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Conjecture on the Origin of Relativistic Mass

Abstract

This conjecture supports the existence of a field of particles in space that I'll call the ***temporal-inertial (TI) field***. This field provides a frame of reference for motion such that the acceleration of an object with respect to the field causes the familiar inertial reaction force. The inertial mass of a massive particle or object comprising massive particles is a measure of the object's resistance to acceleration relative to the TI field. We can say that the inertial mass couples the acceleration of the object to its reactive force. Particles of the TI field permeate space including the space within atoms. A massive particle or object moving through the TI field at constant velocity experiences a constant flux of particles of the TI field and is unrestrained in its motion. If the object is accelerated, the object experiences a change in the flux. The inertial reaction force is proportional to the rate of change of flux. The rate of change in flux for a given acceleration is, relativistic effects notwithstanding, independent of the velocity of the particle. The basic coupling of a matter particle with the TI field is fixed and does not change with the velocity of the particle relative to the TI field. This coupling is the particle's rest mass. As the velocity of a massive particle increases, its resistance to acceleration increases in proportion to the Lorentz factor γ. This apparent increase in mass reflects an increase in the interaction of the particle with the TI field. The relativistic effect causing the increase in resistance to acceleration is length contraction of the TI field and it produces an increase in the density of particles of the TI field encountered by the massive particle. A given acceleration of an object thus produces a change in particle flux of the TI field proportional to the product of the acceleration and the Lorentz factor γ. Relativistic mass is the measure of this total resistance to acceleration at relativistic velocity. Both mass and relativistic mass are emergent properties of matter arising from the interaction between matter particles or objects comprising matter particles and particles of the TI field.

Contents

A Note on Nomenclature

I shall be referring to two types of particles, particles of the TI field and massive particles such as protons and neutrons. Clump the massive particles together and you have an object. I'll write about the inertial interaction between an object and the TI field, but what should be understood is that the interaction occurs at the particle level.

Behavior of the Temporal-Inertial (TI) Field [1]

The behavior of the ***Temporal-Inertial (TI)*** field and its interaction with matter particles underlies the discussion of this paper.

1. The TI field exerts the inertial force on matter particles in proportion with the acceleration of matter particles relative to the field.
2. When a matter particle or an object composed of matter particles is accelerated by an external force, its motion is resisted by its acceleration relative to the TI field. This reactive force of space is the familiar inertial force..
3. The reactive force of the TI field on accelerated matter does not confer mass on matter, but acts only as a force resisting such acceleration.

Rest Mass and the Particle Flux of the TI Field

Particles of the TI field permeate space including the space within atoms. In this conjecture the distribution and hence the density of these particles throughout all of space in the universe is uniform and isotropic. Particle flux is defined as '...the rate of transfer of particles across a given surface.' [2] The particle flux of the TI field is the only metric encountered by a moving object, the only metric that provides at the object a measure of its velocity or change in velocity. Hence only the particle flux or change in particle flux of the TI field can affect the behavior of the object in its response to a change in velocity.

A massive object moving through the TI field at constant velocity encounters a constant flux of particles of the TI field and is unrestrained in its motion. If the object is accelerated, the object experiences a change in this flux. The inertial reaction force is proportional to this rate of change of flux. The rate of change in flux for a given acceleration is, relativistic effects notwithstanding, independent of the velocity of the particle.

The so-called rest mass of a massive particle is a measure of the resistance of the particle to acceleration. This measure is taken at low velocity where the effects of relativity are nil. The rest mass couples the acceleration of the massive particle (relative to particles of the TI field) to its inertial reaction force. [3] The parenthetical expression, 'relative to particles of the TI field', is important. The definition of rest mass in this conjecture is unequivocal: It is the measure of resistance of the mass or object to acceleration relative to particles of the TI field, but without consideration of relativistic effects. At low velocity, relative to the speed of light, the rest mass does not depend on the velocity of the mass nor the location or the velocity of an observer. The TI field provides the frame of reference for motion.

Relativistic Mass

> 'The term relativistic mass ... is the total quantity of energy in a body or system (divided by c^2). The relativistic mass (of a body or system of bodies) includes a contribution from the kinetic energy of the body, and is larger the faster the body moves, so ... the relativistic mass depends on the observer's frame of reference. However, for given single frames of reference and for closed systems, the relativistic mass is also a conserved quantity.' [4]

Relativistic mass in this conjecture is a measure of the resistance of a massive particle or object comprising massive particles to acceleration. This measure includes relativistic effects. The formula for the inertial reaction force is given by

$$F = \gamma M a \tag{1}$$

where

F is the inertial reaction force.
γ is the Lorentz factor: $\gamma = 1 / (1 + v^2 / c^2)^{1/2}$.
M is the rest mass of the particle or object.
γ M is the relativistic mass of the particle or object.
a is the acceleration of the object relative to particles of the TI field.

We would like to know how the increase in velocity of the object increases its relativistic mass. How can we model this process? Knowing the formulation in advance facilitates constructing a model of the process by which relativistic mass might be created. We know that the governing equation of the inertial interaction at high velocity is F = γ M a. We know that acceleration produces a change in flux of particles of the TI field at the particle. We also know that at low velocity the change in flux for a given acceleration is independent of the velocity of the particle. Ask now what can increase the flux by the ratio of γ. It's not velocity alone; we've just said that (without relativity) velocity has no effect on the change in flux for a given acceleration. So what will? The relativistic effect of ***length contraction*** in the direction of motion would increase the particle density of the TI field at the massive particle. Length contraction [5] is formulated as:

$$L = L_0 / \gamma \quad (2)$$

where

L is the length of an object observed by an observer in motion relative to the object (average distance between particles of the TI field)
L_0 is the proper length of an object in its rest frame (average distance between particles of the TI field)
γ is the Lorentz factor

If this effect is real, the density of particles of the TI field in the direction of motion of the object and the change in flux encountered at the particle for a given acceleration would be increased by the factor γ. Just what we need. The resistance of the matter particle to acceleration would thus be increased by the factor γ.

Relativistic Mass and the Particle Density of the TI Field

A given acceleration of an object yields the same rate of change of flux encountered by the object regardless of the velocity of the object, relativistic effects notwithstanding. When relativistic effects are included, the resistance of a massive particle or an object comprising massive particles increases in proportion to the product of the object's acceleration and the Lorentz factor γ. The question to be answered in this conjecture is how velocity of the object contributes to the increase in resistance of the object to acceleration. The question reduces to how the particle flux of the TI field is changed when relativistic velocity of the object is considered. Only one effect will contribute to an ***increased change in flux*** for a given acceleration. That effect is an increase in particle density of the TI field with an increase in velocity of the object relative to the field.

In the frame of the moving object the distance between particles of the TI field is shortened by the Lorentz factor γ. This effect is formulated in Eq (2). This shortening occurs only in the direction of motion of the object relative to the TI field. The particle density of the TI field is thus increased in the direction of motion by the Lorentz factor. A given acceleration of the object now yields a rate of change of flux of particles of the TI field that is proportional to the product of the acceleration and the Lorentz factor γ. The inertial reactive force caused by acceleration is thus increased by the Lorentz factor γ. ***Relativistic mass is born!***

It is clear that this model denies the existence of the so-called transverse relativistic mass. The increase in particle density that gives rise to relativistic mass occurs only in the direction of motion of the moving object. The object's resistance to acceleration perpendicular to its direction of motion would be proportional to its rest mass. There would be no relativistic effect on the object's resistance to acceleration perpendicular to its direction of motion.

Relativistic Mass and the Frame of Reference

Relativistic mass, the resistance of an object to acceleration, depends on the particle density of the TI field encountered by the moving object. This particle density is proportional to the Lorentz factor γ that itself depends on the object's velocity relative to particles of the TI field. Accordingly, relativistic mass is independent of the frame of reference of an observer. An observer traveling at any velocity relative to the object would find the object's resistance to acceleration enhanced by the Lorentz factor γ, the same as though the observer, not the object, were at rest relative to the TI field. The choice of reference frame has no influence on the interaction of a moving object with the TI field.

Dependence of the Inertial Reaction on Velocity

An object can move through space at relativistic velocity with no resistance to its motion. At low velocity relative to the speed of light the inertial reaction to acceleration is independent of the velocity of the object. At greater velocity relativistic effects become significant and the resistance to a given acceleration of an object becomes a function of that velocity. The resistance to acceleration of an object depends on the rate of change of particle flux of the TI field encountered by the object. The properties of mass and relativistic mass are measures of this resistance to acceleration.

We label the resistance to acceleration at low velocity (relative to the speed of light) as mass. When relativistic effects become significant, we label the resistance to acceleration as relativistic mass. The relativistic effect that enhances the inertial reaction at high velocity is the length contraction of the TI field encountered by the moving object. The length contraction of the TI field manifests itself as an increase in the particle density of the TI field encountered by the object. The rate of change of particle flux for a given acceleration is increased in proportion to this increased particle density. Table 1 summarizes the inertial reaction of a massive object in three regimes of motion of the object.

Table 1. The Inertial Reaction of a Massive Object Versus Its Velocity

Status of the Object	Behavior
Velocity of the object is constant. Relativistic effects are irrelevant.	There is no resistance to the motion of the object, regardless of its velocity.
Velocity of the object is small relative to the speed of light. Relativistic effects are nil. The object is accelerated relative to particles of the TI field.	The change in particle flux of the TI field is proportional to the acceleration of the object, regardless of its initial velocity. The resistance of the object to acceleration is proportional to the rate of change of particle flux of the TI field. ***At low velocity the inertial reaction force of a massive object does not depend on its velocity.*** The rest mass of the object is a measure of its resistance to acceleration at low velocity.
Velocity of the object is significant relative to the speed of light. Relativistic effects are significant. The object is accelerated relative to particles of the TI field.	***The particle density of the TI field encountered by the moving object is increased by the length contraction of the TI field.*** The particle density of the TI field is increased by the Lorentz factor γ in the direction of motion of the object. A given acceleration of the object yields a change in particle flux that is proportional to the product of the Lorentz factor γ and the acceleration. A given acceleration of the object yields an inertial reaction force that is proportional to the product of the Lorentz factor γ and the acceleration of the object relative to particles of the TI field. ***At high velocity the inertial reaction force of a massive object depends on its velocity.*** The relativistic mass of the object is the measure of this inertial reaction force.

Conclusions

1. In these conclusions velocity and acceleration are measured relative to particles of the TI field.
2. Rest mass and relativistic mass have only one meaning in this conjecture: Both are measures of the resistance of an object to acceleration.
3. Both rest mass and relativistic mass are emergent properties of matter arising from the interaction between a matter particle or object comprising matter particles and particles of the TI field.
4. The rest mass of a particle or object comprising massive particles is a measure of the resistance of the object to acceleration when the velocity of the object relative to particles of the TI field is so low that relativistic effects are nil.
5. The relativistic mass of a particle or object is a measure of the resistance of the object to acceleration when the velocity of the object relative to particles of the TI field is non-zero and relativistic effects are significant.
6. The rest mass of a massive particle or object comprising massive particles couples the acceleration of the object to its inertial reaction force. The value of rest mass does not change with the velocity of the object. The increase in resistance to acceleration accompanying relativistic velocity of the object is caused by the increase in particle density of the TI field that results from length contraction of the TI field encountered by the object.
7. The rate of change of flux of particles of the TI field is proportional to the acceleration relative to particles of the TI field of the massive particle or object comprising massive particles.
8. A given acceleration of an object yields the same rate of change of flux encountered by the object regardless of the velocity of the object, relativistic effects notwithstanding.
9. The resistance to acceleration, the inertial reaction force, of an object comprising massive particles is proportional to the rate of change in particle flux of the TI field encountered by an object that is accelerating relative to particles of the TI field.
10. The change in the inertial reaction force at relativistic velocity reflects a change in the particle density of the TI field, that in turn enhances the coupling between the massive particle or object and the TI field.
11. A given acceleration of an object moving at high velocity yields a rate of change of particle flux of the TI field that is proportional to the product of the acceleration and the Lorentz factor γ. The inertial reactive force caused by acceleration is thus increased by the Lorentz factor γ.
12. The choice of reference frame has no influence on the interaction of a moving object and the TI field.
13. This model denies the existence of the so-called transverse relativistic mass. The increase in particle density that gives rise to relativistic mass occurs only in the

direction of motion of the moving object. There would be no relativistic effect on the object's resistance to acceleration perpendicular to its direction of motion.

References

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