# A Photon's Journey Through the Universe

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***Abstract***

The constancy of the speed of light offers a clue about how the Universe works. The speed of light in each galaxy is the same as in every other galaxy even as the galaxies move at relativistic speed relative to each other in the general expansion of the Universe. In addition, each galaxy is accelerated by the gravitation of nearby galaxies that adds the so-called peculiar velocity of the galaxy to the velocity of the general expansion at the galaxy. The propagation of photons is supported by a medium that permeates space at all scales. The medium that permeates a given galaxy must move at the same rate as the combined velocity of the general expansion at the galaxy and the peculiar velocity of the galaxy. We examine two models of gravity to determine which supports the concerted motion of the medium and its host galaxy. We find that only one of the two models supports this concerted motion.

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## 1.0 First Matters

The properties and behavior of a model of gravity that I've named the TI field model of gravity are compared with the properties of the familiar Newtonian model. The object of this paper is to compare the properties of the two models of gravity that affect their role in mediating gravity. These properties are compared by considering the speed of photons as they originate from a distant galaxy and pass through several other galaxies on their journey toward Earth.

The properties of the two models are compared briefly in Table 1.1 and described more fully in Appendices A and B.

**Table 1.1**

| Table 1.1 | Brief Comparison of Properties of the TI Field Model and Newtonian Model of Gravity and Inertia |
|---|---|
| **TI Field Model of Gravity and Inertia** | **Newtonian Model of Gravity and Inertia** |
| The TI field is directly subject to gravity. | The TI field is not subject to gravity. |
| The acceleration of the TI field in response to gravity is resisted by the Static field. | NA |
| The TI field does not assert the gravitational force. | The TI field does not assert the gravitational force. |
| The TI field supports the propagation of nature's force particles. | NA |
| The acceleration of the TI field in response to gravity applies the same acceleration to a freely moving matter object within the TI field. [7] | NA |
| Matter objects are not directly subject to gravity. | Matter objects are directly subject to gravity. |
| The acceleration of a matter object in response to a non-gravitational force is resisted by the TI field. | The acceleration of a matter object in response to either a gravitational or non-gravitational force is resisted by the TI field. |
| Matter objects assert the gravitational force. | Matter objects assert the gravitational force. |

## 2.0 The Propagation of Light Through the Universe

Galaxies are treated as monolithic objects in this study, while it is clear that they are not. Galaxies have billions of constituent parts, namely stars, that move relative to each other. The TI field itself is blended into orbital currents that control the motion of the stars. The study of how this complex environment affects light moving through a galaxy is beyond the scope of this paper and is addressed in reference [5].

## 2.1 The Speed of Light Provides a Clue

> 'It is evident that in the post-Copernican era of human history, no well-informed and rational person can imagine that the Earth occupies a unique position in the universe.' [1] [8]

The constancy of the speed of light offers a clue about how the Universe works. The speed of light in each galaxy is the same as in every other galaxy even as the galaxies move at relativistic speed relative to each other. This may seem obvious, but let's think about it by configuring a thought experiment.

The primary assumption of our thought experiment deserves repetition: ***The speed of light in each galaxy is the same as in every other galaxy even as the galaxies move at relativistic speed relative to each other.*** How do we know this? Bluntly, the speed of light has been measured in our vicinity in our own galaxy; and our own galaxy, give or take a few billion stars, is the same as any other galaxy. The Copernican principle is at work. [1]

So, what are the assumptions in this thought experiment?

| **Table 2.1** | **Assumptions of the Thought Experiment** |
|---|---|
| **Item** | **Assumption** |
| 1 | Photons don't move through space like little bullets, they propagate through space. |
| 2 | There exists a medium that supports the propagation of photons. |
| 3 | The speed of photons relative to the medium itself is c. |
| 4 | Assign a name to this medium: the Temporal Inertial (TI) field. |

## 2.2 The Photons' Journey Through the Universe

Proceed with our thought experiment as listed in Table 2.2.

**Table 2.2**

| Table 2.2 | The Thought Experiment at Light Speed |
|---|---|
| **Item** | **Thought Experiment** |
| 1 | A distant galaxy is known to recede from our location on Earth at relativistic speed. |
| 2 | Launch a packet of photons from this distant galaxy toward the Earth. |
| 3 | As the photons propagate toward the Earth, they pass through other galaxies in their path. |
| 4 | Each of these galaxies is itself receding from Earth at a relativistic speed that increases with distance from the Earth. |
| 5 | Superimposed on the recessional velocity of each galaxy is the galaxy's peculiar motion in response to local variations in gravity caused by the disposition of nearby galaxies. [4] |
| 6 | In each galaxy through which the photons pass, their speed relative to the galaxy is the same: c. |
| 7 | At long last the photons reach Earth and their speed is measured to be c. |

## 2.3 Observations of the Thought Experiment

| Table 2.3 | Observations of the Thought Experiment |
|---|---|
| **Item** | **Observations** |
| 1 | As specified in Table 2.1, the speed of photons relative to the TI field is c. As observed in the thought experiment of Table 2.2, the speed of photons relative to a galaxy in their path is c. Accordingly, the motion of the TI field must be the same as that of the galaxy the field permeates. |
| 2 | As the motion of the TI field is in concert with the motion of its host galaxy in their peculiar motion in response to the gravity of other galaxies we are faced with two possibilities:<br>• Galaxies are directly subject to gravity but the TI field is not.<br>• The TI field is directly subject to gravity but galaxies are not. |
| 3 | Absent a discontinuity in the medium supporting the propagation of photons In between the galaxies along the path of the photons from their source in the distant galaxy, the motion of the TI field must be in continuous transition between galaxies. |
| 4 | Item 3 suggests that in between galaxies, the peculiar velocity of the TI field derives from the gravity of nearby galaxies. |
| 5 | We can generalize that the recessional motion of galaxies away from Earth in the direction of the source of the packet of photons represents a three-dimensional recession, not just the one dimensional recession of our thought experiment. |

## 2.4 Conclusions from the Thought Experiment

The response of the TI field and its host galaxy to the gravitational force of nearby galaxies provides an opportunity to compare properties of the TI field model with those of the Newtonian model. Recognize that a galaxy is a huge, extended object and its own gravitational field and that of nearby galaxies is not uniform throughout the galaxy.

We are interested in how galaxies and the TI field permeating them are accelerated by the gravitational fields of nearby galaxies. As noted in Table 2.3, the velocity of the packet of photons passing through a galaxy is the same as their velocity relative to the TI field. Accordingly, the peculiar velocity of each galaxy and the TI field that permeates it must be the same.

## 2.5 The Peculiar Velocity of Galaxies and the TI Field

The peculiar velocity of a galaxy is defined as the component of velocity of a galaxy that deviates from that of the Hubble flow at the galaxy. [4] The Hubble flow is a measure of the expansion of the Universe. [2] The peculiar velocity of a galaxy results from the gravitational attraction of other nearby galaxies.

In the TI field model of gravity, matter objects are not ***directly*** subject to gravity. This means that gravity acts through the mediation of the TI field, not directly on matter objects. Gravity accelerates particles of the TI field. Any difference in acceleration between the TI field and a matter object applies a force to the matter object that eliminates the difference in acceleration. Gravity is the prime mover in the transaction, but operates ***indirectly*** through the TI field.

In the Newtonian model of gravity, the gravity of a gravitational body acts directly on matter objects to accelerate them toward the gravitational body. The TI field is not subject to gravity.

## 2.6 Which Gravitational Model Supports the Concerted Motion of Galaxy and TI Field?

We need some criterion by which to discriminate between the two models of gravity. The two models differ primarily in how matter objects and particles of the TI field react to gravity. The premises for the two models are the following:

1. Premise of the Newtonian model of gravity: Galaxies (matter objects) are directly subject to gravity, but the TI field is not subject to gravity.
2. Premise of the TI field model: The TI field is directly subject to gravity, but galaxies (matter objects) are not.

We examine each gravitational model to determine whether it supports the concerted motion of the galaxy and the TI field within the galaxy in their response to the gravitational fields of nearby galaxies. If this concerted motion is supported, the model is validated, else the model is invalidated.

It will be shown that of the two models of gravity examined, only one supports the concerted motion of the galaxy and the TI field within the galaxy. Tables 2.4 and 2.5 present the arguments and conclusions from these thought experiments.

### *2.6.1 Premise of the Newtonian Model of Gravity: Galaxies (Matter Objects) Are Directly Subject to Gravity, but the TI Field Is Not Subject to Gravity*

| **Table 2.4 Premise of the Newtonian Model of Gravity: Galaxies (Matter Objects) Are Directly Subject to Gravity, but the TI Field Is Not Subject to Gravity** |
|---|
| **Observation** |
| As given in Table 2.3, the peculiar velocity of the TI field matches that of its host galaxy in response to the gravitational field of nearby galaxies. |
| **Arguments** |
| Could a galaxy drag the TI field along in its response to the gravitational field of nearby galaxies? |
| The acceleration of a matter object is resisted by the TI field. It is likely that this inertial reaction of the TI field causes the acceleration of the TI field itself. However, the inertial reaction of the TI field is localized within the immediate envelope of the matter object itself. While we can think of a galaxy as a matter object, it comprises billions of much smaller matter objects: stars (not to mention volumes of gas). The acceleration of the TI field in its inertial reaction to the acceleration of a given star would be confined to the envelope of the star itself and not applied to the TI field between stars. |
| **Conclusion** |
| A galaxy does not drag the TI field along in its response to the gravitational field of nearby galaxies. |
| **Arguments** |
| The only way the velocity of the TI field could equal that of its host galaxy would be if the TI field were subject to gravity which is precluded by the premise of the Newtonian model of gravity. |
| **Conclusions** |
| If the TI field is not subject to gravity; its velocity cannot equal that of its host galaxy in response to the gravitational force of nearby galaxies. |
| Galaxies (matter objects) cannot be directly subject to gravity while the TI field is not subject to gravity. |
| The premise of the Newtonian model of gravity is violated. |

### *2.6.2 Premise of the TI Field Model of Gravity: the TI Field Is Directly Subject to Gravity, but Galaxies (Matter Objects) Are Not*

| **Table 2.5 Premise of the TI Field Model of Gravity: The TI Field Is Directly Subject to Gravity, but Galaxies (Matter Objects) Are Not** |
|---|
| **Arguments** |
| The TI field is subject to gravity and is accelerated by the gravitational fields of nearby galaxies. |
| The acceleration of the TI field in its response to the gravitational field of nearby galaxies imparts the same acceleration to its host galaxy, thus the host galaxy is entrained in the motion of the TI field permeating the galaxy. |
| **Conclusions** |
| The TI field is directly subject to gravity, but galaxies (matter objects) are not. |
| The premise of the TI model of gravity is validated. |

## 3.0 Conclusions

| **Table 3.1 Conclusions** |
|---|
| The TI field is directly subject to gravity. |
| Matter objects (galaxies) are not directly subject to gravity. |
| The TI field model of gravity is validated. |

## 4.0 References


1. ^ **a b** Copernican principle, https://en.wikipedia.org/wiki/Copernican_principle, Retrieved May 2020.
2. **^** Hubble’s law, https://en.wikipedia.org/wiki/Hubble%27s_law, Retrieved Nov 2020.
3. **^** Mass, https://en.wikipedia.org/wiki/Mass, Retrieved Sep 2020.
4. ^ **a b** Peculiar velocity, https://en.wikipedia.org/wiki/Peculiar_velocity, Retrieved Oct 2020.
5. **^** Peters, Richard A., A Photon’s Journey Through a Spiral Galaxy, Work in Progress.
6. **^** Peters, Richard A., Crafting a Model for the Creation of Dark Matter, https://vixra.org/abs/2004.0196.
7. ^ **a b c d e** Peters, Richard A., Hidden Parameters in the Universal Gravitational Constant, viXra:1802.0296 submitted on 2018-02-21.
8. **^** Rowan-Robinson, Michael (1996), Cosmology (3rd ed.), Oxford University Press, https://www.amazon.com/Cosmology-Oxford-Physics-Michael-Rowan-Robinson/dp/0198518846

# Appendix A

# Properties of the Temporal Inertial Field in Brief [6]

## A.1 Definitions of Mass

A brief description follows of the forms of mass existent in the two models of gravity described in this paper. I paraphrase the three definitions of mass offered by Wikipedia [3] for the Newtonian model and modify those definitions where appropriate for the TI field model.

| Table A.1 | Definitions of Mass |
|---|---|
| **Mass in the Newtonian Model** | **Definition** |
| Active gravitational mass of a matter object | A measure of the gravitational force exerted by a matter object. |
| Passive gravitational mass of a matter object | A measure of the gravitational force experienced by a matter object in a known gravitational field. |
| Inertial mass of a matter object | A measure of a matter 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 a matter object | A measure of the gravitational force exerted by a matter 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 a matter object | Matter 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 a matter object | A measure of a matter object's resistance to being accelerated by a non-gravitational force. |

## A.2 Mass Properties of the Newtonian and TI Field Models of Gravity

**Table A.2 Mass Properties of the Newtonian and TI Field Models of Gravity**

| | | | |
|---|---|---|---|
| **Gravitational Model** | **Active Gravitational Mass** | **Passive Gravitational Mass** | **Inertial Mass** |
| Matter Objects in the Newtonian Model | Yes, matter objects assert the gravitational force. | Yes, matter objects are directly subject to gravity. | Yes, matter objects resist acceleration relative to the TI field in response to either a gravitational or non-gravitational force. |
| Matter Objects in the TI Field Model | Yes, matter objects assert the gravitational force. | No, matter objects are not directly subject to gravity. | Yes, matter objects resist acceleration relative to the TI field in response to a non-gravitational force. |
| Particles of the TI Field in the Newtonian Model | No, particles of the TI field do not assert the gravitational force. | No, particles of the TI field are not subject to gravity. | Yes, particles of the TI field resist acceleration relative to the static field. |
| Particles of the TI Field in the TI Field Model | No, particles of the TI field do not assert the gravitational force. | Yes, particles of the TI field are directly subject to gravity. | Yes, particles of the TI field resist acceleration relative to the static field in response to a gravitational force. |

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

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

| Table A.3 Properties and Behavior of Matter Objects in the TI Field Model of Gravity |
|---|
| **Matter Objects Possess Active Gravitational Mass** |
| Matter objects exert the gravitational force by the emission of gravitons. |
| The rate of emission of gravitons by a matter object is proportional to the active gravitational mass of the object. |
| **Matter Objects Do Not Possess Passive Gravitational Mass** |
| Matter objects are not directly subject to gravity. |
| Matter objects respond to the gravitational force indirectly through the intermediation of the TI field. See Table A.4 below. |
| **Matter Objects Possess Inertial Mass** |
| The inertial mass of a matter object is a measure of the resistance of the object to its acceleration relative to the TI field in response to a non-gravitational force. |
| The resistance of a matter object to the acceleration caused by the application of a non-gravitational force is proportional to the product of the inertial mass of the object and 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 Matter Objects with the TI Field** |
| The inertial mass of a matter 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 matter object within the TI field. This force causes the matter 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

# Two Models of Gravity and Inertia

## B.0 The Newtonian and TI Field Models of Gravity and Inertia

There are two different models of gravity and inertia discussed in this study; the Newtonian model and the TI field model. Their main difference is in their definitions of mass and how matter objects move in response to gravity.

## B.1 The Newtonian Model of Gravity and Inertia

### *B.1.1 Definition of Matter Particles and Matter Objects in the Newtonian Model*

Throughout this paper I define matter particles by two of their properties of mass rather than by their constituents, e.g., sub-atomic particles. The definition is this: Matter particles exhibit active gravitational mass and inertial mass. Matter particles may or may not exhibit passive gravitational mass depending on the gravitational model.

Similarly I define a matter object by two of its properties of mass rather than by its constituents, e.g., atoms, sub-atomic particles. The definition is this: A matter object exhibits active gravitational mass and inertial mass. A matter object may or may not exhibit passive gravitational mass depending on the gravitational model.

A matter object may comprise one or more matter particles. A galaxy may be considered a matter object.

### *B.1.2 Definition of Particles of the TI Field in the Newtonian Model*

In the Newtonian model, particles of the TI Field possess inertial mass, but do not possess either active or passive gravitational mass.

### *B.1.3 How A Matter Object Moves in Response to a Gravitational Force*

Recall that the passive gravitational mass of a matter object is a measure of the object's response to the gravitational force and the object's inertial mass is a measure of its resistance to acceleration relative to the TI field. It's logical then that the acceleration of a matter object in response to a gravitational force is proportional to the object's passive gravitational mass and inversely proportional to its inertial mass. Indeed, I show in reference [7] this is just so. Unfortunately, as asserted in reference [7], the ratio of an object's passive gravitational mass to its inertial mass is sequestered in the universal gravitational constant G.

### *B.1.4 How A Matter Object Moves in Response to a Non-Gravitational Force*

The acceleration of a matter object in response to a non-gravitational force is proportional to the applied force and inversely proportional to the object's inertial mass. Again, for the Newtonian model, the inertial mass of a matter object is a measure of the object's resistance to acceleration relative to the TI field.

## B.2 The Temporal Inertial (TI) Field Model of Gravity and Inertia

### *B.2.1 Definition of Matter Particles and Matter Objects in the TI Field Model*

In the TI field model, matter particles possess active gravitational mass and inertial mass. Matter particles do not possess passive gravitational mass.

An object may comprise one or more matter particles. A galaxy may be considered a matter object.

### *B.2.2 Definition of Particles of the TI Field in the TI Field Model*

In the TI field model, particles of the TI field possess inertial mass and passive gravitational mass, but do not possess active gravitational mass. In the TI field model, particles of the TI field are directly subject to gravity, but do not assert the gravitational force.

### *B.2.3 How A Particle of the TI Field Moves in Response to a Gravitational Force*

Recall that the passive gravitational mass of a particle of the TI field is a measure of the particle's response to the gravitational force and the object's inertial mass is a measure of its resistance to acceleration relative to the Static field. It's logical then that the acceleration of a particle of the TI field in response to a gravitational force is proportional to the particle's passive gravitational mass and inversely proportional to its inertial mass. Indeed, I show in reference [7] this is just so. Unfortunately, as asserted in reference [7], the ratio of the passive gravitational mass of a particle of the TI field to its inertial mass is sequestered in the universal gravitational constant G.

### *B.2.4 How A Matter Object Moves in Response to a Gravitational Force*

In the TI field model, matter particles have no passive gravitational mass. Matter particles are not subject directly to the gravitational force.

As particles of the TI field are accelerated in response to a gravitational force they impart the same acceleration to a matter object in the field. Once a matter object is entrained in the TI field, its velocity relative to the TI field remains unchanged.

### *B.2.5 How A Matter Object Moves in Response to a Non-Gravitational Force*

The acceleration of a matter object in response to a non-gravitational force is proportional to the applied force and inversely proportional to the object's inertial mass. In both the Newtonian model and the TI field model, the inertial mass of a matter object is a measure of the object's resistance to acceleration relative to the TI field.

## B.3 Summary of the Mass Properties of Matter Objects and Particles of the TI Field in the Newtonian and TI Field Models of Gravity and Inertia

These properties are summarized in Table A.2 in Appendix A.