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The Increase in Relativistic Inertial Mass is Equivalent to the Increase in Rotation Speed in the Sinusoidal Helicoid Model for Particle Motion

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Summary
The equations of Relativistic Mechanics and Wave Mechanics are used to describe the dynamics of a particle in the Helical Solenoid Model, showing that the increase in relativistic inertial mass is apparent, and is equivalent to the increase in rotational energy.

Introduction
For more than a century, Relativistic Mechanics has allowed us to satisfactorily explain many phenomena that were outside the scope of Classical Mechanics. One of its most important contributions, within the Theory of Special Relativity, is the impossibility of the speed of a particle being able to equal or surpass the Speed of Light, and that part of the energy supplied to said particle to accelerate it is transformed into "inertial mass", according to the Lorentz Transformation. In this article it is shown that the equations of Special Relativity fit perfectly to the Sinusoidal Helical Model, proposed by Consa O. (2018), first for the motion of the electron, and then for all particles [1]. It follows, as a consequence, that the apparent increase in inertial mass of Relativistic Mechanics can be explained as an increase in the rotational energy of the particles around their axis, in the Sinusoidal Helical Motion Model.

Development
The Relativistic Formula for Energy is Well Known

$$E = m_r c^2 \quad (1)$$

Where:
E = total energy of a mass in motion. m_r = relativistic mass. c = speed of light.

Relativistic mass (m_r) is the product of the rest mass (m_0) by the "*Lorentz factor*" (γ)

$$m_r = m_0 \left(\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \right) \quad (2)$$

Where v is the speed of displacement relative to the reference system, which we will hereafter call Translation Velocity (V_{TR}).

The Lorentz factor can be expressed in this form:

$$\frac{c}{\sqrt{c^2 - {V_{TR}}^2}}$$

Consequently, the equation for the total energy of the moving mass (1) would become:

$$E = m_0 \left(\frac{c^3}{\sqrt{c^2 - {V_{TR}}^2}} \right) \quad (3)$$

On the other hand, the relationship between the energy of the mass at rest (m 0) and the energy due to the velocity of the mass (V_{TR}) is expressed as follows:

$$E^2 = p^2 c^2 + {m_0}^2\, c^4 \quad (4)$$

Where p is the Relativistic Momentum, which can be Expressed as Follows:

$$p = m_0 \left(\frac{1}{\sqrt{1 - \frac{{V_{TR}}^2}{c^2}}} \right) V_{TR}$$

Which is transformed into

$$p = m_0 \left(\frac{c\, V_{TR}}{\sqrt{c^2 - {V_{TR}}^2}} \right)$$

The development of equation (4) leads to:

$${m_0}^2 \left(\frac{c^6}{c^2 - {V_{TR}}^2} \right) = {m_0}^2 \left(\frac{c^4}{c^2 - {V_{TR}}^2} \right) {V_{TR}}^2 + {m_0}^2\, c^4 \quad (5)$$

Eliminating the Common Factor m 0, we can Simplify:

$$\frac{c^4}{c^2 - {V_{TR}}^2} = \frac{c^2\, {V_{TR}}^2}{c^2 - {V_{TR}}^2} + c^2$$

Which we can express as:

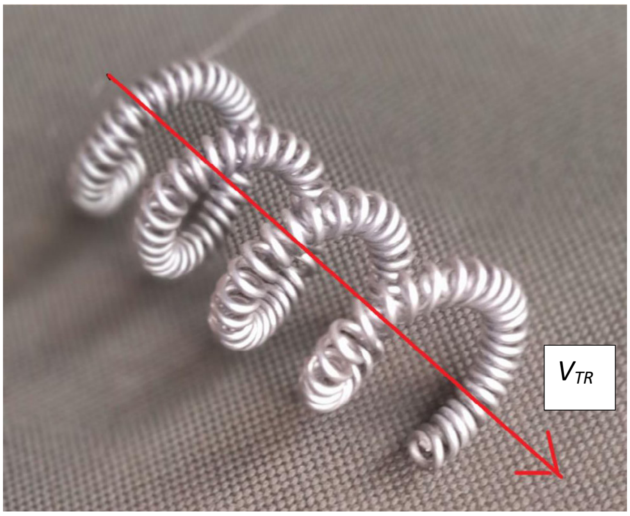
$$\frac{c^2}{\sqrt{c^2 - {V_{TR}}^2}} = \sqrt{\frac{c^2\, {V_{TR}}^2}{c^2 - {V_{TR}}^2} + c^2} \quad (6)$$

Multiplying both sides of this equation by m 0 and c, we obtain a new expression for the energy equation:

$$E = m_0 \frac{c^3}{\sqrt{c^2 - {V_{TR}}^2}} = \sqrt{(m_0)^2 \frac{c^4\, {V_{TR}}^2}{c^2 - {V_{TR}}^2} + (m_0)^2\, c^4} \quad (7)$$

The importance of this equation lies in the fact that it defines the energy E in terms of the Translational Velocity (T_{TR}), the Rest Mass (m 0), and the Speed of Light. (C), without needing to appeal to the relativistic concept of increasing inertial mass.

However, this new energy equation must be the expression of a physical model, and this is the Helical Solenoid Model, proposed by Consa, O. (2018), first for the motion of the electron, and then generalized for all particles [2]. In the Helical Solenoid Model, a particle moves along a "double helix" path, defined by two circular or Rotation paths, and a longitudinal or Translation path.



The first circular path is the one that a particle travels around the axis of a toroidal solenoid, a state that is called "rest", at a speed that we will call $V\ R1$. This path is orthogonal to the circular path that constitutes the axis of the toroidal solenoid, which the particle travels at a speed $V\ R2$. The geometric sum of V_{R1} and $V\ R2$ is equal to the speed of light (C). Only at this speed can the particle remain in equilibrium, in a "state of rest" with respect to the reference system [3].

When the particle acquires a net movement relative to the reference system, it does so follow a helical trajectory, generated by the transverse movement of the toroidal solenoid relative to its plane of rotation, at a translational speed that we will call $V\ TR$. This speed is the only one that can be directly measured by physical means.

Part of the energy supplied externally to the particle is used to increase the frequency and radius of rotation around the translation axis, which are the parameters of the Rotational Velocity. (V_{R2}). For this reason, the translational speed V_{TR}, cannot exceed the speed of light (C).

Since $V\ R2$ and $V\ TR$ *are orthogonal to each other, a Tangential Velocity of the particle (VTG)* can be defined, equal to the geometric sum of those. The Total Particle Velocity ($V\ TT$) *is the geometric sum of* $V\ TG$ *and* $V\ R1$. The Momentum (p) of the particle is defined $p = m0\ VT$.

$$p = m_0\ V_{TG}$$

$V\ R1$ is constant, and equal to the Speed of Light (C). Since $V\ R2$ and $V\ TR$ are orthogonal to each other, and their geometric sum is equal to $V\ TG$, it can be shown that $VTR2$

$$V_{R1} = \frac{{V_{TR}}^2}{\sqrt{c^2 - {V_{TR}}^2}}$$

In equation (6)

$$\frac{c^2}{\sqrt{c^2 - {V_{TR}}^2}} = \sqrt{\frac{c^2\ {V_{TR}}^2}{c^2 - {V_{TR}}^2} + c^2}$$

The first member:

$$\frac{c^2}{\sqrt{c^2 - {V_{TR}}^2}}$$

Defines the Total Velocity of the particle (V_{TT}).
When the Translation Velocity (V_{TR}) = 0, V_{TT} = C (speed of light)
When $V\ TR$ is not equal to 0, $V\ TT$ will be greater than C.

In the second member of equation (6), the term

$$\frac{c^2\, {V_{TR}}^2}{c^2 - {V_{TR}}^2}$$

can be expressed like this

$$\left(\frac{c\, V_{TR}}{\sqrt{c^2 - {V_{TR}}^2}}\right)^2$$

This is the mathematical expression of the square of the Tangential Velocity (V_{TG}) of the particle moving in the helical path defined by its circular motion, at the speed $V\ R2$, and by its translational motion, at the speed V_{TR}. According to this expression, the Tangential Velocity (V_{TG}) can be greater than the Speed of Light.

The circular motion of the particle at the Rotational Velocity V_{R1} (always equal to C), has as its axis the major helical path of the particle, and is orthogonal to it. Consequently, their geometric sum will be equal to the Total Velocity V_{TT}, as expressed in equation (6).

Rewriting equation (6) in terms of the previously defined velocities, we obtain this new equation:

$${V_{TT}}^2 = \sqrt{{V_{TG}}^2 + C^2} \quad (8)$$

Multiplying equation (8) by $m\ 0$ and C, we obtain

$$m_0\ C\ \ {V_{TT}}^2 = \sqrt{{m_0}^2\, c^2\, {V_{TG}}^2 + \ {m_0}^2\, C^4} \quad (9)$$

This equation is the expression of the Total Energy of the particle (E), and is equivalent to the relativistic expression

$$E^2 = p^2c^2 + {m_0}^2\, c^4$$

since $p = m\ 0\ V\ TG$

Length broglie wave in the helical solenoid model.

The well-known de Broglie equation for the wavelength of a particle

$$\lambda = \frac{h}{p}$$

can be expressed in this form

$$\lambda = \frac{h}{\left(\frac{c}{\sqrt{c^2 - {V_{TR}}^2}}\right) m_0\, V_{TR}}$$

Applying this equation to the Helical Solenoid Model, we define the Wavelength (λ) as the distance traveled by the particle in the longitudinal direction, in the direction of the solenoid axis, during a complete rotation cycle in a direction transverse to said axis.

$$\lambda = \frac{V_{TR}}{f} \qquad (11)$$

Where $V\ TR$ is the longitudinal translational velocity in the direction of the solenoid axis, and f is the rotation frequency.

Combining equations (10) and (11), we can express

$$\frac{m_0\ c\ \ {V_{TR}}^2}{\sqrt{c^2 - {V_{TR}}^2}} = \ h\, f$$

then

$$m_0\ c\ V_{R2} = h\ f \qquad (11)$$

The physical meaning of the above equation is that the energy associated with the wave motion of a particle is due to the rotation around its axis, following a helical path.

Equation (11) can be expressed in terms of the Angular Velocity (ω) and the Reduced Planck $_{\text{Constant}}$ ($\hbar$)

$$m_0\ c\ V_{R2} = \hbar\ \omega$$

Now, we can express the radius of rotation of the particle (R)

$$R = \frac{V_{R2}}{\omega} = \frac{\hbar}{m_0\ c}$$

This equation implies that the radius of rotation of a particle in its helical motion is inversely proportional to its inertial mass "at rest" ($m\ 0$).

Conclusion

Sinusoidal Helical model for particle motion explains the apparent increase in "inertial mass" as translational speed increases, as an increase in the rotational speed inherent to helical motion. The frequency and radius of a particle's rotational motion are inversely proportional to its rest mass.

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