Towards a New Physics

(Based on the variable speed of light on quantum level)

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Abstract: The Author presents an alternative interpretation to quantum phenomena based on a non-constant speed of light concept. Besides its enormous significance about the interaction between charged particles, it leads to a new Mass-Energy equivalence that supplements Einstein's original one. The technological implications of this discovery may actually open the "doors" for real inertia control through electromagnetic means.

Keywords: Inertia, Variable Speed of Light, Special Relativity, EM Inertial Drive, Casimir Force, Electric Force

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1. Introduction

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The Schrödinger equation plays the role of Newton's laws and conservation of Energy in classical mechanics. It is essentially based on a *wave function*, which is able to predict the outcome of an interaction in a probabilistic manner. The present work is an attempt to share an *alternative view* (variable speed of light concept) in regards to the underlying mechanism of *kinetics* and *tunneling effects* of quantum world, by reinterpreting existing laws of Physics.

Starting from the differential form of the general equation of motion (Newton's 2nd law), implies:

$$\frac{d\vec{p}}{dt} = \sum \vec{F}_{ext} + \vec{u}_R \frac{dM}{dt} = \sum \vec{F}_{ext} + \vec{u}_R R_M \quad (1)$$

$$\vec{F}_A = \frac{d\vec{p}}{dt}$$

$$\frac{d\vec{p}}{dt} = \sum \vec{F}_{ext} + \vec{u}_R \frac{dm}{dt} = \sum \vec{F}_{ext} + \vec{u}_R R_m \quad (2)$$

F_A: action force
F_{ext}: external force
M: object Mass
R_M: rate of Mass ejection (as expelled from object Mass)
R_m: rate of mass displacement (medium displacement)
u_R: velocity of exhaust/displacement relative to object Mass

An object being at rest can be set in motion either when an external force is exerted upon it or an amount of its mass is expelled from it (1) or an amount of medium mass is being displaced (2) by it, always in regards to its *unchangeable center of mass*.

Assuming the sum of all applying external Forces is null, (1) and (2) become:

$$\sum \vec{F}_{ext} = \vec{0} \Rightarrow \vec{F}_A = \frac{d\vec{p}}{dt} = \vec{u}_R \frac{dM}{dt} \quad (3)$$

$$\sum \vec{F}_{ext} = \vec{0} \Rightarrow \vec{F}_A = \frac{d\vec{p}}{dt} = \vec{u}_R \frac{dm}{dt} \quad (4)$$

A positive relative velocity combined with a positive mass rate would lead to no mass ejection or medium mass displacement but local mass confinement that would result to object's (M) inertia gain and eventually to no motion.

Consequently, the mass rate must be in both cases negative and in order to agree with the momentum conservation, the RHS of (3) and (4) should have in front of them, a negative sign:

$$\sum \vec{F}_{ext} = \vec{0} \Rightarrow$$

$$\vec{F}_A = \frac{d\vec{p}}{dt} = -\vec{F}_R = -\vec{F}_T = -\vec{u}_R \frac{dM}{dt} \quad (5)$$

and

$$\vec{F}_A = \frac{d\vec{p}}{dt} = -\vec{F}_R = -\vec{F}_T = -\vec{u}_R \frac{dm}{dt} \quad (6)$$

F_R: reaction force
F_T: thrust (reaction force)

The difference between (5) and (6) is that (5) does not require (e.g. rocket thrust) a material medium as compared to (6) e.g. ship thrust. In Fig. 1 is presented a new method of propulsion that uses internal forces in order the object to propel itself.

Would Newton's 2nd and 3rd law be in this case violated? A short answer would be "yes" since these laws are assumed to apply to the center of mass of the object that does not change while the force is being exerted upon it.

The *center of mass* of an object is given by the following expression:

$$\vec{r}_{CM} = \frac{1}{M} \int \vec{r}\, dm_M \ \ or\ \vec{r}_{CM} = \frac{1}{M} \sum_{i=1}^{n} m_i \vec{r}_i$$

The time derivative will give:

$$\vec{u}_{CM} = \frac{d\vec{r}_{CM}}{dt} = \frac{1}{M} \sum_{i=1}^{n} \frac{d}{dt}(m_i \vec{r}_i) \quad (7)$$

or

$$\vec{u}_{CM} = \frac{d\vec{r}_{CM}}{dt} = \frac{1}{M} \sum_{i=1}^{n} m_i \vec{u}_i \quad (8)$$

But:

$$\vec{p}_{TOTAL} = M\vec{u}_{CM} = \sum_{i=1}^{n} \vec{p}_i \quad (9)$$

and

$$\vec{F}_A = \frac{d\vec{p}_{TOTAL}}{dt} = \frac{d(M\vec{u}_{CM})}{dt} = \sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} \quad (10)$$

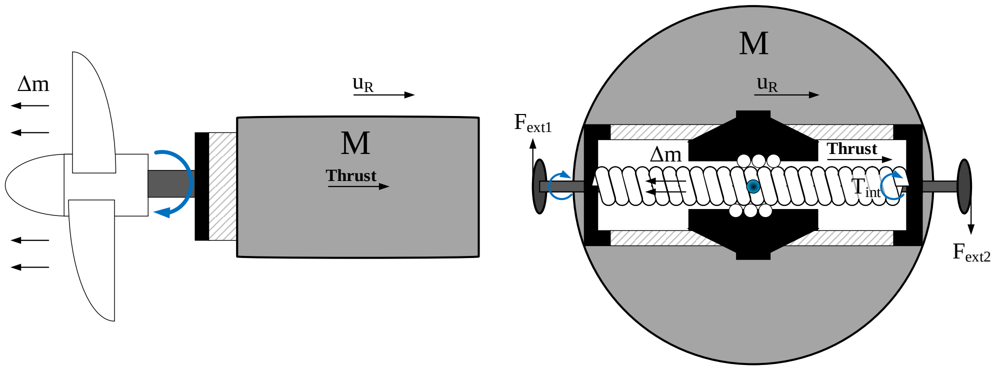

Fig.1 – Left: Ship thrust using a variable pitch propeller. Right: Object thrust using variable inertia (triggered by a pair of forces).

The expression (10) is identical to (2) which is the compact form of the total derivative. In absence of external forces, (10) turns into (5) and (6):

$$\vec{F}_A = \frac{d\vec{p}_{TOTAL}}{dt} = \sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} = -\vec{u}_R \frac{dM}{dt} \quad (11)$$

or

$$\vec{F}_A = \frac{d\vec{p}_{TOTAL}}{dt} = \sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} = -\vec{u}_R \frac{dm}{dt} \quad (12)$$

A *ship thrust mechanism* is based on water acceleration caused by the torque of the propeller, where each water particle acquires a mean momentum that is equal:

$$\vec{F}_A = \frac{d\vec{p}_{TOTAL}}{dt} = \sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} \Rightarrow$$

$$\sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} = \frac{d}{dt}\left(\vec{p}_1 + \vec{p}_2 + \ldots + \vec{p}_n\right)$$

$$but\ \vec{p}_1 = \vec{p}_2 = \ldots = \vec{p}_n = \vec{p}_p \Rightarrow$$

$$\sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} = n\frac{d\vec{p}_p}{dt} = -\vec{u}_R n \frac{dm_p}{dt} \Rightarrow$$

$$\sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} = \vec{F}_A = -\vec{u}_R \frac{dm}{dt}$$

Thus, for blades being at zero angle of attack:

$$-\vec{u}_R \frac{dm}{dt} = \vec{0} \Rightarrow \vec{F}_A = \frac{d\vec{p}_{TOTAL}}{dt} = \vec{0}$$

On the other hand, a *variable inertia thrust* is created by the internal forces imbalance, resulting to a *redeployment of the center of mass* (blue dot on Fig. 1) that carries away the entire mass of the object.

The mechanism that moves the center of mass consists of a translation screw (see Fig. 1) that transforms (*assuming lossless transformations*) the applied moment of pair forces to coupled mass (two trapezoid rolling masses) linear motion:

$$\vec{F}_{ext1} = -\vec{F}_{ext2}\ and\ \sum \vec{F}_{ext} = \vec{F}_{ext1} + \vec{F}_{ext2} = \vec{0}$$

$$\frac{d\vec{L}}{dt} = \vec{r}_{cm} \times \vec{F}_{ext1} + \vec{r}_{cm} \times \vec{F}_{ext2} \neq 0 \Rightarrow$$

$$\vec{F}_A = \frac{d\vec{p}_{TOTAL}}{dt} = \sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} \Rightarrow$$

$$\sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} = \frac{d}{dt}\left(\vec{p}_1 + \vec{p}_2 + \vec{p}_{n-1} + \ldots + \vec{p}_n\right)$$

$$\vec{p}_1 = \vec{p}_2 = \ldots = \vec{p}_{n-1} = \vec{0}\ but\ \vec{p}_n \neq 0 \Rightarrow$$

$$\sum_{i=1}^{n} \frac{d\vec{p}_i}{dt} = \frac{d\vec{p}_n}{dt} = \vec{F}_A = -\vec{u}_R \frac{dm}{dt} \quad (13)$$

Reinterpretation of 2nd Law of motion

Based on the internal forces imbalance
(Asymmetrical inertia reduction)

$$\vec{F}_A = \frac{d\vec{p}}{dt} = -\vec{F}_T = -\vec{u}_R \frac{dm}{dt} \quad (14)$$

or

$$\vec{F}_A = \frac{\Delta\vec{p}}{\Delta t} = -\vec{F}_T = -\vec{u}_R \frac{\Delta m}{\Delta t} \quad (15)$$

$$\vec{u}_R = \vec{u}_M - \vec{u}_{\Delta m}$$

or

$$\vec{u}_R = \vec{u}_{CM_a} - \vec{u}_{CM_b}$$

F_A: action force
F_T: thrust (reaction force)
CM: center of mass
$CM_{(a)}$: CM position during the inertia imbalance
$CM_{(b)}$: CM position prior the inertia imbalance

2. Inertia

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The previous expressions lead to a novel acceleration mechanism, which uses no propellants and is applicable in absolute vacuum.

Postulate (1): *The acceleration of an object is fundamentally created by the internal forces imbalance (asymmetrical inertia reduction), resulting to a redeployment of the center of mass that carries away the entire mass of the object.*

A system of parts that transforms the linear to rotational motion (coupled with F_{ext1}) makes Fig. 1 also relevant for external forces having a non-null sum. Apparently, (14) and (15) become:

Reinterpretation of 2nd Law of motion
Based on the internal forces imbalance caused by external forces
(Asymmetrical inertia reduction)

$$\vec{F}_A = \frac{d\vec{p}}{dt} = \sum \vec{F}_{ext} = -\vec{F}_T = -\vec{u}_R \frac{dm}{dt} \quad (16)$$

or

$$\vec{F}_A = \frac{\Delta\vec{p}}{\Delta t} = \sum \vec{F}_{ext} = -\vec{F}_T = -\vec{u}_R \frac{\Delta m}{\Delta t} \quad (17)$$

Postulate (2): *The acceleration of an object is fundamentally created by the internal forces imbalance (asymmetrical inertia reduction) while a non-null sum of external forces is being applied to it.*

Taking (17) one-step further and applying it for charged particles then, the Δm can be written as the difference between the actual and the rest inertia:

$$\Delta m = m_i - m \Rightarrow$$

$$\frac{\Delta p}{\Delta t} = \sum F_{ext} = -u_R \frac{m_i - m}{\Delta t} \Rightarrow$$

$$m_i = m\left(1 - \frac{\Delta p}{m u_R}\right) \quad (18)$$

Setting the relative velocity to a constant maximum value that is indicative on how fast the *inertia* changes are taking place, it makes inertia depended just on *momentum variance*.

Since there are no mechanical or other moving parts in quantum world, the maximum allowed speed is addressed by the electromagnetic interactions speed c.

The *relativistic relative velocity* equation applies just for massive objects, but it could also be used for the demonstration of its limit when two objects move in parallel but with opposite momenta:

$$u_M \to c \text{ and } u_{\Delta m} \to -c$$

$$u_R = \frac{|u_M - u_{\Delta m}|}{1 - \frac{u_M u_{\Delta m}}{c^2}} \Rightarrow u_R \to c \quad (19)$$

Fundamental Law of Inertia
Non-Relativistic

$$m_i = m\left(1 - \frac{\Delta p}{mc}\right) \quad (20)$$

$$u_R = c \text{ and } \Delta p << mc$$

Postulate (3): *Initiation of motion or acceleration of an object presupposes the reduction of its rest inertia; otherwise, acceleration can never take place.*

Considering the construction with the translation screw (Fig. 1) and the frame of a charged particle as black boxes, the question that arises for both is what is being expelled from each of them while they are being accelerated.

Postulate (4): *The acceleration of an object in vacuum presupposes the existence of a medium (vacuum) that can be displaced proportional to momentum variance.*

The non-relativistic kinetic Energy based on (20) is:

$$U_k = \frac{m u_p^{\ 2}}{2}\left(1 - \frac{\Delta p}{mc}\right)$$

$$\text{but } \Delta p << mc \Rightarrow \Delta p / mc \approx 0 \Rightarrow m_i \approx m$$

$$U_k = \frac{m u_p^{\ 2}}{2}\left(1 - \frac{\Delta p}{mc}\right) \approx \frac{m u_p^{\ 2}}{2}$$

3. Extending Einstein's Relativity

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The RHS of (20) represents the actual rest mass of a charged particle that could be blended with the relativistic expression as follow:

$$m\left(1-\frac{\Delta p}{mc}\right)\Rightarrow m_i = m\left(1-\frac{\Delta p}{mc}\right)\gamma \quad (21)$$

$$m_i = m\left(1-\frac{\Delta p}{mc}\right)\left(1-\frac{u_p^{\ 2}}{c^2}\right)^{-1/2} \quad (22)$$

Assuming the initial momentum of a charged particle is nearly zero then, the momentum ratio of (21) becomes:

$$\Delta p = p_{sw} - p_0 \ but \ p_0 \to 0 \Rightarrow \Delta p \to p_{sw}$$

$$\frac{\Delta p}{mc} = \frac{p_{sw}}{mc} \Rightarrow \left(\frac{p_{sw}}{mc}\right)^2 = \frac{u^2{}_{sw}}{c^2} \quad (23)$$

Fundamental Law of Inertia

Relativistic

$$m_i = m\left(1-\frac{u^2{}_{sw}}{c^2}\right)\left(1-\frac{u_p^{\ 2}}{c^2}\right)^{-1/2} \quad (24)$$

u_{sw}: speed during acceleration
u_p: speed post acceleration (final speed)

Obviously, the new relativistic expression is described by two different speeds. The u_{sw} represents the changing speed, which equals to u_p while the charge is being accelerated. On the other hand, the u_p is the final speed when the charge in not any more under the influence of an electrostatic potential (post acceleration).

Fundamental Law of Inertia

General Relativistic Inertial Mass

$$m_i = m\left(1-\frac{u^2{}_{sw}}{c^2}\right)\left(1-\frac{u_p^{\ 2}}{c^2}\right)^{-1/2} \quad (25)$$

Relativistic Inertial Mass during acceleration

$$u_p = u_{sw}$$

$$m_i = m\left(1-\frac{u_{sw}^{\ 2}}{c^2}\right)^{1/2} \quad (26)$$

Relativistic Inertial Mass post acceleration

$$u_{sw} = 0$$

$$m_i = m\left(1-\frac{u_p^{\ 2}}{c^2}\right)^{-1/2} \quad (27)$$

The expression (26) was discovered first by *Ricardo L. Carezani* who derived it using a single reference frame for the coordinate transformations, in his work called *Autodynamics*.

Stemming from (20) and (24), the kinetic Energy is now given by:

Kinetic Energy

General Relativistic Kinetic Energy

$$U_k = mc^2\left(1-\frac{u^2{}_{sw}}{c^2}\right)(\gamma-1) \quad (28)$$

Kinetic Energy during acceleration

$$u_p = u_{sw}$$

$$U_k = mc^2\left(1-\frac{u^2{}_{sw}}{c^2}\right)(\gamma-1) \quad (29)$$

Kinetic Energy (Einstein) post acceleration

$$u_{sw} = 0$$

$$U_k = mc^2(\gamma-1) \quad (30)$$

The Lorentz factor can be expanded into a Taylor series, obtaining:

$$\gamma = \left(1-\frac{u_p^{\ 2}}{c^2}\right)^{-1/2} = \sum_{n=0}^{\infty}\left(\frac{u_p}{c}\right)^{2n}\prod_{k=1}^{n}\left(\frac{2k-1}{2k}\right)\Rightarrow$$

$$\gamma = \left(1-\frac{u_p^{\ 2}}{c^2}\right)^{-1/2} = 1+\frac{1}{2}\left(\frac{u_p}{c}\right)^2+\frac{3}{8}\left(\frac{u_p}{c}\right)^4 .. \Rightarrow$$

Thus:

$$u_p << c \Rightarrow \frac{3}{8}\left(\frac{u_p}{c}\right)^4 << \frac{1}{2}\left(\frac{u_p}{c}\right)^2 \Rightarrow$$

$$\gamma = \left(1-\frac{u_p^{\ 2}}{c^2}\right)^{-1/2} \approx 1+\frac{1}{2}\left(\frac{u_p}{c}\right)^2$$

Hence, the classical limit of the relativistic kinetic Energy becomes:

$$U_k = mc^2\left(1-\frac{u^2{}_{sw}}{c^2}\right)(\gamma-1)\Rightarrow$$

$$U_k \approx mc^2\left(1-\frac{u^2{}_{sw}}{c^2}\right)\frac{1}{2}\left(\frac{u_p}{c}\right)^2 \Rightarrow$$

$$U_k \approx \frac{mu^2{}_p}{2}\left(1-\frac{u^2{}_{sw}}{c^2}\right) \quad (31)$$

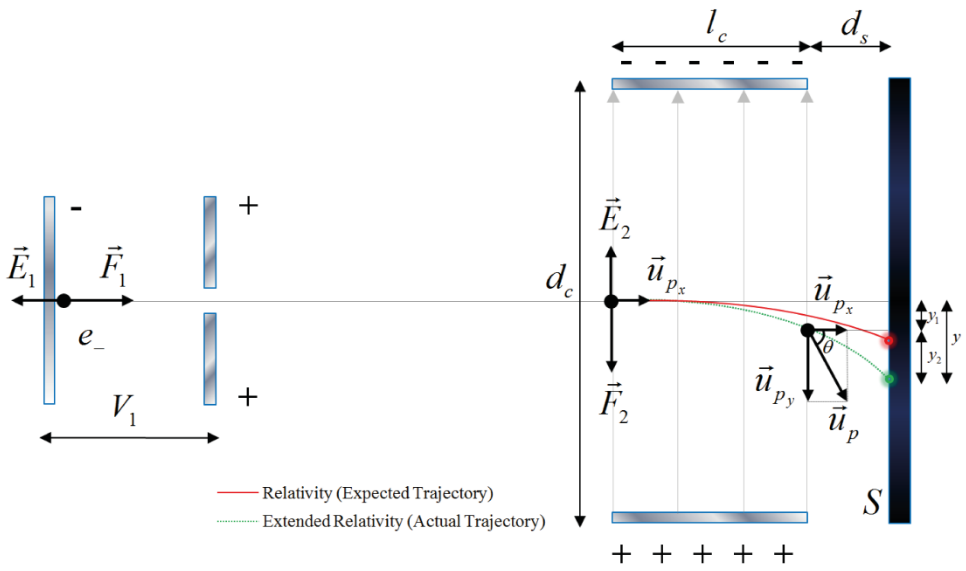

Fig.2 – Deviation from the expected Relativistic deflection.

A classical electrostatic deflection setup that uses careful scaling and Energy levels is proposed for the detection of significant deviations from Einstein's Relativity:

Electrodynamics

Electrostatic deflection

$$q_eV_1 << m_ec^2 \Rightarrow m_i \approx m_e \Rightarrow q_eV_1 \approx \frac{1}{2}m_eu^2{}_{p_x}$$

X-Axis: Non-relativistic

$$u_{p_x} = \left(\frac{2q_eV_1}{m_e}\right)^{1/2} \text{ and } t = \frac{l_c}{u_{p_x}}$$

Y-Axis: Relativistic

$$q_eV_1 > 0.03 \cdot m_ec^2 \Rightarrow m_i > m_e \Rightarrow a = \frac{q_e}{m_i}\frac{V_2}{d_c}$$

$$u_{p_y} = at = \frac{q_e}{m_i}\frac{V_2}{d_c}\frac{l_c}{u_{p_x}}$$

Inside E_2: Acceleration

$$V_2 = V_{sw} \Rightarrow y_1 = \frac{at^2}{2} = \frac{m_e}{4m_i}\frac{V_2}{V_1}\frac{l^2{}_c}{d_c}$$

$$\tan\theta = \frac{u_{p_y}}{u_{p_x}} = \frac{y_2}{d_s} \quad (32)$$

Exiting E_2: Post acceleration

$$V_{sw} = 0 \Rightarrow y_2 = \frac{m_e}{2m_i}\frac{V_2}{V_1}\frac{l_cd_s}{d_c}$$

Vertical Deflection on screen

$$y = y_1 + y_2$$

The product $p_{sw}\cdot c$ of (23) is equivalent to:

$$\frac{p_{sw}c}{m_ec^2} = \frac{|q_eV_{sw}|}{m_ec^2} = \frac{u^2{}_{sw}}{c^2} \quad (33)$$

Then (25) becomes:

$$m_i = m_e\left(1 - \frac{|q_eV_{sw}|}{m_ec^2}\right)\left(1 - \frac{u_{p_y}{}^2}{c^2}\right)^{-1/2} \quad (34)$$

and

$$|q_eV_2| = m_ec^2\left(1 - \frac{u_{p_y}{}^2}{c^2}\right)^{-1/2} - m_ec^2 \Rightarrow$$

$$\left(1 - \frac{u_{p_y}{}^2}{c^2}\right)^{-1/2} = 1 + \frac{|q_eV_2|}{m_ec^2} \quad (35)$$

Placing (35) onto (34) results:

$$m_i = m_e\left(1 - \frac{|q_eV_{sw}|}{m_ec^2}\right)\left(1 + \frac{|q_eV_2|}{m_ec^2}\right) \quad (36)$$

Finally:

$$V_2 = V_{sw} \Rightarrow y_1 = \frac{V_2}{4V_1}\frac{l^2{}_c}{d_c\left(1 - \left(\frac{q_eV_2}{m_ec^2}\right)^2\right)}$$

$$V_{sw} = 0 \Rightarrow y_2 = \frac{V_2}{2V_1}\frac{l_cd_s}{d_c\left(1 + \frac{|q_eV_2|}{m_ec^2}\right)}$$

$$V_1 = 2000V \text{ and } V_2 = 35KV$$

$$d_c = 0.3m \text{ and } l_c = 0.1m$$

$$d_s = 0.01m$$

Extended Relativity

$$y = 0.174m = 17.4cm$$

Einstein's Relativity

$$y = 0.164m = 16.4cm$$

4. Variable Speed of Light

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The general relativistic Energy of an arbitrary charged particle is given by the product of (25) or (36) with the speed of light squared:

General Relativistic Energy

$$U_i = mc^2\left(1-\frac{u^2{}_{sw}}{c^2}\right)\left(1-\frac{u_p{}^2}{c^2}\right)^{-1/2} \quad (37)$$

or

$$U_i = mc^2\left(1-\frac{|qV_{sw}|}{mc^2}\right)\left(1+\frac{|qV|}{mc^2}\right) \quad (38)$$

A closer look to both expressions reveals a new factor that might be an alternative to the variable inertia mechanism:

$$mc^2\left(1-\frac{u^2{}_{sw}}{c^2}\right)\left(1-\frac{u_p{}^2}{c^2}\right)^{-1/2} \Rightarrow$$

$$mcu\left(1-\frac{u_p{}^2}{c^2}\right)^{-1/2}$$

and

$$mc^2\left(1-\frac{|qV_{sw}|}{mc^2}\right)\left(1+\frac{|qV|}{mc^2}\right) \Rightarrow$$

$$mcu\left(1+\frac{qV}{mc^2}\right)$$

Variable speed of light

$$u = c\left(1-\frac{u^2{}_{sw}}{c^2}\right) = c\left(1-\frac{|qV_{sw}|}{mc^2}\right) \quad (39)$$

$$|qV_{sw}| > 0 \quad \textit{(Always)}$$

u_{sw}: speed during acceleration
V_{sw}: local electrostatic potential (during acceleration)

Postulate (5): *The speed of light varies proportional to the magnitude of the local electrostatic potential.*

Based on (38) and (39), the electrostatic potential Energy becomes:

$$U_E = \frac{q_1 q_2}{4\pi\varepsilon_o r}\frac{u}{c} \quad and \quad u = c\left(1-\frac{|q_1 V_2|}{m_{tot}c^2}\right)$$

but

$$q_1 V_2 = \frac{q_1 q_2}{4\pi\varepsilon_o r}$$

$$m_{tot} = m_{q_1} + m_{q_2}$$

Electrostatic potential Energy

(q_1 in the presence of q_2)

$$U_E = \frac{q_1 q_2}{4\pi\varepsilon_o r}\frac{u}{c} \quad (39.1)$$

$$u = c\left(1-\frac{|q_1 q_2|}{4\pi\varepsilon_o r(m_{q_1}+m_{q_2})c^2}\right) \quad (40)$$

or

$$U_E = \frac{q_1 q_2}{4\pi\varepsilon_o r}\left(1-\frac{|q_1 q_2|}{4\pi\varepsilon_o r(m_{q_1}+m_{q_2})c^2}\right) \quad (41)$$

Setting (40) equals to zero:

$$u = 0 \Rightarrow 1-\frac{|q_1 q_2|}{4\pi\varepsilon_o r(m_{q_1}+m_{q_2})c^2} = 0 \Rightarrow$$

$$r = \frac{|q_1 q_2|}{4\pi\varepsilon_o (m_{q_1}+m_{q_2})c^2} \quad (42)$$

$$but \quad (m_{q_1}+m_{q_2})c = \frac{h}{\lambda}$$

Then (42) becomes:

$$r = \frac{|q_1 q_2|\lambda}{4\pi\varepsilon_o hc} \Rightarrow$$

Fine structure constant

(General form)

$$\frac{2\pi r}{\lambda} = \frac{|q_1 q_2|}{2\varepsilon_o hc} = \alpha \quad (43)$$

or

$$\frac{2\pi r}{\lambda} = \frac{2\pi r}{h}\left(m_{q_1}+m_{q_2}\right)c = \alpha \quad (44)$$

Postulate (6): *The speed of light varies inverse proportional to the separation distance between two arbitrary charged particles or from the surface of each one separately.*

The *electromagnetic equivalent* of a pair of forces that might additionally play the role of a translation screw (see Fig. 1) is two EM waves having opposite momenta, forming an EM *standing wave*. The thrust mechanism is completed by coupling the mass (M) within the standing wave.

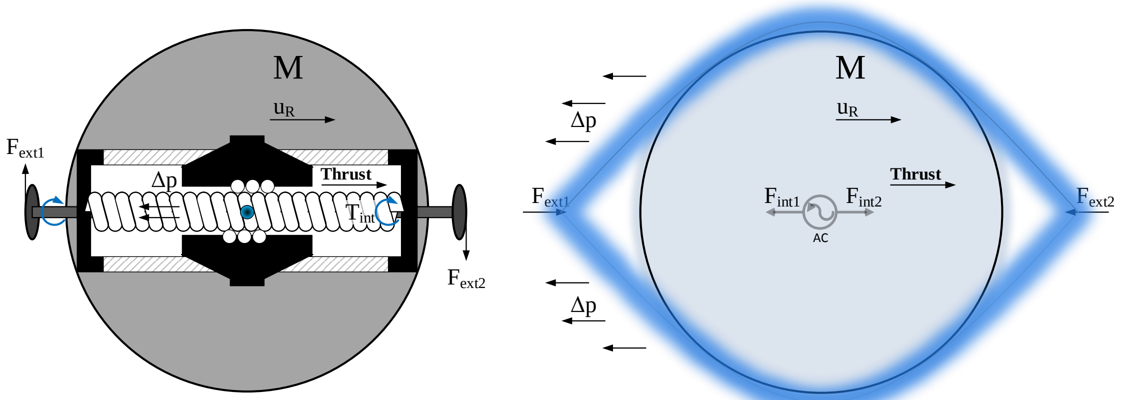

Fig.3 – Right: Inertial Drive (Electromagnetic equivalent): Mass (M) coupled within an EM standing wave (EM translation screw).

A frequency or *phase shift* on standing wave results to *anti-nodes shift* that carries the coupled (trapped) mass (M) away. It is worth noticing the translation screw mechanism (see Fig. 3) is within the mass (M) and can be set in motion either by external or internal forces (*internal torque* T_{int}).

On the other hand, the standing wave (*electromagnetic translation screw*) of a real *EM Inertial Drive* is actually created and set in motion from within the mass (M), which means the generator is located and coupled to mass (M) from inside (or outside for small prototypes and just for demonstration purposes).

The concept of the moving standing wave was discovered first by *Yuri N. Ivanov* in his work called *Rhythmodynamics*, which addresses the nature of motion of an object in a non-relativistic manner giving results that are very different from this work.

A standing wave is consisted of two identical waves and a frequency equals to *2f* that corresponds to a π phase. Thus:

$$\left.\begin{matrix} f_s \to \phi \\ 2f \to \pi \end{matrix}\right\} \Rightarrow \frac{f_s}{2f} = \frac{\phi}{\pi} \quad but \quad f_s = 2f_{shift}$$

$$\frac{f_s}{2f} = \frac{\phi}{\pi} \Rightarrow c\frac{f_s}{2f} = c\frac{\phi}{\pi} \Rightarrow$$

Standing wave speed

Based on the standing wave frequency or phase shift

$$u_{sw} = c\frac{f_s}{2f} = c\frac{\phi}{\pi} \quad (45)$$

EM Inertial Drive

Based on the variable speed of light on quantum level

$$M_i = M\left(1 - \frac{u^2{}_{sw}}{c^2}\right)\left(1 - \frac{u_M{}^2}{c^2}\right)^{-1/2} \quad (46)$$

or

$$U_i = Mcu\left(1 - \frac{u_M{}^2}{c^2}\right)^{-1/2} \quad (47)$$

$$u = c\left(1 - \frac{u^2{}_{sw}}{c^2}\right) \; and \; u_{sw} = c\frac{f_s}{2f} = c\frac{\phi}{\pi} \quad (48)$$

During the standing wave frequency or phase shift

$$u_M = u_{sw} = c\frac{f_s}{2f} = c\frac{\phi}{\pi}$$

$$0 < u_M = u_{sw} < +\infty$$

$$U_i = Mc^2\left(1 - \frac{u_M{}^2}{c^2}\right)^{1/2} = \frac{Mc^2}{\gamma} (49)$$

Reaching the speed of light

$$if \; u_M = u_{sw} = c \Rightarrow U_i = 0$$

$$u = 0$$

Faster than Light (FTL)

$$if \; u_M = u_{sw} > c \Rightarrow U_i \to imaginary$$

$$u < 0$$

u_{sw}: standing wave speed
u: propagation speed (velocity) of the electromagnetic waves

Wave-Particle Relativistic Energy

$$U_i = mc^2\left(1 - \frac{u^2{}_{sw}}{c^2}\right)\left(1 - \frac{u_p{}^2}{c^2}\right)^{-1/2} \quad (50)$$

$$0 < u_p = u_{sw} < +\infty$$

$$u_p = u_{sw} = c\frac{f_s}{2f} = c\frac{\phi}{\pi} = \sqrt{\frac{|qV_{sw}|}{m}}$$

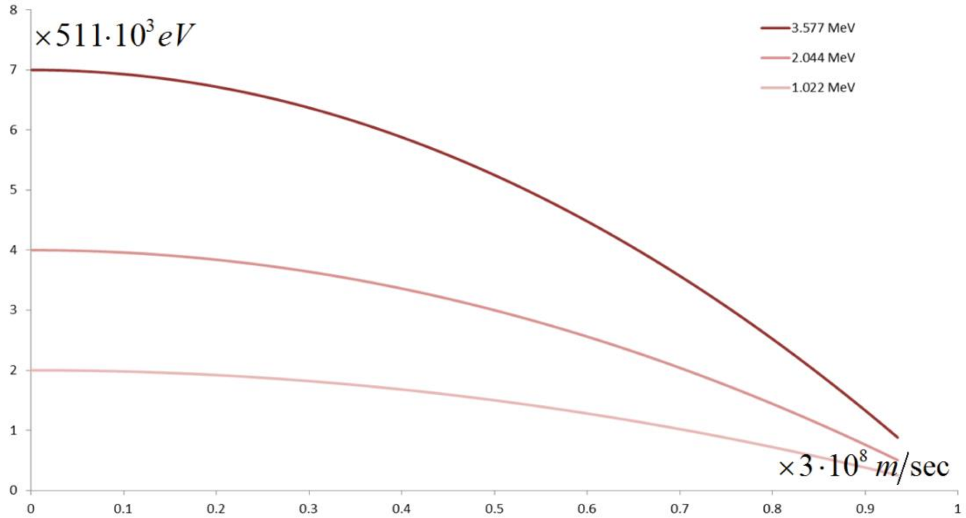

Fig.4 – Electrons Relativistic kinetic Energy drops proportional to standing wave (wave-particle) speed squared.

During *solar storms*, relativistic electrons have been known suddenly to vanish from the radiation belt. The strange phenomenon was discovered back in 1960s and it has puzzled scientists ever since. Some latest reports appear to have indications through satellite probes that the effect appears to be associated with a ULF or VLF wave-particle interaction.

Relativistic electrons suddenly vanish

(Quantum tunneling through the vacuum)

Wave-Particle Relativistic Kinetic Energy

$$u_{sw} = a\cdot t = c\frac{f_s}{2f} \ \ and\ \ \gamma = \left(1-\frac{{u_p}^2}{c^2}\right)^{-1/2}$$

$$U_k = m_e c^2\left(1-\frac{u^2{}_{sw}}{c^2}\right)(\gamma-1) \ (51)$$

or

$$U_k = m_e c^2\left(1-\frac{(a_{sw}\cdot t)^2}{c^2}\right)(\gamma-1) \ (52)$$

During the standing wave frequency or phase shift

$$u_p = u_{sw} = a_{sw}\cdot t = c\frac{f_s}{2f} = c\frac{\phi}{\pi}$$

$$u = c\left(1-\frac{u^2{}_{sw}}{c^2}\right)$$

$$U_k = m_e c^2\left(\left(1-\frac{{u_{sw}}^2}{c^2}\right)^{1/2} - \left(1-\frac{u^2{}_{sw}}{c^2}\right)\right) \ (53)$$

Reaching the speed of light

$$if\ u_p = u_{sw} = c \Rightarrow U_k = 0$$

$$u = 0$$

u_{sw}: *standing wave speed*

u: *propagation speed (velocity) of the electromagnetic waves*

5. EM Inertial Drive

The simplest version of an EM Inertial Drive that may demonstrate its basic working principle (acceleration over the redeployment of its center of mass using internal forces) is consisted of a coil with a ferrite ring core, a signal generator and a power amplifier.

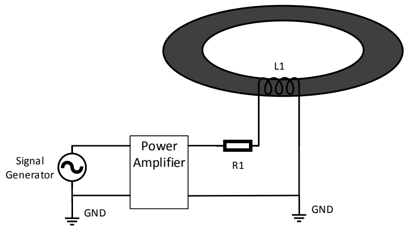

Fig.5 – EM Inertial Drive prototype.

A ferrite core is a composite material (Mn/Zn) having a density of 4900 Kgr/m^3 that is close to the monatomic Selenium element (4819 Kgr/m^3). Applying (25) and (33) for the non-relativistic case, results:

$$u_p << c \ and \ \frac{u^2_{sw}}{c^2} = \frac{|qV_{sw}|}{mc^2} \Rightarrow$$

$$m_i \approx m\left(1 - \frac{u^2_{sw}}{c^2}\right) \approx m\left(1 - \frac{|qV_{sw}|}{mc^2}\right) \quad (53.1)$$

Replacing the electrostatic potential with an EM wave Energy, (53.1) becomes:

$$|qV_{sw}| = U_{EM} \Rightarrow m_i = m\left(1 - \frac{U_{EM}}{mc^2}\right) \quad (53.2)$$

The rest Energy of an atom in vacuum is given by the known mc^2. In a different medium, the atom appears a rest Energy equals:

$$mc^2 \Rightarrow mcu_M = \frac{mc^2}{n_r} \Rightarrow$$

$$m_i = m\left(1 - \frac{U_{EM}}{mc^2} n_r\right) \quad (53.3)$$

or

$$m_i = m\left(1 - \frac{U_{EM}}{mcu_M}\right) \quad (53.4)$$

The ring coil in Fig. 5 is actually a closed loop Antenna having a radiation resistance:

$$R_r = R_M \frac{8}{3}\pi^3 \left(N \frac{A}{\lambda_M^2}\right)^2 \quad (53.5)$$

R_M: radiation resistance of medium
λ_M: wavelength in medium

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In an arbitrary medium, the propagation speed of the EM waves is given by the following general expression:

$$u_M = \left(\frac{\varepsilon_r \cdot \varepsilon_0 \cdot \mu_r \cdot \mu_0}{2}\left[\sqrt{1 + \left(\frac{\sigma}{\omega \cdot \varepsilon}\right)^2} - 1\right]\right)^{-1/2}$$

Metals and ferromagnetic materials for f<200 KHz

$$for \ \sigma >> \omega\varepsilon \Rightarrow u_M = \sqrt{\frac{4\pi f}{\mu_r \mu_0 \sigma}} \quad (53.6)$$

$$R_M = \mu_r \mu_0 u_M \ and \ \lambda_M = \frac{u_M}{f} \quad (53.7)$$

The applied power density for a single particle equals to the applied power density for the bulk material:

$$D = \frac{P}{A} = D_p = \frac{P_p}{a_p} \Rightarrow P_p = a_p D = a_p \frac{I^2 R_r}{A}$$

$$U_{EM} = U_{EM_p} = \frac{P_p}{f} = \frac{a_p}{A}\frac{I^2 R_r}{f} \quad (53.8)$$

EM Inertial Drive

Non-Relativistic basic equation (ferromagnetic material)

$$m_i = m\left(1 - \frac{U_{EM}}{mcu_M}\right) \quad (53.9)$$

$$m_i = m\left(1 - \frac{a_p}{A}\frac{I^2 R_r}{mcu_M f}\right)$$

Technical data from Author's conducted experiment

$a_p = 1.294 \cdot 10^{-19} m^2 \ and \ A = A_{R(eff.)} = 1.94 \cdot 10^{-4} m^2 \ | \ N = 6$

$\mu_r \approx 8500 \ and \ \sigma \approx 10 \ S \cdot m^{-1} \ and \ c = 3 \cdot 10^8 m \cdot \sec^{-1}$

$f = 5694 Hz \Rightarrow u_M = 818 \ m\sec^{-1} \Rightarrow R_r \approx 2.29 \ Ohm$

$I \approx 0.24A$ *current through the ring radiation resistance*

$m = 1.31 \cdot 10^{-25} Kgr$

$F_F \approx 0.4N$ *required (measured) force for constant speed*

$m_F \approx 0.2Kgr$ *ferrite ring mass*

$F_{SF} \approx 0.6N$ *measured static friction force*

$F_{KF} \approx 0.4N$ *measured kinetic friction force*

$u_{sw} \approx 0.01 m/\sec$ *measured ring speed*

$$m_i = m\left(1 - 8.35 \cdot 10^{-6} I^2\right)$$

$$F_F = \frac{\Delta m_F}{\Delta t} u_M = \Delta m_F u_M f \approx -0.47N$$

or

$$F_F = -m_F u_M f_s \approx -0.47N \Rightarrow f_s \approx 28mHz$$

Force to Power Input

$$F_F / P_{in} \approx |-0.47N/22W| \approx 21.3N/KW$$

6. Electric Force

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The electric force between two arbitrary charged particles is the derivative of the electrostatic potential Energy (see (41)):

$$U_E = \frac{q_1 q_2}{4\pi\varepsilon_o r}\left(1 - \frac{|q_1 q_2|}{4\pi\varepsilon_o r(m_{q_1}+m_{q_2})c^2}\right)$$

$$F_E = -\frac{dU_E}{dr} \Rightarrow$$

Electric Force

Between two arbitrary stationary charges

Magnitude and Vector form

$$q_1 q_2 < 0 \Rightarrow$$

$$F_E = \frac{q_1 q_2}{4\pi\varepsilon_o r^2}\left(1 + \frac{q_1 q_2}{2\pi\varepsilon_o\left(m_{q_1}+m_{q_2}\right)c^2 r}\right) \quad (54)$$

$$\vec{F}_E = \frac{q_1 q_2}{4\pi\varepsilon_o}\frac{\vec{r}}{|\vec{r}|^3} + \frac{q^2{}_1 q^2{}_2}{8\pi^2\varepsilon^2{}_o\left(m_{q_1}+m_{q_2}\right)c^2}\frac{\vec{r}}{|\vec{r}|^4} \quad (55)$$

and

$$q_1 q_2 > 0 \Rightarrow$$

$$F_E = \frac{q_1 q_2}{4\pi\varepsilon_o r^2}\left(1 - \frac{q_1 q_2}{2\pi\varepsilon_o\left(m_{q_1}+m_{q_2}\right)c^2 r}\right) \quad (56)$$

$$\vec{F}_E = \frac{q_1 q_2}{4\pi\varepsilon_o}\frac{\vec{r}}{|\vec{r}|^3} - \frac{q^2{}_1 q^2{}_2}{8\pi^2\varepsilon^2{}_o\left(m_{q_1}+m_{q_2}\right)c^2}\frac{\vec{r}}{|\vec{r}|^4} \quad (57)$$

The expression (55) is consisted of two parts, an attractive and a repulsive one, e.g. (Fig. 6) electric force and electrostatic potential Energy between two electrons.

Then from (56):

$$q_1 = q_2 = q_e \ and \ m_{q_1} = m_{q_2} = m_e$$

$$F_E = \frac{q^2{}_e}{4\pi\varepsilon_o r^2}\left(1 - \frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2 r}\right) \quad (58)$$

Hence (58), becomes practically the known Coulomb force when:

$$\frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2 r} \approx 0 \Rightarrow$$

$$r >> 100\frac{\lambda_{ce}}{4\pi} \approx 1.92\cdot 10^{-11} m$$

Then:

$$r = 100\frac{\lambda_{ce}}{4\pi} \Rightarrow 1 - \frac{q^2{}_e}{100\cdot\varepsilon_o m_e c^2\lambda_{ce}} \approx 0.99985 \Rightarrow$$

$$F_E = \frac{q^2{}_e}{4\pi\varepsilon_o r^2}\left(1 - \frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2 r}\right) \approx \frac{q^2{}_e}{4\pi\varepsilon_o r^2}$$

The local maximum of the electric force occurs when:

$$\frac{dF_E}{dr} = \frac{d}{dr}\left(\frac{q^2{}_e}{4\pi\varepsilon_o r^2}\left(1 - \frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2 r}\right)\right) = 0 \Rightarrow$$

$$r = \frac{3}{2}\frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2} = \frac{3}{2}r_e \approx 4.22\cdot 10^{-15} m \Rightarrow$$

$$F_E \approx 4.32N$$

$$F_{Coulomb} \approx 12.95N \ and \ F_{Attractive} \approx -8.63N$$

The electric force becomes zero when:

$$F_E = \frac{q^2{}_e}{4\pi\varepsilon_o r^2}\left(1 - \frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2 r}\right) = 0 \Rightarrow$$

$$r \to +\infty \ or \ r = \frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2} \approx 2.817\cdot 10^{-15} m$$

$$F_E \approx 0.00N$$

$$F_{Coulomb} \approx 29.10N \ and \ F_{Attractive} \approx -29.10N$$

The electric force appears a maximum when the electrostatic potential Energy goes to zero:

$$r = \frac{q^2{}_e}{8\pi\varepsilon_o m_e c^2} = \frac{r_e}{2} \approx 1.40855\cdot 10^{-15} m \Rightarrow$$

$$F_E \approx -118N$$

Now the derivation of the electric field of a single charge requires knowing the expression of the electrostatic potential:

$$q_1 = q_2 = q \ and \ m_{q_1} = m_{q_2} = m_q \Rightarrow$$

$$V_E = \frac{U_E}{q} \Rightarrow$$

Electrostatic Potential

At a distance from an arbitrary charge

$$V_E = \frac{q}{4\pi\varepsilon_o r}\left(1 - \frac{q^2}{8\pi\varepsilon_o m_q c^2 r}\right) \quad (59)$$

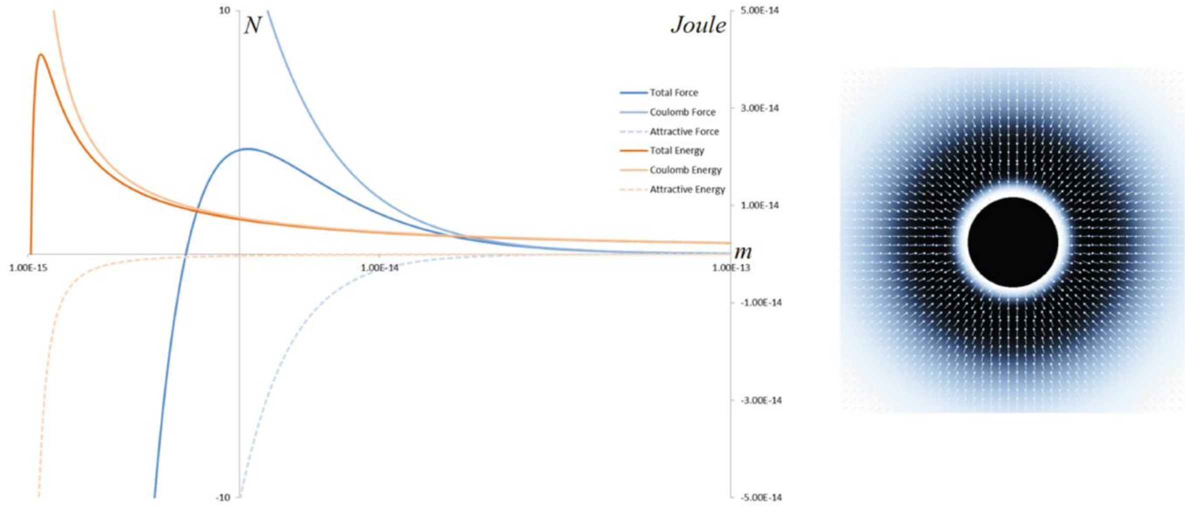

Fig.6 – Left: Electric force (two electrons) and electrostatic potential Energy diagrams. Right: Electron's electric field.

Electric Field

Magnitude and Vector form

$$\vec{E} = -\nabla V_E$$

$$E = \frac{q}{4\pi\varepsilon_o r^2}\left(1 - \frac{q^2}{4\pi\varepsilon_o m_q c^2 r}\right) \quad (60)$$

$$\vec{E} = \frac{q}{4\pi\varepsilon_o}\frac{\vec{r}}{|\vec{r}|^3} - \frac{q^3}{16\pi^2\varepsilon^2{}_o m_q c^2}\frac{\vec{r}}{|\vec{r}|^4} \quad (61)$$

The second term of the electric force appears to have a link to the Casimir force. Starting from (58):

$$F_E = \frac{q^2{}_e}{4\pi\varepsilon_o r^2}\left(1 - \frac{q^2{}_e}{4\pi\varepsilon_o m_e c^2 r}\right) \Rightarrow$$

$$F_E = F_{Cb} + F_A \Rightarrow$$

$$F_A = -\frac{q^4{}_e}{16\pi^2\varepsilon^2{}_o m_e c^2 r^3} \quad (62)$$

Then, from the fine structure constant:

$$\frac{2\pi r_e}{\lambda_{ce}} = \frac{q^2{}_e}{4\pi\varepsilon_o \hbar c} = \alpha \Rightarrow \frac{q^2{}_e}{4\pi\varepsilon_o} = \hbar c\frac{2\pi r_e}{\lambda_{ce}} \Rightarrow$$

$$F_A = -\left(\frac{q^2{}_e}{4\pi\varepsilon_o}\right)^2 \frac{1}{m_e c^2 r^3} \Rightarrow$$

$$F_A = -\left(\hbar c\frac{2\pi r_e}{\lambda_{ce}}\right)^2 \frac{1}{m_e c^2 r^3} \Rightarrow$$

$$F_A = -\frac{\hbar^2}{\lambda_{ce}}\frac{4\pi r_e{}^2}{r^3}\frac{\pi}{\lambda_{ce}\cdot m_e} \Rightarrow$$

$$F_A = -4\pi r_e{}^2\frac{\hbar}{r^3}\frac{\pi}{\lambda_{ce}\cdot}\frac{\hbar}{\lambda_{ce} m_e}\frac{c}{c} \Rightarrow$$

Thus:

$$\lambda_{ce} = \frac{h}{m_e c} = 2\lambda \ and \ A = 4\pi r_e{}^2 \quad (63)$$

$$F_A = -A\frac{\hbar}{4\lambda}\frac{c}{r^3} \quad (64)$$

$$\lambda = \frac{2\pi r}{\alpha} \Rightarrow A_\alpha = 4\pi r_e{}^2\alpha \Rightarrow A_\alpha = \alpha \cdot A$$

Second term of the Electric Force

Second term turns to Casimir force at critical distance

$$F_A = -A_\alpha\frac{\pi^2\hbar c}{8\pi^3 r^4} \approx -A_\alpha\frac{\pi^2\hbar c}{248.05 r^4} \quad (65)$$

$$r = r_c = r_e/2$$

$$F_A = -A_\alpha\frac{\pi^2\hbar c}{248.05 r_c{}^4} = -\frac{q^4{}_e}{16\pi^2\varepsilon^2{}_o m_e c^2 r_c{}^3}$$

$$r >> r_c = \frac{r_e}{2} \Rightarrow \lambda >> \frac{\lambda_{ce}}{2} \Rightarrow A >> 4\pi r^2{}_e\alpha$$

$$\Downarrow$$

General form of the attractive Casimir Force

$$F_A = -A\frac{\hbar}{4\lambda}\frac{c}{r^3} \approx -A_\alpha\frac{\pi^2\hbar c}{248.05 r^4} \quad (66)$$

Deviation from the original Casimir Force

$$1 - \frac{|F_A|}{|F_{Casimir}|} \approx +3.24\%$$

General form of the repulsive Casimir Force

$$F_A = A\frac{\hbar}{4\lambda}\frac{c}{r^3} \approx A_\alpha\frac{\pi^2\hbar c}{248.05 r^4} \quad (67)$$

7. Universe Properties

The (62) and (64) are based on electron-electron interaction and can be written as follow:

$$\lambda_{ce} = \frac{h}{m_e c} = 2\lambda \ and \ A = 4\pi r_e^2$$

$$F_A = -\frac{q^4{}_e}{16\pi^2\varepsilon^2{}_o m_e c^2 r^3} = -A\frac{\hbar}{4\lambda}\frac{c}{r^3} \quad (68)$$

The above might be equivalent to a gravitational force between two electrons using a variable gravitational constant:

$$F_A = -\frac{G_r m_e^2}{r^2} = -\frac{q^4{}_e}{16\pi^2\varepsilon^2{}_o m_e c^2 r^3} \quad (69)$$

and

$$F_A = -\frac{G_r m_e^2}{r^2} = -4\pi r_e^2 \frac{\hbar}{2\lambda_{ce}}\frac{c}{r^3} \quad (70)$$

Variable Gravitational constant

$$G_r = \frac{q^4{}_e}{16\pi^2\varepsilon^2{}_o m_e^3 c^2 r} \quad (71)$$

or

$$G_r = \frac{\lambda_{ce}c^3}{h}\frac{r_e^2}{r} \quad (72)$$

Setting (71) or (72) equals to Newtonian Gravitational constant results a number in the scale of the Universe radius (see Lars Waehlin, "*The Deadbeat Universe*"):

Universe Properties

$$G_r = G$$

$$G = 6.67384\cdot 10^{-11} N \frac{m^2}{Kgr^2}$$

Universe Radius

$$r = r_u = \frac{q^4{}_e}{16\pi^2\varepsilon^2{}_o m_e^3 c^2 G} = \frac{\lambda_{ce}c^3}{h}\frac{r_e^2}{G} \quad (73)$$

$$r_u \approx 1.1763\cdot 10^{28} m$$

Universe Age

$$t_u = \frac{r_u}{c} \approx 3.9211\cdot 10^{19} \sec$$

or

$$t_u = \frac{r_u}{c} \approx 1243.3\cdot 10^{9} yr$$

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Universe Properties

Universe minimum frequency

$$f_{\min} = \frac{1}{2\pi\cdot t_u} = 4.0589\cdot 10^{-21} Hz$$

Universe deceleration

$$a_u = \frac{c^2}{r_u} = \frac{hG}{r_e^2\lambda_{ce}c} \approx 7.6509\cdot 10^{-12} m/\sec^2$$

Universe Mass

$$M_u = \frac{a_u r_u^2}{G} \approx 1.5863\cdot 10^{55} Kgr$$

Universe Energy

$$E_u = M_u c^2 = 1.4277\cdot 10^{72} Joule$$

Universe thermodynamic Temperature

$$T = \sqrt[4]{\frac{E_u f_{\min}}{\sigma\cdot S_u}} \approx 2.768 Kelvin$$

$$\sigma = 5.6704\cdot 10^{-8}\frac{Joule}{\sec^2\cdot m^2\cdot K^4}$$

$$D_u = \frac{E_u f_{\min}}{S_u} = \sigma T^4 \ and \ S_u = 4\pi r^2{}_u$$

A dimensional analysis of (72) or by setting:

$$G_r = G \Rightarrow$$

$$r_q = r_u = r_e \rightarrow \text{Minimum possible distance}$$

Quantum Length

$$r_q = \frac{hG}{\lambda_{ce}c^3} = 6.7502\cdot 10^{-58} m$$

Quantum Graininess (Science Daily Link)

Quantum Time

$$t_q = \frac{r_q}{c} = \frac{hG}{\lambda_{ce}c^4} = 2.2501\cdot 10^{-66} \sec$$

Fine structure constant

Linked to the dimensions of the Universe

$$r_u r_q = r_e^2 \quad (74)$$

$$\alpha = \frac{2\pi r_e}{\lambda_{ce}} = \frac{q^2{}_e}{4\pi\varepsilon_o\hbar c} = \frac{2\pi\sqrt{r_u r_q}}{\lambda_{ce}} \quad (75)$$

8. Relativistic Hamiltonian

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The *relativistic Hamiltonian* of a charged particle as influenced by an electrostatic potential (constant potential) is given by:

$$H = \sqrt{(pc)^2 + (mc^2)^2} + q_p V \quad (76)$$

p: charged particle's momentum
V: electrostatic potential

The (76) under a non-constant speed of light turns into:

General Relativistic Hamiltonian
Based on the variable speed of light on quantum level

$$H_i = \frac{u}{c} H$$

$$u = c\left(1 - \frac{|q_p V_{sw}|}{mc^2}\right) = c\left(1 - \frac{u^2{}_{sw}}{c^2}\right)$$

$$H_i = \frac{u}{c}\left(\sqrt{(pc)^2 + (mc^2)^2} + qV\right) \quad (77)$$

$$qV << mc^2 \Rightarrow u \approx c \Rightarrow H_i = H$$

Electric Force upon a single charge
Partial Hamiltonian Derivative

$$\frac{dp}{dt} = -\frac{\partial H_i}{\partial r} = F_E$$

$$V_{sw} = V = \frac{q}{4\pi\varepsilon_o r}$$

$$F_E = \frac{qq_p}{4\pi\varepsilon_o r^2}\left(1 - \frac{|qq_p|}{2\pi\varepsilon_o r mc^2}\right) \quad (78)$$

$$qV << mc^2 \Rightarrow u \approx c \Rightarrow F_E \approx \frac{qq_p}{4\pi\varepsilon_o r^2}$$

or

$$r >> \frac{qq_p}{2\pi\varepsilon_o mc^2} \Rightarrow u \approx c \Rightarrow F_E \approx \frac{qq_{EP}}{4\pi\varepsilon_o r^2}$$

Since the ratio of velocities in (23) equals to the ratio of momentums, then:

$$\frac{u^2{}_{sw}}{c^2} = \left(\frac{p_{sw}}{mc}\right)^2 \Rightarrow$$

Variable speed of light

$$u = c\left(1 - \frac{u^2{}_{sw}}{c^2}\right) = c\left(1 - \left(\frac{p_{sw}}{mc}\right)^2\right) \quad (79)$$

General Relativistic Energy

$$(mcu)\left(1 - \frac{u^2{}_p}{c^2}\right)^{-1/2} = \frac{u}{c}\left(\sqrt{(pc)^2 + (mc^2)^2}\right)$$

LHS RHS

$$u = c\left(1 - \frac{u^2{}_{sw}}{c^2}\right) = c\left(1 - \left(\frac{p_{sw}}{mc}\right)^2\right)$$

Velocity (speed) of a single charge
Partial Hamiltonian Derivative

$$\frac{dr}{dt} = \frac{\partial H_i}{\partial p} = u_p$$

During acceleration

$$V_{sw} = V \Rightarrow u_{sw} = u_p \Rightarrow p_{sw} = p$$

$$u = c\left(1 - \frac{u^2{}_{sw}}{c^2}\right) = c\left(1 - \left(\frac{p_{sw}}{mc}\right)^2\right)$$

$$(80)$$

$$u_p = c\left(1 - \left(1 - \left(\frac{p}{mc}\right)^2\right)^2 \left(1 + \left(\frac{p}{mc}\right)^2\right)\right)^{1/2}$$

u_{sw}: changing speed (during acceleration)
p_{sw}: changing momentum (during acceleration)

Post interaction

$$V_{sw} = 0 \neq V_{EP} \Rightarrow u_{sw} = 0 \neq u_p \Rightarrow p_{sw} = 0 \neq p$$

$$u \approx c$$

$$(81)$$

$$u_p = \frac{p/m}{\sqrt{1 + (p/mc)^2}}$$

u_p: charged particle's final speed
p: charged particle's final momentum

Conclusion

The discovery of a variable speed of light proposes a new but falsifiable mechanism as the main cause behind the quantum phenomena, through a single and consisted theoretical framework.

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