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T-invariance and Antiparticles (Antiquanta)

The treatment of *antiparticles* as *particles with negative energy for which time flows backward* arouses the groundless objections.

Recall that antiparticles have been introduced by Dirac as particles with negative energy [1]. Later on the comprehension came that they are products of the Minkowski space invariance relative to the relativistic reflection (4-inversion) R=PT [2,3]. Here P is the space reflection, T is the inversion (sign change) of time. As a result of R- reflection , $x^i \to -x^i$ and 4-velocity

$$u^i = (u^0, u^\alpha) = dx^i / d\tau \qquad (1)$$

(where $x^i = (x^0, x^\alpha)$; $x^0 = t$, c=1; α=1,2,3; τ is the invariant proper time) also changes the sign. Therefore, for antiparticles

$$u_a^i = -u^i . \qquad (2)$$

In particular, the negative sign of the time component (the time derivative)

$$u_a^0 = -u^0 = -dt / d\tau = -\gamma , \qquad (3)$$

where γ is the Lorentz factor, says that time flows backward for antiparticles (the known Stueckelberg-Feynman interpretation). As a result, for the antiparticles energy we have indeed

$$\mathrm{E}_a = mu_a^0 = -mu^0 = -\mathrm{E} . \qquad (4)$$

Thus, as a factual consequence of T-invariance, ***every elementary particle mast have the corresponding antiparticle***. For example, the antiparticle of photon is an antiphoton (the photon with negative energy and opposite helicity) [4]. The antiphoton analogues: the antigraviton and the antigluons are antiquanta of gravitational and nuclear fields and so on.

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Lorentz Force and Rotational Relativity

Recent experimental investigation on electrodynamics revealed that the velocity appearing in Lorentz force is the velocity of the charge relative to the bodies-magnets or carrying current wires- which generate the magnetic field. All above in full agreement with Einstein's early suspicion: *"It is known that Maxwell's electrodynamics (as usually understood at the present time) when applied to moving bodies, leads to asymmetries which do not appear to be inherent in the phenomena"*. Albert Einstein, *« Zur Elektrodynamic Bewegter Körper »*. Annalen der Physik, **17** (1905).

In fact, motional electromagnetic induction is a true relativistic (*i.e.* relational [1,2]) phenomenon [3,4,5,6,7,8,9,10] despite involving rotations, i.e. non-inertial frames [11,12,13]. Now we are able to reinterpret Figure 1 in a modern way [3-10]. Lorentz' force due to the spinning magnet acting on the stationary charge q reads $\boldsymbol{F}_L = q\,(\boldsymbol{\omega} \times \mathbf{r}) \times \boldsymbol{B}$ wherein the angular velocity $\boldsymbol{\omega}$ involved in the above expression is $\boldsymbol{\omega} = \boldsymbol{\omega}_q - \boldsymbol{\omega}_m$, i.e. the velocity of the charge *relative* to the magnet. Besides, $\boldsymbol{\omega}_q$ and $\boldsymbol{\omega}_m$ are –respectively- the charge and magnet angular velocities measured with respect to the lab. These velocities are defined in terms of Figure 1 notation, as: $\boldsymbol{\omega}_q = 0$ and $\boldsymbol{\omega}_m = -\omega \cdot \boldsymbol{u}_z$, from which follows that a magnet's clockwise rotation beneath a charge at rest in the lab is equivalent to the charge's counterclockwise rotation ($\boldsymbol{\omega}_q = \omega \cdot \boldsymbol{u}_z$) with the magnet anchored to the lab ($\boldsymbol{\omega}_M = 0$).

After a century from its discovery, Lorentz' force acquires a clear and unambiguous physical meaning, without involving hypothetical *observers*.

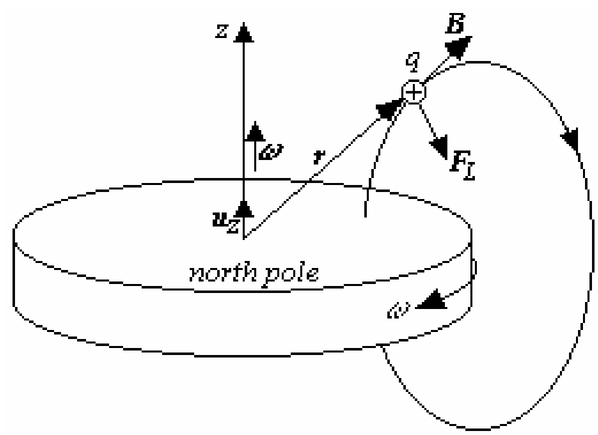

Figure 1

Lorentz Force on a Stationay charge due to a Spinning Magnet

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Quantum Foam

Based on the theory of elastic spacetime (see Comments section in JOT Vol. 6-3, Gravity and Spacetime) where spacetime has an elastic constant k, it was shown that

$mc^2 = (1/2)kx^2$ {1}

where m = mass of particle that corresponds to the potential energy stored in the spacetime fabric [1]. It was also shown that k in the potential energy formula above is the same ($k = 7.18 \times 10^{17}$) for the boundary conditions of the four forces as follows:
{x = radius of universe = 1.9×10^{26} meters, m = mass of universe = 1.44×10^{53} Kg}.
{x = Planck Length, m = predicted mass of photon = 10^{-69} Kg},
{x = strong force range = 2×10^{-14} meters, m = mass of proton} and
{x = weak force range = 10^{-18} meters, m = predicted mass of electron-neutrino = 2.24 eV/c^2 }.

As {1} is based on the integration of Hooke's force law, it should also be true that F = kx, which is the force of compression or tension in the spacetime fabric and we find that this is the case for the boundary condition of x = radius of universe as follows:

$F = kR_u = G(M_uM_u)/(R_u)^2$ {2}

Where M_u is mass of universe, R_u is radius of universe and $k = 7.18 \times 10^{17}$ as found above. Equation {2} simply states that the mass of the universe acting upon itself over its own radius is equal to k multiplied by a spacetime displacement equal to the radius of the universe. This is the overall stretching force of the universe corresponding to its mass and it produces a pulling force that can produce standing-wave ripples (whose amplitude is the rest energy, mc^2 of a particle) in the fabric of spacetime. For any material of mass/unit-length u, where we introduce a force along one axis in the material we get waves of speed v as follows:

$v = (F/u)^{1/2}$ {3}

We know from {2} that $F = kR_u$ for spacetime and we now make the assumption that the spacetime fabric is a quantum foam of miniature, primordial blackholes as described by Hawking[2]. We assume that all the blackholes in this scenario are connected from one

Schwarzchild radius to another and that they will have the same Schwarzschild radius, r_s = Planck length = 1.616 x 10^{-35} meters. We know that $r_s = 2GM/c^2$ so that the mass of each blackhole is M = 10^{-8} Kg. Then u = mass/unit-length = $c^2/(2G)$ and {3} becomes

$$v = (2GkR_u/c^2)^{1/2} \qquad \{4\}$$

For R_u = radius of universe and k as found above it is shown that v = c, showing that the speed of a wave in the space-time fabric produced by the universal tensile force in {2} is equal to the speed of light. Note that v is not the speed of the mass itself but rather the speed of its DeBroglie wave which we assume travels in the plane normal to the particle's velocity vector. We assume this because the rest-energy of the particle can be set equal to the quantized energy in a two-dimensional quantum well and then the relation in {1} is derived[3]. This then defines the rest-energy of the particle from its mass as mc^2 which is based on the energy in its DeBroglie wave, which is proportional to v^2 when v = c. The particle may be moving at some speed and this produces separate, non-standing DeBroglie waves based on the particle's speed but in {4} we propose that standing DeBroglie waves normal to the velocity vector is what defines the rest energy of the particle.

From {4} we know that the upper limit for v is c and this corresponds to a tensile force equivalent to the mass of the universe, therefore smaller masses will exhibit a force that is smaller than {2}. If we take a given mass of say, 10^6 Kg and calculate from {1} what the displacement x is (knowing k from above) we find x = 500.6 meters. This is the average stretch in spacetime that corresponds to this mass and because the force is smaller than in {2} we expect a smaller velocity for the corresponding DeBroglie waves which will amount to time-dilation effects at distance R from the gravitational source. When we substitute x = 500.6 meters into {4} in place of R_u we find v = 0.73 cm/sec which is the velocity of DeBroglie waves in the quantum foam at 500.6 meters from the center of the mass. When we take the ratio of this velocity to the maximum possible velocity c we find v/c = 2.43 x 10^{-12} and

$$(v/c)^2 = 5.90 \times 10^{-24} \qquad \{5\}$$

In general relativity the time dilation at a distance R from the center of the gravitational source M is

$$T = T_0 / (1-2GM/(Rc^2))^{1/2} \qquad \{6\}$$

For the mass of 10^6 Kg and R = x = 500.6 meters , $2GM/(Rc^2) = 2.96 \times 10^{-24} = (1/2)(v/c)^2$ where $(v/c)^2$ is found from {5}. Therefore, the time dilation formula of {6} when combined with the DeBroglie velocity waves of {5} and {4} becomes,

$$T = T_0 / (1-.5(v/c)^2)^{1/2} \qquad \{7\}$$

which excluding the factor of 0.5 which may be an averaging effect, is the standard Lorentz transformation for time dilation of a mass moving at velocity v. So we find the time dilation effects due to general relativity {6} and special relativity {7} are essentially the same when the velocity of DeBroglie waves is considered. Although we used a specific mass for this example of m = 10^6 Kg, it can be shown in general by combining {4} and {1}, and substituting x = R that

$$0.5(v/c)^2 = 2GM/(Rc^2) \qquad \{8\}$$

It is also interesting to note that the mass of the primordial black holes multiplied by the radius of the universe gives the mass of the universe (again, one-axis model):

$(M_{blackhole} = 10^{-8}$ Kg)* $R_u / r_s = 10^{53}$ Kg = approximate mass of universe

From the above discussions it is proposed that the spacetime fabric is a quantum foam composed of elastic, primordial blackholes that exhibit characteristics of elastic materials such as Hooke's Law.

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