Richard A. Peters

Affiliation: None

In Support of a New Gravitational Model

Abstract

If gravity is mediated by the exchange of gravitons between objects, then the acceleration of an object toward a gravitational body (GB) is proportional to the graviton flux emitted by the GB that impinges on the object. Any motion of the object relative to the GB will affect the graviton flux from the GB on the object. The acceleration of the object relative to the GB will thus depend on both the object's distance from the object and its motion relative to the GB. This behavior defies the known acceleration profile that is absent any factor of the velocity of an object in the gravitational field. If an object were directly subject to gravity, the gravitational field of a GB could not be characterized, as it is known to be, solely as a function of the active gravitational mass and distance of the GB. The only mechanism that can be invoked to nullify the certain and irrefutable effect of the augmentation of graviton flux by the velocity of an object toward a GB is one that denies altogether the direct effect of graviton flux on the acceleration of an object in a gravitational field. ***In simpler terms: massive objects are not directly subject to gravity!***

The Temporal Inertial (TI) field model of gravity and inertia is a conjecture of this author. The TI field acts as an intermediary in the transmission of the gravitational force between objects. Particles of the TI field are directly subject to gravity but objects are not. An object is accelerated toward a GB at the same rate as the TI field. The TI field supports the propagation of gravitons. No matter how the TI field moves, the velocity of gravitons is constant relative to the TI field, hence there is no increase in graviton flux as the TI field moves toward a GB except for the increase in graviton flux caused by the proximity to the GB.

Table of Contents

Table of Contents

Table of Contents

1.0 First Matters

1.1 Yes, Virginia, There Is An Ether

'Robert B. Laughlin, Nobel Laureate in Physics, endowed chair in physics, Stanford University, had this to say about ether in contemporary theoretical physics:' [1]

> 'It is ironic that Einstein's most creative work, the general theory of relativity, should boil down to conceptualizing space as a medium when his original premise [in special relativity] was that no such medium existed [..] The word 'ether' has extremely negative connotations in theoretical physics because of its past association with opposition to relativity. This is unfortunate because, stripped of these connotations, it rather nicely captures the way most physicists actually think about the vacuum. . . . Relativity actually says nothing about the existence or nonexistence of matter pervading the universe, only that any such matter must have relativistic symmetry. [..] It turns out that such matter exists. About the time relativity was becoming accepted, studies of radioactivity began showing that the empty vacuum of space had spectroscopic structure similar to that of ordinary quantum solids and fluids. Subsequent studies with large particle accelerators have now led us to understand that space is more like a piece of window glass than ideal Newtonian emptiness. It is filled with 'stuff' that is normally transparent but can be made visible by hitting it sufficiently hard to knock out a part. The modern concept of the vacuum of space, confirmed every day by experiment, is a relativistic ether. But we do not call it this because it is taboo.' [1] [11]

Throughout this paper I argue that the propagation of light and gravity is supported by a common medium that I've labeled the Temporal Inertial (TI) field. In this narrow sense the TI field is part of an ether theory. More broadly, the TI field model of gravity and inertia was originally formulated in reference [16] to support known gravitational and inertial interactions. In essence, the TI field mediates gravitational and inertial interactions. The relation between the TI field and the Higgs field is undefined as I ascribe behavior to the TI field that is not known to exist for the Higgs field.

1.2 Glossary

I depart from convention in more ways than one in this paper. Here I place the Glossary at the beginning rather than the end of the paper, so that the reader doesn't have to jump to the end to find the definitions of terms needed to understand early sections of the paper.

Table 1. Glossary

Table 1.	**Glossary**
Term	**Definition**
Acceleration profile	The acceleration profile about a gravitational body (GB) is described by a mathematical formula expressing the acceleration experienced by an object vs the distance of the object from the gravitational center of the GB. See Eq (1).
Flux variant of the Newtonian model	A variant of thes Newtonian model of gravity in which the motion of an object relative to a GB affects the graviton flux at the object resulting in a change in the acceleration of the object relative to the GB.
Flux variant of the TI field model	A variant of the TI field model of gravity in which the motion of particles of the TI field relative to a GB affects the graviton flux at the particles resulting in a change in the acceleration of the particles relative to the GB.
Gravitational body (GB)	In this paper, a gravitational body is a spherically symmetric, homogeneous, massive body such as an idealized planet or star.
Graviton	A graviton is the hypothetical elementary particle that mediates the force of gravity. [9] Gravitons propagate at the speed of light. [2]
Graviton flux	Graviton flux is a measure of the number of gravitons from a GB passing through a given area external to the GB per unit time. The acceleration profile about the GB is a measure of the graviton flux vs distance from the GB.
Mass	There are three forms of mass for each gravitational model: active gravitational mass, passive gravitational mass and inertial mass. The properties of these forms of mass depend on the gravitational model as described in Table 3.

Table 1.	Glossary
Term	**Definition**
Matter particle	I define matter particles by their properties of mass rather than by their constituents, e.g., sub-atomic particles. One or more matter particles comprise an object. As individual particles or constituents of objects, their properties depend on the gravitational model as described in Table 3.
Newtonian model of gravity and inertia	'… Newton's law of universal gravitation… describes gravity as a force which causes any two bodies to be attracted to each other, with the force proportional to the product of their masses and inversely proportional to the square of the distance between them.' [10] Properties that distinguish the Newtonian model from the TI field model are shown in Tables 2 and 3 and Appendix A.
Object	I define an object by its properties of mass rather than by its constituents, e.g., atoms. An object comprises one or more matter particles. The properties of mass of an object depend on the gravitational model as described in Table 3.
Particle flux	Particle flux is the rate of transfer of particles through a unit area per unit time. [6]
Particle of the TI field	An elementary particle of the TI field. Properties and behavior of the TI field are described in Table 2 and Appendix A.
Static field	A hypothetical field, originated by this author, that resists the acceleration of the TI field in its response to gravity.
Temporal Inertial (TI) field model of gravity and inertia	The Temporal Inertial (TI) field model is a conjecture of this author. [16] This hypothetical model mediates the force of gravity. The TI field permeates all of space from the expanse of the Universe to the space within atoms. Properties that distinguish the TI field model from the Newtonian model are shown in Table 2 and Appendix A.

1.3 Two Models of Gravity and Inertia

Two models of gravity and inertia are considered in this paper, the familiar Newtonian model and the Temporal Inertial (TI) field model that is a conjecture of this author. [16] The fundamental difference between the two models resides in how each model mediates gravity.

- In the Newtonian model, objects are directly subject to gravity.
- In the TI field model, objects are not directly subject to gravity.

The numerous properties and behaviors that support these two principal behaviors are discussed in subsequent sections and in Appendix A.

1.4 Behavior that Distinguishes the TI Field Model from the Newtonian Model of Gravity and Inertia

The TI field model of gravity is a stand-alone model of gravity, but also participates in an important role in the Newtonian model. That role is the resistance of the TI field to the acceleration relative to the TI field of an object in the object's response to both gravitational and non-gravitational forces.

Table 2.	**Behavior that Distinguishes the TI Field Model from the Newtonian Model of Gravity and Inertia**
Gravity Model	**Behavior**
TI Field	Particles of the TI field are directly subject to gravity, but objects are not.
TI Field	The TI field supports the propagation of photons. Photons propagate at the velocity of c relative to the TI field.
TI Field	The TI field supports the propagation of gravitons. (To be argued herein.)
Newtonian	Objects are directly subject to gravity, but particles of the TI field are not.
Newtonian	The TI field resists the acceleration of an object in the object's response to a gravitational force.

Table 2.	Behavior that Distinguishes the TI Field Model from the Newtonian Model of Gravity and Inertia
Gravity Model	**Behavior**
TI Field and Newtonian	Objects are the source of the gravitational force, but particles of the TI field are not.
TI Field and Newtonian	The TI field resists the acceleration of an object relative to the TI field itself in the object's response to a non-gravitational force.

1.5 Definitions of Mass

A brief description follows of the forms of mass existent in the two models of gravity described in this paper. More is said of mass in Appendix A. I paraphrase the three definitions of mass offered by Wikipedia [12] for the Newtonian model and modify those definitions where appropriate for the TI field model.

Table 3.	**Definitions of Mass**
Mass in the Newtonian Model	**Definition**
Active gravitational mass	A measure of the gravitational force exerted by an object.
Passive gravitational mass	A measure of the gravitational force experienced by an object in a known gravitational field.
Inertial mass	A measure of an object's resistance to being accelerated by a gravitational or non-gravitational force.
Mass in the TI Field Model	**Definition**
Active gravitational mass of a particle of the TI field	Particles of the TI field do not possess active gravitational mass.
Active gravitational mass of an object	A measure of the gravitational force exerted by an object.
Passive gravitational mass of a particle of the TI field	A measure of the gravitational force experienced by a particle of the TI field in a known gravitational field.
Passive gravitational mass of an object	Objects do not possess passive gravitational mass.
Inertial mass of a particle of the TI field	A measure of the resistance of a particle of the TI field to being accelerated by the force of gravity.
Inertial mass of an object	A measure of an object's resistance to being accelerated by a non-gravitational force.

1.6 The Prime Objectives of this Paper

There are three prime objectives of this paper:

- Show that the Newtonian model of gravity and inertia is not viable.
- Show that the TI field model of gravity and inertia is a viable alternative to the Newtonian model.
- Show that the propagation of gravitons is supported by the TI field.

2.0 The Newtonian Model of Gravity and Inertia

> ‘ … for most applications, gravity is well approximated by Newton’s law of universal gravitation, which describes gravity as a force which causes any two bodies to be attracted to each other, with the force proportional to the product of their masses and inversely proportional to the square of the distance between them.’ [10]

> ‘Newton's law of universal gravitation states that a particle attracts every other particle in the universe with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers.’ [13]

> ‘A hypothesis is that gravitational interactions are mediated by an as yet undiscovered elementary particle, dubbed the graviton.’ [9]

I would characterize Newtonian model of gravity and inertia as follows:

The Newtonian model of gravity and inertia asserts that a gravitational body (GB) produces an acceleration of an object that is proportional to the active gravitational mass of the GB and inversely proportional to the square of the distance between the gravitational centers of the object and the GB. Furthermore, the acceleration profile about the GB is proportional to the ratio of the passive gravitational mass to the inertial mass of such an object. [17]

Implicit in the current notion about the Newtonian model of gravity, is that gravity is effected by the exchange of gravitons between objects. An object emits gravitons and is itself subject to the force transmitted by gravitons.

The acceleration of an object subject to the gravitational force is resisted by the TI field. The acceleration of an object in response to the gravitational force would be unlimited were it not for the resistance given by the TI field.

2.1 The Acceleration Profile About a Gravitational Body

Table 2 shows that in the Newtonian model, objects are directly subject to gravity. The acceleration profile about a GB is proportional to the active gravitational mass of the GB and inversely proportional to the square of the distance from the GB at which the acceleration is measured. [8] This relationship is portrayed in Eq (1). Other parameters contribute to this relationship, but are sequestered within the universal gravitational constant G itself [17], and do not alter this discussion.

$$a = GM / r^2 \tag{1}$$

where

> a is the acceleration, relative to the GB, of the object toward the GB at the distance r from the GB.
>
> G is the universal gravitational constant.
>
> M is the active gravitational mass of the GB.
>
> r is the distance between the gravitational centers of the GB and the object.

2.2 Graviton Flux in the Newtonian Model, The Flux Variant

> 'According to special relativity, *c* is the maximum speed at which all conventional matter and hence all known forms of information in the universe can travel. Though this speed is most commonly associated with light, it is in fact the speed at which all massless particles and changes of the associated fields travel in vacuum (including electromagnetic radiation and gravitational waves.)' [19]

The pertinence of this quotation arises in the calculation of graviton flux about a GB. Another relationship can be inferred from Eq (1). It is believed that gravitons mediate the gravitational force, hence the acceleration profile of the GB is also a measure of the graviton flux vs distance r from the GB. All we have to do is introduce a constant of proportionality K into Eq (1).

$$Flux_{static} = K\,GM / r^2 \tag{2}$$

Equation (1) and Eq (2) tell us that the acceleration of an object in the gravitational field of a GB is a measure of the graviton flux at the object. Equation (2) holds only if the object is stationary relative to the GB, but the object is accelerating and, hence, it's moving. So the graviton flux seen by the object will be affected by the object's motion. In the Newtonian model this flux effect is certain and irrefutable. As the object ***approaches*** the GB it will see an increase in graviton flux proportional to its velocity toward the GB. The velocity of photons and gravitons was confirmed to be the same by the LIGO experiments. [2] Accordingly, in the Newtonian model, the velocity of gravitons relative to the GB is the same as the velocity c of light. Graviton flux is augmented by the velocity of an object toward the GB as expressed in Eq (3).

$$Flux_{motion} = Flux_{static} \, (1 + v / c) \qquad (3)$$

where

$Flux_{motion}$ is the graviton flux at an object moving toward a GB.

$Flux_{static}$ is the graviton flux at the object that is stationary relative to the GB.

v is the velocity of the object relative to the GB.

c is the velocity of gravitons relative to the GB.

If the object were receding from the GB the sign of v in Eq (3) would be negative denoting a decrease in graviton flux for an object receding from the GB.

The form of Eq (3) is similar to that of the Doppler effect [3] for waves. The object moving toward the GB sees a greater number of gravitons per unit time than if the object were stationary relative to the GB. Equations (1), (2) and (3) can be combined to yield Eq (4).

$$a = K \, (1 + v / c) \, GM / r^2 \qquad (4)$$

Equation (4) tells us that the acceleration of an object in the gravitational field of the GB is proportional to the total graviton flux at the object. Equation (4) defines the ***flux variant of the Newtonian model,*** a variant of a gravitational model in which objects are directly subject to gravity and the acceleration of an object is affected both by its proximity to the GB and by its velocity relative to the GB.

2.3 Drawback of the Newtonian Model of Gravity

Consider that an object moving toward a GB would experience an increased flux of gravitons due to its velocity toward the GB as described by Eq (4). The acceleration of the object would thus be increased relative to its value if the graviton flux were not augmented by the object's velocity toward to the GB. A problem with this model is obvious when you consider a second object at the same distance from the GB, but moving faster toward the GB than the first object. The acceleration of the second object, at the same distance from the GB, would be greater than that of the slower moving first object. The acceleration of objects in the vicinity of a GB would thus depend both on their distance from the GB and on their velocity relative to the GB as described by Eq (4). This behavior defies the known acceleration profile defined by Eq (1) that is absent any factor of the velocity of an object in the gravitational field. If Eq (4) were valid, the gravitational field of a GB could not be characterized, as it is known to be, solely as a function of the active gravitational mass and distance of the GB.

The only mechanism that can be invoked to nullify the certain and irrefutable effect of the augmentation of graviton flux by the velocity of an object toward a GB is one that denies altogether the direct effect of graviton flux on the acceleration of an object in a gravitational field. ***In simpler terms: massive objects are not directly subject to gravity! More broadly, the Newtonian model of gravity and inertia is invalid.***

3.0 The TI Field Model of Gravity and Inertia

The Temporal Inertial (TI) field model of gravity and inertia is a conjecture of this author. Its properties were originally formulated in reference [16] to support known gravitational and inertial interactions. The relation between the TI field and the Higgs field is undefined as I ascribe behavior to the TI field that is not known to exist for the Higgs field.

In the TI field model, in contrast to the Newtonian model, objects emit gravitons but are themselves not directly subject to the force transmitted by gravitons. The TI field acts as an intermediary in the transmission of the gravitational force between objects. Particles of the TI field are directly subject to gravity but objects are not. The resistance to acceleration between an object and the TI field acts to entrain the object in the TI field. An object is entrained not by the velocity of the TI field, but by its acceleration. Thus an object is accelerated toward a GB at the same rate as the TI field.

The TI field participates in the Newtonian model in its resistance to the acceleration of objects in their response to gravitational and non-gravitational forces. As a stand-alone theory, the TI field model differs from the Newtonian model in its role in mediating gravity. The properties and behavior of the TI field that distinguish the TI field model from the Newtonian model and that are pertinent to this paper are given in Table 2 and in Appendix A.

3.1 Graviton Flux in the TI Field Model

Consider a region of space dominated by the gravitational field of a single, large GB. If the TI field does not fall directly toward the GB within this region then it must either orbit the GB or spiral into the GB. These motions require consideration of their effects on graviton flux on the acceleration profile about the GB. Designate these effects as three graviton flux variants of the TI field model. The flux variants of the TI field model are gravitational models in which the motion of particles of the TI field relative to the GB affects the graviton flux at the particles and hence the acceleration of the TI field relative to the GB. The three graviton flux variants of the TI field are listed in Table 4.

Table 4.	**Three Flux Variants of the TI Field Model of Gravity**
Flux Variant	**Description**
Infall	Particles of the TI field fall directly toward the GB in accord with Eq (B-5) in Appendix B.
Orbital	Particles of the TI field are in a circular orbit about the GB with an orbital speed given by Eq (B-3).
Spiral	Particles of the TI field spiral toward the GB with a speed between the orbital speed given by Eq (B-3) and the infall speed given by Eq (B-5).

3.2 Effects of Graviton Flux in the TI Field Model

It's possible that the TI field exhibits all three forms of motion identified in Table 4, depending on the distance of the field from the GB. If graviton flux is augmented by any or all of these motions, we must look for evidence of that augmentation. One obvious choice of such evidence is the effect of augmented graviton flux on the orbital periods of planets in the Solar System. Another choice is the effect of augmented graviton flux on the orbital periods of GPS satellites. Basic gravitation formulas pertinent to the TI field model are shown in Appendix B.

The effect of graviton flux for the infall variant on the period of an object in a circular orbit is developed in Appendix C.

3.3 Effects of Graviton Flux in the Infall Variant of the TI Field Model

Previous studies [16] [18] have shown that In the near vicinity of the Earth, particles of the TI field fall directly toward the Earth at the negative of the escape velocity from the Earth at the distance of these particles from the gravitational center of the Earth. It is safe to generalize this finding by assuming the same behavior for the TI Field in the near vicinity of all large gravitational bodies (GBs). (Near vicinity is undefined.) One would think that as particles of the TI field fall toward any GB they would experience an increase in graviton flux similar to that described in Section 2.2 for the Newtonian model. If there were such an increase in the flux of gravitons seen by the TI field, then the acceleration of the TI field would be augmented by this increase in graviton flux.

Calculations (Appendix C) show that the increase in acceleration of the TI field accompanying this increase in graviton flux caused by the direct infall of the TI field toward the Earth yields orbital periods for the GPS satellites that disagree with calculated values. We must conclude that either the TI field does not fall directly toward the Earth at the altitude of GPS satellites or that graviton flux is unaffected by such motion.

Evidence developed in the studies [16] [18] alluded to above validate the radial infall of the TI field toward the Earth. Thus the only manner in which graviton flux cannot be augmented by the infall velocity of the TI field is one in which the propagation of gravitons is supported by the TI field. Thus gravitons must propagate at a constant velocity relative to the TI field regardless of the velocity of the TI field relative to the Earth. Hence the flux of gravitons seen by particles of the TI field is independent of the velocity of the TI field relative to the Earth and depends only on the proximity to the Earth. We can generalize and conclude that the flux of gravitons seen by particles of the TI field is independent of the velocity of the TI field relative to any GB and depends only on the proximity to the GB.

3.4 Invalidation of the Infall Variant is Invalidation of All Variants

As the propagation of gravitons is supported by the TI field, there can be no augmentation of graviton flux by the motion of the TI field in its response to gravity. The graviton flux and resultant acceleration at any point in the TI field thus depends only on the distance of that point from the center of mass of the GB. There is no augmentation of graviton flux nor acceleration in the infall, orbital or spiral variants of the TI field model. These variants need not be considered further.

3.5 Are Gravitons Directly Subject to Gravity?

Clearly, gravitons are not directly subject to gravity. How could they be? If they were, gravitons would have to emit gravitons and those gravitons would have to emit gravitons and so on in an infinite cascade. What is the logic behind this assertion? We do know that gravitons are emitted by a GB. If gravitons were subject to gravity there would be an interaction between gravitons. This interaction would require that a given graviton ‘see’ a flux of other gravitons at its location. As gravitons propagate from a GB they disperse away from each other. No graviton ‘sees’ a flux of gravitons at its location with the obvious exception of the near vicinity of the extended mass of a GB where gravitons do cross each others paths. Beyond this region, there is no interaction between gravitons unless each graviton itself emts gravitons.

However, gravitons are indirectly subject to gravity through the mediation of the TI field. Gravitons propagate at constant velocity relative to the TI field which itself is directly subject to gravity.

3.6 According to Einstein, Gravity Is Subject to Gravity

Einstein said gravity ***is*** subject to gravity. The simplest mechanism that accommodates this assertion is described in Sections 3.3 and 3.5 in which the propagation of gravitons is supported by a field that is itself subject to gravity. So gravity is itself subject to gravity indirectly through the mediation of the TI field. However, the net effect on an object within the TI field is zero. See the gravitation equation in Section B.1.

3.7 Gravitons Propagate Through the TI Field at the Speed of Light

Previous studies [18] have shown that light propagates through the TI field at a velocity of c. The velocities of photons and gravitons were confirmed to be the same by the LIGO experiments. [2] Is it logical to believe that two different particles, photons and gravitons, propagate at the same speed each in a separate medium or that their propagation is supported by the same medium? I believe it's logical to presume that the propagation of photons and gravitons is supported by the same medium.

Hence, gravitons propagate at a velocity of c relative to the TI field, just as do photons.

4.0 Crafting a New Model of the Gravitational Interactions

4.1 Invalidation of the Newtonian Model of Gravity and Inertia

Section 2.3 concluded with the bizarre assertion that massive objects are not directly subject to gravity. One of the basic tenets of the Newtonian model of gravity is that massive objects *are* directly subject to gravity. We must conclude that the Newtonian model is invalid. The TI model of gravity offers a viable alternative to the Newtonian model.

4.2 Reformulation of the TI Field Model of Gravity and Inertia

The augmentation of graviton flux by motion of the TI field toward a GB in the infall variant of the TI field model causes discrepancies in the calculated orbital periods of GPS satellites.

These discrepancies doom the notion that graviton flux is augmented by the motion of the TI field toward a GB. We must conclude that such an effect does not occur. To repeat the assertion made in Section 3.3, the only manner in which graviton flux cannot be increased by the infall velocity of the TI field toward a GB is one in which the propagation of gravitons is supported by the TI field and only by the TI field. In accord with this null effect, the graviton flux seen by the TI field is independent of the velocity of the TI field relative to a GB. Gravitons move at constant velocity relative to the TI field regardless of the velocity of the TI field relative to a GB.

Accordingly, the acceleration profile about a GB is as described in Section B.1, devoid of any contribution from the velocity of the TI field toward the GB.

5.0 Conclusions

Table 5. Conclusions for the Newtonian Model of Gravity
The acceleration profile about a GB is proportional to the active gravitational mass of the GB and inversely proportional to the square of the distance from the GB.
The flux of gravitons at a given distance from a GB is proportional to the active gravitational mass of the GB and inversely proportional to the square of the distance from the GB.
The acceleration profile about a GB and the flux profile of gravitons about the GB are proportional to each other.
If an object is moving relative to a GB, the graviton flux at the object will change in accord with the velocity of the object relative to the GB. If the object is directly subject to the gravitational force, its acceleration toward the GB will be affected in accord with the resulting change in graviton flux.
This behavior defies the known acceleration profile that is absent any factor of the velocity of an object in the gravitational field. If an object were directly subject to gravity, the gravitational field of a GB could not be characterized, as it is known to be, solely as a function of the active gravitational mass and distance of the GB.
The only mechanism that can be invoked to nullify the certain and irrefutable effect of the augmentation of graviton flux by the velocity of an object toward a GB is one that denies altogether the direct effect of graviton flux on the acceleration of an object in a gravitational field. ***In simpler terms: massive objects are not directly subject to gravity! More broadly, the Newtonian model of gravity and inertia is invalid.***

Table 6. Conclusions for the TI Field Model of Gravity
Previous studies have shown that the TI field supports the propagation of photons.
The LIGO study showed that gravity propagates at the same speed as photons.
Therefore gravitons propagate at the velocity of c relative to the TI field.
Thus the velocity of gravitons relative to the TI field is constant, regardless of the motion of the TI field relative to a gravitational body (GB).
Accordingly, there is no augmentation of graviton flux by the motion of the TI field relative to a GB.
Gravitons are not directly subject to gravity.
Gravitons are indirectly subject to gravity through the mediation of the TI field.
Particles of the TI field are directly subject to gravity.
Particles of the TI field are accelerated by gravity.
An object in the gravitational field of a GB accelerates toward the GB at the same rate as particles of the TI field.
The static field resists the acceleration of particles of the TI field in their response to gravity.
The TI field resists the acceleration of an object in the object's response to a non-gravitational force.
Objects are not directly subject to gravity.

6.0 References

1. ^ a b Aether theories, https://en.wikipedia.org/wiki/Aether_theories#Mechanical_gravitational_aether, Retrieved Jul 2018.
2. ^ a b c Chu, Jennifer, MIT News Office, LIGO and Virgo make first detection of gravitational waves produced by colliding neutron stars, Laser Interferometer Gravitational-Wave Observatory, https://www.ligo.caltech.edu/page/press-release-gw170817, 20 Oct 2017.
3. ^ Doppler effect, https://en.wikipedia.org/wiki/Doppler_effect#Flow_measurement, Retrieved Jun 2018.
4. ^ Earth radius, https://en.wikipedia.org/wiki/Earth_radius#Mean_radius, Retrieved Jun 2018.
5. ^ a b Escape velocity, https://en.wikipedia.org/wiki/Escape_velocity, Retrieved May 2018.
6. ^ *Flux,* http://en.wikipedia.org/wiki/Flux, February 2014.
7. ^ Global Positioning System, https://en.wikipedia.org/wiki/Global_Positioning_System#cite_note-7, Retrieved Aug 2018.
8. ^ Gravitational acceleration, https://en.wikipedia.org/wiki/Gravitational_acceleration, Retrieved Jun 2018.
9. ^ a b Graviton, https://en.wikipedia.org/wiki/Graviton, Retrieved Jun 2018.
10. ^ a b Gravity, https://en.wikipedia.org/wiki/Gravity, Retrieved Jun 2018.
11. ^ Laughlin, Robert B. (2005). A Different Universe: Reinventing Physics from the Bottom Down. NY, NY: Basic Books. pp. 120–121. ISBN 978-0-465-03828-2.
12. ^ Mass, https://en.wikipedia.org/wiki/Mass, Retrieved Jun 2018.
13. ^ Newton's law of universal gravitation, https://en.wikipedia.org/wiki/Newton%27s_law_of_universal_gravitation, Retrieved Jun 2018.
14. ^ a b Orbital period, https://en.wikipedia.org/wiki/Orbital_period, Retrieved Jun 2018.
15. ^ a b Orbital speed, https://en.wikipedia.org/wiki/Orbital_speed, Retrieved May 2018.
16. ^ a b c d e f g h i Peters, Richard A., Conjecture on Time Dilation, Gravity and Inertia, http://vi^ ra.org/abs/1205.0112, 30 May 2012.
17. ^ a b Peters, Richard A., Hidden Parameters in the Universal Gravitational Constant, http://vi^ ra.org/abs/1802.0296, Feb 2018.
18. ^ a b c d e Peters, Richard A., The Physics Heresies, ISBN 978 148 355 2682, Apr 2015.

19. ^ Speed of light, https://en.wikipedia.org/wiki/Speed_of_light, Retrieved Jun 2018.
20. ^ Standard gravitational parameter, https://en.wikipedia.org/wiki/Standard_gravitational_parameter, Retrieved Jun 2018.

Appendix A

Distinguishing Properties and Behaviors of the Newtonian and TI Field Models of Gravity and Inertia

A.0 Introduction

There are three forms of mass for each of the Newtonian and TI field models of gravity and inertia:

- active gravitational mass,
- passive gravitational mass
- inertial mass

These forms of mass were described in Section 1.5 and Table 3. The properties of these forms of mass depend on the gravitational model as described in Table A.1 The behaviors inherent in the Newtonian and TI field models depend on the properties of mass in each model, as delineated in Tables A.2 through A.5.

A.1 Mass Properties of the Newtonian and TI Field Models

The TI field model is a conjecture of this author. Its properties were originally formulated in reference [16] to support known gravitational and inertial interactions.

Table A.1	Mass Properties of the Newtonian and TI Field Models
Model	**Description**
Newtonian	Objects possess active gravitational mass, passive gravitational mass and inertial mass.
TI Field	Objects possess active gravitational mass and inertial mass, but do not possess passive gravitational mass.
Newtonian	Particles of the TI field possess inertial mass, but do not possess active gravitational mass nor passive gravitational mass.

Table A.1	Mass Properties of the Newtonian and TI Field Models
Model	**Description**
TI Field	Particles of the TI field possess inertial mass and passive gravitational mass, but do not possess active gravitational mass.
TI Field	Particles of the static field do not possess active gravitational mass nor do they possess passive gravitational mass. It is not known whether they possess inertial mass.

A.2 Properties and Behavior of Objects in the Newtonian Model of Gravity

The properties and behavior of objects in the Newtonian model of gravity and inertia depend on the properties of mass of objects in this model.

Table A.2 Properties and Behavior of Objects in the Newtonian Model of Gravity
Objects Possess Active Gravitational Mass
Objects exert the gravitational force by the emission of gravitons.
The rate of emission of gravitons by an object is proportional to the active gravitational mass of the object.
Objects Possess Passive Gravitational Mass
Objects experience the gravitational force through their interaction with gravitons.
The gravitational force experienced by an object is proportional to the passive gravitational mass of the object.
Objects Possess Inertial Mass
An object resists the acceleration caused by the application of either a gravitational or non-gravitational force.
The inertial mass of an object is a measure of the coupling between the object and the TI field. (The TI field plays a role in both the Newtonian and TI field models of gravity.)
The resistance to the acceleration of an object caused by the application of a gravitational or non-gravitational force is proportional to the inertial mass of the object and to the acceleration of the object relative to the TI field.

A.3 Properties and Behavior of Objects in the TI Field Model of Gravity

The properties and behavior of objects in the TI model of gravity and inertia depend on the properties of mass of objects in this model.

Table A.3 Properties and Behavior of Objects in the TI Field Model of Gravity
Objects Possess Active Gravitational Mass
Objects exert the gravitational force by the emission of gravitons.
The rate of emission of gravitons by an object is proportional to the active gravitational mass of the object.
Objects Do Not Possess Passive Gravitational Mass
Objects are not directly subject to gravity.
Objects respond to the gravitational force indirectly through the intermediation of the TI field. See Table A.4 below.
Objects Possess Inertial Mass
The inertial mass of an object is a measure of the coupling between the object and the TI field.
An object resists the application of a non-gravitational force. An object resists acceleration relative to the TI field in the object's response to a non-gravitational force.
The resistance of an object to the acceleration caused by the application of a non-gravitational force is proportional to both the inertial mass of the object and to the acceleration of the object relative to the TI field. (F = ma).

A.4 Properties and Behavior of the TI Field in the TI Field Model of Gravity

The properties and behavior of the TI field itself in the TI model of gravity and inertia depend on the properties of mass of particles of the TI field in this model.

Table A.4 Properties and Behavior of the TI Field in the TI Field Model of Gravity
Particles of the TI Field Do Not Possess Active Gravitational Mass
Particles of the TI field do not exert the gravitational force.
Particles of the TI Field Possess Passive Gravitational Mass
Particles of the TI field experience the gravitational force through their interaction with gravitons.
The gravitational force experienced by a particle of the TI field is proportional to the passive gravitational mass of the particle.
The acceleration of a particle of the TI field is proportional to the graviton flux at the particle.
Particles of the TI Field Possess Inertial Mass
Particles of the TI field resist the application of the gravitational force.
The resistance of a particle of the TI field to the application of a gravitational force is proportional to the inertial mass of the particle.
Interaction of Objects with the TI Field
The inertial mass of an object is a measure of its coupling with the TI field.
The acceleration of the TI field in its response to gravity applies a force to any object within the TI field. This force causes the object to accelerate at the same rate as particles of the TI field at the location of the object.

A.5 Properties and Behavior of the Static Field in the TI Field Model of Gravity

The static field is a conjecture of this author that is required to resist the acceleration of particles of the TI field in their response to gravity. Absent such resistance, the acceleration of particles of the TI field would be unlimited.

Table A.5 Properties and Behavior of the Static Field in the TI Field Model of Gravity
Particles of the Static Field Do Not Possess Active Gravitational Mass
Particles of the static field do not exert the gravitational force.
Particles of the Static Field Do Not Possess Passive Gravitational Mass
Particles of the static field do not experience the gravitational force.
Whether Or Not Particles of the Static Field Possess Inertial Mass Is Undefined
The static field resists the acceleration of particles of the TI field in the response of the TI field to gravity.

Appendix B

Basic Gravitation Formulas Pertinent to the TI Field Model

B.0 Introduction

Section B.1 through Section B.6 apply to the infall variant of the TI field model of gravity. Section B.7 through Section B.9 apply to the orbital variant of the TI field model of gravity. The equations of acceleration and motion appear identical, but some of the terms may apply to different entities. See Tables B.1 and B.2 for summaries of the equations.

B.1 The Acceleration Profile About a Gravitational Body (GB)

Table 2 shows that in the TI field model, particles of the TI field are directly subject to gravity. Just as in the Newtonian model, the acceleration profile about a GB is proportional to the active gravitational mass of the GB and inversely proportional to the square of the distance from the GB at which the acceleration is measured. This relationship is portrayed in Eq (B-1), an iteration of Eq (1) with the difference that Eq (B-1) describes the acceleration of particles of the TI field rather than the acceleration of an object. However, as noted in Section 3.0, the resistance to acceleration between an object and the TI field acts to entrain the object in the TI field. An object is entrained not by the velocity of the TI field, but by its acceleration. Thus an object within the TI field is accelerated toward the GB at the same rate as the TI field.

$$a = GM / r^2 \qquad \text{(B-1)}$$

where

a is the acceleration, relative to the GB, of particles of the TI field toward the GB at the distance r from the GB. Later discussion will show that this is also the acceleration, relative to the GB, of an object.

G is the universal gravitational constant.

M is the active gravitational mass of the GB.

GM: The product of GM taken together is termed the standard gravitational parameter. [20]

r is the distance of the gravitational center of the GB from the point where the acceleration is measured.

B.2 The Speed of an Object in a Circular Orbit About a GB

The acceleration of particles of the TI field toward a GB is expressed by Eq (B-1). An object within the TI field is accelerated toward the GB at the same rate as the TI field. If the object is in a circular orbit, this acceleration can be expressed by Eq (B-2) in terms of the angular velocity ω of the object about the GB and the radius r of the particles and object from the GB. Keep in mind that the object is in a circular orbit about the GB, but the velocity of particles of the TI field is directly toward the GB.

$$a = \omega^2 r = GM / r^2 \qquad \text{(B-2)}$$

Manipulate Eq (B-2) to give the orbital speed ωr of the object in a circular orbit about the GB [15]:

$$v_{orbital} = \omega r = (GM / r)^{1/2} \qquad \text{(B-3)}$$

B.3 The Escape Velocity of an Object from a GB

This section is pertinent only to the infall variant of the TI field model.

> ‘In physics, escape velocity is the minimum speed needed for an object to escape from the gravitational influence of a massive body.’ [5]

An object initially moving at the escape velocity from a GB reaches zero velocity relative to the GB when an infinite distance from the GB. The escape velocity of an object from a GB is given by Eq (B-4). [5]

$$v_{escape} = (2 GM / r)^{1/2} \qquad \text{(B-4)}$$

B.4 The Infall Velocity of the TI Field Toward a GB

This section is pertinent only to the infall variant of the TI field model.

An object falling from an infinite distance from the GB and toward the GB, and not influenced by any other forces, reaches the (negative of) the escape velocity when it reaches the GB. (Neglect little things like the infinite time the fall would take, the expansion of space and other trivia.)

Now, instead of an object falling toward a GB, contemplate particles of the TI field falling from a very great distance (infinity is really too far to consider) toward a GB. The infall velocity of these particles of the TI field is equal, but opposite in sign, to the escape velocity of an object (in the Newtonian model) at a given radius from the GB as shown in Eq (B-4).

The infall velocity of the TI field is equal to the magnitude of the escape velocity of an object at a given radius from a GB as given by Eq (B-5). In the TI field model, particles of the TI field are subject to gravity just as objects are in the Newtonian model.

$$v_{infall} = (2 GM / r)^{1/2} \tag{B-5}$$

B.5 The Period of an Object in a Circular Orbit About a GB Sans Any Flux Variant

The period P of an object in a circular orbit about a GB is given by Eq (B-6). This formula is the same as that for a small object in orbit about a much larger GB. [14]

$$P = 2 \pi (r^3 / GM)^{1/2} \tag{B-6}$$

B.6 Summary of the Gravitation Formulas (Sans Graviton Flux) for the Infall Variant of the TI Field Model

These formulas do not express any effect of the augmentation of graviton flux by the infall velocity of the TI field. See Appendix C for those formulas that do.

Table B.1	Summary of Gravitation Formulas for the Infall Variant of the TI Field Model	
Description	**Formula**	**Equation**
Acceleration Profile of Particles of the TI Field	$a = GM / r^2$	(B-1)
Orbital Speed of an Object	$v_{orbital} = (GM / r)^{1/2}$	(B-3)
Escape Velocity of an Object	$v_{escape} = (2 GM / r)^{1/2}$	(B-4)
Infall Velocity of Particles of the TI Field	$v_{infall} = (2 GM / r)^{1/2}$	(B-5)
Orbital Period of an Object	$P = 2 \pi (r^3 / GM)^{1/2}$	(B-6)

B.7 The Speed of Particles of the TI Field in a Circular Orbit About a GB

This section is pertinent only to the orbital variant of the TI field model.

The acceleration of particles of the TI field in a circular orbit about a GB is the same as given by Eq (B-1) for particles of the TI field falling directly toward the GB. This acceleration can be expressed as in Eq (B-7) in terms of the angular velocity ω of the particles about the GB and the radius r of the particles from the GB:

$$a = \omega^2 r = GM / r^2 \qquad \text{(B-7)}$$

Manipulate Eq (B-7) to give the orbital speed ωr of particles of the TI field in a circular orbit about a GB. [15]

$$v_{orbital} = \omega r = (GM / r)^{1/2} \qquad \text{(B-8)}$$

B.8 The Period of Particles of the TI Field in a Circular Orbit About a GB

This section is pertinent only to the orbital variant of the TI field model.

The period P of particles of the TI field in a circular orbit about a GB is given by Eq (B-9). This formula is the same as Eq (B-6) for a small object in orbit about a much larger GB. [14]

$$P = 2 \pi (r^3 / GM)^{1/2} \qquad \text{(B-9)}$$

B.9 Summary of the Gravitation Formulas (Sans Graviton Flux) for the Orbital Variant of the TI Field Model

These formulas do not express any effect of the augmentation of graviton flux by the orbital velocity of the TI field.

Table B.2	Summary of Gravitation Formulas for the Orbital Variant of the TI Field Model	
Description	**Formula**	**Equation**
Acceleration Profile of Particles of the TI Field	$a = GM / r^2$	(B-7)
Orbital Speed of Particles of the TI Field	$v_{orbital} = (GM / r)^{1/2}$	(B-8)
Orbital Period of Particles of the TI Field	$P = 2 \pi (r^3 / GM)^{1/2}$	(B-9)

Appendix C

The Infall Flux Variant of the TI Field Model

C.0 Introduction

In this Appendix, I hypothesize that the flux of gravitons 'seen' by particles of the TI field is augmented by the velocity of particles of the TI field toward the GB. Then in Section C.3 I show that the effect of this augmented flux causes a decrease in the orbital periods of GPS satellites that does not occur in reality. This null effect yields three conclusions:

- The propagation of gravitons is supported by the TI field.
- Graviton flux at a given point in the TI field is independent of the motion of the TI field toward a GB, and depends only on the distance between the point and the gravitational center of the GB.
- All graviton flux variants of the TI field model of gravity are invalid.

Table C.1 Motion of Particles of the TI Field and Objects in the Infall Flux Variant of the TI Field Model
Particles of the TI field are accelerated directly toward the center of gravity of the GB.
The velocity of particles of the TI field is directly toward the center of gravity of the GB.
In the infall flux variant, the acceleration of particles of the TI field is increased by the augmentation of graviton flux caused by the velocity of particles of the TI field toward the GB.
An object is accelerated directly toward the gravitational center of the GB at the same rate as particles of the TI field.
An object may follow any path relative to the GB, but the equations to follow deal only with an object in a circular orbit about the GB.

In the infall flux variant of the TI field model, particles of the TI field fall directly toward a gravitational body (GB). The radial acceleration of particles of the TI field toward the GB thus accelerates any object in the field at the same rate as particles of the field.

C.1 The Period of an Object in an Idealized Circular Orbit About a GB in the Infall Flux Variant

In the TI field model in which I include the effect of the infall velocity on the graviton flux at a given radius from the GB, the acceleration at that radius is given by Eq (C-1).

$$a = (GM / r^2) (1 + v / c) \qquad \text{(C-1)}$$

where

a is the acceleration of particles of the TI field. This is also the acceleration of an object.

GM is the standard gravitational parameter of the GB.

r is the radius from the GB at which the acceleration is measured.

v is the infall velocity of particles of the TI field toward the GB.

c is the velocity of light.

Incorporate the infall velocity v of particles of the TI field given by Eq (B-5).

$$a = (GM / r^2) \{ 1 + [2 GM / (r c^2)]^{1/2} \} \qquad \text{(C-2)}$$

If the object is in a circular orbit, this acceleration can be expressed by Eq (C-3) in terms of the angular velocity ω of the object about the GB and the radius r of the particles and object from the GB.

$$\omega^2 r = a = (GM / r^2) \{ 1 + [2 GM / (r c^2)]^{1/2} \} \qquad \text{(C-3)}$$

where

ω is the angular velocity of the object in rad / sec.

The angular velocity of the object is given by Eq (C-4).

$$\omega = (GM / r^3)^{1/2} \{ 1 + [2 GM / (r c^2)]^{1/2} \}^{1/2} \qquad \text{(C-4)}$$

The orbital period of the object is

$$P_{infallfluxvariant} = 2\,\pi / \omega \qquad \text{(C-5)}$$

or

$$P_{infallfluxvariant} = 2\,\pi\,(r^3 / GM)^{1/2} / \{ 1 + [2\,GM / (r\,c^2)]^{1/2} \}^{1/2} \qquad \text{(C-6)}$$

The orbital period of the object, if there is no effect of the infall velocity of the TI field on graviton flux, is given by Eq (B-6) repeated here as Eq (C-7) with the subscript added to denote that the period is calculated without the effect of augmented graviton flux.

$$P_{noflux} = = 2\,\pi\,(r^3 / GM)^{1/2} \qquad \text{(C-7)}$$

C.2 The Change in Orbital Period of an Object in the Infall Flux Variant

Let x equal the denominator of Eq (C-6).

$$x = \{ 1 + [2\,GM / (r\,c^2)]^{1/2} \}^{1/2} \qquad \text{(C-8)}$$

The difference in orbital period between the infall flux variant and the model without flux is then:

$$P_{infallfluxvariant} - P_{noflux} = P_{noflux}\ [(1 / x) - 1] \qquad \text{(C-9)}$$

where

$P_{infallfluxvariant}$ is the orbital period of the object given in Eq (C-6).

P_{noflux} is the orbital period of the object given in Eq (C-7).

C.3 GPS Orbits About the Earth

Comparison of Eq (C-6) and Eq (C-7) shows that the increase in acceleration of the TI field due to the increase in graviton flux results in a decrease in the orbital period of an object if such an effect actually exists.

The change in orbital period that would be caused if graviton flux were increased by the infall velocity of the TI field on GPS satellites is given by Eq (C-9). The result is shown in Table C.2.

The difference in the orbital period of GPS satellites is small, less than 0.4 sec, but more than noticeable and clearly intolerable in a system as precise as the GPS.

This discrepancy dooms the notion that graviton flux is enhanced by the infall velocity of the TI field toward a GB. We must conclude that such an effect does not occur. Evidence developed in the studies [16] [18] alluded to in Section 3.3 validate the radial infall of the TI field toward the Earth. The only manner in which the graviton flux cannot be increased by the infall velocity of the TI field toward a GB is one in which the propagation of gravitons is supported by the TI field and only by the TI field. Just as the propagation of photons is supported by the TI field, so must be gravitons.

Gravitons propagate at the speed of light relative to the TI field regardless of the motion of the TI field relative to the GB. The motion of the TI field cannot affect the flux of gravitons seen by the TI field. Hence the flux of gravitons seen by particles of the TI field is independent of the velocity of the TI field relative to the GB and depends only on the proximity to the GB. Table C.2 lists the parameters used in the calculation of GPS orbits and the result.

Table C.2	GPS Orbits for the Infall Flux Variant *
GPS Satellite Parameter	**Value**
Altitude, km	2.018E+04
Radius of Earth, km	6.378E+03
Radius from Earth's Center, km	2.656E+04
Orbital Period, No Flux, Calculated, sec	4.307E+04
Difference in Orbital Period, Flux Model - No Flux, sec	-3.94E-01

* [4] [7]

Appendix D

Flux Variants of the Newtonian and TI Field Models of Gravity

D.0 Introduction

What are flux variants? Recall their definitions in the Glossary which are repeated and expanded below in Table D.1.

Table D.1	Flux Variants Defined
Flux Variant	**Definition**
Flux variant of the Newtonian model	A variant of the Newtonian model of gravity in which the motion of an object relative to a GB affects the graviton flux at the object resulting in a change in the acceleration of the object relative to the GB. See Table D.2.
Flux variants of the TI field model	Variants of the TI field model of gravity in which the motion of particles of the TI field relative to a GB affects the graviton flux at the particles resulting in a change in the acceleration of the particles relative to the GB. The three flux variants of the TI field model are identified by the motion causing the variant: Infall variant, orbital variant and spiral variant. See Table D.3.

D.1 The Flux Variant of the Newtonian Model

The flux variant of the Newtonian model is a gravitational model in which the motion of an object relative to a GB affects the graviton flux at the object and hence the acceleration of the object relative to the GB. The effects of graviton flux in the Newtonian model are described in Table D.2.

Table D.2	The Flux Variant of the Newtonian Model of Gravity
Item	**Description**
1	Recall that in the Newtonian model of gravity, objects are directly subject to gravity.
2	Consequently the acceleration of an object is directly proportional to the graviton flux at the object.
3	In this description of the flux variant of the Newtonian model, we're interested only in the variation of graviton flux with the velocity of an object relative to the GB, not with the object's proximity to the GB. The graviton flux at an object near a GB is affected by the velocity of the object relative to the GB. If the object moves toward the GB the graviton flux and acceleration of the object toward the GB increases. If the object moves away from the GB the graviton flux and acceleration of the object toward the GB decreases.
4	Item 3 is the essence of the flux variant of the Newtonian model.
5	The behavior described in Item 3 defies the known acceleration profile about a GB defined by Eq (1) that is absent any factor of the velocity of an object in the gravitational field.
6	If the flux variant were valid, the gravitational field of a GB could not be characterized, as it is known to be, solely as a function of the active gravitational mass and distance of the GB.
7	The only mechanism that can be invoked to nullify the certain and irrefutable effect of the augmentation of graviton flux by the velocity of an object toward a GB is one that denies altogether the direct effect of graviton flux on the acceleration of an object in a gravitational field. ***In simpler terms: massive objects are not directly subject to gravity! More broadly, the Newtonian model of gravity and inertia is invalid.***

D.2 The Flux Variants of the TI Field Model

The flux variants of the TI field model are gravitational models in which the motion of particles of the TI field relative to a GB affects the graviton flux at the particles and hence the acceleration of the TI field relative to the GB. Three distinct motions of the TI field are considered as listed in Table D.3.

Table D.3	Three Flux Variants of the TI Field Model of Gravity
Flux Variant	**Description**
Infall	Particles of the TI field fall directly toward the GB in accord with Eq (B-5) in Appendix B.
Orbital	Particles of the TI field are in a circular orbit about the GB with an orbital speed given by Eq (B-3).
Spiral	Particles of the TI field spiral toward the GB with a speed between the orbital speed given by Eq (B-3) and the infall speed given by Eq (B-5).

D.3 Summary of the Effect of Graviton Flux on the Three Variants of the TI Field Model

Appendix C describes how the infall variant of the TI field model yields an orbital period of a typical GPS satellite that disagrees by a small, but detectable amount with the calculated value for a circular orbit of the satellite (See Table C.2). This discrepancy dooms the viability of the infall variant of the TI field model. Thus graviton flux cannot be augmented by the infall velocity of the TI field toward a GB. This finding does not dismiss the occurrence of the infall of the TI field toward a GB, only the augmentation of graviton flux by the infall velocity of the TI field, except for the increase in flux caused by the proximity to the GB. In the near vicinity of Earth particles of the TI field do indeed fall directly toward the Earth as described in previous studies. [16] [18]

The only manner in which graviton flux cannot occur in the TI field is one in which the propagation of gravitons is supported by the TI field. Thus the velocity of gravitons relative to the TI field is constant regardless of the motion of the TI field relative to a GB. Similarly, the orbital and spiral variants of the TI field model do not augment the graviton flux ‘seen’ by the TI field.