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ARE MASSES OF ELEMENTARY PARTICLES AND OF THE SOLAR SYSTEM TRULY KNOWN?

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Abstract

We recall that gravitation is characterized by the *rest energy,* rather than the *mass* of a body, and reformulate Newton's equation accordingly also to achieve universality of gravitation, thus inclusive of light. We then point out that, from the precise knowledge of the trajectories of the planets of our Solar system, we can derive with great accuracy the rest energies of the members of our Solar system, although the corresponding value of the masses are an assumption at this writing because they are calculated via the mass-energy equivalence principle $E = mc^2$ whose validity is certain under the conditions stated by Einstein, for *point particles* moving in vacuum, but not certain for *extended bodies* due to the unknown value of the maximal causal speed in their interior. We point out the occurrence of a similar situation in particle physics and suggest a possible experimental verification of the mass-energy equivalence principle for extended bodies. The cosmological implications for the removal of the far reaching conjectures of the universe expansion, dark matter and dark energy are briefly indicated.

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An important property of gravitation which is often ignored is that the source of the gravitational field is given by *rest energy* and not by *mass.* In fact, the source term in Einstein-Hilbert field equations is given by the *energy-momentum tensor* while, by contrast, the "mass-momentum tensor" does not exist because geometrically, let alone physically inconsistent. This occurrence has suggested the author to write for quite some time to write the celebrated Newton equations [1]

$$F = g\ \frac{M_1 M_2}{r^2} \tag{1}$$

in the *identical* form [2]

$$F = \frac{M_1 M_2}{r^2} \equiv \frac{E_1 E_2}{r^2 c^4} = \hat{g}\ \frac{E_1 E_2}{r^2}, \quad \hat{g} = \frac{g}{c^2}, \tag{2}$$

where $E_1,\ E_2$ refer to the rest energies of the two bodies, their kinetic energy being ignorable for the initiating character of this note.

It should be stressed that we are here referring to an *identical* reformulation of Newton's equation without any intended structural change. As an illustration, for the case of an electron, we would write for the case of Newton's original formulation the value of the electron mass $M_1 = 9.109 \times 10^{-31} Kg$, while for our reformulation we write the *identical* value $0.511\ MeV/c^2$. Similarly, for the proton we would write for Newton's original formulation $M_2 = 1,672 \times 10^{-27}\ Kg$, while for our reformulation we would write the identical value $938,272\ MeV/c^2$. Therefore, under the above assumption, the formulation of Newton's gravitation in terms of masses and that in terms of rest energy give the same results.

Despite such an identity, the indicated reformulation is not trivial. To begin, we recall that It should be indicated that the reformulation originated from the intent of achieving a true "universality" of Newtonian gravitation. In fact, a mass cannot attract light according to Newton's original formulation (1) since light has no mass. By contrast, a body with rest energy E_1 can indeed attract light with energy $E_2 = h\nu$ according to reformulation (2), thus achieving the desired universality and raising the unresolved issues (not considered in this note) as to whether the bending of light is due to Newtonian "universal" gravitational attraction or to actual curvature of space [2].

Additionally, said reformulation essentially implies that, from known orbits and data, we can derive with extreme accuracy the *rest energies* of the members of the Solar systems, but the corresponding values of their *masses* are unknown at this writing on serious scientific ground without unverified assumptions. In fact, the derivation of masses from rest energies depends on the familiar mass-energy equivalence principle

$$E = m\ c^2 \tag{3}$$

which is experimentally verified under the conditions stated by Einstein, for point particles moving in vacuum (exterior dynamical problem), but its validity for extended masses is a mere unverified assumption to our best knowledge.

In essence, the speed of light c can be safely assumed as being the maximal causal speed in vacuum and its validity for point particles is also beyond doubt due to the lack of a structure. When passing to extended masses, the situation is fundamentally different because the formulation of their energy equivalence requires the knowledge of the maximal causal speed in their interior, whose value is vastly unknown at this writing.

As an illustration, for the case of the electron we can safely interchange rest energy with mass, i.e., $M_1 = 9.109 \times 10^{-31} Kg \equiv 0.511\ MeV/c^2$, again, because the electron has no structure, in which case, the validity of c as the maximal causal speed for its structure is beyond doubt. In the transition to the proton, the situation is not equally established because the proton has a big volume (for particle standards) filled up with a hyperdense hadronic medium. In this case, the identity of the mass of the proton $1,672 \times 10^{-27}\ Kg$ with its rest energy $938,272\ MeV/c^2$ is a theoretical assumption which is not only experimentally unverified (see Refs. [2], Vol. IV), but also questionable on grounds that it implies the speed of light *in vacuum* as being the maximal causal speed in the *hyperdense medium* in the interior of the proton. In conclusion, for the case of elementary particles at large, we can safely assume that rest energies are indeed accurate, but the corresponding masses are generally unknown except for point particles. The situation for the masses of our Solar system is essentially the same.

More generally, there are serious indications of the lack of exact validity of special relativity for extended objects and electromagnetic waves moving within a physical medium (interior dynamical problem) for various mathematical, physical and experimental reasons, including: the inability to place inertial reference systems in the interior of physical media due to the resistance; the impossibility of representing numerical data on the refraction of light in water via the reduction to photons of *all* frequencies besides the few ones truly admitting quantum absorption and re-emission; experimental evidence on deviations from the Doppler law within transparent physical media with a frequency shift without any relative motion between the source, the medium and the observer (called *isoredshift* for the case of reduced frequencies and *isoblueshift* for the case of increased frequency); and other evidence [3].

Extensive studies for interior dynamical systems (such as the structure of hadrons, nuclei and stars) have suggested the use of the most general possible symmetric spacetime with line element

$$x^2 = \frac{x_1^2}{n_1^2} + \frac{x_2^2}{n_2^2} + \frac{x_3^2}{n_3^2} - t^2\ \frac{c^2}{n_4^2}, \tag{4}$$

admitting as particular cases all possible spacetimes in (3+1)-dimensions (including all infinitely possible Minkowskian, Riemannian , Finslerian and other spacetimes) all possessing the unifying and universal *Lorentz-Poincaré-Santilli (LPS) isosymmetry* for interior physical media [1,2].

Line element (4) is characterized by: n_4 representation an average of the index of refraction in the medium considered; $n_k^2, k = 1, 2, 3$, representing symmetrized space counterparts; n_k^2/n_4^2 representing the general anisotropy and inhomogeneity of physical media; and all $n_\mu, \mu = 1, 2, 3, 4$, being normalized to the value for the vacuum

$n_\mu = 1$. It should be indicated that the n-quantities, called *characteristic quantities of the medium,* are not arbitrary parameters, but actually measurable physical quantities, as it is the case for the index of refraction.

In particular, the Lorentz-Poincaré-Santilli isosymmetry predicts the *light isocone* along the space direction s $x^2 = x_s^2/n_s^2 - t^2c^2/n_4^2 \equiv 0$ with consequential *maximal causal speed* for interior conditions in the s space direction [2,3]

$$V_{max} = c\,\frac{n_s}{n_4}, \tag{5}$$

which is *smaller* then c for media of low density (such as atmospheres, chromospheres, etc.) and *bigger* than c for media of high density (such as interior of stars, quasars and black holes). Note the impossibility of using the speed of light as the maximal causal speed for interior dynamical problems, trivially, because they are in general opaque to light, thus demanding broader geometrical vistas. The speed of light is recovered as the maximal causal speed in vacuum, but only thanks to the identity in that case $n_4 = n_s$.

It should be noted that *all fits of experimental data in particle physics via the Poincaré-Santilli isoisymmetry have systematically provided values of V_{max} inside hadrons as being bigger than the speed of light in vacuum* (see Vol. IV of Refs. [2]).

It is evident that the universal LPS isosymmetry predicts the following *mass-energy isoequivalence principle* in the s-direction

$$E = mV_{max}^2 = mc^2\frac{n_s^2}{n_4^2}. \tag{6}$$

where the reader should always keep in mind that, for the studies herein considered, the fixed quantity is the energy E, while the quantity m, referred to the *inertial mass,* is generally a local quantity depending on the characteristics of the medium considered. As an example, for a given planet with internal inhomogeneity (due to variable density) and anisotropy (due to rotation), the total energy E is a fixed quantity, but the corresponding inertial mass m is predicted to depend on the selected direction, with particular reference to different values of the inertial mass in the equatorial radial direction as compared to the corresponding value for the axial direction.

As indicated above, isostructures (4)-(6) have been verified for all available fits of experimental data for interior particle conditions. Their additional independent verification, with particular reference to that of the isoequivalence principle (6), are far from trivial. A conceivable experimental verification is that via the measurement in exterior conditions of the isotopic shift of the frequency of light emitted in interior conditions, that is, a shifty in the absence of relative motion. Consider the *Doppler-*

Santilli isoshift law along the third axis, Eq. (13) Ref. [3],

$$\nu' = \frac{1 - \hat{\beta}\ cos(\alpha)}{\sqrt{1 - \hat{\beta}^2}}\ \nu,\ \hat{\beta} = \beta\ \frac{n_3}{n_4} \tag{7}$$

uniquely prediucted bvy the LPS isosymmetry, with approximate form for the case of the third axis

$$\nu' \approx\ [1 \pm \frac{v_3}{V_{max}} + ...)\nu, \tag{8}$$

thus illustrating the prediction of both the isored- and isoblue-shift without any relative motion between the source, the medium and the detector. In fact, the ratio n_3/n_4 is generally dependent on velocity, e.g., in a linear form, in which case $Lim - v \to 0 v_3/V_{max} \neq 0$. Recall that the decrease of frequency is merely due to the loss of energy by light to the medium of low density generally assumed in its ground states (thus unable to supply energy). while the increase of frequency is due to the acquisition of energy by light from ,media of high density (thus being in a highly excited state).

The comparison between a conventional prediction of frequency for photons emitted in the interior and their value measured in the exterior is expected to provide a value of V_{max} at least in a preliminary form. To illustrate the complexity of the problem here addressed, we should indicate that, assuming the suggested measurement is achieved for one extended body, such a result *does not* necessarily apply to another body. It is hoped this comment dismisses the expectation that the problem of establishing experimentally the energy equivalence of extended bodies can at best be identified in this note and definitely not resolved.

We close this note with the indication that deviations from the mass-energy equivalence principle for physical media appear to have important cosmological implications, such as the elimination of the far reaching conjectures of the universe expansion, dark matter and dark energy. Recall that all astrophysical measurements are based on *readshifts,* and 20th century theories are generally based on the tacit assumption of the exact validity of special relativity at large, thus including the Doppler shift, throughout all conditions existing in the universe.

In fact, the conjecture of the expansion of the universe is a consequence of the measured cosmological redshift of light from far away galaxies under the tacit assumption of the exact validity of special relativity for intergalactic media, since the latter assumptions solely allows the former. However, the cosmological redshift turned out as being the same in all directions, thus losing plausibility due to the placement of Earth at the center of the expansion. Plausibility was further reduced by the evidence of the increase of the redshift with the distance from Earth, in which case special relativity and the Doppler shift solely allow the additional conjecture of the

acceleration of the expansion with the distance from Earth. The experimental verification of Santilli isoredshift presented in Ref. [3] eliminates the need for Earth being at the center of the universe, and eliminated as well as the universe expansion and its acceleration, since the cosmological redshift is reduced to loss of energy by light to the intergalactic medium. Such a loss is proportional to the distance traveled in said medium with consequential elimination of the acceleration of the expansion.

The conjecture of dark energy was voiced and rapidly accepted quite widely, in support of the conjectures of the expansion of the universe and its acceleration. The conjecture of dark energy did succeed in derailing attention on deviations from special relativity, but without resolving the problems for which the conjecture was ventured. As stressed in this note, "energy" is the source of the gravitational field. Consequently, dark energy should contract the universe and definitely not accelerate its expansion. Additionally, when uniformly distributed, dark energy has no possible or otherwise plausible gravitational effect on any galaxy. Finally, possible local concentrations to achieved the desired expansion and acceleration of the expansion are faced with serious global inconsistencies.

The universal Poincaré-Santilli isosymmetry eliminates any need for the dark energy. This is achieved first via the elimination of the expansion of the universe (and the related big bang conjecture), but also via the isotopic mass-energy equivalence. As an illustration, the conjecture that dark energy constitutes 90% of the energy in the universe, is eliminates via the increased maximal causal speed in the interior of astrophysical bodies and the expression [3]

$$E_{dark\ energy} = m_{univ}(V_{max}^{aver,2} - c^2) \tag{9}$$

where V_{max}^{aver} is an average of the maximal causal speed in interior of stars, quasars and black holes. In particular, dark energy as comprising 90% of our universe is eliminated for $V_{max}^{aver} \approx 10\ c$. By recalling trhat the fit ofd all particle data yields V_{max} bigger than c in the interior of particles (e.g., a value $V_{max} = 1.65\ c$ for the interior of the proton Vol. UV, Refs. [2]), value $V_{max}^{aver} \approx 10\ c$ is rather moderate when keeping into account the much denser interior of stars, quasars and black holes.

We finally recall that dark matter originated from the claim that peripheral galactic stars have the same speed despite the decrease of their distance from the galactic center. A scientifically more accurate statement is that peripheral galactic stars have a redshift that increases with the decrease of the distracted from the galactic center. The conjecture of equal peripheral speeds is a consequence of the tacit assumption of the exact validity of special relativity and the Doppler shift law within innergalactic media that are clearly visible with telescopes. Santilli's isoredshift also eliminates the conjecture of dark matter because innergalactic media have a density that increases with the decrease of the distance from the galactic center, thus causing an increasing isoredshift without any need for far reaching conjectures.

In summary, this note addresses the limitations of special relativity, including the limitations of the mass-energy equivalence principle, the Doppler shift and other laws, for physical conditions much beyond those of their original conception and experimental verification, point particles and electromagnetic waves in vacuum. Since the entire 20th century physics was based on the tacit assumption of the exact validity of special relativity for all possible conditions, the author hopes to stimulate a moment of reflection on the expectation that dramatic structural revisions should be expected for all 20th century conjectures, whenever dealing with interior dynamical problems, thus including structural revisions on the masses of particles, the masses of the solar system, the expansion of the universe, its acceleration, the big bang, dark matter, dark energy and numerous others, all intimately reducible to the assumption of exact validity of Einsteinian doctrines within physical media.

Acknowledgment

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