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Experimental confirmation of Santilli's IsoRedShifts and IsoBlueShifts[1]

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Abstract. While stressing the need for additional independent verifications, in this paper we provide: 1) Confirmatory measurements of Santilli's 1991 hypothesis of the anomalous *IsoRedShift* (IRS) for the propagation of a blue laser light in a 60 ft ≈ 18 m long steel pipe containing air at a maximum of 70°F ≈ 21°C and at 2,000 psi ≈ 137 bars without any relative motion between the source, the medium and the analyzer; 2) Confirmatory measurements of Santilli's 1991 hypothesis of the anomalous *IsoBlueShift* (IBS) for a blue laser light in the same conditions as above except for air being at a minimum of 130°F ≈ 54°C; 3) Experimental evidence on the transition from IRS to IBS with the increase of the temperature, thus confirming Santilli's *NoIsoShift* (NIS); 4) Measurements showing no frequency shift for a blue laser light reflected on a polished metal mirror at temperatures ranging from 70°F ≈ 21°C to 280°F ≈ 137°C, with consequential apparent absence of frequency shift for the scattering of light in a gas, since the Boltzman distribution apparently implies no frequency shift for light scattering in a gas due to relative motions averaged down to zero; and 5) Consequential confirmation of Santilli's 1991 hypothesis that the large difference in cosmological redshift between certain quasars and associated galaxies when physically connected via clear gamma spectroscopic evidence, originates from largely different IRS in the dramatically different quasars chromospheres and innergalactic media. Cosmological and other implications of Santilli IRS, IBS and NIS are discussed by other contributions in these proceedings.

Keywords: IsoRedShift, IsoBlueShift, NoIsoShift

1. Historical notes

This paper is devoted to experiments on anomalous frequency shift of light propagating within gaseous mediaconfirming the following symmetric nonsingular spacetime for the geometrization of physical media proposed by R.M. Santilli (see Eq. (2), Ref. [1] of 1983; Refs [2] of 1991 for the ensuing covering relativity; Refs [3] for a comprehensive treatments of the covering symmetry and ensuing relativity; Refs [4,7] for the underlying covering geometry; Refs [5,6] for experimental verifications relevant for this paper; Ref. [8] for a recent update; and Ref. [27] for a general review):

$$x^2 = x_1^1 b_1^2 + x_2^2 b_2^2 + x_3^2 b_3^2 - t^2 c^2 b_4^2 = x_1^2/n_1^2 + x_2^2/n_2^2 + x_3^2/n_3^2 - t^2 c^2/n_4^2, \tag{1}$$

where: $b_\mu = 1/m_\mu, \mu = 1, 2, 3, 4$, are called the *characteristic quantities* of the medium considered; $C = cb_4 = c/n_4$ is the local speed of electromagnetic waves; $n_4 = 1/b_4$ is the familiar index of refraction; $n_k = 1/b_k, k = 1, 2, 3$, characterize the inhomogeneity and anisotropy of the medium

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considered; all $n_\mu, \mu = 1, 2, 3, 4$, are normalized to the value $n_\mu = 1/b_\mu = 1$ for the vacuum; and the characteristic quantities have the most general known nonlinear, nonlocal and nonpotential dependence on local variables such as time t, coordinates x, velocities v. density d, frequency ω, etc., $n_\mu = n_\nu(t, x, v, d, \omega, \ldots)$. Spacetime (1) has been identically formulated in term of the characteristic quantities b_μ and n_μ because early studies in the field used the former, while all recent studies use the latter.

Spacetime (1) is called *Santilli isospacetime*, where the prefix "iso" denotes the use of the underlying novel *isomathematics* with *Santilli Lie-isotopic structure* [3]; it constitutes the most general possible *symmetric* nonsingular spacetime written in the diagonal form from its symmetric character; and intriguing non-diagonal (but still symmetric) forms are studied in monographs [4]. The sole possible nonsingular generalizations of isospacetime (1) are of *non-symmetric* character; they are known as *Santilli genospacetime,* where the prefix "geno" denotes the use of the yet broader *genomathematics* with *Santilli Lie-admissible structure* [3] for the study of irreversible processes which are not considered in this paper. The experimental measurements presented in this work refer to isospacetime (1), thus deferring the inclusion of possible, generally small irreversible contributions to future more refined measurements.

In order to conduct studies of general spacetime (1), during his stay at MIT (1974–1977) and at Harvard University (1977–1983), Santilli constructed the axiom-preserving isotopies of 20th century applied mathematics (today known as *Santilli isomathematics*), with particular reference to the nonlinear, nonlocal and nonpotential isotopies of Lie's theory [2a,3a]. These isotopies were necessary since the conventional Lie theory is inapplicable for the invariance of spacetime (1) due to the strict linearity of the former compared to the strict nonlinearity of the latter. In fact, isomathematics in general, and the Lie-isotopic theory in particular, were built by Santilli for the specific intent of achieving the invariance of nonlinear spacetime (1), as well as of nonlinear systems at large (see Ref. [1] for comprehensive literature).

Following the prior construction of the needed novel mathematics, Santilli achieved in 1983 [2] the isotopies of the Lorentz-Poincaré (LP) symmetry for the universal invariance of general spacetime (1) (today known as the *Lorentz-Poincaré-Santilli* (*LPS*) *isosymmetry*). Thanks to such a new isosymmetry, Santilli was able to construct in the same paper [2] the *isotopies of special relativity* (today known as *Santilli isorelativity*) that were first presented in a systematic way in monographs [2] of 1991, and subsequently expanded in monographs [3] of 1995, which remain to this day the best and most technical source in the field. Sunsequently, Santilli constructed in Ref. [4] of 1998 the isotopies of the Minknowskian geometrry, today known as *Santilli iso-Minkowskian geometry*, which constitute the ultimate geometric foundation of this paper.

Santilli isorelativity is based on the axiom-preserving isotopies of the conventional five axioms of special relativity (called *Santilli isoaxioms*) whjch are uniquely and unambiguously characterized by the LPS isosymmetry and the background iso-Minkowskian geometry. These isoaxioms were fully identified in Ref. [2b], Chapter 4, with particular reference top Section IV.9, pp. 190–214. Various authors have shown the "direct universality" of Santilli isoaxioms, in the sense of admitting as particular cases Einstein's axioms (for $n_\mu = 1/b_\mu = 1$, as well as all available deviations from Einsteinian axioms via different expansions in terms of different variables with different truncations ("universality"), directly in the frame of the experimenter, thus without the use of coordinate transformations ("direct universality") [3]. This feature can be easily seen from the universality of invariant (1) for all possible inhomogeneous and anisotropic, but symmetric spacetimes, the universality of the LPS isosymmetry for invariant (1) and, consequently, the universality of the characterized isoaxioms. The "axiom-preserving character" of the isoaxioms is stressed by Santilli throughout his works by proving that, at the abstract realization-free level, special relativity and isorelativity coincide by conception and construction. In this way, Santilli points out that his isoaxioms merely permit the broadening of the applicability of Einsteinian axioms, as the best way to honor the founders of special relativity,

To prevent the usual *ad hoc* adaptation of physical reality to preferred theories, Santilli stressed the geometric incompatibility of inhomogeneous and anisotropic physical media (such as our atmosphere) with the strictly homogeneous and isotropic Minkowskian spacetime, thus mandating, on serious scientific grounds, the study of covering isospacetime (1), of the related covering symmetry, and of the corresponding covering relativity and geometry [3].

Santilli also presented various arguments preventing the exact validity of special relativity within our atmosphere, such as the impossibility of even defining correctly Einstein's axioms due to the evident impossibility of having inertial reference frames in our atmosphere, geometric incompatibilities of the axioms of special relativity with the characteristic features of physical media, absence of purely Hamiltonian interactions, and other arguments [3].

Additionally, Santilli presented numerous evidence preventing the reduction to photons of "all" electromagnetic waves when "propagating" within physical media, such as [3,5]:

1) The lack of "numerical" (rather than the customary conceptual) representation of the angle of refraction of a light beam in water (evidently because photons would scatter in all directions at the impact with the surface of the medium);
2) The lack of a "numerical" (rather than conceptual) representation of the reduction of speed of light in water (the scattering of photons among molecules can at best represent a 5–7% reduction of the speed of light in water which speed in reality is reduced by about 33%);
3) The reduction of light to photons would require that an extremely large number of photons traverse *without scattering* an equal number of atoms and nuclei on a straight line, as a necesssary condition to represent the undeniable physical evidence of the propagation of a light beam in water along a straight line;
4) The lack of "numerical" (rather than conceptual) representation of the propagation of a light beam in water with minimal dispersion due to scattering (because photons would scatter in all directions);
5) The impossibility of a "credible" reduction to photons of electromagnetic waves with large wavelength, e.g. of 1 m wavelength, that experience within physical media the same phenomenology experienced by light; and other arguments.

The above and other evidence does not deny Einstein's quantized "absorptions", although only for "certain" frequencies depending on the medium at hand, as clearly expressed by Einstein in his writings. The same evidence does not deny the existence of scattering of light in all directions, which is notoriously the origin of the decreased intensity of a light beam.

Evidence 1) to 5) establishes the need for the *return to the Maxwellian conception of light as an electromagnetic wave* (*photons being merely given by wavepackets*) *propagated by the ether as a universal substratum for both light and matter.* In fact, such a conception resolves all inconsistencies of the reduction of propagating light to photons, by additionally establishing the *generally varying character of the speed of light,* while maintaining its (non-universal) constancy in vacuum for inertial reference frames (only) as a particular case. As an incidental note, Santilli shows that, contrary to popular beliefs, a universal substratum *does not* violate Einsteinian theories in vacuum because of the evident impossibility for us to identify the hypothetical absolute frame at rest with the ether. In the absence of the experimental detection of an absolute reference frame, all related coinsiderations are scientifically vacuous.

2. Main predictions of santilli IsoGeometry, IsoSymmetries and IsoRelativity

As outlined above, Santilli has conducted systematic and comprehensoive studies for interior dynamical problems of extended particles and electromagneitc waves propagating within physical media, which have resulted in the deeply inter-related isogeometry, isosymmetry and isorelativity with universal isoinvariant (1).

The main predictions of these covering formulations are characterized by Santilli Isoaxioms I, II, III, IV and V. Isoaxioms I to IV have now received significant experimental verifications, both individually and collectively (see review [27]). This paper deals with experimental verifications of Isoaxiom V, Ref. [2b], p. 210, that predicts *deviations from the conmventional Doppler shift law for light propagating within gaseous media, such as our atmosphere* (today known as the *Doppler-Santilli isoshift law*). In first term approximation, Isoaxiom V can be written for speeds v in (absolute value) along the third axis (see Refs [3b,4b] for the general case)

$$\nu = \nu_0 / \left(1 \pm \frac{v^2}{c^2} \frac{b_3^2}{b_4^2} + \ldots \right) \approx \nu_0 / \left(1 \pm \frac{v^2}{c^2} \frac{n_4^2}{n_3^2} + \ldots \right), \tag{2}$$

where the negative sign refers to source and observers moving away from each other at speed v, while the positive sign refers to the case in which source and observer move toward each other at speed v.

A rather deep implication of Isoaxiom V is the prediction that *the frequency of light can be decreased by the medium in which it propagates in a way independent from the relative motion between the source and the observer.* Santilli called this shift the *isotopic redshift* (Ref. [2b], page 210), subsequently abbreviated in the same monograph to *isoredshift* (see also the "Index" of Ref. [2b], pp. 353–354, under the heading "Isospecial relativity" and then the subclass "Isodoppler's law, 210").

To understand the measurements presented in this paper, we should recall that, in the above original derivation, the isoshift law was presented as a superposition of a contribution from the isotopic redshift due to propagation within physical media, plus the conventional Doppler shift caused by relative motion. Such a definition of the isoshift dating back to 1991 remains fully valid to this day because it remains the most general formulation derivable from the LPS isosymmetry. By contrast, all measurements presented in this paper deal with the particular case in which there is no appreciable relative motion between the source and the observer, thus in the absence of any Doppler's contribution.

Another fundamental prediction of Ref. [2b] is that *the redness of "direct" Sunlight at Sunset is due to the isoredshift caused by the propagation of light within our inhomogeneous and anisotropic atmosphere, the isoredshift being proportional to the travel of light within our atmosphere.* This prediction is formulated in Ref. [2b], p. 330, via the following proposed:

Experiment III: Measure in our laboratories the possible IsoRedShift of sun light in the transition from the zenith to the horizon.

It should be stressed that the above experimental proposal strictly refers to "direct Sunlight", thus avoiding scattering that, notoriously cannot possibly propagate along a straight line for all electromagnetic frequencies (see Section 5 for theoretical and experimental evidence).

It should be indicated that Santilli reached the IsoRedShift prediction of the redness of the Sun at Sunset on pure geometric grounds.The argument is that our atmosphere is clearly inhomogeneous (because of the variation of the density with the elevation) and anisotropic (because of Earth's rotation), thus preventing the exact validity of the Minkowskian spacetime. Santilli then proved that any deviations from the Minkowski spacetime necessarily implies the IsoRedShift. The universality of isospacetime (1), its LPS isosymmetry, isogeometry and isorelativity then led to the universality of isotopic law (2).

Fig. 1. A view of the IsoShift Testing Station built by Santilli and his technicians in early 2009 due to the rejection for over twenty years by physics laboratories around the world to test his IsoRedShift hypothesis [5].

Additionally, Santilli introduced (apparently for the first time in Ref. [2b] and then developed in Ref. [3b]), the *isotopic blueshift,* later shortened to *isoblueshift,* via the following (Ref. [2b], p. 211):

Proposition IV.9.5: Any (topology preserving) modification of the Minkowski metric implies a necessary mutation of the Doppler shift which can be bigger, equal or smaller than the Einsteinian value depending on the local conditions of the interior medium considered.

The most important hypothesis at the foundation of the anomalies here onsidered is that expressed as follows (Ref. [2b], p. 212):

Proposition IV.8.5: The presence of energy in any of its possible forms, whether due to light, matter, particles, etc., causes an alteration (called "mutation") of the geometry of the Minkowski spacetime.

This conclusion is also reached on geometric grounds. In fact, *Santilli argues that there cannot be any modification of any characteristics of light, whether of speed, frequency, polarization, etc., without a mutation of spacetime itself.* As an example, the representation of a locally *varying* speed of light C = c/n requires generalized invariant (1) for which the mutation of spacetime is inevitable.

The physical notion underlyng the mutation of spacetime is at the foundation of the entire field herein considered. In fact, the anomalous measurements presented in this paper can be all construed as experimental evidence of the mutation of spacetime caused by a physical medium.

In the early 1970s, Santilli had been impressed by *Arp's discovery of quasars physically connected to associated galaxies according to clear gamma spectroscopic evidence, while the cosmological redshifts of quasars and associated galaxies generally have very large differences.* These differences clearly suggest possible deviations from special relativity in the structure of associated quasars and galaxies because special relativity would imply that the quasars and galaxies should have been separated billions of years ago and move at very different speeds away from Earth.

In Ref. [2b], *Santilli interpreted the dramatic differences of cosmological redshifts of quasars and of their associated galaxies as being due to the dramatic differences in the density of the related media, the* *very large and dense quasar chromospheres and the correspondingly much thinner interior of galaxies.* Via the use of his IsoRedShift, Santilli argued that light exits the quasars chromospheres in a form dramatically more IsoRedShifted than light exiting innergalactic media. The conventional. Doppler shift was maintained in Ref. [3b] because of the admission of the possibility that the pair of quasar and associated galaxy could move away from Earth at the *same* speed v. However, Santilli stressed in page 211 of Ref. [2b] that the IsoRedShift should be expected independently from the Doppler shift because quasars chgrmospheres are dramatically denser than innergalactic spaces.

The numerically exact and time invariant, isotopic representation of all pairs of quasars and associated galaxies known at the time, was provided in Ref. [2b], Section VII.3, pp. 323–328. To our best knowledge, this representation is still fully valid to this day, besides from being the most general possible, as well as providing a geometric unification of alternative models (see Section 5 below). To confirm his isotopic representation, Santilli proposed in Ref. [3b], pp. 329–330, the following two experiments that have remained ignored by the astrophysics community to this day (and, regrettably, we cannot possibly consider in this paper):

Experiment I: Measure in our laboratories the possible IsoRedShift of light from a quasar before and after going through the atmosphere of a member of our solar system, such as Jupiter's atmosphere.
Experiment II: Measure in a satellite the possible IsoRedShift of light from a quasar before and after going through Earth';s atmosphere.

By using the data for the characteristic quantities of isorelativity derived from the fit of the data from the quasars, and by approximating the ratio between the density of the quasar chromosphere and Earth's atmosphere, Santilli achieves a numerical prediction of IsoRedShift for Sun light at Sunset (Ref. [2b], pp. 331–332).

In Section VII.5 of Ref. [2b], Santilli also proposed:

Experiment IV: To confirm or deny the impossibility for the Minkowskian geometry as being "exactly" valid within the hyperdense medium inside hadrons. This occurrence was subsequently established by Santilli via numerous fits of particle data [8,27]: and
Experiment V: To confirm or deny the deformability of the charge distributions of protons and neutrons when constituents of nuclei because it is necessary to achieve an exact representation of nuclear magnetic moments (although with the loss of quantum mechanics in favor of the covering hadronic mechanics).

These experimental proposals will not be considered in this paper.

In the years following 1991, Santilli wrote numerous papers for the study of each isotopy of the LP symmetry and of special relativity studied in detail in monographs [4]. In going deeper into the issues, Santilli discovered that the functional dependence of the ratio of the characteristic quantities $K = b_3/b_4 = n_4/n_3$ remains completely unrestricted by the isotopies, thus including the dependence on the speed, $K = K(v, \ldots)$. Consequently, *the LPS isosymmetry and isorelativity admit an anomalous shift of the frequency of light propagating within a physical medium even when the relative speed v is null,* with resulting expression [4b,5]:

$$\nu_{v=0} = \nu_0/(1 \pm K + ...), K = \left[\frac{v^2}{c^2}\frac{b_3^2}{b_4^2}\right]_{v=0} = \left[\frac{v^2}{c^2}\frac{n_4^2}{n_3^2}\right]_{v=0} \neq 0, \tag{3}$$

where K is locally constant for the medium considered in this paper, with the understanding that, when the relative velocity is not null, isolaw (3) is replaced by broader isolaw (2).

The above clarification finalized the terminology in the field as follows [5]:

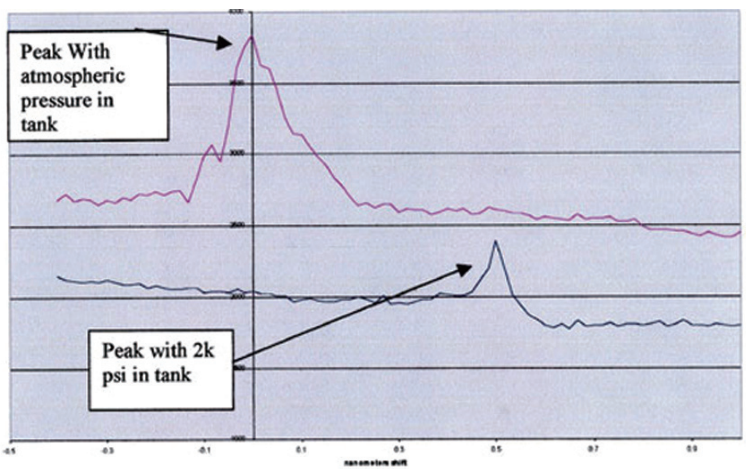

Fig. 2. A view of the first measurement of a deviation from Doppler's law in our atmosphere in favor of the IsoRedShift achieved by Santilli in June 15, 2009 [5] with the stated understanding that these measurements were intended to establish the *existence,* and not the accurate value, of the IsoRedShift due to their initial character.

Santilli IsoShift (IS), (where the prefix "iso" denotes the derivation via the underlying isomathematics) is a *shift of the frequency of light when propagating within a physical medium without any relative motion between the source, the medium and the observer.* IsoShift are then classified into:

IsoRedShift (IRS), occurring when the medium is at a sufficiently low temperature to assume its atoms being mostly in their ground state, in which case light *loses* energy $E = h\nu$ to the medium with consequential anomalous redshift.

IsoBlueShift (IBS), occurring when the the medium is at a sufficiently high temperature to assume most of its atoms being in excited states, in which case light *acquires* energy $E = h\nu$ from the medium with consequential anomalous blueshift.

NoIsoShift (NIS), occurring when the energy lost by light to the medium is equal to the energy released by the medium to light with no anomalous shift.

The above termonilogy will be adopted in this paper and its technical understanding will be tacitly assumed hereon.

3. Aims of the paper

Since his formulation in 1991 [3b], Santilli submitted proposals to various physic laboratories around the world to conduct measurements of light propagating in air at various temperatures and pressures in order to verify or dismiss the existence of anomalies.

Following about two decades of refusals by physics laboratories to even consider the proposed experiments, despite their low cost but fundamental implications (refusals apparently due to the expected violation of Einstein's special relativity), Santilli had no other choice than that of conducting the needed measurements himself.

Therefore, with the assistance of the technicians of the *Institute for Basic Research* in Florida, as well as the assistance of external laser experts, Santilli constructed the *IsoShift Testing Station* reproduced in Fig. 2 that comprises: an initial air-conditioned cabin containing a blue laser; a second air-conditioned

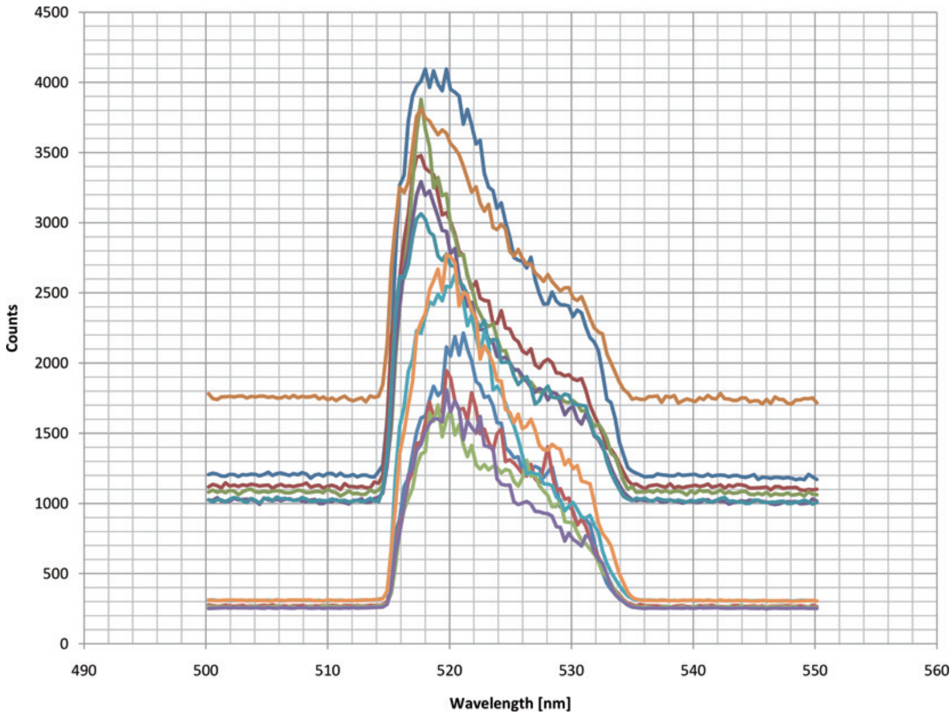

Fig. 3. A view of the measurement on the increase of the IsoRedShift with the increase of pressure at the same temperature first presented in Ref. [5] of 2010.

cabin containing wavelength analyzers, the laser and analyzer being interconnected by a 60 ft ≈ 18 m long steel pressure pipe containing air at pressures up to 2,000 psi ≈ 1137 bars.

Following about nine months of measurements, Santilli released the results for publication in 2010 [5] reporting the existence of a systematic and measurable IRS (see Fig. 3) for blue laser light propagating within 60 $ft \approx 18\ m$ of air at $2,000\ psi \approx 1137\ bars$ and at the winter temperature in Florida of about 70° F ≈ 21°C. Ref. [5] also reported systematic measurements of increases of the IRS with the increase if the pressure at the indicated winter temperature (see Fig. 4). Ref. [5] then suggested the conduction of independent verifications or dismissal of the IRS measurements. A review of Santilli's measurements can be viewed in the film accessible from link [6].

By using the same equipment as that used in Ref. [5], in this paper we provide: While stressing the need for additional independent verifications, in this paper we provide:

1) Confirmatory measurements of Santilli's 1991 hypothesis of the anomalous *IsoRedShift* (IRS) for the propagation of a blue laser light in a 60 ft ≈ 18 m long steel pipe containing air at a maximum of 70°F ≈ 21°C and at 2,000 psi ≈ 137 bars without any relative motion between the source, the medium and the analyzer;
2) Confirmatory measurements of Santilli's 1991 hypothesis of the anomalous *IsoBlueShift* (IBS) for a blue laser light in the same conditions as above except for air being at a minimum of 130°F ≈ 54°C;
3) Experimental evidence on the transition from IRS to IBS with the increase of the temperature, thus confirming Santilli's *NoIsoShift* (NIS);
4) Measurements showing no frequency shift for a blue laser light reflected on a polished metal mirror at temperatures ranging from 70°F ≈ 21°C to 280°F ≈ 137°C, with consequential apparent absence

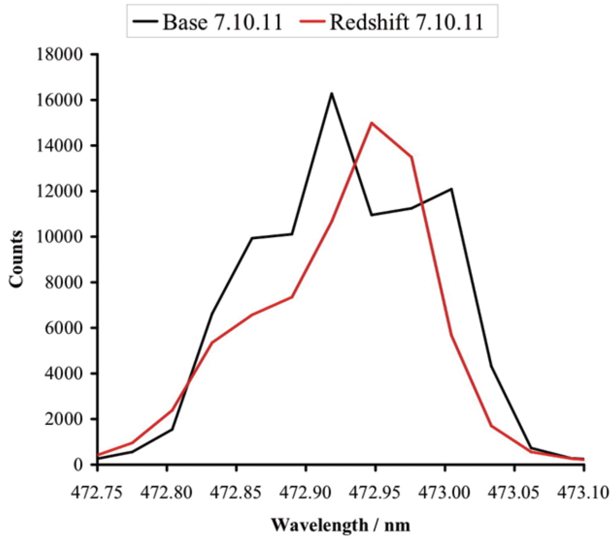

Fig. 4. A representative spectrogram confirming Santilli IRS first predicted in Ref. [2b] of 1991 and first detected in Ref. [5] of 2010. Additional IRS spectrograms are available in Ref. [12].

of frequency shift for the scattering of light in a gas, since the Boltzman distribution apparently implies no frequency shift for light scattering in a gas due to relative motions averaged down to zero; and

5) Consequential confirmation of Santilli's 1991 hypothesis that the large difference in cosmological redshift between certain quasars and associated galaxies when physically connected via clear gamma spectroscopic evidence, originates from largely different IRS in the dramatically different quasars chromospheres and innergalactic media.

Apparent experimental confirmation opf the IRS origin of the redness of Sunlight at Sunset is presented in the adjoinming paper [10] and its cosmological implications are presented in paper [11].

To avoid un-necessary repetitions, a technical knowledge of the measurements presented in Ref. [5] is assumed. It should be indicated that this paper solely deals with measurements of anomalous IS. Therefore, all theoretical considerations are left to theoreticians expert in the field, including interpretations of the measurements different than those presented by the authors.

Finally, we would like to stress that the primary purpose of this paper is that of reporting experimental measurements confirming the *existence* of Santilli's IRS, IBS and NIS, as well as identifying the conditions under which they have been measured. By contrast, the authors make no claim on the exact character of the *numerical values* of the reported shifts due to the insufficiency of the available experimental set up, as well as the dependence of said numerical values on a number of delicate factors, all in need of strict control for accuracy. For instance, thje presentation of errors is carefully avoided to prevenmt a possible misinterporetations of our results. Consequently, the authors definitely support the conduction of independent re-runs.

4. Experimental confirmations of santilli IsoRedShift, IsoBlueShift and NoIsoShift

In this section, we review our independent measurements confirming the existence of Santilli IRS for a blue laser light in air and provide, apparently for the first time, experimental evidence of the existence

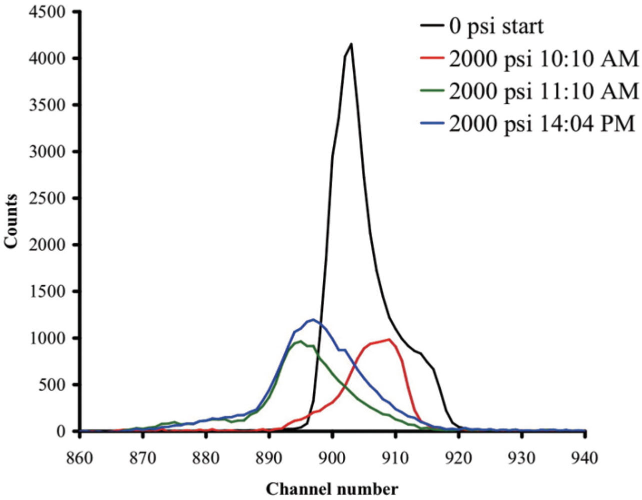

Fig. 5. The first spectrogram obtained on June 12, 2011, showing the existence of Santilli IBS. In this picture, the large central peak represents the wavelength of the blue laser light at atmospheric pressure; the peak to the right represents the IRS at pressure; and the peak to the left represents the IBS also at pressure. This first IBS detection was quite accidental, because due to the Sun warming up the pipe immediately following the detection of the IRS.

of the IBS and the NIS. To prevent the possible conduction of tests different than those of Ref. [5], it was necessary to use the same IsoShift Testing Station used by Santilli (Fig. 2). We should indicate emphatically that Santilli was solely interested in detecting the IRS in the pipe filled up with air, because the tests were primarily intended as experimental evidence for the IRS origin of the redness of the Sun at Sunset studied in the next section. Consequently, we solely conducted tests in air and leave to interested scientists test with different gases. A film on the measurements presented in this section and in the next sections can be viewed from the link of Ref. [9].

In our tests, we used the same equipmenmt used in Ref. [5], namely an Ultralasers blue laser model DHL-B50N (TEM00, 50 mW; 473 nm). The wavelength analyzer was a Avantes Co., The Netherlands, model Avaspec-3648-FCPC Fiber Optic Spectrometer (500 nm blaze grating 2400 lines/mm; 10 micrometer entry slit and an order sorting filter for 2nd order effects larger than 385 nm).

Correct measurements of IRS require the laser and the analyzer being at constant low temperature of about 70°F $\approx$ 21°C. According to Santilli's principles [3–5], the gas contained in the pressure pipe has to be at a sufficiently low temperature to assume that most of its atoms are in the ground state. According to our results, measurable IRS could be detected at air temperature up to 70°F $\approx$ 21°C, beyond which value atoms were excited to such a point to prevent meaningful IRS detections. As recalled earlier, under a sufficiently low temperature, the energy needed for the interaction is provided by light, $E = h\nu$ mresulting in the decrease of the light frequency and therefore, an increase of the wavelength.

As shown below, when passing the air temperature of 70°F $\approx$ 21°C, we have Santilli NIS in which the energy released by light to air is equal but opposite to the energy released by air to light. Since at the temperatures of our tests atoms were not evidently all in their ground state, our IRS measurements are in reality the difference between energy released by light to air and the energy released by air to light, the latter being smaller then the former at air temperatures less than 70°F $\approx$ 21°C.

Correct measurements of IBS also require that the laser and the analyzer be at constant low temperature of about 70°F = 21°C. According to Santilli's principles, the IBS requires that the gas in the pipe be at a sufficiently high temperature so that its atoms are mostly in their excited state. According to our results,

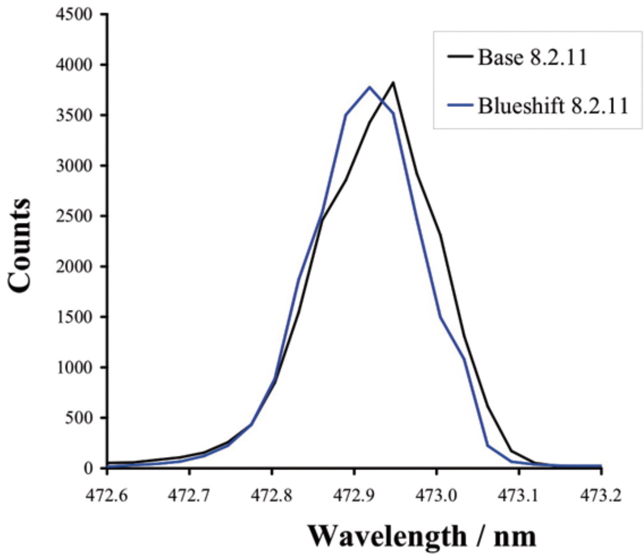

Fig. 6. A representative spectrogram confirming the existence of Santilli IBS first proposed in Ref. [2b] of 1991 and apparently verified in this paper for the first time. Various additional spectrograms are available in Ref. [13].

in order to have a measurable IBS, the air in the pressure pipe has to be at a temperature of at least 130°F ≈ 54°C. As recalled earlier, under these conditions, the interaction energy is predominantly released by the excited atoms and consequently acquired by light, resulting in a blueshift.

Our IRS measurements were conducted as follows. Acceptable IRS measurements at the IsoShift Testing Station in Florida during summer are done at night or early in the morning due to the pipe temperature generally bigger than what indicated. By keeping the above principles in mind, we first compressed air in the pipe up to 2,000 psi ≈ 1137 bars via a commercially available compressor, and then verified that the laser, the analyzer and the pipe were at a maximum of 70°F ≈ 21°C. We then measured and recorded the wavelength of the blue laser light coming out of the terminal window with the pipe at the indicated pressure.

We subsequently discharged the air in the pipe as fast as permitted by safety, and pulled a vacuum on it with commercially available pump. After verifying that the laser and the analyzer had remained at their original temperature, we measured and recorded the wavelength of the laser light through the pipe at vacuum.

Comparison of the two measurements clearly showed a systematic, repeatable and measurable shift of the blue laser light toward the red between the light through the pipe at vacuum and the same at pressure. Since the redshift occurs without any relative motion between the laser, the analyzer and the gas inside the pipe, the measurements provide clear experimental confirmation of deviations from the Doppler law for light propagating in our atmosphere in favor of the covering Santilli isolaw and related IRS. A representative IRS spectrogram is presented in Fig. 4, while various additional IRS spectrograms are available from Ref. [12].

Note that measurements at pressure are done before those under vacuum in order to minimize the lapse of time in between the two measurements. In fact, bringing the pipe to pressure, and then waiting for air to stabilize, requires such a large lapse of time to cause significant climactic changes with consequential loss of accuracy.

The measurements of IBS in Florida were done in summer 2011 during the day when the pipe is exposed to the strong Florida Sun. We then followed the same procedures as those of the IRS, namely,

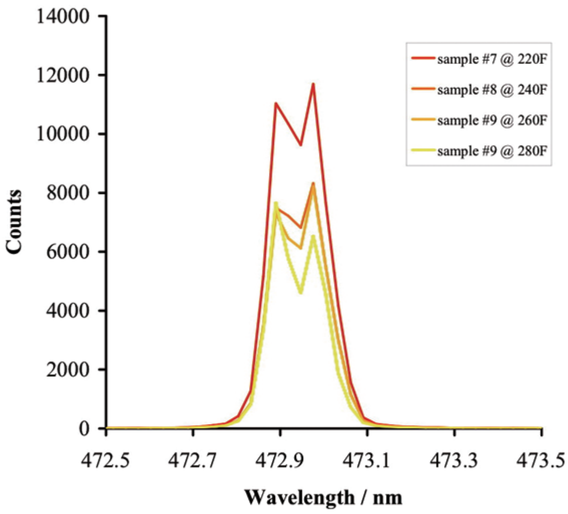

Fig. 7. A spectrogram illustrating Santilli NIS at intermediate air temperature predicted in Refs [2–5]. Additional NIS spectrograms are available in Refs [12,13].

we first measured and recorded the wavelength of the laser light when the pipe was at pressure and at about 130°F ≈ 54°C; we then emptied the pipe as rapidly as permitted by safety; and a vacuum in it; and we measured and recorded the wavelength of the laser light propagating under vacuum.

Comparison of the two wavelengths provided systematic, repeatable and measurable shifts of the blue laser light to the left, thus characterizing a blueshift. Since the shift occurs without any relative motion between the laser, the air and the analyzer, the measurements provide systematic, repeatable and measurable confirmations of the existence of Santilli IBS. A representative IBS spectrogram is presented in Figs 5 and 6, while various additional IBS spectrograms are available from Ref. [13]. A film on the measurements can be viewed from the link of Ref. [9].

We have also done a third type of measurements as follow. We first measured an IRS with the pipe at pressure and at the indicated low temperature. We then kept the pipe at pressure, and waited until the pipe was exposed to the Sun to achieve maximal temperature while continuously monitoring and recording the wavelength of the laser light. During these measurements, we have seen the wavelength changing from the IRS to the IBS, thus necessarily passing through the null value of the isoshift. These measurements confirm Santilli NIS, in which the energy lost by light to air is balance by the energy released by air to light resulting in no measurable shift. Figure 8 shows a representative spectrogram of NIS while Fig. 9 presents the plot of Santilli IS with the increase of the temperature while keeping the pressure constant, thus showing the transition from the IRS to the IBS with the necessary passage through the NIS.

The measurements of NIS at temperatures intermediate between 70°F ≈ 21°C and 130°F ≈ 54°C are important to prevent possible erroneous "disproofs" of Santilli's IS in an evident attempt of maintaining the validity Einsteinian theories in our atmosphere, which "disproofs", under the indicated conditions, would be quickly dismissed and denounced by experts in the field.

5. Scattering and IsoRedShift in the colors of our atmosphere

Following thirty years of mathematical, theoretical and experimental research, Santilli; i [5] has studied the following problems: I) the "redness" of the atmosphere "surrounding" the Sun at Sunset; 2) The

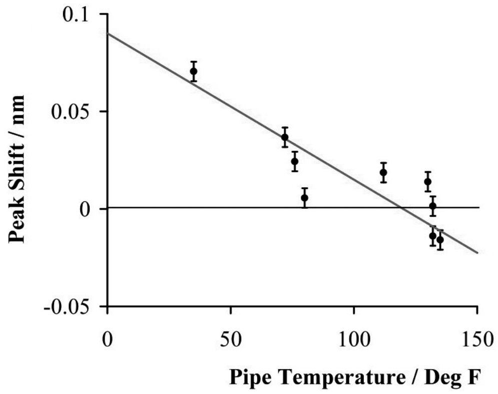

Fig. 8. A plot of the dependence of Santilli's IsoShift a function of the air temperature while keeping the pressure constant. This plot confirms the existence of Santilli NIS since, with the increase of the temperature, IRS can solely turn into IBS by passing through NIS. Additional plots are available in Ref. [12,13].

Fig. 9. A picture from Ref. [5] depicting the same beach at the horizon, the left picture depicting a blue atmosphere during the day, and the right picture depicting the same atmosphere now red at Sunset. Santilli [5] has shown that this color shift can only be quantitatively represented via the IRS, since red is absorbed during the relatively short travel of light in our atmosphere during the day, as established by the picture on left. Consequently, redlight cannot possibly reach us following the much longer travel at the horizon. Hence, the red color at right can only be blue light IsoRedShifted to red.

"redshift" of "direct" Sunlight in the transition from the Zenith to the horizon; and 3) The "redshift" of the color of the atmosphere at the horizon from blue during the daytime to red at Sunset.

5.1. Problem 1 [5]: "Redness" of the atmosphere at sunset

Santilli evidently confirms that the redness of the atmosphere at Sunset is due indeed to scattering, since, scattering is the origin of the very colors of our atmosphere. More specifically, Santilli points out that, since our atmosphere is gaseous, its color is evidence that scattering is characterizing light continuously bounding off one and another air molecule, resulting in the typical "zig-zag" trajectory which is inherent in the very definition of scatter. Consequently, in the absence of scattering, or in the event scattering would occur along a straight line, our sky would be black both during the day and night.

The separate issue of the origin of the red light scattering at sunset is addressed in Problem 3 below, and the popular belief that scattering itself causes redshift of light is dismissed theoretically and experimentally in the next section,

5.2. Problem 2 [5]: "Redshift" of sunlight from the zenith to the horizon

When passing to the study of the separate problem of the redness of the atmosphere surrounding the Sun at Sunset (which is often deceptively confused with that of the atmosphere surrounding the Sun), Santilli dismisses scattering as the origin of the redness (see, e.g., Refs [15–21] on various counts, such as:

1) Scattering cannot occur along a straight line for all frequencies, as well known;
2) Scattering cannot possibly generate a redshift of the entire Solar spectrum, as also well known;
3) The scattering origin of the redshift of "direct" Sunlight at Sunset is a theoretical conjecture without experimental verifications, thus mandating the conduction of Experiment III, Ref. [2b], page 330 reviewed in Section 1.

Of course, Santilli confirms the existence of scattering for a percentage of direct Sunlight because that scattering is the origin of the dimming of Sunlight at the horizon, besides being necessary to explain the color of the atmosphere at Sunset. In fact, as noted above, without such a scattering, the sky would be black at Sunset. Consequently, the very fact that the atmosphere at Sunset has a color is confirmation of the existence of the scattering of a percentage of direct Sunlight at Sunset which scattered light is dispersed throughout the atmosphere. The same color of the atmosphere at Sunset is then clear evidence that scattering is caused by "zig-zag" trajectories of light in air, thus prohibiting the interpretation of scattering as being the physical origin of the redness of "direct" Sunlight at Sunset.

Since (as indicated in Section 3) physics laboratories around the world refused even the consideration, let alone the conduction of the indicated Experiment III, and since he consequently lacked the astrophysical equipment to measure the expected IRS of direct Sunlight from the Zenith to the horizon, Santilli constructed the IsoShift Testing Station and measured in this way for the first time the existence of the IRS in air.

To prevent possible misinterpretations, Santilli pointed out that the experimental detection of the IRS in the pipe filled up with air necessarily implies the existence of IRS for Sunlight at Sunset. In fact, by prorating the measured IRS in the pipe to the travel of direct Sunlight at Sunset, he achieved the first known *numerical* representation of the redness of the Sun at Sunset, as well as its increase with the decrease (increase) of the elevation (travel in air) [5].

As indicated earlier, Santilli was not able to conduct measurements of direct Sunlighgt at Sunset due to the lack of the necessary equipment [5]. The necessary equipment has now been identified and the first apparent experimental confirmation of the IRS of Sunlightr at Sunset is presented in paper [10] jointly with expected cosmological implications (see also the lecture availa ble from the link of Ref. [11]).

5.3. Problem 3 [5]: "Redshift" of the atmosphere from blue to red

Santilli additionally addressed the changing of color of our atmosphere at the horizon, from blue during the day to red at Sunset, and concluded that the only quantitative, experimentally verified origin is that of the IRS of blue light into red. The trajectory of light when the Sun is at the Zenith can be assumed to be of the order of 260 000 ft $\approx$ 80 000 m, while the trajectory of light at the horizon is of the order of 23 000 000 ft $\approx$ 7 000 000 m (beyond which values absorption and scattering effects are ignorable). Therefore, the trajectory of light at Sunset is about 88 times bigger than that when the Sun is at the Zenith.

According to clear experimental evidence (confirmed with the behavior in other media such as seawater), the absorption of light in a transparent medium is proportional to the wavelength, thus occurring predominantly for red light. This law is established beyond doubt by the fact that the blue color of our atmosphere during the day, including the atmosphere at the horizon (Fig. 11).

Santilli's argument is the following [5]. Recall the visual experimental evidence that red light cannot reach us during the day when Sun is at the zenith and, therefore, light covers a distance of about 49 mi $\approx$ 80 km. The trajectory of Sunlight at the horizon, that is, along a trajectory tangent to Earth, is of of the order of 4 356 mi $\approx$ 7 000 km (given by Earth's radius 3,968 mi $\approx$ 6,384 km plus the atmosphere along said tangent).

The above data constitute incontrovertible evidence that red light cannot possibly reach us at Sunset. In fact, red light does not reach us already for the shortest possible travel of 49 mi $\approx$ 80 km. Consequently, red light cannot, Consequently, red light cannot possibly reach us for the much longer trajectory of 4 356 mi $\approx$ 7 000 km, namely for a trajectory which is about 875 times longer.

The above evidence confirms quite forcefully Santilli's argument [5] that the redness of the atmosphere "surrounding" the Sun at Sunset is an additional evidence of the IRS, since it can only be constituted by blue light shifted to red following a trajectory of about 4 356 mi $\approx$ 7 000 km.

In summary, the only experimentally established physical law remains the proportionality of the absorption with the wavelength for light propagating in a medium, while the popularly belief that scattering causes redshift [15–21] is dismissed theoretically and experimentally in the next sections.

6. "Falsification" of scattering as the origin of frequency shifts

Immediately following the discovery in 1929 by Edwin Hubble [22] and others of the cosmological redshift, Fritz Zwicky [23] and others submitted the hypothesis of the "tired light", according to which the cosmological redshift is due to loss of energy $E - h\nu$ by light scattering in intergalactic gases during the long travel to reach Earth.

Despite qualified supporters (such as Hubble., de Broglie, Fermi, et cla), *Zwicky's hypothesis of the scattering origin of the cosmological redshift was "falsified" [24] in favor of the Einsteinian interpretation with the assumption of the exact validity of Doppler's law in intergalactic spaces and the consequential expansion of the universe.* This historical "falsification" was based on various grounds, such as [*loc. cit.*]:

1) Scattering cannot occur along straight lines for all frequencies since, by definition, light "scatters" in all directions while our view of galaxies is direct;
2) The cosmological redshift occurs for all frequencies, thus preventing a quantitative representation via scattering since the latter is generally believed to occur for only one frequency per a given gas; and
3) Scattering would dim direct view of galaxies to such an extent to render them invisible to us for sufficiently large distances.

Additionally, we should recall that recent measurements via the Hubble Space Telescope have ruled out the "Tired Light" hypothesis at a significance level of better than 10 sigma. the authors agree on this conclusion, namely that scattering cannot possibly provide a consistent explanation of the cosmological redshift.

As recalled in the preceding section, when passing to the redness of Sunlight at Sunset, the scattering origin has been widely assumed for the evident intent of preserving the Einsteinian interpretation despite the absence of relative motion between Sun and Earth. With the passing of time, the scattering origin of the redness of the Sun at Sunset has been brought to highly sophisticated theoretical treatments [15–21]. We hereby contend that *the arguments used for the "falsification" of the scattering origin of the cosmological redshift must be identically applied, for scientific consistency, for the "falsification" of the scattering origin of the redness of Sunlight at Sunset.*

It should be recalled that, from a spectrographic viewpoint, the cosmological redshift and the redness of Sunlight at Sunset are equivalent in the sense that,m in both cases, we have the shift of the entire visible spectrum toward the red. Nevertheless, for the case of the cosmological redshift (where we have no visual evdience of relative motion) the scattering origin is dismissed to maintain Einsteinian theories at intergalactic distance. By contrast, quite significantly, for the case of the redness of Sunlight at Sunset (where we have indeed visual evdience of the absence of relative motion) the scattering origin is almost universally accepted for the same objective as the preceding one, to maintain the validity of special relativity within our atmosphere.

The mathematical and theoretical resolution of this blatant difference has been provided years ago by Santilli [2b] by reducing both events to the same physical laws, mutation of the Minkowskian spacetine caused by energy (or gases) and consequential IRS. Experimental confirmations are presented in the adjoining paper [10].

In closing, to prevent easily predictable misrepresentations, we recall the dramatic structural difference between Zwicky's tired light and Santilli IRS identified in details in Ref. [5]. The Zwicky's hypothesis implies the exact validity of special relativity in intergalactic spaces as inherent in the very scattering of light. By contrast, Santilli's IRS is based on a structural generalization of spacetime itself caused by the presence of energy at large, or matter in particular, with consequential structural generalization of the Minkowski spacetime, its symmetry and special relativity.

7. Experimental confirmation of the absence of frequency shift for the scattering of light in gases

Additionally, we should recall (as indicated in the preceding section) that *the conjecture on the scattering origin of the redness of Sunlight at Sunset has no experimental verification, thus being a purely theoretical conjecture intended to maintain the Einsteinian interpretation of the redness despite the absence of relative motion.*

The conjecture that scattering causes redshift has been dismissed by Santilli [5] on theoretical grounds. As it is well known, the Doppler redshift requires the motion of scattering molecules away from the light source. However, Boltzmann's distribution in a gas requires a statistically equal number of gas molecules moving *away and toward* the light source. Consequently, Santilli argues that *the hypothetical redshift of light caused by scattering with a given molecule is balanced by an equal but opposite blueshift of light hitting another molecule, resulting in the prediction that scattering of light in a gas causes no frequency shift at all* (except for minor spreads here ignored).

In view of the plausibility of the above theoretical arguments, we here report, apparently for the first time, measurements confirming Santilli's dismissal ofredshift in scattering. In July 2011, we used the same blue laser light and the same analyzer used in the measurements of IRS, IBS and NIS presented in Section 3, the laser and analyzer being at about 70°F $\approx$ 21°C. We then sent the blue laser light against a mirror given by polished aluminum plate, and recorded as well as analyzed the reflected light.

Subsequently, by using the same experimental set up, we increased the temperature of the mirror with a torch placed in the back of the aluminum plate; we detected and recorded the wavelength for the temperature increase from 70°F $\approx$ 21°C to 280°F $\approx$ 137°C; and established the *absence in the reflection of light on a mirror of any frequency shift, both at ambient as well as increasing temperatures.*

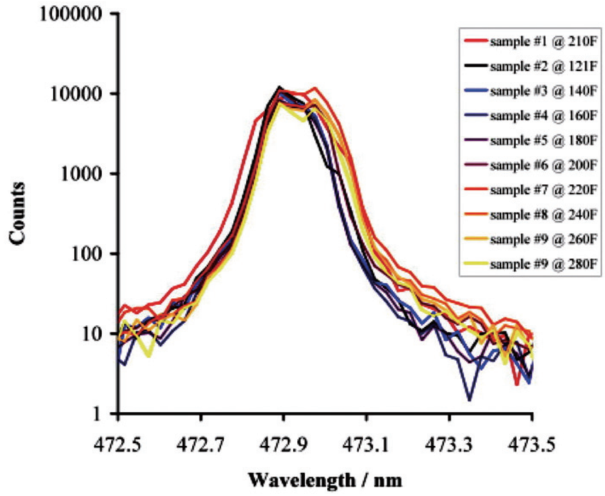

Fig. 10. A plot of the same blue laser light used in the IRS-IBS-NIS tests of Section 3 when reflected from a metal mirror showing no frequency shift in the temperature range from ambient to 280°F $\approx 137^\circ$C Subject to independent verifications, these measurements confirms Santilli's additional view [5] that scattering produces no frequency shift. Additional data are available in Ref. [14].

The above measurements were repeated various times to established that the results are systematic, repeatable and measurable. A representative spectrogram showing the superposition of the wavelength at increasing temperatures is presented in Fig. 10, while various additional spectrograms are available from Ref. [14].

The above results provide clear experimental support for the absence of redshift in the scattering of light in a gas because, once we eliminate from Boltzmann distribution the redshift contribution from the relative motion between the gas molecules and the light source, we solely remain with the possibility that light loses energy at the time of impact with a gas molecule. The latter possibility is excluded by our measurements on the reflection of light in a mirror, thus completing the "falsification" of scattering as the origin of the redshift, not only for galaxies, but also for Sunlight at Sunset.

8. Experimental confirmation of santilli IsoRedShift interpretation of the large redshift differences in quasars and their associated galaxies

We finally address the physical origin of the large difference in cosmological redshifts between Arp's [25] quasars and their galaxies when physically connected according to clear gamma spectroscopic evidence (Fig. 11). This important astrophysical discovery clearly indicates the existence in the universe of conditions violating Einstein's special relativity because its axiom for the Doppler shift law would require that the quasars and the associated galaxy had to be separated billions of years ago and move away from Earth at very different speeds.

It may be important to indicate that two different lines of research have been developed in the field that can be summarized as follows:

Arp's Reconciliation with special relativity. This line of research promoted by H. Arp and his associates is essentially based on the assumption that scattering of light is the origin of the dramatic differences in cosmological redshifts between the quasars and their associated galaxies inferred from

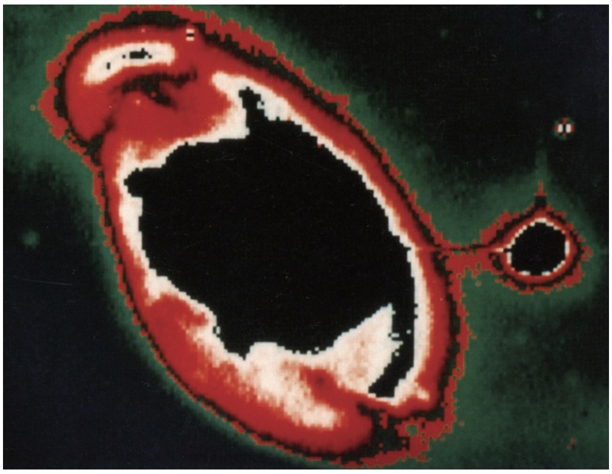

Fig. 11. A view of the historical discovery by Halton Arp [25] in the 1970s of certain quasars that are physically connected to associated galaxies according to clear gamma spectroscopic evidence, while their cosmological redshifts are dramatically different, in visible violation of special relativity. This discovery was instrumental for Santilli's view that special relativity is violated within physical media such as the large quasar chromospheres as well as the less dense yet equally significant gaseous media inside galaxies. In Ref. [2b] of 1991, Santilli provided a numerically exact representation of said large differences in cosmological redshifts via his IRS which remains fully valid to this day.

the dramatic differences between the dense quasar chromospheres as compared to the dramatically less dense media inside galaxies.

Santilli's Violation of special relativity. This line of research promoted by Santilli and his associates (see, e.g., Ref. [26]) is based on structural departures from special relativity caused by the media inside the quasars and their associated galaxies. Said large differences in cosmological redshifts are then due to the large differences in Santilli's IRS for the related physical media.

It is hoped the reader can see that the various measurements presented in this paper, including the "falsification" of the scattering conjecture, exclude Arp's view on numerous grounds, such as: the scattering inability to represent the entire spectra of cosmological redshifts of the associated quasars and galaxies (since scattering would essentially restrict the spectra to red); the inability to see sufficiently far away associated quasars and galaxies' the experimental dismissal of scattering as capable of providing redshift presented in the preceding section; and other reasons.

In particular, Santilli views the large differences in cosmological redshift of Arp's quasars and associated galaxies as measurements supporting the central notions of isorelativity, such as: the need for representing light as an electromagnetic wave propagated by the ether; the mutation of the Minkowskian spacetine into the universal invariant (1) caused by the presence of energy; the related universal LPS isosymmetry; and its consequential isoaxioms.

Needless to say, alternative interpretations remain possible via Raman effects and other mechanics, as presented, e.g., in Refs [15–21]) although, to achieve scientific maturity, they shoudl be subjected to the currenbtly missing systematic measurements and the results confronted with the experimental results of Refs [5,6] and of this paper.

9. Concluding remarks

In this paper, we have presented various spectrographic measurements that confirm the existence of Santilli's hypothesis of anomalous redshift (blueshift) of light propagating within a gaseous medium at sufficiently low (high) temperature without any relative motion between the source, the medium and the observer, with the understanding that the identification of the accurate numerical values of the indicated anomalous frequency shifts, and related errors, are deferred to independent more accurate measurements solicited since Section 3.

The most important consequence of our measurements is a confirmation of Santilli's most fundamental hypothesis first verified in Refs [5,6], namely, the presence of a medium causes a mutation of the Minkowski spacetime into Santilli's iso-Minkowskian spacetime with basic isoinvariant (1) [1,4,7], and consequential unique and unambiguous characterization of Lorentz-Poincaré-Santilli isosymmetry and ensuing isorelativity [1–3]. It is appropriate to recall here Santilli's view according to which [5]: *It is not possible to alter any characteristic of light without an underlying mutation of spacetime and, vice versa, any mutation of spacetime causes an alteration of at least some of the characteristics of light.*

The implications of these advances are evidently far reaching for all possible treatments of dynamical problems within physical media [3]. For instance, the most insidious insufficiency of conventional scattering interpretations of the color of our atmosphere [15–21] is that the above experimental evdience voids the very basic Minkowskian spacetime in which that are formulated, let alone prevents the accuracy of their predictions. More broadly, it is possible that theoretical advances [1–3] and their experimental verifications in ref. [5,6] and in this paper may one day signal the birth of a new technology achieving the control of the characteristics of electromagnetic waves in a way comparable to our current control of sound waves.

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