New Models of Inertial Mass and Passive Gravitational Mass

Richard A. Peters

Abstract

Any proposed model of gravity must exhibit the same behavior as the model it supersedes, even though the mechanism by which the new model operates differs dramatically from the old. In the old temporal inertial (TI) field model of gravity and inertia, an object does not possess passive gravitational mass; an object is not directly subject to gravity. This paper proposes a new model of passive gravitational mass and inertial mass within the fundamental strictures of the TI field model. In the new TI field model, the passive gravitational mass of an object is a measure of the response of the object, not to gravity, but to the acceleration of the TI field. In the volume of space surrounding a gravitational body (GB), the TI field is accelerated toward the center of mass of the GB. In the new model, the passive gravitational mass of an object ***still appears to be*** a measure of the response of the object to gravity. In the new model the property of passive gravitational mass of an object ensures that, within a gravitational field and absent non-gravitational forces, the object accelerates at the same rate as the TI field toward the center of mass of the GB. As the object is not directly subject to gravity and there is no difference in acceleration between the object and the TI field, there is no force on the object. In the new TI field model the inertial mass of an object no longer plays a role in the interaction between an object and gravity. In non-gravitational interactions, it is the TI field that produces the inertial reaction force that opposes the application of a non-gravitational force, not the object itself.

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1.0 Introduction

This introduction describes briefly three models of gravity and inertia: the Newtonian model and two versions of the temporal inertial (TI) field model, a concept of this author. The thrust of this study, however, is to describe the new version of the TI field model in which the properties of both the passive gravitational mass and inertial mass of objects supplant those of the old TI field model.

These three different models of gravity and inertia are discussed in this paper:

- The Newtonian model
- The old temporal inertial field model
- The new temporal inertial field model

1.1 What is an Object?

An object comprises one or more particles of matter, which are primarily protons, neutrons and electrons. Thus a neutron, a brick and a star may each be considered an object. The three gravitational models differ primarily in how an object behaves in gravitational and non-gravitational interactions. This behavior depends on how the mass of an object is characterized in each model.

1.2 What is Mass?

There are three properties of objects that have been identified as mass. These properties are unique and differ from each other. They perform different functions in the interactions of objects with gravity and with non-gravitational forces. These functions are not equivalent; they are not equal. We will look briefly at these interactions as characterized in the three models of gravity and inertia.

2.0 Three Basic Models of Gravity and Inertia

The two TI field models of gravity and inertia differ substantially from the familiar Newtonian model. The most important distinction between the three models is the behavior of objects in gravitational and non-gravitational interactions and the interaction of the TI field itself with gravity. These distinctions are expressed in Tables 1 through 4. No more will be said of the Newtonian model.

2.1 Properties of Mass and the Behavior of Objects in the Newtonian Model of Gravity and Inertia

Table 1. Properties of Mass and the Behavior of Objects in the Newtonian Model of Gravity and Inertia

Properties of Mass	Behavior of Objects
Objects possess active gravitational mass.	Active gravitational mass is a measure of an object's contribution to gravity. Objects are the source of gravitons.
Objects possess passive gravitational mass.	Passive gravitational mass is a measure of an object's response to the gravitational force. Objects are directly subject to gravity.
Objects possess inertial mass	Inertial mass is a measure of an object's resistance to acceleration in response to an applied non-gravitational force. The object resists its acceleration relative to the inertial field by exerting the inertial reaction force opposing the application of the non-gravitational force.

2.2 Properties of Mass and the Behavior of Objects in the Old TI Field Model of Gravity and Inertia

In the old TI field model, shown in Table 2, inertial mass plays a dominant role in the gravitational interaction. In the new TI field model, shown in Table 3, the inertial mass of an object plays no role in the gravitational interaction. Note the dual role of inertial mass in the old TI field model.

Table 2. Properties of Mass and the Behavior of Objects in the Old TI Field Model of Gravity and Inertia

Properties of Mass	Behavior of Objects
Objects possess active gravitational mass.	Objects are the source of gravitons.
Objects do not possess passive gravitational mass.	Objects are not directly subject to gravity.
Inertial mass is a measure of an object's response to the acceleration of the TI field.	The acceleration of the TI field in its response to gravity applies a force to an object until the object accelerates at the same rate as the TI field.
The inertial mass of an object is a measure of the ***resistance of the object*** to the acceleration of the object relative to the TI field.	The application of a non-gravitational force to an object causes the object to accelerate relative to the TI field. The object forcefully resists this acceleration by exerting the inertial reaction force opposing the applied non-gravitational force.

The properties of mass of the old TI field model of gravity and inertia described in Table 2 have been superseded by the new TI field model shown in Table 3. In particular, compare the description of inertial mass in Table 2 with that in Table 3.

- The inertial mass of an object is described in Table 2 as a measure of the ***resistance of the object*** to the acceleration of the object relative to the TI field.
- The inertial mass of an object is described in Table 3 as a measure of the ***resistance of the TI field*** to the acceleration of the object relative to the TI field.

In the old TI field model, the object exerts the inertial reaction force; in the new TI field model, the TI field itself, not the object, exerts the inertial reaction force on the object.

This may appear to be a distinction without a difference. Consider an alternative premise: the object generates the inertial reaction force that opposes the applied non-gravitational force. If the TI field doesn't apply the inertial reaction force, what backs up the force that the object exerts against the applied force? It must be the TI field itself. The premise of the argument is violated. The TI field does generate the inertial reaction force that acts through the object to oppose the non-gravitational force applied to the object.

The inertial mass of the object couples the object to the TI field, but the TI field generates the inertial reaction force that opposes the non-gravitational force applied to the object.

2.3 Properties of Mass and the Behavior of Objects in the New TI Field Model of Gravity and Inertia

Table 3. Properties of Mass and the Behavior of Objects in the New TI Field Model of Gravity and Inertia

Properties of Mass	Behavior of Objects
Objects possess active gravitational mass.	Objects are the source of gravitons.
Passive gravitational mass is a measure of an object's response to the acceleration of the TI field.	An object in a gravitational field accelerates at the same rate as the TI field in the TI field's response to gravity. As the object is not directly subject to gravity and there is no difference in acceleration between the object and the TI field, there is no force on the object.
The inertial mass of an object is a measure of the ***resistance of the TI field*** to the acceleration of the object relative to the TI field. The inertial mass of an object plays no role in the gravitational interaction.	The application of a non-gravitational force to an object causes the object to accelerate relative to the TI field. The TI field, not the object, resists this acceleration by exerting the inertial reaction force opposing the applied non-gravitational force.

2.4 Properties of Mass and the Behavior of the TI Field in the TI Field Model of Gravity and Inertia

Table 4

Table 4. Properties of Mass and the Behavior of the TI Field in the TI Field Model of Gravity and Inertia	
Properties of Mass	**Behavior of the TI Field**
The TI field does not possess active gravitational mass.	The TI field does not contribute to gravity. The TI field is not the source of gravitons.
The TI field possesses passive gravitational mass.	Passive gravitational mass is a measure of the response of the TI field to gravity. The TI field is directly subject to gravity.
The TI field possesses inertial mass	The acceleration of the TI field in response to gravity is proportional to the ratio of the passive gravitational mass to inertial mass of the TI field. This ratio is sequestered in the universal gravitational constant. [1]

3.0 The New Temporal Inertial (TI) Field Model of Gravity and Inertia

We examine the behavior of an object in five different gravitational and non-gravitational interactions. Our new model is successful if it can be used to describe the behavior of an object in each of the interactions.

Table 5. Framing the Behavior of an Object in the New TI Field Model of Gravity and Inertia
How does an object behave in free fall in a gravitational field?
How does an object behave in a circular orbit about a GB?
How does an object behave at rest on the surface of a GB?
How does an object behave in a centrifuge?
How does an object react to a non-gravitational force?
Of these, only the first two are exclusively gravitational interactions. The remainder involve non-gravitational forces.

3.1 The New Temporal Inertial (TI) Field Model - Gravitational Interactions

3.1.1 Gravitational Interactions - Behavior of an Object in Free Fall in a Gravitational Field

Table 6. Gravitational Interactions - Behavior of an Object in Free Fall in a Gravitational Field
The TI field is accelerated toward the center of mass of a GB.
The passive gravitational mass property of an object causes the object to accelerate at the same rate and direction as the acceleration of the TI field at the object.
As the object is not directly subject to gravity and there is no difference in acceleration between the object and the TI field, there is no force on the object. The object is weightless.

3.1.2 Gravitational Interactions - Behavior of an Object in a Circular Orbit About the Earth

Table 7. Gravitational Interactions - Behavior of an Object in a Circular Orbit About the Earth
The TI field is accelerated toward the center of mass of the Earth.
The passive gravitational mass property of an object causes the object to accelerate at the same rate and direction as the acceleration of the TI field at the object.
As the object is not directly subject to gravity and there is no difference in acceleration between the object and the TI field, there is no force on the object. The object is weightless.

3.1.3 Gravitational Interactions - Behavior of an Object at Rest on the Surface of the Earth

Both the passive gravitational mass and the inertial mass of an object ***appear*** to play roles in the behavior of an object at rest on the surface of a GB (the Earth in this example).

An object at rest on the surface of the Earth experiences the acceleration of the TI field toward the center of mass of the Earth, but is itself restrained from accelerating by the surface of the Earth. Enter the inertial mass of the object that reacts to the difference in acceleration between the TI field and the object. The resulting behavior is described in Table 8.

Table 8. Gravitational Interactions - Behavior of an Object at Rest on the Surface of the Earth
In the volume of space surrounding the Earth, the TI field is accelerated toward the center of mass of the Earth.
The inertial mass of an object is a measure of the ***resistance of the TI field*** to the acceleration between the TI field and the object. As the object is restrained from moving by the surface of the Earth, the acceleration of the TI field relative to the object causes the TI field to exert the inertial reaction force (IRF) on the object. The IRF comprises the weight of the object at rest on the surface.
The traditional expression for the weight of an object at rest on the surface of the Earth is that the weight of the object equals the product of the inertial mass of the object and the acceleration of gravity. The acceleration of gravity is the acceleration of the TI field at the object.
The passive gravitational mass of the object plays no role in this interaction.

3.2 The New Temporal Inertial (TI) Field Model - Non-Gravitational Interactions

Non-gravitational interactions involve only the inertial mass of an object, not the passive gravitational mass.

3.2.1 Non-Gravitational Interactions - Behavior of an Object Subject to a Constant Non-Gravitational Force

Table 9. Non-Gravitational Interactions - Behavior of an Object Subject to a Constant Non-Gravitational Force
A non-gravitational force on an object causes the object to accelerate relative to the TI field.
The inertial mass of an object is a measure of the resistance of the TI field to the acceleration of the object relative to the TI field. The response of the TI field to the acceleration of the object relative to the TI field is to exert the inertial reaction force (IRF) on the object. The IRF is equal and opposite in direction to the non-gravitational force applied to the object.
The IRF equals the product of the inertial mass of the object and the acceleration of the object relative to the TI field.
The acceleration of the object relative to the TI field is constant.
The velocity of the object relative to the TI field increases continuously.
The passive gravitational mass of an object plays no role in this interaction.

3.2.2 Non-Gravitational Interactions - Behavior of an Object in a Centrifuge on the Surface of the Earth

The passive gravitational mass of an object plays no role in strictly non-gravitational interactions.

Table 10. Non-Gravitational Interactions - Behavior of an Object in a Centrifuge on the Surface of the Earth
In this example the acceleration of the TI field toward the center of the Earth is neglected.
The object is accelerated toward the center of rotation of the centrifuge.
The acceleration of the object toward the center of rotation of the centrifuge is caused by the non-gravitational centripetal force of the arm of the centrifuge,
The acceleration of the object toward the center of rotation of the centrifuge causes an equal acceleration of the TI field from the center of rotation toward the object.
The inertial mass of the object couples the object to the acceleration of the TI field at the object.
The response of the TI field to the acceleration of the object relative to the TI field is to exert the inertial reaction force (IRF) on the object that is equal and opposite in direction to the centripetal force of the arm of the centrifuge.
The IRF is a centrifugal force; a force that is a real physical force, not a fictitious force.

3.3 Summarizing the Behavior of an Object in Five Gravitational and Non-Gravitational Interactions

Table 11 summarizes the behavior of an object in the five interactions depicted in detail in Tables 6 through 10.

1. Column 1 identifies the interaction.
2. Column 2 shows whether the velocity relative to the TI field of an object in a given interaction is constant or remains the same.
3. Column 3 shows the acceleration of the object relative to the TI field.
4. Column 4 shows whether a force is generated in the interaction.
5. Column 5 shows which type of mass governs the interaction: PGM is passive gravitational mass and IM is inertial mass.

Table 11. Summarizing the Behavior of an Object in Five Gravitational and Non-Gravitational Interactions

Interaction	V / TI	Accel / TI	Force	Type of Mass
Free Fall	Constant	0	No	PGM
Circular Orbit	Constant	0	No	PGM
At Rest on Surface of GB	Constant	Constant	Yes	IM
Constant Non-Gravitational Force	Increase	Constant	Yes	IM
Centrifuge	Constant	Constant	Yes	IM

3.4 Are Passive Gravitational Mass and Inertial Mass Separable Properties of an Object?

In reviewing the behavior of an object in the various interactions depicted in Sections 3.1, 3.2 and 3.3 it is clear that the passive gravitational mass and inertial mass of an object both relate to the acceleration of the object relative to the TI field. In the descriptions given, passive gravitational mass conjoins the acceleration of an object with the acceleration of the TI field. If the acceleration of the object relative to the TI field is caused by the application of a non-gravitational force, the TI field exerts an opposing force on the object proportional to the inertial mass of the object. Are these behaviors two facets of the same attribute?

Passive gravitational mass conjoins the acceleration of an object to the acceleration of the TI field at the object. Inertial mass is a measure of the resistance of the TI field to the difference in acceleration between the object and the TI field. These are two separate and distinct attributes. Inertial mass plays no roll in gravitational interactions. Passive gravitational mass plays no role in non-gravitational interactions.

4.0 Conclusions

Table 12. Conclusions
In the volume of space surrounding the Earth, the TI field is accelerated toward the center of mass of the Earth.
Passive gravitational mass is a measure of an object's response to the acceleration of the TI field at the object. The object's response to the acceleration of the TI field is to accelerate at the same rate and direction as the TI field at the object. This is a force-free interaction.
An object in free fall in a gravitational field accelerates at the same rate as the TI field toward the center of mass of the GB. As the object is not directly subject to gravity and there is no difference in acceleration between the object and the TI field, there is no force on the object. The object is weightless.
An object in orbit about a GB accelerates at the same rate as the TI field toward the center of mass of the GB. As the object is not directly subject to gravity and there is no difference in acceleration between the object and the TI field, there is no force on the object. The object is weightless.
The inertial mass of an object is a measure of the resistance of the TI field to the acceleration between the TI field and the object. An object at rest on the surface of the Earth is restrained from moving by the surface of the Earth. The resulting interaction between the acceleration of the TI field and the object exerts the inertial reaction force (IRF) that comprises the weight of the object at rest on the surface.
The weight of an object at rest on the surface of the Earth equals the product of the inertial mass of the object and the acceleration of gravity. The acceleration of gravity is the acceleration of the TI field at the object.
The application of a non-gravitational force to an object causes the object to accelerate relative to the TI field. This difference in acceleration between the object and the TI field causes the TI field, not the object, to exert the inertial reaction force on the object opposite the direction of the applied non-gravitational force.
The centrifugal force on an object in a centrifuge is a real physical force, not a fictitious force.

5.0 References

1. ^ Peters, Richard A., Hidden Parameters in the Universal Gravitational Constant, https://vixra.org/pdf/1802.0296v1.pdf, Retrieved May 2021.