Experimental Verifications of Isoredshift with Possible Absence of Universe Expansion, Big Bang, Dark Matter, and Dark Energy

Ruggero Maria Santilli*

Institute for Basic Research, P. O. Box 1577, Palm Harbor, FL 34682, USA

Abstract: In this paper, we present systematic studies on the insufficiencies of special relativity within physical media, such as water, atmospheres and the interior of astrophysical bodies. We outline the rather large body of research on the deformations of special relativity applicable within physical media, known under the name of *isotopies*. We then present, apparently for the first time, experimental verifications of the hypothesis formulated by the author in 1991, and today known as *isoredshift,* according to which light propagating within a physical medium experiences a shift of its frequency toward the red without any relative motion between the source, the medium and the observer, the shift originating from expected loss of energy to the medium due to interactions. We then confirm the isoredshift in the colors of our atmosphere as well as in the large difference in cosmological redshift between certain quasars and their associated galaxies; we indicate the consequential conceivable absence of universe expansion, big bang, dark matter, and dark energy; and propose *systematic tests for the resolution of cosmological models via experiments on Earth along the teaching of Galileo Galilei.*

Keywords: Isoredshift, dark energy, dark matter, big bang.

1. THE INTRIGUING HISTORY OF LIGHT

As it is well known (see, e.g., Ref. [1]), Alhazen initiated in 1021 the conception of light as made up of particles, a conception that was subsequently supported by numerous scientists, most notably by Newton.

The advent in 1873 of Maxwell's equations supported the alternative interpretation of light as being made up of (transversal) *electromagnetic waves* propagated by a universal substratum (ether), thus resolving in this way known insufficiencies of the conception of light as being made up of particles.

Nevertheless, with the discovery of the black body radiation, the wave interpretation of light resulted in being insufficient to represent all data, most notably, the discrete character of the absorption and emission of light by atoms. The latter impasse was resolved by Einstein in 1905 with his conception of light as being made up of basic quantum particles called *photons* with energy $E = h\nu$.

In view of the vast experimental evidence in atomic spectroscopy confirming the existence of photons, as well as the historical difficulties posed by the ether for special relativity, during the past century all possible manifestations of light have been reduced to photons propagating in vacuum so as to achieve compatibility with special relativity.

Recall that the validity and experimental verifications of special relativity are beyond doubt for the conditions clearly stated by Einstein, i.e., for point-like particles and electromagnetic waves propagating in empty space, conditions historically known as *exterior dynamical problems,* that include atomic structures, particles in accelerators, and many other systems.

The open issue underlying this paper is whether special relativity is still exact or only approximately valid for physical conditions significantly beyond those of its original conception, generally those of extended particles and electromagnetic waves propagating within physical media, historically referred to as *interior dynamical problems,* for which no *direct* experimental verifications comparable to those in vacuum exist at this writing.

The study is primarily intended for astrophysics and cosmology along the teaching of Galileo Galilei according to which we first identify the largest possible experimental evidence on Earth, and then apply the results to astrophysical and cosmological models.

2. INSUFFICIENCIES OF SPECIAL RELATIVITY FOR INTERIOR DYNAMICAL PROBLEMS

Until the early part of the 20th century, there was a clear distinction between interior and exterior dynamical problems often reflected in the titles of the papers of that time. Since the advent of Einstein's theories, all distinction between exterior and interior problems were dismissed via the reduction of interior systems to isolated particles moving in vacuum.

Even though conceptually appealing, the reduction of interior to exterior systems is afflicted by fundamental insufficiencies nowadays well known to experts in the field (see Refs. [2-7] and quoted literature). Consider first the case of interior dynamical problems characterized by *opaque media.* In this case, there is the lack of propagation of light with consequential impossibility of any consistent classical formulation of the very axioms of special relativity.

*Address correspondence to this author at the Institute for Basic Research, P. O. Box 1577, Palm Harbor, FL 34682, U.S.A.; Tel: +1-727-934 3448; Fax: +1-727-934 9275; E-mail: ibr@verizon.net

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The reduction of a classical opaque medium to a finite number of point-particles moving in vacuum, as necessary to apply special relativity, is prohibited by well known *No Reduction Theorems* [*loc. cit.*] identifying a number of clear inconsistencies, such as the evident violation by the latter system of thermodynamical and other laws verified by the former system. As an illustration, we quote the following:

NO REDUCTION THEOREM [5a]: Nonconservative and irreversible classical systems cannot be consistently reduced to systems characterized by a finite number of point-particles all in conservative conditions and, vice versa, the latter systems cannot consistently reproduce the former under the correspondence or other principles.

The above theorem essentially establishes that, for instance, a spaceship during reentry in our atmosphere cannot be consistently reduced to point-particles all in conservative conditions. By recalling that the axiomatic structure of special relativity is strictly conservative and reversible (invariant under time reversal), the above No Reduction Theorem establishes that special relativity is inapplicable to the spaceship during reentry at both the classical and particle levels.

For the case of interior dynamical problems characterized by *transparent media,* such as water or air, we have a number of additional inconsistencies preventing a correct axiomatic formulation of special relativity [*loc. cit.*].

Let us recall that in empty space, the speed of light is not only constant, but its value is universal in the sense of being the same for all inertial systems. In water, the speed of light is indeed locally constant (from the local constancy of the index of refraction), but its value is not expected as being the same for all inertial systems because inertial reference frames moving in water cannot exist due to friction. Additionally, in vacuum, all inertial frames are equivalent and there is no experimentally detectable privileged system. Ergo, special relativity is valid. In water, there is only one reference frame of physical value, the privileged frame at rest with respect to water. Consequently, there exist serious difficulties for the very *formulation,* let alone experimental verification, of the basic assumptions of special relativity within physical media.

Similarly, it is known that in water particles such as electrons can travel faster than the local speed of light, an occurrence characterized by the emission of the Cerenkov light. In the event the speed of light *in water* is assumed as the maximal causal speed, there is the violation of the principle of causality. In case the speed of light *vacuum* is assumed as the maximal causal speed *in water,* there is the violation of the principle of relativistic superposition of speeds (the sum of two speeds of light in water does not yield the speed of light).

Most compelling is the experimental profile. To the author's best knowledge, *none of the historical experiments that have established the validity of special relativity in vacuum has been repeated within physical media* such as water or air, let alone hyperdense media. As a matter of fact, *there are serious expectations that the repetition of basic experiments in interior conditions will show deviations from the Lorentz symmetry and special relativity.*

Consider, as an example, the historical Fizeau experiment including the passage of light within two pipes of equal length traversed by water flowing in opposite directions, which experiment did indeed confirmed the Lorentz symmetry and special relativity. However, the experiment was conducted for *exterior* conditions, since the observer and all measurements were conducted in air assumed as a good approximation of the vacuum. When the entire experimental apparatus is under water, it is evident that the travel of light in the residual parts of the experimental set up produces contributions expectedly in violation of the Lorentz symmetry and special relativity. Similar deviations are conceivable for the repetition in interior conditions of other experiments, including those on the energy equivalence law $E = mc^2$ (see later on Ref. [8]).

Consequently, a main message attempted to convey by this paper is *the return of astrophysics to the original conception by Galileo Galilei, that is, the establishing of astrophysical models via actual experiments on Earth, thus repeating all basic experiments within physical media before claiming the validity of special relativity in interior conditions, such as the Michelson-Morley experiment, the Fizeau experiment, energy equivalence experiments, and others*.

For additional insufficiencies along these lines and their mathematical treatment, one may consult Refs. [*loc. cit.*]. Note the use of the term “inapplicability” rather than ``violation'' of special relativity, because the latter would be inappropriate since Einstein did not conceive his theories for nonconservative and irreversible systems."

3. INSUFFICIENCIES OF SPECIAL RELATIVITY FOR THE PROPAGATION OF LIGHT IN WATER

Since Einstein's proposal of 1905, light propagating within transparent physical media (such as water) has been generally reduced to photons scattering among or absorbed and re-emitted by the atoms constituting the medium.

The apparent intent or implication of this reduction is that of rendering special relativity applicable within transparent physical media, since light is reduced to photons propagating in vacuum. More specifically, the main intent or implication is that of avoiding the universal substratum, the ether, needed to propagate light as a wave because its expected privileged reference frame was perceived as being in conflict with special relativity.

As it is well known, the experimental foundation of the above view is given by the justly celebrated *Michelson-Morley experiment* that has been traditionally interpreted as establishing the lack of the ether as a universal substratum from the absence of the so-called “ethereal wind” (drag expected for bodies in their motion within the ether.

However, recent studies have indicated that the Michelson-Morley experiment has established the impossibility for us to identify an absolute frame at rest with the ether, as expected from its very universal character as a substratum. Additional Santilli suggested since 1957 the possibility of eliminating the need for the “ethereal wind” *via* the reduction of elementary particles constituting matter to oscillations of the ether (see. for a review, Chapter 3, Ref. [9]).

According to these views, *the ether as a universal substratum is necessary not only for the creation and propagation of electromagnetic waves, but also for the creation and motion of the elementary particles constituting matter, all this in apparent complete agreement with the exact validity of special relativity in vacuum due to the impossibility of identifying a privileged reference frame established by the Michelson-Morley experiment.* The ether as a universal substratum appears also as being needed for the resolution of open issues on the synthesis of the neutron inside stars and the origin of the universe indicated in Section 10.

As a concrete example, the electron is known to have a rest energy of 0.511 MeV characterized by oscillations with 0.829×10^{20} Hz. It is evident that a "little mass" cannot be assumed to create such oscillations. The most plausible characterization of the electron is, therefore, that the oscillations occur in a point of the ether, by therefore eliminating the "ethereal wind" because when an electron is moved, we merely transfer the oscillations from one point of the ether to others. The same can be assumed for all other elementary particles and, therefore, for matter at large, thus eliminating the very historical motivation for the conduction of the Michelson-Morley experiment. Once the "ethereal wind" is eliminated, one can see the plausibility for the return to the Maxwellian conception of light as a transverse electromagnetic wave created and propagated by the ether so as to avoid the excessive abstraction of a wave without a physical medium [5,9].

The above issues have remained dormant for one century because of the elimination of interior dynamical problems and the *entire* reduction of light to photons for all its possible manifestations. However, the above issues emerge as unavoidable in *quantitative* (that is, numerical., rather than epistemological or conceptual) studies of interior dynamical problems at large and, in particular, the propagation of light within transparent physical media, in view of the following insufficiencies or clear inconsistencies:

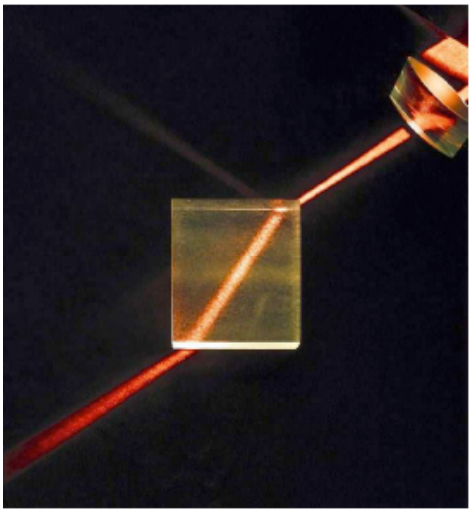

Fig. (1). A view of a light beam propagating in water showing the sharp angle of refraction at the water surface, and the preservation within water of the refracted beam with only partial dispersion.

1) The impossibility for the *entire* reduction to photon of a light beam propagating in water is established by visual inspection and admission of physical evidence (Fig. (**1**)). In fact, such a reduction would imply that the great majority of photons must propagate through a very large number of nuclei without any scattering, as necessary to explain the propagation of the beam along a straight line. To the author's best knowledge, only the interpretation of light as a *transverse electromagnetic wave propagating within the ether* represents the visual evidence of Fig. (**1**) because, in this case, the propagation occurs in the universal substratum underlying nuclei, rather than having particle-type photons propagate through nuclei without scattering.

2) The reduction of light to photons does not admit a numerical representation of the (rather large) angle of refraction of light at the water surface. In fact, photons are expected to be scattered or be absorbed and re-emitted in all directions after hitting the water surface, rather than follow the refractive direction of the beam illustrated in Fig. (**1**). To the author's best knowledge, the refraction can be *quantitatively* (rather than conceptually) represented solely by the wave interpretation of light with the *locally varying speed* $C = c / n$ where n is the index of refraction so familiar prior to Einstein's time.

3) The reduction of light to photons scattered by the water molecules cannot provide a quantitative representation of the rather large decrease (by about $1/3$) of the speed of light in vacuum c when propagating in water, because its numerical representation via photon scatterings would require a virtually complete dispersal of the beam against the visual evidence of Fig. (**1**). A numerical representation via absorption and re-emission of photons is also impossible due to the virtually instantaneous re-emission in all directions of absorbed photons. Again, the sole known quantitative representation of the speed of light in water is the historical form $C = c / n$ with index of refraction depending on frequency ν, density μ, temperature τ, and other local quantities, $n = n(\nu, \mu, \tau, ...)$.

4) The reduction of light to photons is additionally unable to represent experimental evidence on the behavior of electromagnetic waves with large wavelength (such as radio waves with one meter wavelength) when traveling within physical media. In fact, such waves experience the same phenomenology as that of visible light, yet the reduction of large wavelengths to photons is no longer effective, e.g., due to a dramatic decrease in quantitative predictions via scattering and/or absorption and re-emission. Again, the return to the Maxwellian interpretation of light as an electromagnetic wave propagating through the ether is the sole representation known to the author capable of providing a *numerical* representation of the local speed of light for *all* wavelengths (the indication of published evidence to the contrary would be appreciated, with particular reference to the *numerical* representation of physical evidence via the reduction to photons of electromagnetic waves with *large* wavelength).

5) The reduction of light to photons traveling in vacuum is finally incompatible with the apparent existence within hyperdense physical media of causal speeds bigger than that of light in vacuum, as expected in the interior of

gravitational collapse. At any rate, electromagnetic waves propagating at speeds $C = c/n > c,\ n < 1$ have already been identified in laboratory for propagation within special guides (see Ref. [10] and the review in monograph [5a]), and data elaborations in hadron physics *without* the aprioristic assumptions of special relativity, systematically show maximal causal speeds within the hyperdense medium inside hadrons as being bigger than that in empty space [5d]. In the final analysis, the idea that the maximal causal speed inside a black hole is the same as that in vacuum, has no credibility, let alone no hope for direct experimental verification.

Needless to say, the scattering, as well as absorption followed by re-emission, of photons by the atoms of the medium are beyond doubt, but they can only provide a quantitative representation of the *partial* dispersal of the light beam within a transparent physical medium with consequential moderate decrease of its intensity as per visible evidence of Fig. (**1**). Also, Maxwell's wave interpretation of light is not in conflict with its reduction to photons (when applicable) because, in the final analysis, *photons are not "solid particles," but wavepackets*. As such, the reduction of light to photons cannot consistently bypass the fundamental need for the ether allowing photon wavepackets to exist and propagate.

Due to the impossibility of a *numerical* representation of *all* aspects of light for *all* its frequencies for propagation in water, the above evidence establishes the merely *conceptual* nature of the *entire* reduction to photons of light propagating in water. Said reduction also indicates the apparent intent of adapting special relativity to conditions it was not conceived for or verified. The sole quantitative representation known to the author for *all* aspects and for *all* frequencies of light is that via the Maxwell's conception of light as a *transverse electromagnetic wave* created and propagated by a universal substratum, with the consequential local character of the speed $C = c/n(\nu, \mu, \tau, ...)$.

In any case, irrespective of the above insufficiencies, there are numerous experiments establishing not only the *wave* character of light, but also its *transverse* character, in beautiful agreement with Maxwell's theory (see, e.g., Ref. [11]).

In summary, the combined analysis of the preceding section and of this section, confirms the inapplicability of special relativity within water, thus expectedly for interior dynamical problems at large, as studied in detail in Refs. [2-7].

4. INSUFFICIENCIES OF SPECIAL RELATIVITY FOR THE PROPAGATION OF LIGHT IN ATMOSPHERE

The insufficiencies of the entire reduction of light to photons identified in the preceding section persist for all propagations within transparent physical media, not only on Earth, but also in astrophysics and cosmology (see later on Section 9).

As an additional example for conditions on Earth, consider the propagation of light in our atmosphere. Visual evidence establishes that, when the Sun is at the Zenith, our atmosphere is predominantly *blue* not only toward the Zenith, but also toward the horizon, while the atmosphere at Sunset and Sunrise is predominantly *red* (Fig. (**2**)).

The interpretation of the above evidence assumed during the past century has been that the blue color of the sky is due to the scattering of (a small portion of the Sun) blue light, since red light is absorbed by the atmosphere. For Sunset and Sunrise the conventional interpretation is that we have the opposite occurrence, namely, we have the absorption of all light frequencies except for the frequencies of red light.

In the author's view, the interpretation of the blue color of the sky is correct and confirmed by experimental evidence of light propagating within other transparent physical media. For instance, the color of seawater becomes progressively blue with the increase of the depth, to the point that at about $20\,m$ depth only the blue light remains visible, while all other colors are absorbed by the medium. In any case, the conventional quantum scattering theory confirms that the penetration of photons within a transparent medium is proportional to the frequency, the harder the photons, the deeper the penetration. Alternatively, quantum scattering theory establishes beyond doubt that red light is absorbed by media much more than blue light.

By contrast, the current interpretation of the predominant red color at Sunset and Sunrise is in disagreement with various physical laws, being a mere consequence of the adaptation of physical reality to special relativity without prior independent experimental verifications.

Let us recall that Earth perimeter (at the Equator) is of about $40{,}000$ km. Hence, at Sunset we have the tangential speed *away* from the Sun

$$v = |v| = \frac{40{,}000}{24 \times 60 \times 60} = 0.4629 \frac{km}{s}. \tag{1}$$

By recalling *Doppler's shift law* for the frequency (for null angle of aberration and v/c very small)

$$\nu \approx (1 - \frac{v}{c} + ...)\,\nu_o, \tag{2}$$

tangential speed (1) causes a conventional *Doppler redshift* with value

$$\Delta\nu_o = \nu - \nu_o = -\frac{v}{c}\nu_o = -\frac{4.629}{2.997} \times 10^{-6}\ \nu_o = -1.554 \times 10^{-6}\ \nu_o, \tag{3}$$

that, being rather small, is basically unable to represent the transition of the color of the sky at the horizon from blue during the day to red at Sunset (Fig. (**2**)).

For the case of Sunrise, we move *toward* the Sun at speed (1), in which case we have the *Doppler blueshift*

$$\nu \approx (1 + \frac{v}{c})\,\nu_o, \tag{4}$$

with value

$$\Delta\nu_o = +\frac{v}{c}\nu_o = +1.554 \times 10^{-6}\ \nu_o, \tag{5}$$

that, besides being also rather small, its sign is in *violation* of visual evidence of the transition at the horizon from blue to *red*.

Fig. (2). Views taken by the author in Palm Harbor, Florida, of the horizon when the Sun is at the Zenith (left), at Sunset (top right) and Sunrise (bottom right), illustrating the predominant blue color when the Sun is at the Zenith and the predominant red color at both Sunset and Sunrise. Additional color pictures are available in the website [12].

As one can see, the strict application of special relativity to light requires that *Sunset should be red but Sunrise should be blue.* Visual evidence shows that this is not the case, because both Sunset and Sunrise are red, thus establishing the presence of physical conditions beyond those of exact validity of special relativity in favor of the covering *isorelativity* [2-7] as shown below.

Assuming that with the introduction of unknown *ad hoc* parameters, the above physical evidence for the behavior of light at Sunset and Sunrise is manipulated to verify special relativity, we still remain with the basic inability by special relativity to represent quantitatively the transition of the color of the horizon from blue to red at both Sunset and Sunrise, as shown in Fig. (**2**).

Therefore, we reach the same conclusion as that of Section 3, namely, that special relativity is inapplicable within physical media at large, whether gas or liquid, with larger departures for solids or hyperdense media studied in refs. [2-7].

5. SANTILLI DEFORMATIONS/ISOTOPIES OF SPECIAL RELATIVITY

The insufficiencies of special relativity for interior dynamical problems have stimulated rather vast mathematical, physical, chemical, experimental and industrial studies based on a covering relativity achieving the invariance of locally varying speeds of light $C = c / n(r, v, \mu, \tau, ...)$ and allowing, more generally, a geometrization of physical media, irrespective of whether transparent or opaque to light.

As noted by Pauli in his historical treatise *Special Relativity,* Lorentz first attempted in 1898 to achieve the invariance of the locally varying speed of light, but failed to do so, and was forced to restrict the invariance to the constant speed c, that was brilliantly achieved, and it is now known in history as the *Lorentz symmetry* $O(3.1)$.

The author has dedicated his research life to the above identified, *Lorentz problem* beginning with his Ph. D. studies in the mid 1960s (see, e.g., ref. [13] of 1967). For this purpose, the author first proved that Lorentz's inability to achieve the universal invariance of $C = c / n(r, v, \mu, \tau, ...)$ was due to insufficiencies of the background methods, those of *Lie's theory* with familiar product $[A, B] = AB - BA$ among generic matrices or operators A, B, and conventional associative product AB . In fact, Lie's theory is known as being strictly linear and canonical, while any deformation of the Minkowski spacetime to incorporate a locally varying speed of light,

$$x^2 = x_1^2 + x_2^2 + x_3^2 - t^2 c^2 \rightarrow$$

$$\hat{x}^2 = x_1^2 + x_2^2 + x_3^2 - t^2 c^2 / n^2(v, \mu, \tau, ...), \qquad (6)$$

is known as being nonlinear and noncanonical.

Consequently, the author proposed in 1978 [14] a covering of the various branches of Lie's theory (universal enveloping algebras, Lie algebras, Lie group and representation theory) based on the generalized product $[A, B] = ATB - BTA$, where T is a fixed, positive-definite but otherwise arbitrary matrix or operator with an arbitrary functional dependence characterizing the inverse of the generalized unit, $\hat{I} = \hat{I}(r, p, v, \mu, \tau, ...) = 1 / T(r, p, v, \mu, \tau, ...) > 0$ (see Refs. [14-17] for representative mathematical studies, monographs [2] for presentations up to 1982, monographs [3-7] for subsequent studies).

Since the generalized product $[A, B]$ continues to verify Lie's axioms, Santilli called the deformations $[A, B] \rightarrow [A, B]$ *isotopic liftings, or isotopies* for short, of Lie's theory in the Greek sense of preserving the original axioms. The covering theory is today known as the *Lie-Santilli isotheory* [18-25]. Note the use of the plural in the word "isotopies" due to an infinite number of possible matrices or operators $\hat{I} = 1 / T > 0$ since they provide a geometrization of the infinite number of possible interior physical media.

Exterior dynamical problems described via Lie's theory are characterized by the sole knowledge of the Hamiltonian $H(r, p) = p^2 / 2m + V(r)$, the underlying unit of Lie's theory in this case being trivial, e.g., $I = Diag.(1,1,1,1)$. Interior dynamical problems described via the Lie-Santilli isotheory are characterized by the same Hamiltonian H representing long range, action-at-a-distance interactions derivable from a potential $V(r)$, plus the generalized unit $\hat{I}(r, p, v, \mu, \tau, ...)$ representing contact, nonpotential and noncanonical interactions and effects. At the limit $\hat{I} \rightarrow I$ conventional exterior formulations are recovered identically and uniquely (see Refs. [2-7] for specific examples and numerous applications).

Thanks to the prior construction of the isotopies of Lie's theory, Santilli constructed in 1983 the classical [26] and operator [27] deformations/isotopies $\hat{O}(3.1)$ of the Lorentz symmetry $O(3.1)$ with covering transformations

$$x'^1 = x^1,\ x'^2 = x^2, \tag{7a}$$

$$x'^3 = \hat{\gamma}\,(x^3 - \hat{\beta}\frac{n_4}{n_3}\ x^4),\ x'^4 = \hat{\gamma}\,(x^4 - \hat{\beta}\frac{n_3}{n_4}\,x^3), \tag{7b}$$

$$\hat{\gamma} = \frac{1}{\sqrt{1-\hat{\beta}^2}},\ \hat{\beta} = \beta\frac{n_4}{n_3} = \frac{\mathrm{v}_3}{\mathrm{n}_3}\frac{n_4}{c}. \tag{7c}$$

providing the invariance of all infinitely possible, nonsingular, signature preserving, *deformed/isotopic Minkowski spacetimes* with generalized line elements in the diagonal form (see Refs. [4] for nondiagonal cases)

$$\hat{x^2} = x^\mu g_{\mu\nu}(r,p,\nu,\mu,\tau,...)x^\nu = \frac{x_1^2}{n_1^2} + \frac{x_2^2}{n_2^2} + \frac{x_3^2}{n_3^2} - t^2\,\frac{c^2}{n_4^2}, \tag{8}$$

where n_4 is evidently the conventional index of refraction interpreted as a geometrization of the *density* of the medium considered with normalization for the vacuum $n_4 = 1$, and $n_k, k = 1,2,3$, provide a geometrization of the actual shape, as well as the inhomogeneity and anisotropy of the medium with normalization for the vacuum $n_k = 1, k = 1,2,3$. The combined quantities $n_\mu, \mu = 1,2,3,4,$ are called *characteristic quantities* of the medium considered. Note that these quantities *are not* arbitrary parameters as often erroneously perceived, because their value is rigidly set by measurements (see [*loc. cit.*]).

It is evident that deformed/isotopic transformations (7) achieve the desired invariance of all possible, locally variable speeds of light $C = c/n_4$, as well as the invariance of all infinitely possible Riemannian, Finslerian and other line elements in $(3+1)$ dimensions, that are an evident particular case of deformed line element (8).

Subsequently, Santilli achieved the deformations/isotopies of all remaining aspects of the *Poincaré symmetry,* including: the rotational symmetry [28]; the spin symmetry [29]; the Poincaré symmetry [30]; the spinorial covering of the Poincaré symmetry [31,32]; and the Minkowskian geometry [33], that we cannot possibly review here for brevity. The emerging covering is today known as the *Lorentz-Poincaré-Santilli (LPS) isosymmetry.* Among a rather vast literature in the field, we mention Refs. [34,35] showing the *direct universality of the LPS isosymmetry,* namely, its admission as a particular case of all infinitely possible symmetries of deformed line elements (8) (universality), directly in the frame of the experimenter, thus without the use of any coordinate transformation (direct universality).

Following the above preparatory studies, Santilli achieved the deformations/isotopies of all remaining aspects of special relativity, resulting in a covering formulation today known as *Santilli isorelativity* that is based on the following covering axioms first introduced in Refs. [3] of 1991:

ISOAXIOM I. The maximal causal speed within physical media along the z-axis is given by

$$V_{max} = c\frac{n_3}{n_4}. \tag{9}$$

This isoaxiom is an evident direct consequence of the *deformed/isotopic light cone* in $(1+1)$ -dimensions

$$\hat{x}^{\hat{2}} = \frac{x_3^2}{n_3^2} - t^2\,\frac{c^2}{n_4^2} = 0. \tag{10}$$

Note the necessity within physical media of abandoning the interpretation of the local speed of light $C = c/n_4$ as the maximal causal speed, and the identification only in vacuum. As an illustration, by assuming that water is homogeneous and isotropic with $n_3 = n_4$, then the maximal causal speed in water is that in vacuum c, thus salvaging the principle of causality when electrons travel in water faster than the local light speed.

ISOAXIOM II. The deformed/isotopic law of addition of velocities within physical media is given by

$$\mathrm{v}_{Tot} = \frac{\mathrm{v}_1 + \mathrm{v}_2}{1 + \frac{\mathrm{v}_1\mathrm{v}_2}{n_3^2}\frac{n_4^2}{c^2}}. \tag{11}$$

It has been shown that the above law follows uniquely and unambiguously from the LPS isosymmetry. As an illusrration, we have again the correct result that *the sum of two maximal causal speeds within physical media is the maximal causal speed,* as one can verify. By comparison, this law cannot be formulated for special relativity when applied to physical media, as recalled earlier.

ISOAXIOM III. The deformed/isotopic dilation of time, contraction of length, and mass variation are given respectively by:

$$t = \hat{\gamma}\,t_\circ, \tag{12a}$$

$$\ell = \hat{\gamma}^{-1}\ell_\circ, \tag{12b}$$

$$m = \hat{\gamma}\,m_\circ, \tag{12c}$$

where $\hat{\gamma}$ and $\hat{\beta}$ are given by Eqs. (7c).

The above deformed/isotopic laws are also uniquely derived from the LPS isosymmetry. Note that, since the speed is always smaller than the maximal causal speed, $\hat{\gamma}$ cannot assume imaginary values exactly as it is the case for special relativity.

Note the necessity of avoiding the interpretation of the local speed of light as the maximal local causal speed. Note also that the mass diverges at the maximal local causal speed, but *not* at the local speed of light.

ISOAXIOM IV. The deformed/isotopic Doppler law is given by

$$\nu' = \frac{1 - \hat{\beta}\,cos(\alpha)}{\sqrt{1-\hat{\beta}^2}}\,\nu. \tag{13}$$

A study of the above isoaxiom is conducted in the next section, its experimental verification is addressed in Section 7, and its various applications are studied in the remaining sections of this paper. As we shall see, the above isoaxioms allow cosmological models without "big bang" and "dark matter."

ISOAXIOM V. The deformed/isotopic energy equivalence law is given by

$$E = mV_{max}^2 = mc^2 \frac{n_3^2}{n_4^2}. \tag{14}$$

Note that the energy equivalence *does not* diverge at the speed of light c. Consequently, the LPS isosymmetry allows, apparently for the first time, the achievement of causal speeds within physical media bigger than the speed of light in vacuum, exactly as experimentally measured in Refs. [10], as well as in various other tests [5d]. As we shall see later on, these features allow cosmological models without the "dark energy."

Systematic studies have been conducted for the verification of Santilli isorelativity in classical physics, particle physics, nuclear physics, superconductivity, chemistry, astrophysics and cosmology [2-7,18-25]. We cannot possibly review here these studies and suggest the reader to inspect monograph [5d] or Chapter 5 of Ref. [9] for a summary.

In closing we should recall the various *deformations* existing in the literature, such as: the "deformed Lie algebras" with product $(A,B) = AB - qBA$ that were introduced decades following their origination in the 1967 paper [13] (generally without its quotation) presenting the first known, broader deformations with product $(A,B) = pAB - qBA$, where $p, q, p \pm q$ are non null parameters; the "deformed Minkowski space" and "deformed Lorentz symmetry," that are a reproduction *ad litteram* of their origination in the 1983 papers [14,15] (also without quotations of their origination); and other cases.

All these "deformations" are characterized by *deformations of original canonical formulations elaborated with conventional mathematics,* i.e., defined on conventional spaces over conventional fields, elaborated with conventional differential calculus, functional analysis, etc. Consequently, these deformations are *noncanonical* at the classical level and *nonunitary* at the operator level, thus being afflicted by the well known *Theorems of Catastrophic Mathematical and Physical Inconsistencies of Noncanonical and Nonunitary Theories* (see Ref. [5a] for a review and large quoted literature), such as loss of the base field at later times with consequential collapse of the mathematical, structure, the predictions of different numerical values under the same conditions at different times, with consequential collapse of the physical structure, etc.

By comparison, the *isotopies* require the formulation and elaboration of deformed structures via the new *isomathematics* [4,17], including the formulation on the so-called isospaces over isofields, and the elaboration via the novel isodifferential calculus, isofunctional analysis, etc. The latter formulations bypass said inconsistency theorems thanks to the invariance of the generalized unit $\hat{I}$ with consequential invariance of the base isofield, the prediction of the same numerical values under the same conditions at different times, etc.

The reader should be aware that Isoaxioms I to V have been presented here, for simplicity, in their *projection* in our spacetime, while their sole invariant formulation is that on isospaces over isofields and their elaboration via isomathematics [4,17].

6. SANTILLI ISOREDSHIFT

In monographs [3] of 1991, Santilli submitted the hypothesis of the *isoshift,* referred to *a shift of the frequency of light propagating within physical media without any relative motion between the source, the medium and the detector*. Light is said to experience an *isoredshift* when it *loses* energy $E = h\nu$ to the medium due to predictable interactions, with consequential decrease of the frequency. Light is said to experience an *isoblueshift* when it *acquires* energy from the medium with consequential increase of its frequency.

The isoredshift was predicted for light propagating within transparent media of low density, such as our atmosphere, while the isoblueshift was predicted to occur for light traveling within hyperdense media, such as those in the interior of stars and quasars. In the former case, light exits the medium redshifted when compared to the frequency at the source, while in the latter case light exits the medium blueshifted when compared to the original frequency.

Monographs [3] submitted the above hypotheses via their derivation from the axioms of isorelativity, submitted a number of experiments for their verification, and suggested their application to astrophysics and cosmology as reviewed later on in Section 9. The hypotheses were further studied in monographs [4].

At the 2007 International Bolu Conference, Turkey, the author [36] re-examined the above hypotheses. In essence Isoaxiom IV can be written in first approximation along the third axis for null angle of aberration $\alpha = 0$, and v/c very small

$$v' = (1 \pm \hat{\beta} + ...)v = (1 \pm \frac{v_3}{c}\frac{n_4}{n_3} + ...)v. \tag{15}$$

But the characteristic quantities have a general dependence on all possible local quantities, thus including the speed. Consequently, Isoaxiom IV continues to predict a shift even for the case for $v_3 = 0$ we can write

$$\nu' = (1 \pm K)\nu, \tag{16}$$

where K is a constant, the minus sign (isoredshift) is expected for the case of media of low density and the plus sign (isoblueshift) is predicted for media of very high density, under the approximation

$$\frac{n_3}{n_4} \approx \frac{v_3}{K}, \lim_{v_3=0} v_3 \frac{n_4}{n_3} = K. \tag{17}$$

Ref. [36] then submitted additional experiments for the verification of the dismissal of the isoshift, and applied the results for a cosmological model without universe expansion, "dark matter," and "dark energy."

Additionally, Ref. [36] introduced the notion of *Doppler-Santilli isoshift,* referred to the *superposition of the conventional Doppler shift, plus Santilli isoshift,* an occurrence evidently expected when there is a relative motion between the source, the medium, and the observer.

	Key Components of the system
1	3600 line/mm holographic grating from Newport optical
2	10um slit opening from National Aperture
3	473 nm laser Diode Pumped Solid State Laser. Exact Specifications unknown
4	Sony ILX-511 CCD Detector Array with 12 bit Digital USB interface
5	1 inch focusing Mirror

Fig. (3). Components of the open air spectrometer used in the measurements.

Therefore, when a transparent medium of low density moves *away* from the source, isorelativity predicts the superposition of *two redshifts,* one due to the Doppler's shift and one due to Santilli's isoshift; when the same medium moves *toward* the source, we have a superposition of the Doppler's blueshift plus Santilli isoredshift. Note that depending on the conditions, the two shifts can annul each other, namely. have no shift at all despite the existence of relative motion.

7. EXPERIMENTAL VERIFICATION OF SANTILLI ISOREDSHIFT

We here report, apparently for the first time, confirmatory measurements of the isoredshift via the following realization of Experiment 10.2, page 237, Ref. [36]. Various pictures of the *Isoredshift testing Station* specifically built by the author are available in Ref. [37]. Additional measurements are presented in Ref. [38].

For this scope, we built a schedule 80, high pressure, carbon steel pipe $60' = 28.3$ m long, $5" = 12.7$ cm in outside diameter, and transparent ends with $2" = 5.6$ cm thick lexan. The pipe was filled up with filtered air at $2{,}000$ psi ≈ 138 bar pressure. A monochromatic blue light with wavelength 473 nm from a 100 mW diode laser was passed through the pipe and its wavelength measured *in air* following said passage, with the set up and accuracy below.

The compressed air inside the pipe was discharged by restoring atmospheric pressure, but keeping the two lexan terminals. The same monochromatic blue light was then passed through the pipe at atmospheric pressure and its wavelength measured *also in air* after passing through the pipe with the same experimental set-up used at pressure and without any alteration.

In an effort to detect expected very small shifts in wavelengths of laser light, an open air spectrometer was constructed using the key components listed in Fig. (**3**). With this type of a set-up, a very narrow system bandwidth and ultra high resolution can be obtained. To determine the performance of the optical system, a Zemax simulation of the system was first performed.

A functional set-up of this system was then constructed on two optical breadboards. The first breadboard served to focus the laser light exiting the tube onto a system defining slit of 10 nm and then to re-collimate this light onto a high resolution diffraction grating. The second breadboard contained a focusing mirror and a CCD array.

It must be noted that the goal of the measurement is not to obtain ultra high precision of the laser light but to determine with ultra high precision the observed *shift* of the laser light through a media.

The simulation in Zemax was done using a non-sequential optical model. The simulation used a 1.5 m detection distance from the 3600 line/mm diffraction element. This simulation is shown in Figs. (**4**) and (**5**) showing two wavelengths 473 nm and 474 nm being diffracted.

The nominal wavelength of 473 nm was originally measured using an Ocean Optics High Resolution *HR*4000 spectrometer. From this model, we were able to make accurate predictions of pixel level resolution of the optical system. This was calculated as being 0.167 nm/pixel.

A comparison of the data shows a clear increase over background/or statistical fluctuations of the wavelength of light λ_2 passing through the pipe at $2{,}000$ psi ≈ 138 bar compared to the wavelength λ_1 at atmospheric pressure.

In particular, as shown in Figs. (**6**) and (**7**), the measurements showed a redshift characterized by the deviation of the blue laser light well over background of 0.5 nm,

$$\lambda_2 \approx \lambda_1 + 0.5 \text{ nm}, \tag{18}$$

when propagating through the indicated pipe plus the lexan terminals, compared to the same travel of the same light in air plus the travel through the two lexan terminals. Since the deviation occurs without any relative movement of the laser source, the medium or the detector, the above measurements confirm Santilli isoredshift.

By assuming that the speed of light in air is the same as that in vacuum, the corresponding frequencies ν_2 and ν_1 are related to the wavelength by the known law $c = \lambda_1 \nu_1 = \lambda_2 \nu_2$. Therefore, the *increase* of the wavelength $\lambda_2 > \lambda_1$ implies the *decrease* of the frequency $\nu_2 < \nu_1$, thus confirming Santilli isoredshift.

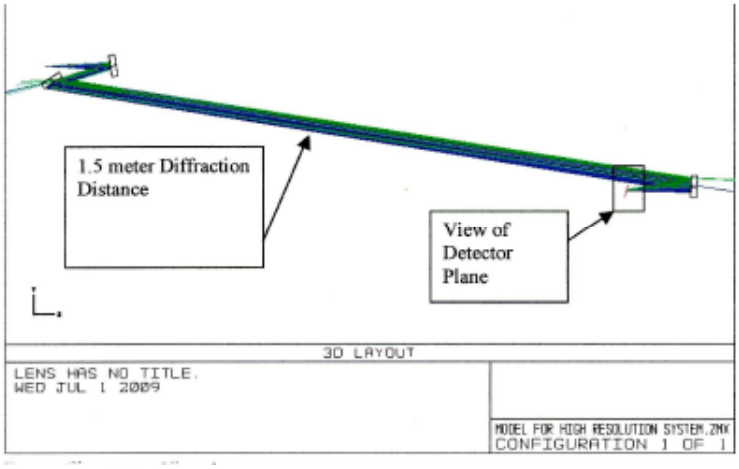

Fig. (4). A first simulation of the measurements.

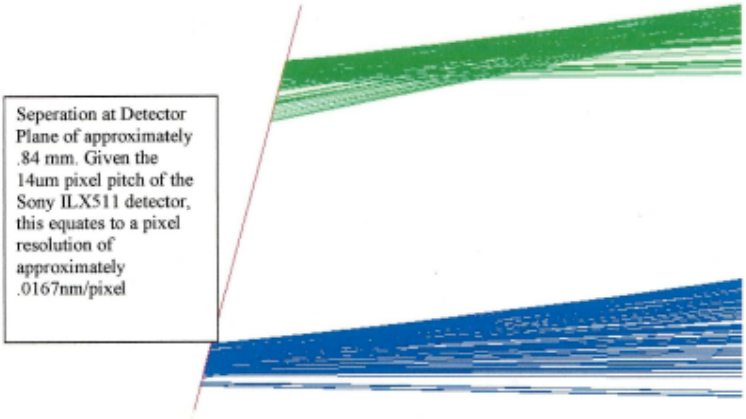

Fig. (5). Another simulation of the measurements.

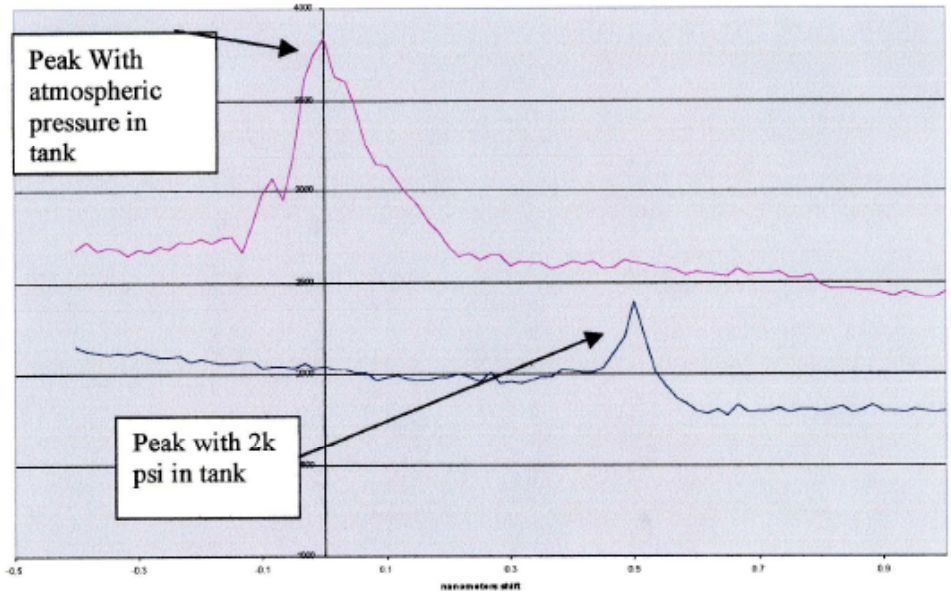

Fig. (6). The first scan confirming Santilli isoredshift obtained at the Testing Station [6] in Florida on June 27, 2009.

Needless to say, the above measurements should be considered preliminary and in need of various reruns and improvements currently under way [38]. Nevertheless, Result (18) has been released in view of: the consistency of the results; its compatibility with other propagations of light within physical media (Sections 2, 3, 8, 9); as well as a number of unverified indications of similar isoredshifts all recommended for test, such as radio communications

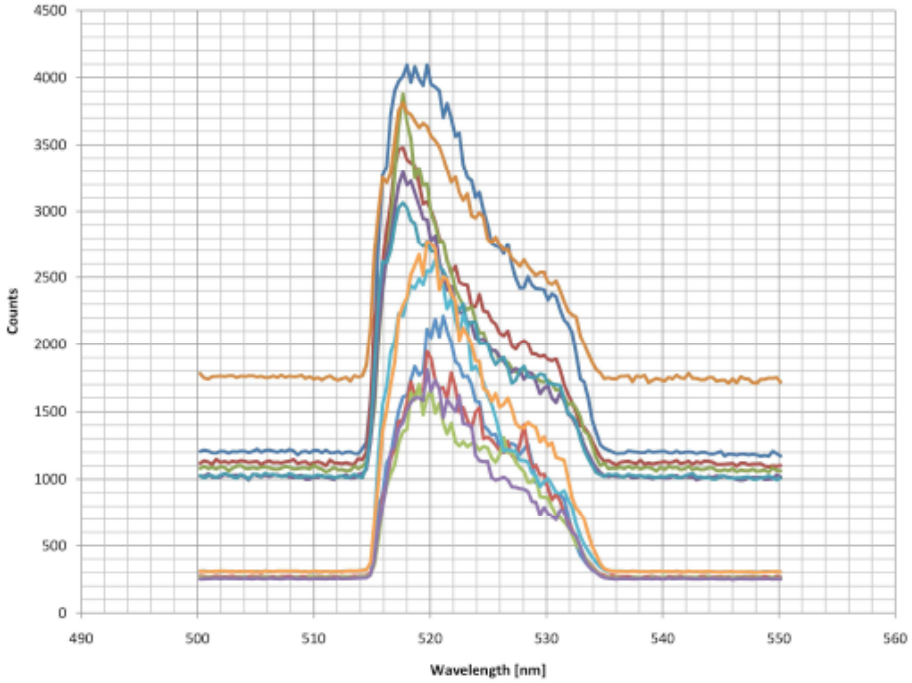

Fig. (7). Example of another scan showing the increase of the isoredshift with the increase of the pressure. Comprehensive quantitative measurements are in progress (see the forthcoming Ref. [38] and others under preparation).

received on Earth from spaceships when passing in the back of planetary atmospheres, light propagating through long optical fibers, and other cases. All this information eliminates vacuous, not so unfrequent *theoretical* disproofs of *measurements,* by confirming that *experimental measurements can be credibly dismissed solely with counter-measurements.*

8. CONFIRMATION OF SANTILLI ISOREDSHIFT IN ATMOSPHERE

As recalled in Section 4, the interpretation of the various colors of our atmosphere adopted during the past century is essentially conceptual, intended to adapt data to special relativity, and afflicted by a number of inconsistencies, such as: the assumption that only the red light reaches us at Sunset and Sunrise against clear evidence of its absorption (as it is the case for the Sun at the Zenith); the assumption of a redshift at Sunrise against the very Doppler law of special relativity requiring a blueshift due to our motion toward the Sun; and other inconsistencies.

In this section, we show that, by comparison, value (18) provides a *numerical* representation of the color of our atmosphere at Sunset and Sunrise, the blue color for the Sun at the Zenith being due to known absorption of the other colors. This numerical interpretation evidently provides significant support to the existence of Santilli isoredshift.

The color of our atmosphere is a very complex event because it originates from a a number of different processes, such as:

a) The scattering of photons among the atoms of our atmosphere that is proportional to the frequency, as established by the relativistic quantum scattering theory;

b) The absorption of light by our atmosphere that is inversely proportional to the frequency, as established by the propagation of light within various transparent media, such as seawater;

c) The Doppler redshift occurring at Sunset, Eq. (2);

d) The Doppler blueshift occurring at Sunrise, Eq. (4); and

e) Santilli isoredshift that is proportional to the density of the transparent medium (as well as dependent on other characteristics not essential for the problem at hand).

As shown in Section 4, the sole use of processes a) to d) does not allow a quantitative representation of all colors of our atmosphere. By contrast, the addition of isoredshift (18) does indeed allow the first quantitative representation known to the author.

Again, processes a) and b) do represent quantitatively the blue color of our atmosphere when the Sun is at the Zenith, including the color of the horizon, under the absorption of all colors with bigger wavelengths, in accordance with relativistic quantum scattering theory.

When passing to Sunset and Sunrise, we should equally assume that solely the blue light penetrates deep into the atmosphere and other colors are absorbed. In any case, if the red color is absorbed by our atmosphere when the Sun is at the Zenith, the same absorption becomes mandatory for a serious study when dealing with the much longer propagation of light at the horizon.

In this way, the problem of the color at Sunset and Sunrise is reduced to a quantitative study of the transition of blue to red light for both cases. The opposing contributions of Doppler's redshift at Sunset and blueshift at Sunrise are

given by the measurable difference in red color between Sunset and Sunrise that is not addressed in this paper, but hoped it is measured by experimentalists in the field.

The blue light of the sky we are referring to has the wavelength of 470 nm, while the red light we see at Sunset and Sunrise has the wavelength of about 670 nm. Therefore, at Sunset and Sunrise we have the isoredshift

$$\Delta\lambda = \lambda_{\text{red}} - \lambda_{\text{blue}} = 200 \text{ nm} = 200 \times 10^{-9} \text{ m}. \tag{19}$$

As indicated above, measurement (18) shows a deviation of 0.5 nm for blue light traveling for $60' = 28.3$ m in air at $2{,}000$ psi $=138$ bar. Assuming a linear proportionality of the isoredshift on length, a travel for 28.3 m at 138 bar is equivalent to the travel at 1 bar of

$$138 \times 28.3 \text{ m} = 3{,}905 \text{ km}. \tag{20}$$

Consequently, the needed isoredshift of 200 nm can be accounted for by the proportion

$$\frac{0.5 \text{ nm}}{3.905 \text{ km}} = \frac{200 \text{ nm}}{x \text{ km}}, \tag{21a}$$

$$x = 200 \times 3.905 \times 2 = 1{,}562 \text{ km}, \tag{21b}$$

namely, measurement (18) predicts that blue light is shifted into red light when propagating for $1{,}562$ km in atmosphere assumed at 1 bar.

However, Earth is curved and Sun light at Sunset and Sunrise passes from empty space to 1 bar approximately in $6{,}000$ km according to a law that, in first approximation, can be assumed as being inversely proportional to the square elevation from sea level. Consequently, $1{,}562$ km are indeed a good approximation of the $6{,}000$ km travel of light from empty space to 1 bar.

This confirms that Santilli isoredshift does provide a quantitative representation of the predominance of red at Sunset and Sunrise. It should be noted that the full treatment of the colors at Sunset and Sunrise requires the Doppler-Santilli isoshift. This approach has not been considered in this paper due to the small value of the Doppler redshift (3) at Sunset and blueshift (5) at Sunrise, but it is hoped will be treated in a future paper.

9. CONFIRMATION OF SANTILLI ISOREDSHIFT IN ASTROPHYSICS

As it is well known, the advancement of astrophysics identified in the second part of the 20th century a number of "anomalies," intended as evidence of apparent deviations from the predictions of special relativity. A notorious case is the controversy surrounding the discovery by H. Arp [39] of quasars that, according to gamma spectroscopy, are physically connected to galaxies, yet their respective cosmological redshifts are dramatically different. An illustration is given by galaxy NGC 4319 and quasar Mark 205 that are physically connected according to gamma spectroscopy, although the quasar Mark 205 has the redshift $z = 0.07$, while the associated galaxy NCG 4316 has the redshift of only $z = 0.0056$ (Fig. (**8**)).

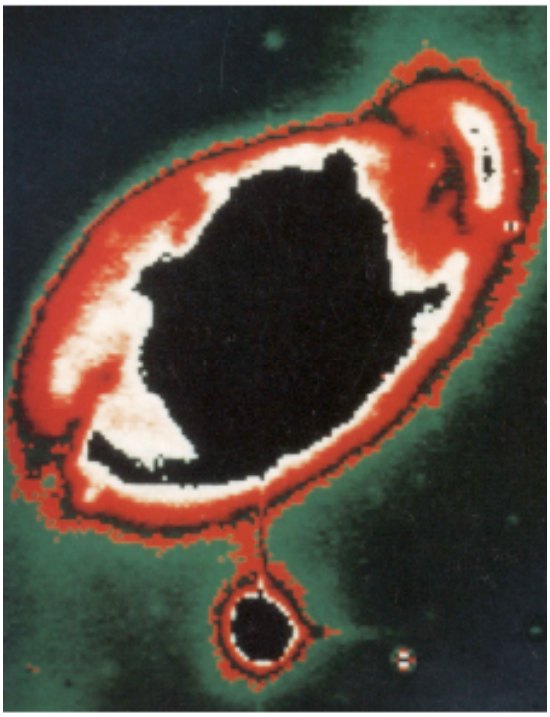

Fig. (8). A view of galaxy NGC 4319 (top) and the quasar Mark 205 (bottom) *via* gamma spectroscopy showing their physical connection under large differences of cosmological redshifts. (picture from H. Arp [39]).

Such a difference clearly indicates a departure from special relativity, because said large difference in cosmological redshift would require that the quasar has at least 104 times the speed of the galaxy, under which conditions the quasar and its associated galaxy would have separated completely billions of years ago. Numerous hypotheses were formulated in order to resolve this "anomaly," while maintaining the validity of special relativity, without achieving a resolution accepted by the scientific community at large.

In an attempt to achieve a scientific resolution of the controversy, that is, a solution established by experiments on Earth, Santilli proposed in Ref. [2b] of 1991 the hypothesis that, *when propagating through the very big quasar chromospheres, light experiences a loss of energy with consequential redshift, as a result of which the quasar light reaches empty space already redshifted.*

The above hypothesis was based on the universal Lorentz-Poincaré-Santilli isosymmetry with consequential isoredshift. In this way, the large value of the cosmological redshift can be reduced to the average value of the index of refraction of the quasar chromosphere as well as to its anisotropy and inhomogeneity.

A similar large cosmological redshift does not exist for the associated galaxy because the galactic medium is dramatically less dense than that of the quasar chromosphere, although light is expected also to exit the galaxy in an isoredshifted form. In this way, light from physically connected quasars and galaxies can reach us with dramatically different redshifts [3b].

GAL.	ω_1	QUASAR	B	$\hat{\omega}_2$
NGC	0.018	UB1	31.91	0.91
		BSOI	20.25	1.46
NGC 470	0.009	68	87.98	1.88
		68D	67.21	1.53
NGC 1073	0.004	BSO1	198.94	1.94
		BSO2	109.98	0.60
		RSO	176.73	1.40
NGC 3842	0.020	QSO1	14.51	0.34
		QSO2	29.75	0.95
		QSO3	41.85	2.20
NGC 4319	0.0056	MARK205	12.14	0.07
NGC 3067	0.0049	3C232	82.17	0.53

Fig. (9). A summary of Mignani's data [40] verifying Santilli's isorelativity [3b] for most quasars physically associated to galaxies known at that time, while having dramatically different cosmological redshifts.

In 1992, R. Mignani [40] provided a direct experimental verification of Santilli's Isorelativity and related isoshift law for the most important pairs of quasars and associated galaxies known at that time. The verification was done via the quantity

$$B = \frac{n_4}{n_s} = \frac{(\delta\omega + 1)^2}{(\delta\omega + 1)^2 + 1} \times \frac{(\delta\hat{\omega} + 1)^2 - 1}{(\delta\hat{\omega} + 1)^2 + 1}, \tag{22}$$

where $\delta\omega$ represents the measured redshift for galaxies, and $\delta\hat{\omega}$ represents the isoredshift for quasars according to Santilli's law (9).

Due to the dependence of the index of refraction on the frequency, Santilli isoredshift also provided a numerical representation, backed by a universal symmetry, of the so-called "internal" blue- and red-shift of a quasar, that provides *additional experimental support of Santilli isoredshift* (see Fig. (**10**) and Ref. [5d]).

Note that the resolution of the controversy on Arp's measurements proposed in Ref. [3b] and verified in Ref. [40] is that based on the Doppler-Santilli isoshift, thus assuming the existence of the expansion of the universe. The additional aspect presented in this paper for the first time, thanks to the verification of the isoredshift, is that dramatically different cosmological redshifts of quasars and associated galaxies can be represented also for the limit case in which both the quasars and their associated galaxies are at rest with respect to us.

10. POSSIBLE ABSENCE OF THE UNIVERSE EXPANSION AND BIG BANG

There is no doubt that the expansion of the universe, and the "Bag Bang" theory on the origin of the universe, constitute quite plausible cosmological models based on the knowledge on the cosmological redshift available at the time

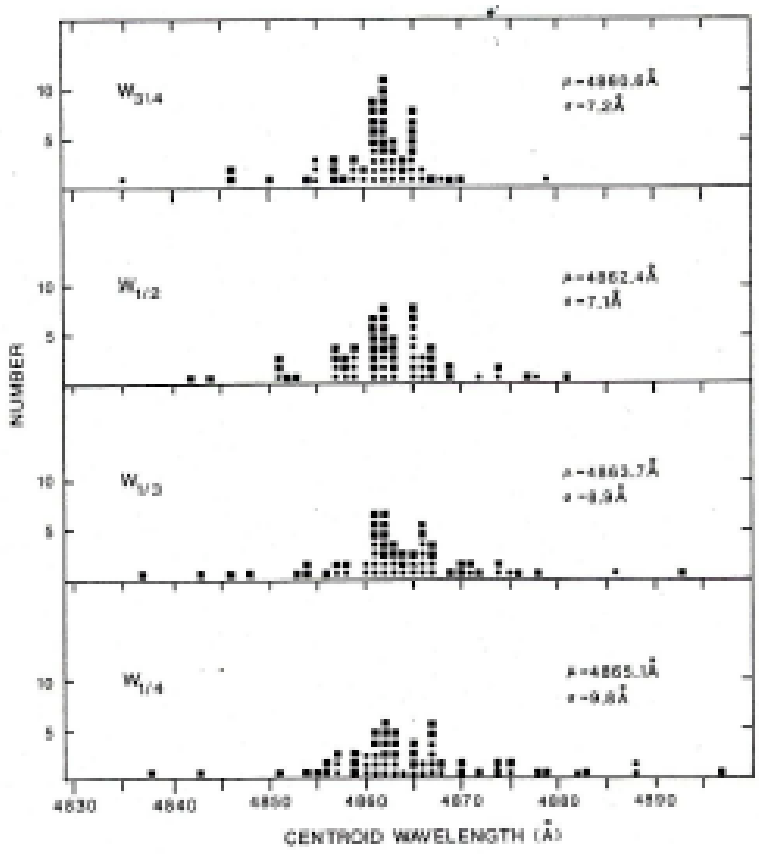

Fig. (10). A schematic view of Sulentic's [41] discovery of the internal red- and blue-shift of quasars, that is, the decrease or increase of the cosmological redshift of the same quasars depending on the frequency. The latter occurrence is a further experimental support of isorelativity.

of their formulation, for which reason they have justly received a rather vast consensus.

Nevertheless, it is the fate of all theories to provide only an approximation of reality and, sooner or later, to show insufficiencies when confronted with the complexity of the universe and the advancement of our experimental knowledge. Consequently, quantitative alternative views on the structure and origin of the universe play an important role toward the achievement of basic advances.

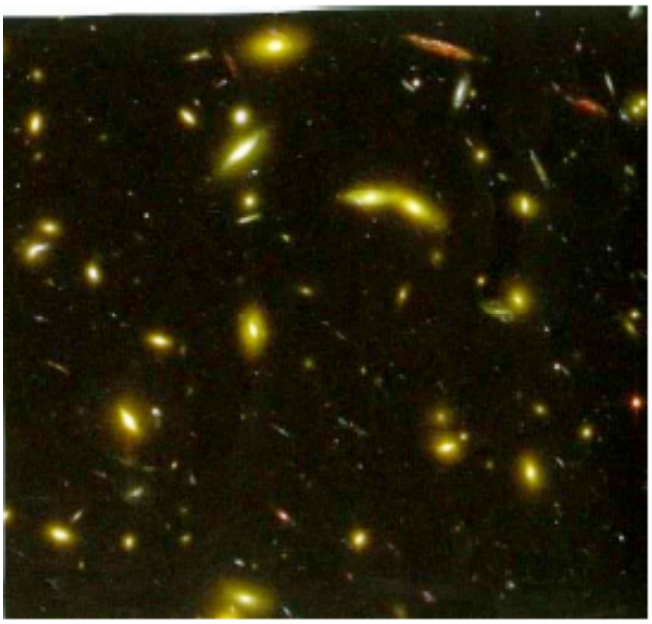

Fig. (11). A familiar view of intergalactic space that appears as being empty, although it is conceived by Santilli [36] as a physical medium primarily characterized by light.

Along these lines, Santilli indicated in Ref. [36] certain shortcomings of the "big bang" theory and pointed out that intergalactic space (see Fig. (**11**)) is not empty, but constitutes a physical medium, in which case the isoredshift could allow an alternative interpretation of the cosmological redshift without relative motion between galaxies and Earth without the universe expansion and, consequently, without the need for the "big bang" hypothesis on its origin due to the absence of expansion following the primordial explosion. The experimental confirmation of the isoredshift reported in this paper then warrants additional studies of the latter alternative view for future collegial resolution.

In essence, Ref. [36] noted that at every point of intergalactic spaces we can see the entire universe. Therefore, *the intergalactic space is a physical medium primarily composed of light,* but including dust, cosmic rays and other energies. But special relativity is expected as being inapplicable to physical media (Sections 2-7). We, therefore, have the following:

HYPOTHESIS 10.1 [36]: The cosmological redshift is an isoredshift due to loss of energy by light to the intergalactic medium and consequential interpretation of the background radiation as characterized by said energy loss, without the expansion of the universe and, consequently, without the ``big bang" hypothesis on its origin.

Ref. [36] then presented the fit of Hubble's law in term of the following realization of intergalactic isoredshift for the limit case of no relative motion at all between galaxies and Earth

$$z_u = \frac{c}{\lambda}(1 - \frac{1}{n_u}) \tag{23}$$

that fully interprets the increase of the cosmological redshift with the distance resulting in a natural distributions of galaxies throughout the universe without any privileged galactic region (see Ref. [36] for brevity).

Note the interpretation of the background radiation as being *continuously* created by the energy lost by light, since the latter is a continuous loss through time. The continuity in the origin of the background radiation is suggested for its preservation due to evident absorptions by dust, stars, and galaxies that, over billions of years, could eliminate said radiation. This interpretation should be compared with that of the "big bang" according to which the background radiation is a remnant of the primordial explosion.

Hypothesis 10.1 is apparently supported by the measurements of isoredshift presented in Section 7, due to the very large difference between the energy density and nature of the Isoredshift Testing Station [37] and the intergalactic medium. Specific additional experiments on Earth are suggested in Section 14.

Intriguingly, as it is typically the case for basic advances, in the event the isoredshift interpretation of the cosmological redshift is confirmed, the absence of the universe expansion and of the "big bang" hypothesis of its origin, would render the problem of the origin of the universe immensely more complex and fascinating, by consequently stimulating new vistas,

One alternative worth indicating is a possible return to *the continuous creation of matter in the universe,* as apparently necessary for the synthesis of neutrons inside stars from the primordial hydrogen due to the historical lack of 0.782 MeV energy per neutron (the difference between the neutron rest energy and the sum of the rest energies of the proton and the electron).

The fascinating, currently unresolved issue is then the following: where is the missing energy of 0.782 MeV per neutron coming from? This question is quite pertinent because, in the event the missing energy originates from the star interior, the majestic birth of a star could not occur since the star would *lose* at its initiation something of the order of 10^{30} MeV per second for a small star, with bigger losses for bigger stars.

In view of the above intriguing, and vastly unexplored scenario, Santilli submitted in Ref. [42] the hypothesis that *the* 0.782 *MeV missing in the synthesis of the neutron inside stars originates from space conceived as a universal substratum with extremely high energy density.* The missing energy was supposed to be delivered to the star by a carrier (which is *not* a particle) tentatively called *etherino.* The isotopic mathematics, mechanics, symmetries and relativities indicated in this paper were primarily worked out for quantitative representations of the transfer of energy from

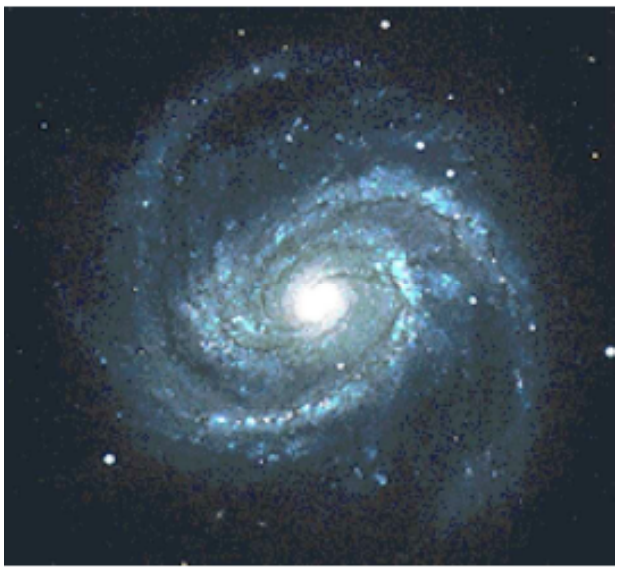

Fig. (12). View of a spiral galaxy clearly showing the presence of a gaseous physical medium in its interior.

space to the visible universe (see Kadeisvili's excellent review [43] with quoted original papers).

By hoping for leniency by colleagues on innovative vistas, the latter possibility has been indicated in this paper, not only to stimulate the currently dormient attention by astrophysicists on the fundamental problem of the synthesis of the neutron, and to indicate a conceivable alternative to the "big bang" origin of the universe for collegial appraisal, but also and perhaps primarily because the absence of the universe expansion and of its "big bang" origin appear to mandate a return to the ether as a universal substratum for the characterization and dynamical evolution of all visible universe, namely, a return to the Maxwellian conception of light and to the notion of ether at the ultimate foundation of this paper (Sections 2-4).

Needless to say, in view of the implications for virtually all of physics, the presentation of alternative models on the energy missing in the neutron synthesis is strongly recommended, provided that they are quantitative (rather than merely conceptual) and represent the *totality* of the characteristics of the neutron in a form invariant over time assured by the Lorentz-Poincaré-Santilli isosymmetry, as done by the isotopic theories (see Ref. [43] and papers quoted therein).

11. POSSIBLE ABSENCE OF "DARK MATTER"

There is no doubt that the hypothesis of "dark matter" for the representation of the dynamics of galaxies is stimulating the imagination of young minds the world over. However, the hypothesis also carries the seeds for an insidious transition of astrophysics from models that can be verified with experiments along the teaching of Galileo Galilei, to unverifiable abstract entities, thus warranting the study of alternative views for future collegial regolution.

Perhaps more insidiously, the hypothesis of the "dark matter" is stimulating studies on possible deviations in the interior of galaxies from our most fundamental law in the dynamics of the universe, Newton's gravitation, with the consequential turning our entire knowledge of the universe into an unsettled state.

Additionally, in the event "dark matter" is uniformly distributed throughout a galaxy, it is evident that it cannot have any measurable effect on galactic dynamics. Therefore, "dark matter" has to be placed *ad hoc* where needed, e.g., in front of a star, in which case the behavior of a nearby star remains anomalous. thus creating doubts on the plausibility of the hypothesis, and confirming again the need for alternative views.

Along the latter lines, Santilli indicated in Ref. [36] certain shortcomings of the "dark matter" hypothesis and pointed out that: 1) Our only measurements on the galactic dynamics of stars are those via their comparatively anomalous redshifts; 2) The interior of galaxies is far from being empty, since it is filled up with various gases, thus being a physical medium much denser than intergalactic space; and 3) Special relativity at large, and Doppler's law in particular, are expected as being inapplicable within physical media (Sections 2-7), thus suggesting the following:

HYPOTHESIS 11.1 [36]: The comparatively anomalous redshifts measured for stars belonging to a given galaxy, originates from an isoredshift caused by the radially decreasing innergalactic medium, thus recovering the full validity of Newton's gravitation for galactic dynamics.

Santilli [*loc. cit.*] then presented the possible absence of "dark matter" *via* the *innergalactic isoredshift* with a number of realizations, e.g., of the type

$$z_g = \frac{c}{\lambda}(1 - \frac{1}{n_g}), \tag{24}$$

where n_g is fitted from the data, is expected to decrease with the radial distance from the galactic center, and then be 1 outside the considered galaxy.

Note that, in the event the galaxy is moving with respect to Earth, or the galactic center is stationary with us but peripheral stars are moving toward or away from us, the applicable law is the *innergalactic Doppler-Santilli isoredshift* thus being given by a superposition of the conventional Doppler's redshift or blueshift due to relative motion of a star away or toward us, and Santilli's isoredshift due to the innergalactic medium without relative motion. Consequently, model (24) is solely applicable in the absence of relative motion of a given star and Earth, therefore, in the absence of relative motion between the galactic center and Earth, as well as when the galactic plane is perpendicular to the distance (see Fig. (**12**)).

As it is the case for the possible absence of universe expansion of the preceding section, in the event confirmed, the absence of "dark matter" would also stimulate new vistas, this time *the reformulation of Newton's gravitation in terms of energies,* rather then its historical formulation in terms of masses [5d,36]

$$F = s\frac{E_1 E_2}{r^2}, s = \frac{g}{c^4}, \tag{25}$$

where g is the conventional gravitational constant, and s is its replacement for energy.

The above reformulation is apparently necessary to render Newton's gravitation truly "universal," thus inclusive of the *Newtonian gravitational attraction of light* that has been missing for centuries due the massless character of light compared to the formulation of Newton's law solely in term of masses.

Note that the achievement of a true universality for Newton';s gravitation requires that *gravitation is originated by energy, rather than mass*. Despite the popular use of masses for centuries, the view is plausible because the structure of bodies is characterized by *energy,* while mass is a mere human abstraction to characterize inertia.

At any rate, Santilli's reformulation (25) is also supported by the Einstein-Hilbert gravitational field equations since their source is given by the "energy-momentum tensor," while a "mass-momentum tensor" would be inconsistent on various geometric counts.

By recalling that Newton gravitation is the ultimate law at the foundation of our knowledge of the universe, reformulation (25) opens a vast n umber of intriguing and vastly unexplored problems, such as the Newtonian origin of the gravitational bending of light, the actual curvature of space beyond the mere mathematical Riemannian formalism, the reformulation of the dynamics of planetary systems (see next section), and other intriguing open problems we can only indicate hoping, again, in leniency by colleagues on new vistas.

12. POSSIBLE ABSENCE OF "DARK ENERGY"

There is equally no doubt that the hypothesis of "dark energy" is one of the most fascinating conceptions in conte-mporary cosmology with vast scientific and epistemological implications. However, as it was the case for "dark matter," "dark energy" also carries the risk of transforming cosmological models into abstract unverifiable views, thus warranting the study of quantitative alternative models without "dark energy."

Additionally, as it was the case for "dark matter," in the event "dark energy" is uniformly distributed throughout the universe, it is evident that it cannot have any measurable effect on the dynamics of the Universe. Therefore, "dark energy" has to be placed *ad hoc* where needed, thus creating doubts on the plausibility of the hypothesis, and confirming again the need for alternative views.

Along the latter lines, Santilli pointed out in Ref. [36] that the hypothesis of "dark energy" is crucially dependent on the validity of special relativity in general, and Einstein's equivalence law $E = mc^2$ in particular, not only in interior conditions but also within the extreme conditions existing in the interior of black holes (see Fig. (**13**)) and other hyperdense astrophysical bodies, where the "inapplicability" (and certainly not the "violation") of special relativity is nowadays accepted by the scientific community at large.

Ref. [36] then indicated that possible maximal causal speeds in interior conditions bigger than the speed of light in vacuum would eliminate the need for "dark energy" evidently in view of the resulting energy equivalence of the universe bigger than that currently estimated. Such a view has been justly excluded until recently because, according to special relativity, speeds bigger than that of light in vacuum violate causality and other laws.

Fig. (13). Conceptual rendering of a black hole illustrating the predicted lack of applicability of special relativity in its hyperdense interior, with causal superluminal speeds, bigger energy equivalence than that predicted by special relativity, and consequential lack of need for "dark energy."

Santilli was in a position to suggest in Ref. [36] causal speeds in the interior of astrophysical bodies bigger than the speed of light in vacuum thanks to decades of prior studies on the isotopies of Lie's theory, the Lorentz-Poincaré symmetry and special relativity for interior conditions. In fact, as indicated in Section 5, the Lorentz-Poincaré-Santilli isosymmetry no longer admits infinities at the speed of light c, thus allowing indeed maximal causal speeds in interior conditions arbitrarily bigger than the speed of light in vacuum (speeds at times called "superluminal"), as per Isoaxiom I, Eq. (9). Bigger values of the energy of the universe are then admitted by Isoaxiom V, Eq. (14).

Independently from the predictions of isorelativity, numerous aspects support causal superluminal speeds in interior conditions (only). To begin, *Einstein formulated his equivalence law, specifically, for point-like particles moving in vacuum,* for which structure the validity of c as the maximal causal speed is out of question. However, the dynamics of the universe requires the energy equivalence of *the interior of stars, quasars and black holes,* namely, for physical conditions dramatically beyond those of Einstein conception, for which we have no experimental backing of any type.

Additionally, the literature on causal superluminal speeds for massive bodies is rather vast (for a review, see monographs [5]). As an indication, we recalled in Section 3 the experimental detection of electromagnetic waves traveling within certain guides at speeds bigger than c [10] that have been dismissed because of the assumption of special relativity in the interior of the guides, while the use

of isorelativity renders these experimental measurements fully acceptable.

Independently from that, the fit of experimental data in particle physics without the aprioristic assumption of special relativity implies the necessary existence of speeds within the structure of hadrons bigger than the speed of light in vacuum (for a review, see monograph [5d] or Chapter 5 of ref. [9]).

We should also recall paper [44] of 1982 indicating the possibility that *strong interactions may accelerate massive particles beyond c in a fully causal way.* The main argument is that the value of c as maximal causal speed solely occurs for the conditions clearly stated by Einstein, a particle in empty space under action-at-a-distance interactions. However, when the same particle is within a hyperdense medium, the contact interactions caused by the environment have no potential energy and, consequently, can indeed propel massive particles to unrestricted causal speeds.

In view of all the above, Santilli indicated in Ref. [36] that the use of isorelativity for the interior of astrophysical bodies, and its Isoaxiom V in particular, eliminate the need for the "dark energy." Under the assumption in first approximation that stars, quasars and black holes are perfectly spherical, homogeneous and isotropic (thus assuming $n_k = 1, k = 1,2,3$), the total energy isoequivalence of the universe is given by [3-7]

$$E_{univ} = m_{univ} C_{aver}^2 = m_{univ} \frac{c^2}{n_{aver}^2}, \tag{26}$$

where C_{aver} is the average maximal causal speed in the *interior* of all astrophysical bodies, and n_{aver} is the value of the index of refraction averaged over all stars, quasars and black holes in the universe. In this case, "dark energy" is merely given by the following expression [40]

$$E_{dark\ energy} = m_{univ}(C_{aver}^2 - c^2). \tag{27}$$

The above rule recovers the current estimates on the total energy in the universe for the average value

$$C_{aver} \approx 10\, c, \tag{28}$$

an increase of the speed of light in vacuum that is rather moderate when compared to the extreme conditions existing in the interior of black holes, and the number of black holes expected to exist in the universe. Smaller values of C_{aver} can be obtained by considering the anisotropy and inhomogeneity of stars, quasars and black holes (see Ref. [5c] for details). Consequently, we have the following:

HYPOTHESIS 12.1 [36]: The total energy of the universe is set by Isoaxiom V, Eq. (14), of the Lorentz-Poincaré-Santilli isosymmetry, with average maximal causal speeds (9) in the interior of astrophysical bodies bigger than the speed of light in vacuum, and consequential absence of "dark energy."

It should be noted that the above hypothesis is a complement of the isoredshift because isorelativity predicts a *decrease* of the speed of light within physical media of low density, such as our atmosphere, and an *increase* of its speed within hyperdense media due to contact effects without potential energy [44].

Consequently, the experimental confirmation of the isoredshift would provide support for maximal causal speeds within hyperdense matter bigger than c. Note, for these new vistas, the necessity of the return to the Maxwellian conception of light as a transverse electromagnetic wave created and propagated by the ether as a universal medium, since photons would be excessively insufficient for Hypothesis 12.1.

It should be also noted that *isotopic speeds arbitrarily bigger than c do not characterize tachyons,* since the latter, by definition, must travel at speeds bigger than the local maximal causal speed. This is an additional aspect preventing the use within physical media of the speed of light c as the maximal causal speed in favor of speed (9).

In closing the author has to appeal again to the leniency of colleagues on new scientific vistas because, in reality, the achievement of a quantitative representation of the dynamics of the universe via Hypothesis 12.1 is substantially more complex than may appear at first inspection. This is due to the apparent need of reformulation (25) of Newton's gravitation in terms of the energy, rather than mass.

Such a reformulation is elementary for light and point-like particles in vacuum, that is, under Einsteinian conditions. However, the same reformulation is far from being trivial in interior condition of extended astrophysical bodies, since it raises all sort of open issues, such as the selection between the gravitational and inertial mass, and others. It is hoped that these open issues will intrigue young minds of any age for much needed collegial studies.

13. COMPARISON OF ISOREDSHIFT WITH THE "TIRED LIGHT"

Numerous hypotheses have been submitted to represent the experimental data on Hubble's law for the cosmological redshift *without* the expansion of the universe (see representative papers [45-49]) in favor of an essentially stable universe, except for possible minor relative motions of galaxies, much along the "steady state cosmology" [1].

These attempts are generally known under the name of *tired light* (or *aging of photons,* and others) and essentially study the possibility that photons lose energy $E = h\nu$ when traveling through very big intergalactic distances. In studies [45-49], the loss of energy is assumed as being due to a variety of reasons, such as interaction of light with intergalactic dust, the conjecture of "photon decay," and others.

It should be noted that all hypotheses [44-48] are based on the following assumptions:

1) The exact validity of special relativity in intergalactic space;

2) The reduction of light to photons; and

3) The propagation of photons at the speed of light c in vacuum.

By contrast, Santilli's [3,5,40] interpretation of the cosmological redshift is based on the following assumptions:

1^*) Intergalactic space is a physical medium primarily characterized by light, for which Special relativity is inapplicable in favor of the universal isorelativity covering;

2^*) Light is a transversal electromagnetic wave created and propagated by the ether as the universal substratum; and

3^*) Physical media alter the geometry of spacetime and, consequently, light propagates in intergalactic spaces at a speed $C = c/n < c$ with ensuing: loss of energy to said medium; isoredshift caused by light propagating through light; and continuous creation of the background radiation.

In the author's view, the hypothesis of tired light, even though scientifically valuable and more plausible than that of the "big bang," does not appear to be sufficient for a consistent interpretation of the cosmological redshift in a way compatible with other experimental evidence on Earth. In fact, events such as the propagation of light in water (Section 3), the color of our atmosphere (Section 4) and others [3b,5d], clearly suggest *deviations from special relativity within all physical media,* thus including the intergalactic medium.

14. PROPOSED NEW EXPERIMENTS

There is no doubt that astrophysics and cosmology of the 20th century have suffered from the aprioristic imposition of the validity of special relativity under conditions dramatically beyond those conceived by Albert Einstein without prior experimental verifications. The maintainment of Einstein's theories has then required the conception and support of far reaching conjectures, such as universe expansion, "big bang," "dark matter," "dark energy," and others despite the lack of experimental support, structural insufficiencies and clear inconsistencies.

It is evident that astrophysics and cosmology cannot continue along these unreassuring lines without risking a severe judgment by posterity. Consequently, Santilli suggests a return of astrophysics and cosmology to its original foundations set forth by Galileo Galilei: establish all astrophysical and cosmological models via experiments conducted on Earth, rather than via sole collegial backing. Along these lines, Santilli suggests the conduction of the following experiments:

PROPOSED EXPERIMENTS 1: Repeat in interior conditions within physical media all most important experiments on special relativity that have been solely conducted until now in vacuum, such as the Fizeau experiment, the Michelson-Morley experiment, the experiments on energy equivalence $E = mc^2$*, and others.*

PROPOSED EXPERIMENTS 2: Conduct comprehensive tests to confirm or deny the structure of light as an electromagnetic wave created and propagated by a universal. substratum, the ether, with particular reference to the experimental finalization of its transversal character, by maintaining the reduction of light to photonic wavepackets, also created and propagated by the universal substratum, when applicable.

PROPOSED EXPERIMENTS 3: Conduct a direct experimental verifications or denials of Santilli's isoredshift interpretation of Hubble's law via an Isoredshift testing Station in which light propagates through light (Proposed experiment 1 of Ref. [40]).

Note that Santilli, a theoretical physicist, was forced to conduct the experiments on the isoredshift (Section 7) due to a widespread lack of interest by academic laboratories. It is hoped that serious scholars, governmental granting officers and scientific observers will admit the current technological feasibility on Earth of all proposed experiments, their moderate costs, their far reaching scientific implications irrespective of their outcome and, therefore, support, rather than generally dismiss, the conduction of truly basic experiments.

15. CONCLUDING REMARKS

If confirmed, the implications of the isoredshift are rather significant, due to the following expected consequences treated in the literature on isotopies for some time [2-7,18-24]:

1) Light returns to acquire its Maxwellian interpretation as a transversal electromagnetic wave, without any conflict with the photon interpretation, although only for light with sufficiently small wavelength, since photons are not "solid particles," but are themselves wavepackets. This interpretation is suggested by the impossibility for photons to traverse a large number of nuclei as necessary for a consistent interpretation of the propagation of a light beam in water as in Fig. (**1**) and numerous other consistency requirements.

2) As it is the case for sound waves, electromagnetic waves cannot exist or propagate without a medium. Therefore, the isoredshift implies the return to the 19th century conception of the ether as a universal substratum characterizing all the visible universe, not only light as a transversal wave, but also all matter as an oscillations of the ether (strings?), thus preventing the existence of the "ethereal wind" [9].

3) The speed of light returns to be a local variable $C = c/n$ with index of refraction n depending on frequency, density, temperature, and other variables. This interpretation is necessary to reach a quantitative representation of the refraction of light at the surface of water as in Fig. (**1**), the reduction of the speed, and other aspects. The entire photon interpretation of light is insufficient to reach a numerical representation of the reduction of the speed of light in water by about $1/3$, the sharp location of the refraction at the water surface, the angle of refraction, and other data. At any rate, the photon interpretation is inapplicable for electromagnetic waves with large wavelengths propagating within physical media that experience similar occurrences.

4) A quantitative study of the colors of our atmosphere reveals clear deviations from special relativity, with particular reference to: the transition from the blue color of the horizon during day time to its predominant red at Sunset and Sunrise; the inability of the Sun red light during Sunset to reach us as established by the relativistic scattering theory,

as well as the impossibility for the conventional Doppler redshift to account for the large shift (of about 200 nm) from blue to red light; the disagreement between the prediction of special relativity of a blueshift at Sunrise due to our motion towards the Sun against the visual evidence of the predominant red color at Sunrise that established the presence of an event beyond special relativity; and other problems.

5) The need for a quantitative representation of the colors of our atmosphere without any relative motions between the source, the medium and the observer (isoredshift), with consequential deviation from the very structure of the Minkowski spacetime for the vacuum (empty space).

6) The consequential absence of the "big bang" and "dark matter," with lack of expansion of the universe, as a limit case not excluding possible local small motions, once intergalactic space is recognized as being a physical medium with considerable energy density due to electromagnetic waves of all types originating from all of the universe, as well as dust, cosmic rays and other matter components. Consequential deviations from the predictions of special relativity for all dynamics in astrophysics and cosmology dealing with the propagation of light (or actual extended particles) within physical media, and consequential expected lack of "dark matter" due to anomalous redshift for light propagating within media inside galaxies.

7) The inevitable existence of causal speeds within hyperdense media inside stars, quasars and black holes bigger than the speed of light in vacuum as per considerable experimental evidence [5d], as well as because internal contact nonpotential forces can accelerate particles without the usual energy needed for their acceleration in vacuum [39], with consequential lack of "dark energy" due to an energy equivalence of the universe much bigger than that predicted by special relativity.

8) The geometrization of all possible physical media via all possible, nonsingular, deformations/isotopies of space-times and related geometries in $(3+1)$-dimensions and consequential universal Lorentz-Poincaré-Santilli isosymmetry, isorelativity, and applicability within physical media of the Riemannian, Finslerian [50] and other geometries via their invariant treatment permitted by isomathematics.

9) The lack of exact character of special relativity within *all* physical media, thus including the scattering region, with consequential possible lack of final character of the *elaboration* via special relativity of actually measured quantities (such as cross sections and scattering angles) [51], inapplicability that can be inferred not only from the experimental evidence presented in this paper, but also from the fact that the axioms of special relativity are reversible over time, while all inelastic scattering processes are notoriously irreversible, thus implying that the former cannot be necessarily exact for the latter (see Ref. [5f,9] for details).

All in all, it is hoped this paper indicates to young minds of any age that, following one millennium of studies, our true understanding of light is still at its infancy, and so is the case for our knowledge of the universe.

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