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EXPERIMENTAL VERIFICATION OF ISOREDSHIFT AND ITS COSMOLOGICAL IMPLICATIONS

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Summary

We recall evidence accumulated during the past fifty years according to which the Lorentz symmetry is not exactly valid within physical media; we recall the vast studies requested for its consistent generalization; we present the experimental verification of the covering symmetry via the the isoredshift referred to a shift of the frequency of light toward the red when propagating within transparent physical media without any relative motion between the source, the medium and the observer; and we indicate that the Lorentz symmetry is nowhere applicable at cosmological distances since the universe at large is a physical medium filled up with light, particles, dust and stars. We finally point out that: the intergalactic isoredshift implies the possible absence of the universe expansion and the big bang; the innergalactic isoredshift implies the possible absence of dark matter; and the isoblueshift predicted in the interior of stars, quasars and black holes implies the possible absence of dark energy, all events being experimentally verifiable on Earth.

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Research conducted by numerous scholars during the past fifty years (see general review [1] and specialized treatments [2-4]) has identified mathematical, physical, chemical, experimental and industrial evidence according to which the Minkowskian geometry, special relativity and the Lorentz-Poincaré (LP) symmetry are not exactly valid for *interior dynamical problems* (e.g., extended-deformable particles and electromagnetic waves propagating within physical media). Needless to say, the exact validity of the Minkowskian geometry, special relativity and the LP symmetry for *exterior dynamical problems* (point particles and electromagnetic waves propagating in vacuum) and their approximate validity for interior problems remain beyond doubt.

The reasons for said insufficiency are numerous indeed, and include: the impossibility of introducing inertial reference frames within physical media (such as air or water) due to known resistive forces, with consequential inability of even formulating relativity principles, let alone testing them experimentally; physical media solely admit the privileged frame at rest with themselves in conflict with relativity axioms; massive particles, such as electrons, can travel in water faster than the local speed of light, thus forcing the assumption in *water* of the speed of light in *vacuum* as the maximal causal speed, in which case the sum of two local speeds of light does not yield the local speed of light in disagreement with the relativistic sum of speeds.

During the 20th century, these insufficiencies were generally dismissed via the reduction of light to photons traveling in empty space and experiencing scattering, absorption and re-emission by the atoms of the medium. However, such a reduction is afflicted by major insufficiencies. As an illustration, for the case of propagation in water, the reduction of light to photons is afflicted by: the impossibility of a numerical representation of the large angle of refraction (since photons must scatter in all directions at the impact with the water surface); the impossibility of a numerical representation of the large reduction of the speed of light by about 1/3 (since scattering, absorption and re-emission of photons can at best account for a small reduction of speed); the impossibility of reducing to photons electromagnetic waves with a large wavelength, e.g., of one meter, that experience the same phenomenology as that of light; the impossibility of the very existence of light within opaque media with consequential obliteration of the conceptual, mathematical and physical framework of special relativity; and other insufficiencies. At any rate, the reduction to photons of the *entire* beam of light in water implies that an extremely big number of photons must traverse an extremely

big number of nuclei without any deflection, as an evident necessary condition to maintain the propagation of a light beam in water along its visible straight line [xx].

It is today known that the sole quantitative representation of *all* experimental evidence for *all* frequencies is given by a return to the Maxwell conception of light (as well as the wavepackets constituting photons as) as being *transverse electromagnetic waves* propagating in the universal substratum known as the *ether* with historical expression for the speed within transparent physical media $C = c/n(x, v, \omega, \delta, ...)$, where c is the speed of light in vacuum and n is the familiar index of refraction with an unrestricted dependence on all needed local variables, such as coordinates x, speed v, frequency ω, density δ, temperature τ, etc.

The return to the Maxwellian conception of light as electromagnetic wave brings into focus the so-called *Lorentz problem,* referred to the construction of the symmetry leaving invariant a locally varying speed of light. As well known to historians, Lorentz first attempted the achievement of the universal symmetry of local speeds $C = c/n(x, v, \omega, \delta, \tau, ...)$, but encountered major technical difficulties that forced him to consider the simpler case of constant speed c by setting up in this way the foundations of special relativity.

The author has dedicated most of his research life to th Lorentz problem beginning with his Ph. D. studies in the mid 1960s. It became soon evident that Lorentz's inability to find the desired invariance was due to *insufficiency of the used mathematics,* because Lie's theory and underlying mathematics are known as being linear, local-differential and Hamiltonian, while the problem considered is generally nonlinear, nonlocal-integral and non-Hamiltonian (i.e., interior dynamical systems cannot be represented via a Hamiltonian due to internal nonpotential interactions [4]).

Consequently, the author had to spend decades of studies for the construction of a new mathematics applicablke within physical media that was finally achieved in memoir [6] of 1996, and is today known as *isomathematics,* where the prefix "iso" indicates the preservation of the original axioms. Additional years of research had to be dedicated to the construction of the isotopies of Lie's theory, today known as the *Lie-Santilli isotheory* [1,5,6]. Only following all these studies, the author was in a position to construct the universal invariance of the locally varying speed of light $C = c/n(x, v, \omega, \delta, ...)$, which is today known as the *Lorentz-Poincaré-Santilli (LPS) isosymmetry,* as well as the isotopeis of special relativity known as *Santilli isorelativity* [1-6].

These studies are nowadays generally referred to the invariance of the following most general possible symmetric line element in (3+1)-dimensions

$$x^2 = \frac{x_1^2}{n_1^2} + \frac{x_2^2}{n_2^2} + \frac{x_3^2}{n_3^2} - t^2 \frac{c^2}{n_4^2}, \tag{1}$$

where $n_\mu, \mu = 1, 2, 3, 4, n_4 = n$, are experimentally measurable charactristics of the medium, whose universal symmetry was first achieved by Santilli [7d]] in 19083 and can be written for the simpler case of motion in the (3,4)-plane (see Ref. [3b] for the general case)

$$x'^1 = x^1, \quad x'^2 = x^2, \tag{2a}$$

$$x'^3 = \hat{\gamma}\ (x^3 - \hat{\beta}\ \frac{n_4}{n_3}\ x^4),\ x'^4 = \hat{\gamma}\ (x^4 - \hat{\beta}\ \frac{n_3}{n_4}\ x^3), \tag{2b}$$

$$\hat{\gamma} = \frac{1}{\sqrt{1 - \hat{\beta}^2}},\ \hat{\beta} = \beta \frac{n_4}{n_3} = \frac{v_3}{c} \frac{n_4}{n_3}. \tag{2c}$$

On primitive grounds, the underlying new geometry, known as the *Minkowski-Santilli isogeometry* [7d,4,6,7h], provides an isotopic unification of all spacetime geometries, including the Minkowskian, Riemannian, Finslerian and other geometries, as evident from the universal nature of invariant (1).

The novel isomathematics, related geometries and physical formulations for nonrelativistic and relativistic, classical and operator formulations for interior dynamical problems have nowadays experimental verifications in all quantitative sciences, including classical physics, particle physics, nuclear physics, superconductivity, chemistry, biology, astrophysics and cosmology (see Refs. [1,4d] for details). Evidently, we cannot possibly review in this short note all these verifications. Hence, we limit ourselves to the review of the deviations from the Lorentz symmetry within physical media (in the absence of gravitation).

Remember that the Doppler law is an ultimate manifestation of the Lorentz symmetry from which it can be uniquely derived, and predicts a null shift for null speed. By contrast, the covering isosymmetry (2) uniquely characterizes a generalized law for the frequency of electromagnetic waves propagating within a physical medium, known as *Doppler-Santilli isoshift law,* that predicts the following frequency shift even for null speed, first identified in Ref. [2b],

$$\omega' = \frac{1 - \hat{\beta}\ cos(\alpha)}{\sqrt{1 \pm \hat{\beta}^2}}\ \omega \approx (1 - \frac{v_3}{c}\frac{n_4}{n_3} + ...)\omega = 1 \pm K(r, v, \omega.\delta, ...),\ K > 0. \tag{3}$$

where: the sign "−" is used for media of low density (such as air or water) and characterizes the *isoredshift* referred to *a shift toward the red for light propagating within transparent physical media without any relative motion between the source, the medium and the observer;* while the sign "+" is used for hyperdense media (such as those in the interior of stars, quasars and black holes) and characterizes the *isoblueshift* referredthis time to an increase of the frequency without relative motion. For the isoredshift, the interactions between light and the medium cause a loses energy $E = h\omega$, thus a decrease of the frequency ω, due to the impossibility that atoms in the medium lose energy since they are generally in their stable ground state. For the isoblueshift, light acquires energy from the medium, thus existing the same isoblueshifted, that is, with frequency shifted toward the blue without any relative motion.

The first experimental evidence known to this author on the existence of the isoredshift (although not interpreted as such) has been the discovery by H. Arp [8] of quasars that, according to gamma spectroscopic evidence, are physically connected to an associated galaxy, yet their respective cosmological redshifts are dramatically different. Such a difference clearly indicates a departure from the Lorentz symmetry because, under its validity, said large difference in cosmological redshifts would require that the quasar has at least 100 times the speed of the galaxy, under which conditions the quasar and its associated galaxy would have separated completely billions of years ago.

Santilli's isotopies of special relativity [2b] wer inspired by Arp's discovery that was recommended for further study. Quite simply, the argument is that quasars have very large chromospheres at times as big as an entire galaxy, while the gaseous medium inside galaxies has a much smaller density. Consequently, for both the quasar and the associated galaxy, light emitted in their interior reaches intergalactic space already redshift, although the isoredshift of the quasar light is much bigger than that of the galaxy due to the indicated much bigger density and size. In 1992, R. Mignani [9] provided a direct experimental verification of Santilli's isorelativity and related isoshift law (3) by showing that they provide a numerical representation of the large difference in cosmological redshifts for all known pairs of quasars and associated galaxies.

Additionally, the colors of our atmosphere were shown in Ref. [2b] as providing further direct experimental verification of the isotopies of special relativity. As established by the conventional quantum scattering theory as well as by visible evidence in air and water, red light is absorbed by physical media, resulting in the predominance of blue light that originates the color of the sky with the Sun at the Zenith (or the color of water at a sufficient depth).

The predominance of red for the Sun at Sunset and Sunrise was interpreted throughout the 20th century via the abrupt and unexplained, opposite assumption, namely, that blue light is absorbed by our atmosphere at Sunset and Sunrise resulting in the predominant red. Santilli [xxb] pointed out that this interpretation is in violation of the quantum scattering theory as well as physical evidence that red light cannot possibly propagate over the large distances at the horizons, while the scattering of photons among the atoms of our atmosphere cannot possibly provide a numerical representation of the large frequency shift (of about 300 nm) necessary to turn blue into red light, thus leaving as the sole plausible interpretation the isoredshift of light which is indeed proportional to the trajectory within the medium considered.

Furthermore, Santilli [2b] pointed out that the predominance of red at Sunset and Sunrise occurs for *direct sunlight,* thus excluding possible interpretation via scattering (that refer to the diffused light), and the isoredshift is rendered necessary by the fact that the predominance of red is essentially the same at Sunset, where we move *away* from the Sun, as well as Sunrise, where we move *toward* the Sun. This establishes that the isoredshift dominates over the Doppler's shift, of course, under a sufficiently long interior trajectory. In view of all the above, Santilli conclude Ref. [xxxb] suggesting the conduction of experiments on Earth,

such as the measurement of a Fraunhofer line of the Sun while moving from the Zenith to the equator, and various other experiments.

Despite the passing of decades, the propagation of the information and the author solicitations for conducting the proposed experiments to various physical and astrophysical laboratories, the above experimental verifications (including Arp's discovery) remained vastly ignored by most physicists and astrophysicists to their evident peril, because such an oblivion is *de facto* in support of the validity of special relativity under conditions it was not conceived for and never tested. Consequently, Santilli [10] had no other choice than that of conducting himself the measurement of the isoredshift, that was done in 2009 in a 20 m long tube containing air at about 140 *bars* with the resulting measurement of about 0.5 nm isoshift of a blue laser light. Ref. [10] then proved the capability of such an isoredshift to provide a numerical representation of Arp's discovery [8], the color of our atmosphere at Sunset and Sunrise [2b], and other interior events.

Ref. [10] also pointed out that, while being locally valid in empty space, *special relativity is nowhere exactly valid in the universe at large, because at cosmological distances the universe is a medium with high energy density (since it is everywhere filled up with light or stars), and the space within galaxies is a notorious physical medium filled up of gases, particles and dust.* Consequently,, the intergalactic isoredshift can imply the absence of universe expansion and of the big bang, including a representation of the background radiation originating from the energy lost by light; the intergalactic redshift can imply the absence of dark matter; and the isoblueshift in the interior of stars, quasars and black holes can imply the absence of dark energy (see also Ref. [11] for p[lausibility arguments), all events experimentally vrifianble via experiments on Earth along the teaching of Galileo Galilei.

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