \cos(\omega t) = 0$

The distance between (A) and (B) is defined as D and restricts the wavelength to whole numbers ($n = 1, 2, 3, \dots$).

The wavelength (λ) of the standing wave is:

$$3. \text{Wavelength} = D/n, n = 1, 2, 3, \dots$$

Moreover, if the wave components of the standing wave are traveling at velocity v , then:

$$4. \text{Frequency} = v/\lambda$$

1.6. Pilot Waves

In the present idealized and modified mechanical model, pilot waves are physical entities in the universe that travel at c , directly interact with matter, move in multiple directions and angles as in Fig. 2 below, and obey the plane wave equation:

$$(\psi(x, t) = A \cos(kx - \omega t + \varphi))$$

Where:

- A = amplitude
- k = wavenumber
- ω = angular frequency
- t = time
- φ = phase constant

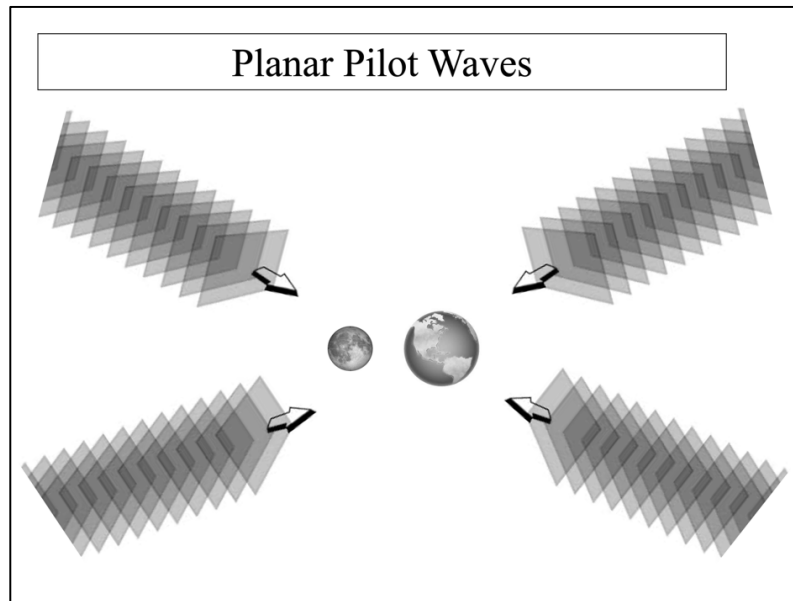


Figure 2: Schematic image of planar pilot waves moving through the universe toward the earth and moon. The waves are propagating in the direction of the arrows. In the expanded pilot wave system the waves propagate in many directions and angles, allowing flexibility in building models to explain natural phenomena

One can envision waves resembling the kind appearing in de Broglie-Bohm theory; however, the focus here is not on a dynamical equation satisfied by these waves but instead on a general conceptual and mechanical scheme of physical, real world waves. The model is a highly simplified version of pilot waves based on the first-order theory of de Broglie's guidance formula [29]. Moreover, the equations and examples (system at rest, in motion, or in a gravitational field) below are kept exceedingly simple to focus on the proposed mechanism of invariant c and apparent time dilation rather than on computations.

1.7. Invariant Speed of Light

The invariant speed of light is explained by photons (in a particle, wave, or wave-particle form) traveling on pilot waves at c independent of the velocity of the atom from which the photon originated. In other words, once created, light is only moved by pilot waves and retains no physical interaction with its atomic source. Thus, light always travels at c when measured against the background structure of the universe (i.e., a fixed coordinate system such as the historical luminiferous aether), irrespective of the motion of the source or observers. The pilot wave model also proposes the second postulate of SR is incorrect. Special relativity asserts the speed of light from a source to an observer is c whether the observer is stationary or is in relative motion to the source. In all circumstances the speed of light is c between the source and the observer. Physical quantities of the universe such as length of objects and time are then calculated using Lorentz transformations, which assume invariant c and preserve the spacetime interval between events [59-62]. In contrast the mechanical pilot wave model argues the relative velocity of pilot waves, and by extension the speed of light, measured from a light source to an observer in motion is additive or subtractive; thus velocities are similar to those of classical Galilean transformations. For example, the speed of light

measured by an observer moving away from a light source at velocity v is $(c - v)$ rather than c as postulated by SR. This distinction is important since the pilot wave model asserts a decrease in pilot wave velocity for a system in motion is responsible for the slowing of the object's behavior.

At present, there is no device an observer can utilize to directly measure the speed of light in one dimension as it travels through space to them from a source. In other words, there is no instrumentation available an observer can use to physically measure the speed of light in transit as it arrives at their location. Instead, for a stationary observer and source, c can be indirectly and approximately determined by knowing the distance between them and time interval for light to traverse from one to the other. However, selection of a proper experimental system to perform such measurements, the consideration of reference frames, and synchronization of clocks located at each site is problematic [63,64]. Thus, the speed of light is most often measured using a two-way reflective system in which light is emitted from a source at a specific location, sent to a mirror, reflected back to the emission location and detected [65,66]. This experimental approach obviates the need for synchronization of clocks and allows for precise measurements of c . SR and the mechanical pilot wave model agree with all experimental two-way measurements of c to date, and both are currently viable explanations of the invariant speed of light. However, given the inability to directly measure the speed of light while it is traveling from a source to an observer, one cannot compare the differing predictions of c for SR versus the pilot wave model. In SR light is postulated to travel at c to an observer irrespective of motion. In contrast, for the pilot wave model the speed of light is always c against the background coordinate structure of the universe, but is additive or subtractive when measured from a source to an observer who is in motion.

2. Results

2.1. Pilot Wave Effects on a Stationary Standing Wave

The effect of a pilot wave on a standing wave system was explored using a simple, idealized model with pre-selected properties and arbitrary units (U). The effect of SR, GR, and other natural forces were excluded from consideration, and a single pilot wave was considered sufficient to create a standing wave that allows for the measurements described below. An external pilot wave that travels at c moves fixed end (A) $0.1U$ upwards and induces traveling waves and then

a standing wave. In this model, the velocity and the impulse of the actuating pilot wave bear a linear relationship with the velocity of the traveling waves.

Length of cord = 1000U

Actuating pilot wave velocity = $c = 200U/sec$

Movement at fixed end (A) = $0.1U$

Standing wave amplitude at antinodes = $10U$

Standing wave wavelength = $5U$

Velocity of traveling waves = $100U/sec$

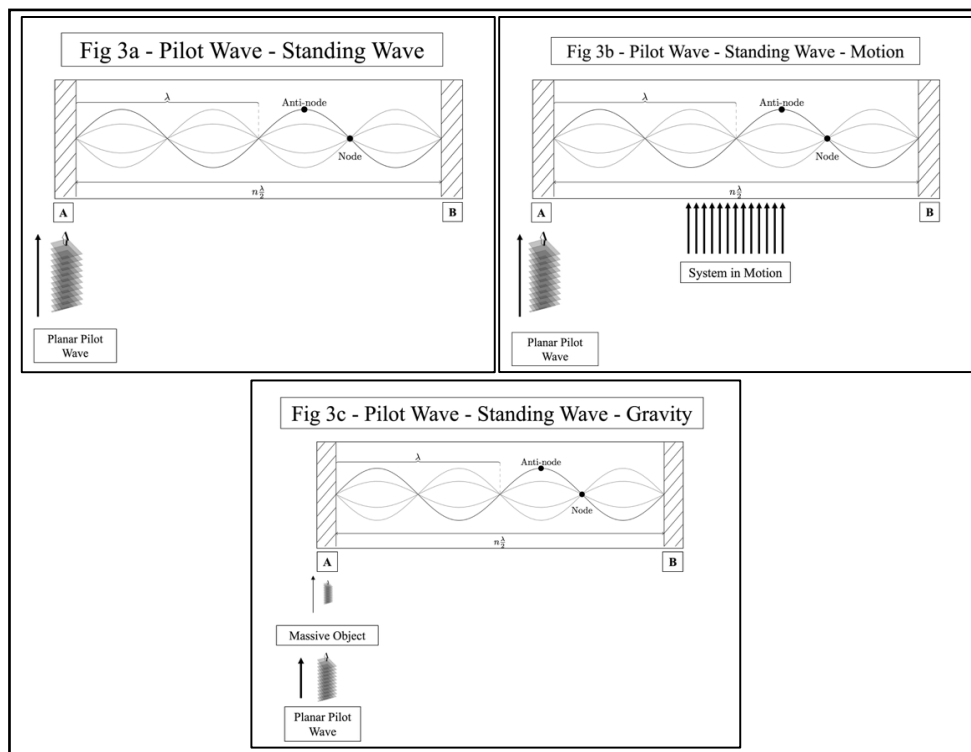


Figure 3: Shows a standing wave created by traveling waves moving in opposite directions between fixed ends (A) and (B) and the effect of changing parameters of the system:

Top Left Panel – A planar pilot wave actuates a standing wave by moving the fixed end of the cord at (A) in the upward direction. A decrease in the velocity of the pilot wave will change the behavior of the standing wave, including fewer wave reflections per second at (B).

Top Right Panel - Movement of the entire standing wave system in the upward direction (indicated by the arrows) will cause an effective decrease in the velocity of the pilot wave at (A), with a concomitant decrease in reflections per second at (B).

Bottom Panel – Interference with the pilot wave by an object with mass will produce an effective decrease in the impulse of the pilot wave at (A) (lighter arrow) and cause a decrease in the number of reflections at (B).

If the number of traveling waves reflected at fixed end (B) are measured, then based on the arbitrarily selected features the number of reflections per second are calculated as:

$$\text{Reflections at (B)} = \text{Frequency of traveling waves} = v / \lambda = 100U/5U = 20/sec$$

A 50% decrease in the velocity of the actuating pilot wave shown in the upper left panel will linearly reduce the

velocity of the traveling waves from $100U/sec$ to $50U/sec$. If the number of traveling waves reflected at fixed end (B) are measured under this condition:

$$\text{Reflections at (B)} = \text{Frequency of traveling waves} = v / \lambda = 50U/5U = 10/sec$$

A 90% decrease in the velocity of the pilot wave will linearly reduce the velocity of the traveling waves from $100U/sec$ to

10U/sec. If the number of traveling waves reflected at fixed end (B) are measured:

$$\text{Reflections at (B)} = \text{Frequency of traveling waves} = v/\lambda = 10U/5U = 2/\text{sec}$$

Overall, a reduction of the velocity of the actuating pilot wave will cause the number of traveling wave reflections at fixed end (B) to decrease proportionally.

2.2. Effect of Pilot Waves on a System in Motion or in a Gravitational Field

The effect of an external pilot wave on the idealized standing wave system can be examined by directly changing the speed of the pilot wave as described above, or alternatively by, a) holding the speed of the pilot wave constant and moving the standing wave system through space, or b) decreasing the impulse of the pilot wave due to a blocking object that interferes with wave propagation. For example, as shown in the top right panel of Figure 3, movement of the standing wave system toward the top of the Figure, in the same direction as the actuating pilot wave, decreases the relative velocity of the pilot wave at fixed end (A). As a specific example, moving the system at 100U/sec upward decreases the relative velocity of the actuating pilot wave by 50%, which in turn reduces the velocity of the traveling waves by 50%. If the number of traveling waves reflected at fixed end (B) are measured:

$$\text{Reflections at (B)} = \text{Frequency of traveling waves} = v/\lambda = 50U/5U = 10/\text{sec}$$

The bottom panel in Figure 3 shows the idealized standing wave system when an object with mass interferes with the actuating pilot wave and reduces the impulse by 50% (lighter arrow), which then reduces the velocity of the traveling waves by 50%. If the number of traveling waves reflected at fixed end (B) are measured:

$$\text{Reflections at (B)} = \text{Frequency of traveling waves} = v/\lambda = 50U/5U = 10/\text{sec}$$

In these examples of motion and gravity, one can use the number of reflections per second at fixed end (B) as a stand-in for a clock that measures elapsed time. When the system was at rest and not in a gravitational field there are 20 reflections/sec. However, movement of the system through space in the same direction as the actuating pilot wave reduces the number of reflections to 10/sec. Similarly, placing an object with mass between the origination site of the pilot wave and the standing wave system also reduces the number of reflections at fixed end (B) to 10/sec.

The 'standing wave reflection clock' appears to exhibit time dilation with motion and gravity because the number of reflections is reduced, as though time had slowed down. However, time did not dilate for the system during movement or due to the nearby object with mass. The system slowed for reasons related to a decrease in the effective pilot wave

velocity or impulse, but time remained constant under all circumstances.

2.3. Differences in Explanations and Predictions

The two types of relativity and the proposed pilot wave model provide different explanations and predictions for the behavior of an idealized standing wave such as the one described above. For SR and GR, the system must be actuated by a standard mechanical force that moves fixed end (A) upward to induce traveling waves and a standing wave. When stationary, there are a starting number of reflections at fixed end (B) based on this force. The reflection number will decrease when the system is moving or subject to a gravitational field, due to time dilation and in accordance with the postulates and equations of SR and GR.

For SR, the effect of motion on the number of reflections at fixed end (B) is calculated by:

$$[\text{Reflections when in motion}] = [\text{Reflections when stationary}] / [1 / \sqrt{1 - (v/c)^2}]$$

Where:

c is the speed of light

v is the relative velocity of the standing wave system in motion

In GR the decrease in reflection rate at fixed end (B) is related to gravitation mass, the distance of the standing wave system from the center of the mass, and the speed of light squared, and is calculated by:

$$[\text{Reflections with gravity}] = [\text{Reflections without gravity}] \times \sqrt{1 - 2GM/r_o c^2} / \sqrt{1 - 2GM/r_f c^2}$$

Where:

G is the gravitational constant

M is the mass of the object creating the gravitational field

r_o and r_f are the distance from the center of the object

c is the speed of light

In contrast, the mechanical pilot wave model asserts that time dilation does not occur under any circumstances nor for any observer. The slowing of the behavior of atoms and objects is due to a change in pilot wave interactions with the standing wave system rather than a true slowing of time. In the model the number of reflections at fixed end (B) with motion is governed by the effective velocity of the actuating pilot wave at fixed end (A), which is calculated by:

$$[\text{Reflections when stationary}] \times [V_e/V_s] = [\text{Reflections when in motion}]$$

Where:

V_e is the effective velocity of the pilot wave at fixed end (A) due to the system being in motion

V_s is the velocity of the pilot wave at fixed end (A) when stationary

The calculation for determining the number of reflections at fixed end (B) also differs between GR and the pilot wave model. The decrease in reflections at fixed end (B) due to a nearby object with mass is related to the amount of pilot wave impulse the standing wave system is subjected to at fixed end (A) and is calculated as:

$$\frac{[\text{Reflections without gravity}] \times [\text{PW MagG} / \text{PW Mag}]}{[\text{Reflections with gravity}]}$$

Where:

PW MagG is the pilot wave impulse at fixed end (A) in a gravitational field

PW Mag is the pilot wave impulse at fixed end (A) with no gravitational field

3. Discussion

The slowing of time as predicted by SR and GR is one of the most intriguing phenomenon ever produced by science. The theories radically alter our understanding of the universe as well as the perceived capacity of humans to intuitively understand how nature functions at a fundamental level [1,17-20]. Depending on one's perspective, time dilation is either a fascinating and awe-inspiring element of nature, or is a troubling concept that must be accepted with little mechanistic explanation. With all theories and concepts, practitioners of science must remain humble, open, cautious, and tentative. At best, theories are approximations of nature that require skeptical appraisal, iterative improvement, or sometimes radical overturning. To examine the concept of time dilation, this report used idealized models in which pilot waves are real structural entities in nature that actuate physical processes. Idealized models are useful in science to examine early-stage theories, interpretations of data, hypotheses, and fundamental principles [67-74]. They allow one to focus on critical elements of a system and crystallize key points in a simplified model that excludes complexity. Certainly, all idealized models need to progress from the concept stage to more complete descriptions of mechanisms, natural phenomena, and predictions of future behavior, including real-world experiments to confirm or reject new ideas. Nonetheless, idealized models are terrifically important starting points to match observations of nature with novel explanations.

3.1. Expanded Pilot Wave Model of Apparent Time Dilation

A simple, expanded pilot wave model of time dilation was examined as a first step towards a more comprehensive description of pilot waves and the passage of time. The model describes a standing wave system that exhibits slowing of behavior, but in which time dilation does not occur. Slowing of physical processes, in this case the number of wave reflections per second at fixed end (B), was due to a change in the external pilot wave force interactions with the system, whether that was caused directly by a change in pilot wave velocity, via motion of the system in the same direction as the pilot wave, or via an object with mass that

physically interacted with the pilot wave and reduced the impulse. The mechanical pilot wave model provides a simple and intuitive explanation for invariant c and apparent time dilation. Moreover, SR, GR, and the pilot wave model make differing predictions about the amount of time dilation that occurs in SR/GR versus the amount of apparent time dilation in the pilot wave model. These differences could be exploited in future experimental studies.

3.2. History of Fields in Science

Suggestion of a matrix of 'mysterious pilot waves,' in the universe may seem unusual or arbitrary, but is firmly in keeping with the historical trend of fields and physical structures describing natural phenomena. For example, in the 18th century Laplace and Le Sage each proposed the ubiquitous particles throughout space that acted as a 'push force' responsible for planetary motion and other natural phenomena [75-77]. Later in the 18th century Isaac Newton invented his theory of universal gravitation to explain planetary motion as a 'pull force,' including a gravitational field acting instantaneously across space to attract distant objects [78-80]. Nineteenth century physics saw the development of electromagnetism and a new understanding of light, and description of electric and magnetic fields by Michael Faraday and James Clerk Maxwell [81]. Albert's Einstein's development of GR in 1915 did not propose a field per se but explained gravity as a warping of three-dimensional space that caused objects to fall into each other, as if rolling down a slope [8-11]. In GR, gravity is not considered a force but rather a consequence of spatial geometry. Throughout the 20th century to today, multiple QM fields were proposed to account for several behaviors of atoms and subatomic particles [82-86]. Today, QM is referred to as quantum field theory and incorporates both earlier versions and more recent advancements, including fields that permeate through space [82-86]. And finally, Louis de Broglie and David Bohm developed pilot wave theory in the early and mid 1900s. Respectively, with Bohm creating a complete mathematical formalism that explains and predicts atomic behavior as effectively as standard QM [29-46]. Since the 1950s, pilot wave theory was less well studied and explored than other atomic theories; however, there were several improvements over the past 70 years and periodic swells of interest in pilot wave theory occurred, such as recent studies that purported to mimic the results of two-slit experiments using a pilot wave model [29,31-35].

3.3. Future Directions

Further expanding the pilot wave and standing wave models to explain apparent time dilation in a real-world, three-dimensional object such as a clock is challenging. Clearly, going beyond the highly simplified, idealized models presented here will require additional ideas, mathematics, and experimental approaches. As a starting point for a more thorough approach, one can propose that clocks or other objects slow with motion and gravity at least in part due to the efficiency of three-dimensional electron orbital standing waves; where atoms at rest and not in a gravitational field are subjected to a uniform structure of pilot waves. In

this circumstance constructive interference in electron standing waves is maximized. Subsequent movement of the atom through the pilot waves or changes in the waves due to a nearby blocking object will alter and disrupt the uniform three-dimensional local wave structure and change parameters of the standing waves. The emergent properties of the system, including standard chemical interactions of atoms and molecular vibrations would be affected in this scenario and events potentially slowed due to the now non-ideal and less efficient state of electrons and molecules. Although highly speculative, this notion can serve as a beginning to expand the simple idealized standing wave and pilot wave interactions in the present report to a full three-dimensional standing wave model that considers and accounts for the effect of pilot waves coming from multiple directions and angles.

4. Conclusion

The present report describes a set of idealized models to explain invariant c and apparent time dilation as an alternative to SR and GR. The goal is to encourage skeptical appraisal of the current orthodoxy around SR and GR, a process that is both essential for progress in science and an enjoyable pursuit for those pondering and questioning ideas.

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