A Star’s Journey Through a Spiral Galaxy

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Abstract

Previous studies have shown that the time dilation of a process (e.g., a ticking clock) is caused by the velocity of the process relative to a medium that supports the propagation of nature’s force particles. Proper operation of the Global Positioning System requires that the Earth and this medium move in concert about the Sun and about the galactic center. Absent this concerted motion there would be a cyclic variation in the time dilation of the GPS satellite clocks, a variation that is not observed. We examine two models of gravity to determine which supports the concerted motion of the medium, the Sun and the Earth. 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 those of the familiar Newtonian model. The object of this paper is to compare the properties of the two models that affect their role in mediating gravity. These properties are compared by considering how they determine the orbit of a typical star within a spiral galaxy. We choose as our exemplars the Sun and the Milky Way Galaxy.

1.1 Motion of the TI Field, the Sun and the Earth

Previous studies [6] [10] have shown that to accommodate proper operation of the Global Positioning System, the Earth and the TI field must orbit the Sun in concert, and by extension, the TI field and the Sun must orbit the Galaxy in concert. (See Section 2.2.) The path of the Earth in space is a helix [4] with the Sun lying along the axis of the helix. The axis of the helix is the orbital path of the Sun about the galactic center. The center of curvature of the axis of the helix is the gravitational center of the Galaxy. The radius of curvature of the axis of the helix is the distance of the Sun from the center of the Galaxy, a distance of some 27,000 light-years. (See Appendix C.)

1.2 Comparison of the Properties of the TI Field Model and Newtonian Model of Gravity

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

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 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.

1.3 Time Dilation

The phenomenon of time dilation lies at the root of the TI field model of gravity and inertia. The TI field model explains how the gravitational interaction between matter objects and particles of the TI field affects the time dilation of a process that moves relative to the TI field, while the Newtonian model does not.

A process that moves through 'space' takes longer than the process that is stationary or moves more slowly through 'space'. The 'space' I refer to is permeated at every scale from subatomic to extra-galactic by a medium that supports the propagation of nature's force particles. Reference [8] showed that time dilation of a process is caused by the velocity of the process through this medium of space. I give this medium a name: the temporal inertial (TI) field. The TI field is thus a frame of reference for motion.

1.4 What is a Process?

A process is an operation, activity or sequence of changes that takes time. The process can be atomic, such as the emission of light from an atom; chemical, such as the reaction of oxidation; biological, such as the aging of an astronaut; or mechanical, such as the rhythm of a metronome or the ticking of a clock.

2.0 The Results of Previous Studies

The conclusions of two previous studies identify the cause of time dilation of a clock and the indirect effect of gravity on the time dilation of the clock. These effects inform us how the TI field moves in response to gravity and how the gravitational model affects that response.

2.1 Results from the Study of the Twin Paradox [8]

It was found in a study of the twin paradox that the time dilation of a process (e.g., a ticking clock) is caused exclusively by the velocity of the process relative to the TI field. Time dilation is not caused directly by gravity nor is it caused by acceleration nor by the velocity of the process relative to an arbitrary frame of reference. Indeed, the TI field itself is a frame of reference for motion in the Universe.

2.2 Considerations of the Global Positioning System [8]

Two phenomena described in the theories of relativity affect the clock rates of GPS satellites: gravitational time dilation and time dilation caused by the orbital velocity of the GPS clocks. Neglect, for the moment, gravitational time dilation. (This subject is addressed briefly in Section 2.3.) The Global Positioning System compensates for the time dilation of each GPS satellite's clock. Considering the Earth's many motions including its orbit about the Sun, about the galactic center and its motion with the Galaxy relative to the Cosmic Microwave Background (CMB), requires that the TI field and the Earth move in concert.

Consider what would happen if this were not true. If the Earth moved with respect to the TI field, the velocity with respect to the TI field of an orbiting GPS satellite would be greater when a component of the satellite's velocity is in the same direction as the Earth's velocity and less when a component of the satellite's velocity is opposite the direction of the Earth's velocity. The rate of its clock due to time dilation would then vary continuously during the orbit. Such behavior is not observed. Given that the Global Positioning System works flawlessly, only one conclusion can be drawn: absent one caveat, the Earth does not move with respect to the TI field. Only one component of the motion of the TI field moves relative to the Earth. The infall velocity of the TI field toward the center of the Earth accounts in full for the gravitational time dilation that occurs in GPS satellite clocks.

2.3 Gravitational Time Dilation in the Global Positioning System

Reference [9] shows that the gravitational time dilation of GPS satellite clocks is not caused directly by gravity, but indirectly by the infall velocity of the TI field toward the Earth that ***is*** caused directly by gravity. The infall velocity of the TI field at a given radius from the Earth is the negative of the escape velocity at that radius.

Now, let us apply these ideas to determine the interaction of gravity with the Earth, the Sun and the TI field.

3.0 The Sun's Journey Through the Galaxy

The principal motion of the Earth is its orbital velocity about the center of mass of the Galaxy. Superimposed on this motion is the much smaller orbital velocity of the Earth about the Sun. These motions also describe those of the TI field, else the motion of the TI field would not be in concert with that of the Earth.

The principal motion of the Sun is its orbital velocity about the center of mass of the Galaxy. The orbit of the Sun is not the idealized circle depicted in reference [3], but is more likely an ellipse distorted by the asymmetrical distribution of stellar masses in the spiral arms and central bar of the Galaxy. Nevertheless, the Sun and the Earth both orbit the Galaxy in the same path as the TI field. The motions of the TI field and the Sun in their response to the gravitational field of the Galaxy depend on the model of gravity that best describes that behavior. The arguments to follow are based on the orbital motions of the Sun and the TI field about the center of the Galaxy.

3.1 Which Gravitational Model Supports the Concerted Motion of the TI Field and the Sun About the Galaxy?

In the TI field model of gravity, matter objects (e.g., the Sun) 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. We conduct two thought experiments to determine which gravitational model supports the concerted motion of the TI field and the Sun.

We need some criterion by which to discriminate between the two models of gravity. The premises for the two models are the following:

1. Premise of the Newtonian model of gravity: the Sun (a matter object) is 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 the Sun (a matter object) is not.

We examine each gravitational model to determine whether it supports the concerted motion of the TI field and the Sun about the Galaxy. 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 TI field and the Sun about the Galaxy. Tables 3.1 and 3.2 present the arguments and conclusions from these thought experiments.

3.1.1 Premise of the Newtonian Model of Gravity: the Sun (a Matter Object) Is Directly Subject to Gravity, but the TI Field Is Not Subject to Gravity

Table 3.1 Premise of the Newtonian Model of Gravity: the Sun (a Matter Object) Is Directly Subject to Gravity, but the TI Field Is Not Subject to Gravity
Observation
As stated in Section 3.0, the orbits of the TI field and the Sun about the Galaxy are the same.
Arguments
Could the Sun drag the TI field along in its response to the gravitational field of the Galaxy?
The acceleration of the Sun (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 Sun itself. The acceleration of the TI field in its inertial reaction to the acceleration of the Sun would be confined to the envelope of the Sun itself and not applied to the TI field beyond the Sun.
Conclusion
The Sun does not drag the TI field along in its response to the gravitational field of the Galaxy.
Arguments
The only way the orbit of the TI field could match that of the Sun 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 orbit cannot match that of the Sun in response to the gravitational force of the Galaxy.
The Sun (a matter object) cannot be directly subject to gravity while the TI field is not subject to gravity.

Table 3.1 Premise of the Newtonian Model of Gravity: the Sun (a Matter Object) Is Directly Subject to Gravity, but the TI Field Is Not Subject to Gravity
The premise of the Newtonian model of gravity is violated.

3.1.2 Premise of the TI Field Model of Gravity: the TI Field Is Directly Subject to Gravity, but the Sun (a Matter Object) Is Not

Table 3.2 Premise of the TI Field Model of Gravity: The TI Field Is Directly Subject to Gravity, but the Sun (a Matter Object) Is Not
Arguments
The TI field is subject to gravity and is accelerated by the gravitational field of the Galaxy.
The acceleration of the TI field in its response to the gravitational field of the Galaxy imparts the same acceleration to the Sun, thus the Sun is entrained in the motion of the TI field at the Sun.
Similarly, the acceleration of the TI field in its response to the gravitational field of the Sun superimposes the same acceleration on the Earth, thus the Earth is entrained in the motion of the TI field at the Earth, which causes the Earth to orbit both the Sun and the center of the Galaxy.
Conclusions
The TI field is directly subject to gravity, but the Sun and the Earth (both matter objects) are not.
The premise of the TI model of gravity is validated.

4.0 Conclusions

Table 3.3 Conclusions
The TI field is directly subject to gravity.
Matter objects are not directly subject to gravity.
The TI field model of gravity is validated.

5.0 Reference

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Appendix A

Properties of the Temporal Inertial Field in Brief

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 [5] 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.

Appendix C

Orbital Values of the Sun and Earth

Table C.1

Table C.1	Orbital Values of the Sun and Earth	
Description	**Value**	**Units**
Orbital velocity of the Earth about the Sun [1]	2.98E+01	km / sec
Orbital velocity of the Sun about the center of mass of the Galaxy [11]	2.40E+02	km / sec
Distance of the Sun from the Galactic Center[2]	2.67E+04	lt-yr
Period of the Galactic year [3]	2.25E+08	yr