The Case of the Fifth, Non-Local Dimension - Unveiled by Fundamentals of Light-Matter Interactions. *

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Abstract

The Planck thermal distribution, the Schroedinger equation, and Maxwell's equations are recast into forms encoded for by a geometrical framework characterized by an inherent line increment and a quantitative formulation of the concept of non-locality. The line increment can be solved numerically from the Bohr atom in the ground state, yielding $7.714 \times 10^{-27}/m$ corresponding 71.36 km/second/Mparsec, in good agreement with astronomical observations of local objects. As a result, the Planck length can be factorized and the detailed physical mechanisms encoded for by the Planck distribution and the Schrödinger equation can be evaluated, revealing circular electric current and magnetic components. The factorization of Planck's constant leaves the quantum concept somewhat vulnerable and this is further pursued by evaluating how the chosen geometrical framework may encode some physical processes hidden in Maxwell's equations. It is found that while the signal is emitted from the local frame of observation it is absorbed by the non-local observer (in the wavefront-electron cloud) in a process mediated by a Lorentz transformation between the frames. The non-local observer resides at the wave node where the curls are maximal and sees the perpendicular field components delayed and phase-shifted because of an aberration effect encoded by the geometry as the velocities become relativistic. A complementary observer in the field sees the reverse effects so that the contributions from any to or fro velocity is canceled around a phase shift of pi/4 where c=1 in the non-local frame. Hence, the light retains its wave properties until it is absorbed which allows an easy interpretation of multi-photon absorption, 'quantum-fraction' sub-cycle absorption, field-momentum transformation, and self-lasing. Finally, it is discussed how the proposed geometrical framework may provide a platform for a new perspective on some additional physics phenomena like vacuum fluctuations, thermal agitation and large scale cosmology.

1 Introduction

On the one hand, Planck's constant, unquestioned and untouched for more than 100 years still delivers the mystique of the discrete quantum word and on the other, Special Relativity theory (SR) institutionalized and dubbed as *the* 'natural' geometry provides an instrument with which many physical process in deed have been dissected and analyzed. Does the success of these concepts prove that they provide the ultimate description of the phenomena to which they apply? Not so if one could replace the quantum mystique with a concrete physical mechanism and exchange the stand-alone geometry of SR for a geometry that *encodes* physical processes. How to do this is the subject of the present paper. One must first realize that if there are laws in Nature, then any geometry should reflect these laws in one way or another but a geometry that encodes the physical processes has the chance of promoting a better understanding of the world. The current intellectual environment in physics is that the Planck constant underpins the energy-level picture of thermal radiation turned into the photon-particle concept whereas SR underpins General Relativity theory (GR) and the latter's extension into various tremendously complicated theoretical constructs such as, for example, the untouchable 'dark matter'.

This development is not satisfactory from the point of view of the present paper. SR was developed in the beginning of the 20th century from the Cartesian coordinate system by adapting it to the maximal velocity of light in vacuum, so it can be regarded primarily as a correction to the 3-dimensional space thought at that time to represent the real world. SR leads to many concepts that are not physical processes. For example, neither time nor space are physical processes although they appear in the four-vector concept which is of central importance in SR. If one is looking for a geometry that truly encodes real physical processes one should not ignore that real space-time comes with a line increment, the local apparent Hubble expansion rate. The apparent cosmological expansion was not known at the time SR was discovered and was soon given a mechanistic interpretation generally believed to be true even today.

Another feature of real space-time is its non-local features evident in may electromagnetic phenomena and also in the so called 'matter waves'. The non-locality of some physics phenomena has been much discussed over the past 100 years and early descriptions of it were ferociously attacked by the early founders of SR. The sentiment was then, and still is, that non-locality violates the idea (the pillar to make or break both SR and GR) that nothing can be transmitted faster than light. Knighted by the worry of the early founders of SR and GR that their theories might be wrong, because of accumulating evidence of non-local phenomena in physics, a theory of such phenomena is long over-due.

The first step towards this aim, pursued for a little less than 20 years by the author, is actually a step backwards, namely to admit the existence of only one spatial dimension along the line of sight, which makes the remaining two perpendicular spatial dimensions non-local by reference to this one dimension. One can then accept the concept of non-locality intuitively and one will also be able to admit that a simple Lorentz transformation from the non-local (perpendicular) frame to the local one encodes communication between two space-like separated observers of a kind entirely different from the signal and its velocity. Before demonstrating in detail how Nature has employed a single dimension to out-smart the early founders of modern physics consider how such a perspective can be justified scientifically.

In the first place, this might be the way that the primordial atom sees the world since it is forced (by its electron-wave function) to either ignore the signal or absorb it in a discrete all-or-none fashion. It is unable to negotiate an angle for the momentum transfer to a higher quantum level except through probabilities that depend on the incident angle of the radiation. Thus, in a classical quantum transfer the received momentum counts as 'head-on' irrespective of angle. Furthermore, from a mathematical point of view, starting with a more complex system, like 3-D, without having defined how to arrive at it (or whether building on the outset axioms serves any purpose at all) is not the proper way to go. That has recently been shown in the theory of infinities an infinitesimals where numerals even in excess of 1, 2 and 'many' are the cause of stumbling [1]. Infinities are implicit in cosmology and consequently expected in the real world so why not just keep what can be measured during an interval of time, say between $t = -1$ and $t = 0$ and leave the rest to be undetermined and non-local. That should be the way an atom sees the world anyway as argued above and it should also be the easiest possible way for the universe to materialize from primordial hydrogen atoms. However, from the privileged position of an observer aware of a 3-dimensional world it is permitted to poke into various physical processes and determine that for many of them the three spatial dimensions are not equal in the sense that they carry different physical processes. This is particularly striking in the case of electromagnetic radiation the spatial source of which can be identified along the line of sight whereas its electric and magnetic fields are perpendicular to the line of sight and, *non-local* in the wavefront as shown by double-slit interference experiments. Hence, even if there are three spatial dimensions they are not equivalent from the perspective of the signals carrying information about them. Realizing this, one has the choice of either admitting the possibility that the signal adapts to an inherent asymmetry-anisotropy in the non-equivalent spatial dimensions of the world or else, hang on to the textbook SR-dogma of observer equivalence in the spatial coordinates.

In the present paper, these ideas will be made quantitative based on the Planck distribution, the Schrödinger equation, the apparent Hubble expansion rate and Maxwell's equations, addressing many hitherto unsolved problems as well as raising new questions. However, before embedding these centenaries in one and the same encoding geometry consider the half-philosophical issue of whether or not the world is enriched by admitting only one spatial dimension: One concludes that from the perspective of one dimension only, there must exist another perpendicular dimension the contents of which can not be localized by reference to the one known dimension. Those who like many dimensions can now go on and say that for each by us known three spatial dimensions there exists a non-local dimension, yielding with time altogether 7 dimensions that are intuitively acceptable without any mathematics whatsoever. In the present theory though it suffices to acknowledge one 'fifth' non-local dimension in addition to the three known spatial dimensions and time. This non-local dimension harboring the wavefront will be given a quantitative formulation based on Maxwell's equations. From the perspective of one spatial dimension only it is intuitively acceptable that time not can be grasped since anything perpendicular to one dimension is non-local and so is time as will be explained. Therefore one must conclude that the world is considerably enriched and made better understood by admitting one spatial dimension only, even before exploring the metaphysical and philosophical implications of such an amendment to the Galilean mechanistic world picture. It is now time to proceed to the details.

2 The Abstract Geometry

Like before, e.g. [2] [3] [4] [5], define two observers connected by Lorentz transformations at two instants of time, $\bar{t} = -1$ and $\bar{t} = 0$ in the barred frame thus defining a time interval $\overline{\Delta t} = 1$ in that frame which will be seen to accommodate local physical processes.

$$(q_0, t_0) = \left(\frac{\sqrt{1-\frac{v^2}{c^2}}}{v} \frac{m^2}{s}, 0 \right); \qquad (\bar{q}_0, \bar{t}_0) = \left(\frac{1}{v} \frac{m^2}{s}, -s \right) \tag{1}$$

$$(q_r, t_r) = \left(\frac{\sqrt{1-\frac{v^2}{c^2}}}{v} \frac{m^2}{s}, s\sqrt{1-\frac{v^2}{c^2}} \right); \qquad (\bar{q}_r, \bar{t}_r) = \left(\frac{1}{v} \frac{m^2}{s} - vs, 0 \right) \tag{2}$$

$$\overline{\Delta q} = -vs \ , \qquad \overline{\Delta t} = \bar{t}_r - \bar{t}_0 = s \quad \Rightarrow \frac{\overline{\Delta q}}{\overline{\Delta t}} = -v \tag{3}$$

$$\Delta q = 0 \ , \qquad \Delta t = t_r - t_0 = s\sqrt{1-\frac{v^2}{c^2}} \quad . \tag{4}$$

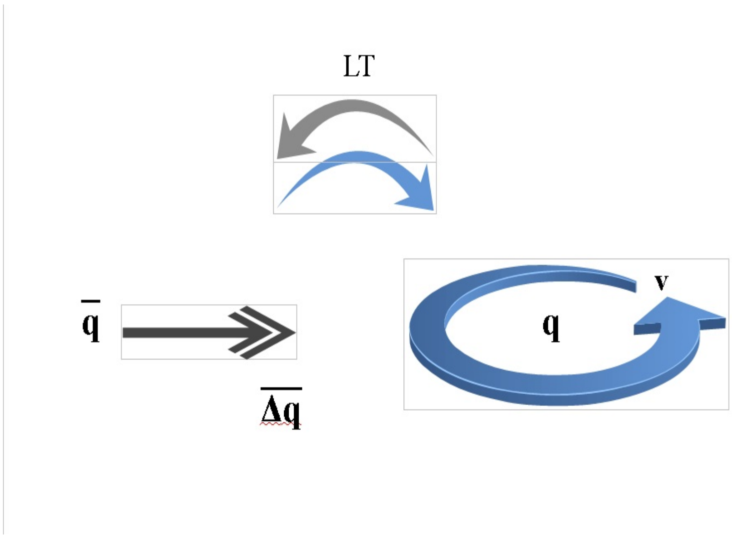

Figure 1: Schematic illustration of the geometrical context of the local observer (left) who sees line increments, momentum, along the line of sight, and of the non-local observer (right) who infers a tangential velocity. The two observers' coordinates are connected by Lorentz transformations (LT)

with

$$\overline{\Delta q} = \frac{-m^2}{\overline{q}} \quad . \tag{5}$$

Here, m is the unit of length, s the geometrized unit of time and $m/s = c = 1$ [1]. This system of equations defines two observers, one located at the origin (un-barred) and the other at radius distance from the origin (barred observer). The latter observer is capable of observing line increments per unit time along the momentum axis, $\overline{\Delta q}$, while the observer at the origin only is aware of time and recognizes a tangential velocity v. Therefore, the un-barred observer at the origin is non-local as judged by the barred observer, which is trivial considering that the frames are perpendicular and the local observer only sees in one direction. The space-like separation of all space and time -coordinates [3] also supports the notion that the observers are non-local by reference to each other.

The two observers are related by Lorentz transformations like in SR, distinguished from SR however by the absence of spatial measurements in one frame of observation ($\Delta q = 0$ in eq. 4). Spatial measurements are redundant or even 'nonphysical' in a non-local frame of observation harboring fields and waves that have not yet been 'observed' in the sense of quantum physics. This geometry can be schematically illustrated as in Fig. 1. As will be seen, the Lorentz transformations, previously known as a mere mathematical tool employed in adapting the Galilean 3-space to the maximal velocity of light, now acquire a physically manifest role in the interplay between the local and the non-local frames of observation.

From

$${q_r}^2 + \frac{1}{c^2}\frac{m^4}{s^2} = \frac{1}{v^2}\frac{m^4}{s^2} = \overline{q_r}^2 \quad \Rightarrow \quad \left(\frac{\Delta t}{s}\right)^2 + \left(\frac{\overline{\Delta q}}{m}\right)^2 = 1 \tag{6}$$

[1] using non-standard notation, s replacing m, for the purpose of distinguishing the two units

TABLE I A-D

1-D Local $[\overline{\ }]$	1-D Non-Local $[\tilde{\ }]$
Length [m]	Time [s], Velocity [m/s]
Momentum [p]	Mass [kg]
Magnetic Charge $[\overline{C}]$; $ec/2\alpha$	Electric Charge, Polarization [C]
Power [W]	Force [N]
Scalar Potential [V]	Vector Potential [**A**]
Electrical Resistance [Ω]	Light's Velocity [c]

Table I A. Frame assignment of some physical units to the local and the non-local observer according to theory. Here, the dimension appears as if in the numerator (above the unit symbol).

$(1\text{-D})^{-1}$ Local $[_{-}]$ **or** $_{\sim}\ _{\sim}$	$(1\text{-D})^{-1}$ Non-Local $[_{\sim}]$
Magnetic field (H) $A/\overline{m}$	
Intensity $(\overline{V}A/\overline{m}\ \overline{m})$	
Poynting vector $(\overline{W}/\overline{m}\ \overline{m})$ Wave number $(2\pi/\overline{\lambda})$	Frequency Hz

Table I B. Frame assignment of some physical units to the local and the non-local observer according to theory. Here, the dimension appears inverse as if in the denominator. Eq. 7 allows two non-local terms to form one local term (left column)

Dimension-Less or Converting Units
Acceleration $(\overline{m}/\widetilde{s}\ \widetilde{s})$
Local Intensity $\overline{c^2}\ (\ _{\sim}I\ _{\sim}) \quad \leftrightarrow \quad (\overline{c^2}\ \overline{V}A/\overline{m}\ \overline{m})$
Current $(A = \widetilde{C}/\widetilde{s})$
Electric Field Strength $(\overline{V}/\overline{m})$
Electric Field Strength $(\widetilde{\delta\mathbf{A}}/\widetilde{\delta t})$

Table I C. Frame assignment of some dimension-less physical units where Eq. 7 leads to canceling of the dimensionality contributed by the factors. Entities with composite unit assignment are capable of converting between local and non-local frames.

Examples of Multi-Dimensional Units
Energy J $= (\overline{m}\ \overline{m}\ \widetilde{kg}/\widetilde{s}\ \widetilde{s}) \quad [^{-}\,_{\sim}{}^{-}] = [^{\sim}\ ^{\sim}\ ^{\sim}]$
Force N $= \overline{m}\ \widetilde{kg}\ /\widetilde{s}\ \widetilde{s} \quad [\overline{\sim}] = [^{\sim}]$ (force field)
Pressure Pa $= \widetilde{kg}/\overline{m}\ \widetilde{s}\ \widetilde{s} = [_{-}\ _{\sim}][_{\sim}\ _{\sim}\ _{\sim}]$

Table I D. Examples of multi-dimensional units that can be interpreted with the help of eq. 7

by analogy with the unit circle, $(cos\ x)^2 + (sin\ x)^2 = 1$, the line increment in the local frame and the time-interval in the non-local frame are perpendicular. Hence, time is a property of the non-local frame and runs parallel with the tangential velocity. The continuous process of circulation around the origin with a characteristic time scale for each process can then be thought of as chopping off oscillating discrete line increments. Eq. 3 right side, which tells that some factors in the local frame are numerically equal to other factors in the non-local frame, provides the key to physical applications of the geometry. Namely, if local terms are kept barred, a tilde is used for non-local terms, and one introduces the following counting rules for dimensionality transitions between the local and non-local frames (to be verified),

$$\overline{A} = \overline{BC} = \widetilde{B}\ \widetilde{C} \quad , \qquad \frac{\overline{A}}{\widetilde{\overline{B}}} = \widetilde{C} \quad , \tag{7}$$

then length, L, time, t, velocity, v, momentum, p and mass, M, are identified as being assigned to the local and non-local frames as

$$\frac{\overline{L}}{\widetilde{\overline{t}}} = \widetilde{v}; \qquad \overline{p} = \widetilde{M}\ \widetilde{v} \quad \Rightarrow \overline{m}, \quad \widetilde{s}, \quad \widetilde{kg}. \tag{8}$$

where the dimensionality of the units are shown to the right. 'kg' is the SI unit of kilogram whereas 's' is the geometrized unit of time (non-standard notation, m is 'meter' not mass). Since momentum and length have the same dimensionality the geometry accommodates that real (cosmological) space comes with a line increment per unit length and unit time (eq. 3, left side). The line increment can thus be regarded as a kind of momentum in the local frame provided by the circulation (curl) in the non-local frame. From eq. 8 above one can proceed and use the standard SI-units as defined in common text-books (e.g. ref. [6] to give frame assignment to all physical units. This is exemplified in Table I A-D.

One is then able to tell, not only in which of the frames the units belong, but also to evaluate if they mediate processes involving both frames as might be the case for assignments with composite dimensions. This will be exemplified later based on 'acceleration' and the 'intensity' of electromagnetic radiation. *A priori*, any composite frame assignment of a physical unit or constant might require special attention regarding how to interpret its possible meaning in the present geometry. 'Energy' and 'Pressure' provide two examples that verify the counting rules of eq. 7 since they both appear as non-local in three dimensions, which agrees with classical physics and intuition. Putting charge into the non-local frame agrees with the electron cloud concept of quantum mechanics where the electron is hidden from sight until any moment its location is probed. The electron also has a mass which makes the frame assignment of its SI-unit, kg, appear natural. Non-locality of mass is well established in the case of matter waves. At the macroscopic level mass is measured with a balance and should not be confused with gravitational pull. Non-locality of mass is also inferred in the case of atom-nucleus-shells and rotating black hole layers, or at any other level such as the solar system where the centrifugal and centripetal forces act as a balance and the celestial bodies perpetually evade the line of sight. In a similar fashion any force with its counter-force acts as a balance, which makes the assignment of force to the non-local frame intuitively acceptable too (as would be the case for a 'field' of force). However, the frame assignment of time leads to a revision of classical thinking as already hinted at in the case of SR, where the relativistic time dilatation originally emerged out of necessity by implementing the Fitzgerald length contraction to one *local* dimension. The concept of a visible relativistic length contraction in the local frame has since been shown to be dubious [7] [8] (see also [9]). I the present geometry though (eqs. 1 and 2), the length contraction is pushed into the non-local frame due to the latter's absence of spatial observations (line increments).

3 Introductory Implementations of the Geometry

Whereas time and momentum provided the key to the frame assignment of physical units eq. 3 (right side) provides the key to embedding known physical processes into the geometry. The equation tells that some processes in the local frame represented by the term $\overline{\Delta q}/s$ are numerically equal to some other processes in the non-local frame represented by the term v. How to equate physical entities then becomes constrained by the present geometry compared to algebraically adding, subtracting, multiplying and dividing at will on this or that side of the equal sign, which is the standard procedure in mathematical physics. Hence, the present geometry acts like a 'quasi-topological' framework for the physics with the potential to *encode* the actual processes taking place. After having rearranged the terms properly according to frame assignment one can start to look for how the terms *encode* the actual physical processes taking place. This is different from the classical algebraic 'equal-to' approach, slightly different from quantum physics where the measurement is important, and opposite to SR where the physics is instead adapted to the admittedly stand-alone type of geometry and analyzed in its context.

The cross product of the magnetic and electric fields of electromagnetic radiation, the so called 'Poynting vector' constitutes a classical example yielding results analogous to the present case,

$$\mathbf{S} = \mathbf{E} \times \mathbf{H} \tag{9}$$

Here, the rules of vector algebra establish that the vector $\mathbf{S}$ is perpendicular to $\mathbf{E}$ and $\mathbf{H}$ which are also mutually perpendicular. The Poynting vector has momentum character in the selected one dimension whereas the field components do not (cf. [10]). In the present case of eqs. 1 - 5 and Fig. 1 though, the momentum term is connected by a Lorentz transformation to the perpendicular term(s). Whereas eq. 9 is based on classical 3-space with 'connectivity' throughout by use of vector algebra, the 1-D momentum observer of Fig. 1 is unable to see the details of the perpendicular dimension inferred by the non-local observer. Use of the 'interval' defined in SR on the space and time coordinates also supports such a conclusion.

Evaluating the geometry of eqs. 1 - 5 in physics then amounts to collecting local terms on one side (to the left by the author's convention), non-local ones to the right of the 'equal-to' sign and mixed local-nonlocal terms together with any dimensionality-changing factors such that these latter transform back and forth between the two frames. With such a construction one has the possibility of a 'dual' world with transitions back and forth from non-local (non-existing) to local (existing) taking place every instant. Thermal radiation will be shown to constitute one such example of the non-existing sustaining the existing. Hiding away as many as possible non-local terms from the observer in one dimension also makes a good starting point if one wants to follow the mathematician's example [1] of starting from fundamentals (0, 1 and 'many'). In the following it will be shown that one can reach surprisingly far based on these ideas.

The importance of choosing geometrical framework for some physical process becomes apparent already at such an elementary level as the Galilean acceleration, $v = at \rightarrow L[m/s] = a[m/s^2]\ t[s]$, which is written here

$$L[m] = a[\frac{m}{s^2}]\ [s]\ t[s] \Rightarrow \overline{L} = a\widetilde{s}\widetilde{t} \tag{10}$$

.

Gone is now the derivative of velocity, a 17:th century mathematical construct, and acceleration instead appears as a mediator between the local and non-local frames, moving terms from the right side to the left, similarly to an 'operator' in modern physics.

From eq. 10 one can proceed to the simplest cosmology that can possibly be imagined by applying it to the apparent local Hubble expansion rate with $H_0 = \overline{\Delta q}/ms$,

$$1 = \frac{\overline{\Delta q}}{ms} t_u[s] \Rightarrow 1[m] = \frac{\overline{\Delta q}}{s} t[s] \Leftrightarrow 1[\frac{m}{s}] = \frac{\overline{\Delta q}}{s} t_u \tag{11}$$

By analogy with eq. 10 the time t_u (age of the universe) produces the velocity $1m/s$ ($= c$) seen by the matter in the local frame. The same result is obtained by assuming that the universe is equivalent at present time in each segment of unit length along the line of sight. Then the velocity $c = 1m/s$ obtained from eq. 3 by adding the line increments in consecutive units of length along the line of sight is a characteristic of the relativistic horizon at radius $m^2/\overline{\Delta q}$ where the local observer can measure it and conclude that the world exists. Eq. 11 encodes a physical process in as much as the observer is turned local by measuring the light signal as will be shown based on Maxwell's relativistic equations in Section 4. The same applies to any observer so any observer has an equivalent perception of the universe at this elementary level. This follows from the very constrained locality in eqs. 1 - 5 where basically only the line increment along one direction can be seen and everything else is non-local. It is more difficult to defend the observers' equivalence independently of location at a higher level, e.g. our 3-dimensional, apparently (by vector algebra) connected world where such observer equivalence is incompatible with astronomical observations [11]. This problem is avoided in SR-GR where observer equivalence has the mathematical meaning of invariance of physical laws irrespective of the observer's motion relative to the object studied. In the present geometry the local observer is always in its rest frame, which is the place of interest where the local matter is. Another benefit of keeping the cosmology at the elementary level of eq. 11 is that the transverse time axis, t_u, gives c as a function value so that the apparent age of objects emerges due to the limited velocity of light, which allows each object to keep its own characteristic time scale and its own rate of evolution independently of distance. Observer invariance on a time axis correlated with the length of sight then means that any unit length on the line of sight with its characteristic magnitude of its line increment can be contracted back to a unit length having a line increment equal to the local line increment at present time. -The observer equivalence herein only applies to present time in a rest frame anywhere in the universe. In standard cosmology the line increment is interpreted as a literal expansion of space traceable *via* its visibly moving astrophysical objects assumed to be evolving on a common cosmological time scale whereas in the present model the line increment is only a label characteristic of the distance, overlaid with observational distortions not yet fully understood whereby each object has its own time scale. Hence, there are subtle differences between a world everywhere connected in three or more dimensions and the one-dimensional world of eq. 11 where information about the apparent age of remote objects is provided *via* the limited velocity of light. Eq. 11 is perhaps an instance of the hen-and-egg problem, which one came first, which is solved by the 'evolution' of species and the evolution of the universe respectively. No law of nature dictates that the evolution of astrophysical objects proceeded on a global (everywhere equal) time scale for which reason the primordial atom, expected to be present anywhere on the line of sight, is the safest approach to define a time scale. This can be done by solving the line increment from the Bohr atom in the ground state:

$$a_0 = \frac{4\pi\epsilon_0}{e^2} \frac{\hbar^2}{M_e} \rightarrow \tag{12}$$

$$\Big(\frac{a_0 \alpha M_e}{\hbar}\Big) \Big[\frac{\sim}{{}_{-}}\Big] \Big(\frac{e^2}{4\pi\epsilon_0\alpha}\Big)\Big[\,{}^{-}\;\;{}^{-\sim}\Big] = \hbar\Big[\,{}^{-}\;\;{}^{-}\Big] \tag{13}$$

where the dimensions, taken from Table I or obtained by the counting rules of eq. 7, are indicated in square brackets after the terms. The left parenthesis is numerically equal to unity (geometrized units) and stricken out but leaves the dimension ${}^{\sim}/_{-}$, so from eq. 13:

$$\Big[\frac{\sim}{{}_{-}}\Big]\Big(\frac{\alpha}{\epsilon_0\pi c^2}\Big) \Big(\frac{e^2c^2}{4\alpha^2}\Big) = \hbar \tag{14}$$

where, because of charge invariance, the numerical value of c in the expression for magnetic charge, $ec/2\alpha$, is maintained (c is not geometrized here, that is). Then, since $\epsilon_0 = 1/\mu_0 c^2$, $\mu_0 = 4\pi \times 10^{-7} Henry/m$, $Henry = Joule/Ampere^2$ and in geometrized units $1J = 0.8261 \times 10^{-44} m$;

$$2.4113 \times 10^{-53} \Big(\frac{1}{Ampere^2} \frac{e^2 c^2}{4\alpha^2} \Big) = \hbar \tag{15}$$

from where a line increment is solved as

$$\overline{\Delta q} = \frac{\pi^2 \times 2.4113 \times 10^{-53}}{4} = 7.714 \times 10^{-27} \tag{16}$$

enabling, for the first time, a factorization of the Planck length [12] [**?**],

$$\sqrt{\hbar} = \overline{\Delta q}\; 2 \frac{ec}{2\alpha}\; \frac{1}{\pi\ Ampere} \quad . \tag{17}$$

By multiplying eq. 14 by a geometrized value of c one can avoid the composite dimensionality of the therein stricken out left parenthesis which then (by the factors αc) takes the form of Bohr radius times electron momentum divided by Planck's constant times c, a composite term that can be justified from the perspective of the Heisenberg uncertainty relations[2]. If so, the factor c, velocity of light, will appear on the right side of eq. 15 so the line increment will get dimension length per unit length per second (s) which agrees with the widely accepted dimension of Hubble's constant. The numerical value obtained, $7.714 \times 10^{-27} s^{-1}$ as in eq. 16, corresponds to 71.36 $km/second/Mparsec$ which fits very well with cosmological model-independent measurements based on local astrophysical objects [13] [14] [15]. Furthermore, the (plainly linear) inverse of the line increment yields the value 13.7 billion years for the universe's apparent age, which numerically agrees quite well with contemporary Standard Cosmology. As a result, one can safely conclude that the time scale of the universe is equivalent of that of the primordial hydrogen atom.

Deriving the Hubble constant from the primordial hydrogen atom seems to be a far-fetched catch but it can be motivated by an observer equivalence argument: If the universe is isotropic in all directions on a large scale, then a local observer is at the center of its mass. Since its center of mass can not be at two different locations at the same time (in anyone's intuitive Standard Contemporary Cosmology at least) this observer rightfully disagrees with some observer a few light years away who also claims to be in the center of mass and both observers can not be right if one is wrong. However if the mass is seen by the non-local observer as shown by the frame assignment of mass in Table I A (cf. Fig. 1, right side) then the mass circulates with some arbitrary long period (or arbitrarily short, at the particle level) and both observers can rightfully claim to be in the center of the universe's mass[3].

Hence, the universe is everywhere the same thing so the primordial hydrogen atom is also the same thing, which justifies drawing conclusions about the universe from the atom. If one is not convinced by this argument one can imagine being at the center of a hydrogen atom lasing at all its intermediate energy levels. (The hydrogen atom is described in e.g. [16]) Then the radiation will be red-shifted from further away located sources in agreement with astrophysical observations. On the other hand if one chooses to be located at the outer edge of the highest energy level of the lasing hydrogen atom then the signal sources from the various other intermediate energy levels will be seen to originate as if accelerated towards the far, which may or may not agree with astrophysical observations (the apparent literal cosmological expansion, that is, slightly accelerated? [11] [17]). From the latter perspective, suppose the local observer is rotating like the Earth spins around its own axis, then the hydrogen's

[2]not in terms of these well-characterized and known vacuum fluctuations as such but in terms of the geometry sustaining (stabilizing) physical processes that can be regarded as oscillations in vacuum

[3]GR invites a fallacy of thinking here since *its* mass increases with curvature of space as if it were the equivalent of gravitational pull

center of mass will be blurred out over the horizon so it is in effect non-local. Non-locality at the cosmological level is hidden from sight not only by the geometry of the universe but also by the limiting velocity of light and by the uncertainty of the paths of distant astrophysical objects. By reference to the solar system such non-locality appears in two dimensions (the orbiting Sun's evading a fixed line of sight) but the argument can be repeated from the perspective of the local observer in the electron cloud of an atom and then the rotating hydrogen nucleus would spread out indeterminately as if on the surface of a sphere so the non-locality would refer to any other dimension than the line of sight, like in the present geometry. This comparison with the hydrogen atom helps realize that the universe may not at all have been smaller in earlier epochs of its evolution even though there are some red-shifts and apparent boosts on the face of it.

Rather, the apparent line increment may be a property of space-time instead of a literal expansion of space emanating from a 'Big Bang' and this hypothesis will now be evaluated by putting it to work, quantitatively, in the Planck thermal distribution and the Schrödinger equation. The conclusion from the following results will be that the apparent cosmological line increment in the current epoch of the universe's evolution (at present time, that is, not blurred by the uncertainty of distant observation) has manifest roles in physical processes taking place at the atomic and sub-atomic level and has had these same roles ever since the first hydrogen atom was created apparently 13.7 billion years ago (the atom's time scale, that is).

As already discussed above the standard procedure is now to collect local terms to the left and non-local ones to the right and then evaluate what kind of physical processes the geometry encodes. The frequency distribution of thermal radiation from a hot body (Planck distribution, [18]),

$$U(\nu)d\nu^{-1} = \frac{8\pi h\nu^3}{c^3}\;\frac{1}{exp\Big(\frac{h\nu}{kT}\Big) - 1} \tag{18}$$

is then written

$$\frac{h\nu}{c}\;exp\Big(\frac{-h\nu}{kT}\Big) = \frac{c^2}{8\pi}\;U(\nu)d\nu^{-1}\;\tau^2\;\Big(1 - exp\Big(\frac{-h\nu}{kT}\Big)\Big)\quad . \tag{19}$$

The local transfer of a light quantum to and from the matter on the left side constitutes the known physical process coded for whereby the exponential term is a long known probability factor that expresses the stability of the excited state. When the light quantum is on the left side it can not be in the non-local field on the right side so the exponential terms on both sides of the equal sign are complementary. In the now classical literature on thermal radiation there exists two different views on the radiation's intensity, one is that it is a function value (e.g. [18] [19] [20]) and the other is that it can be regarded as a function variable [21] and eq. 19 above supports the latter view. Although it is evident that the left side (momentum axis) represents a physical process encoded for by the geometry it is not immediately clear from the terms as written what kind of physical processes take place in the non-local field. However, an interesting feature is that the field intensity, here c^2I (Table I), transforms the non-local terms (the radiation's oscillation period) to local ones and seems to act analogously (cf. Table I) to the acceleration in eq. 10 (and eq. 11). Light acting on light is a contemporary emerging topic in optics but the physical process hidden on the right side also has more or less classical aspects: The intensity of radiation has been linked to a squared probability amplitude and to the cross product of the electric and magnetic fields, the so called 'Poynting vector', a mathematical construct. In the former case three distinct probabilities expressed by eq. 19 and their interplay might clarify what kind of processes take place. The present geometry provides yet another setting for the intensity of radiation based on Maxwell's relativistic equations as explained in Section 4. How to understand and quantify processes that take place non-locally such that they cause things to happen locally is of course a very important subject! Eq. 19 will be reexamined further in a while but first, consider how the proposed geometry together with eq. 17 can give a concrete physical meaning to the Schrödinger equation, rearranged with the Planck length substituted from

$$\frac{p^2}{2M_e}\Psi = -i\hbar\frac{\delta}{\delta t}\Psi \quad\rightarrow\quad \frac{\hbar^2\nabla^2}{2M_e}\Psi = -i\hbar\frac{\delta}{\delta t}\Psi \quad\rightarrow\quad \frac{\hbar}{2}\Big(\frac{\delta}{\delta x}\Big)^2\Psi = -iM_e\frac{\delta}{\delta t}\Psi \tag{20}$$

to

$$\underbrace{\Big(\overline{\Delta q}\Big)^2 \Big(\frac{ec}{2\alpha}\Big)^2 \Big(\frac{\delta}{\delta x}\Big)^2\Psi}_{local\ terms} = \underbrace{-2iM_e\frac{\delta}{\delta t}\Psi\Big(\frac{\pi}{2}Ampere\Big)^2}_{non-local\ terms} \quad . \tag{21}$$

The substitution yields a circular current surrounding two magnetic charges, $ec/2\alpha$, similarly to the magnetic field enclosed by any solenoidal current, and invokes the atom's well-known structure with its spherical non-local (on average appearing charge-neutral) electron cloud. In comparison with the plain Schrödinger equation, which has been criticized for being too mathematical (even though useful), the terms with the Planck length substituted as written provide direct access physical processes known to take place in the atom. Hence, like in the case of the Planck distribution, the geometry encodes some physical process. Furthermore, the mysterious Planck length has been replaced with the apparent cosmological expansion rate in the current epoch so at least one knows now what one potentially is dealing with. As written above, terms to the left represent local processes taking place in the atomic nucleus whereas terms to the right are linked to the non-local electron cloud. The importance of being able to factorize the Planck length can not be underestimated since its indivisibility underpins the quantum picture of physical processes and from there, the photon-particle concept. In Section 4, where it is shown that electromagnetic radiation may keep its wave properties until it is absorbed, Planck's constant will again be scrutinized from this perspective.

First, however, the substitution of $h = 2\pi\hbar$ by eq. 17, cf. text below, can also be done in eq. 19 yielding, as a first approach

$$\frac{\nu}{c}\ (\overline{\Delta q})^2\Big(\frac{ec}{\alpha}\Big)^2\ exp\Big(\frac{-h\nu}{kT}\Big) = \frac{\pi}{2}\ c^4\ U(\nu)d\nu^{-1}(\tau)^2\ Ampere^2\Big(1 - exp(\frac{-h\nu}{kT})\Big) \tag{22}$$

where the factor 8π ascribed to polarization and surface angle in the classical derivations has been removed. Eq. 22 is analogous to eq. 21 down to the factor $\pi/2$ which corresponds to the complex plane. The wave vector, $k = \nu/c$, much used previously in physics appears as the 'natural' description in the present geometry. Then one has the result that thermal radiation, lasing (stimulated emission as described in ref. [21]) and the Schrödinger equation all conform to the same geometry. This is what is expected of a geometry that encodes physical processes as opposed to a stand-alone geometry like SR. It is interesting to do the substitution of eq. 17 also in the exponential term of the Planck distribution yielding, as a first approach

$$\frac{h\nu}{kT} = \frac{2}{kT\ \pi\ Ampere^2}\ (\frac{ec}{\alpha})^2\ \overline{\Delta q}^2\ \nu \tag{23}$$

to be further elaborated later on. Above, it is the numerical values of the terms $\overline{\Delta q} = H_0$ and ν that most catch the attention. Namely, if $H_0 = 0.7714 \times 10^{-26}/ms$ then the inverse of the frequency at the transition from Thompson to Compton scattering has approximately the same value, 10^{-26}, so the frequency slices the unit length in segments of length equal to $H_0 = \overline{\Delta q}/ms$. The transition frequency is where the radiation starts to behave as particles as is well known from Compton scattering. In theory [22], the transition corresponds to where the (photon) momentum can be neglected. The numerical results above indicate a possibility that the particle nature of electromagnetic radiation emerges above a threshold where it is sustained by the inherent line increment of cosmological space-time at present time. Then there emerges a possibility that there are no photon *particles* below that frequency and that the discovery of Compton scattering caused some premature conclusions. The ambiguous nature of 'photons' has previously been discussed in the context of vacuum fluctuations [23] [24]. Luckily, the geometry of eq. 1 - 5 encodes a physical mechanism by which the radiation interacts with matter so it is now possible to reevaluate the wave-particle properties of light in detail from a new perspective. This will be done in the next section and it will be shown that, in the present geometry 1) The soft 'photon' maintains its wave properties until it is absorbed. 2) The field-matter interactions take place *via* electromagnetic field gradients and rates of change of the fields. This mechanism can accommodate multi-photon absorption at various frequencies if the phases match. 3) The radiation is absorbed by the non-local observer in the non-local wave-front and/or the electron cloud - this settles the source-sink problem of Maxwell's equations. 4) A physical mechanism emerges which suggests the possibility of a momentum component in the direction of the radiation but the momentum only appears during the matter-field interaction and is absent from the field *per se.* This mechanism is capable of explaining self-lasing in that the atom(s) provide their own, momentum-preserving mirrors. 5) None of these interpretations require that the soft photon be a particle.

4 Interpreting Maxwell's Equations in Terms of Local and Non-Local Observers

Maxwell's equations in their relativistic form provide the key to evaluating the geometry of eq. 1 - 5 with respect to light-matter interactions as previously reported [25]. The standard procedure that has now emerged is to identify local and non-local terms, collect them separately and from there try to interpret what kind of physical processes take place. Hence, selecting one polarization component from[4] (cf. [26])

$$B_y = \frac{1}{\sqrt{1-\beta^2}}\Big(\overline{B_y} + \beta\overline{E_z}\Big), \quad E_y = \frac{1}{\sqrt{1-\beta^2}}\Big(\overline{E_y} - \beta\overline{B_z}\Big) \tag{24}$$

$$B_z = \frac{1}{\sqrt{1-\beta^2}}\Big(\overline{B_z} - \beta\overline{E_y}\Big), \quad E_z = \frac{1}{\sqrt{1-\beta^2}}\Big(\overline{E_z} + \beta\overline{B_y}\Big) \tag{25}$$

and rearranging, conforming to eq. 1 and 2,

$$E_y = \frac{1}{\sqrt{1-\beta^2}}\Big(\overline{E_y} - \beta\overline{B_z}\Big) \Rightarrow \frac{c\,\sqrt{1-\beta^2}}{v} E_y = \frac{c}{v}\;\overline{E_y} - \overline{B_z} \Rightarrow \tag{26}$$

$$\frac{c}{v}\;\overline{E_y} = E_y\;\frac{c\,\sqrt{1-\beta^2}}{v} + \overline{B_z} \tag{27}$$

$\overline{q_0}$ of eq. 1 is recovered on the left side and q_0 of eq. 1 on the right side. It is then easy to guess that processes in the non-local frame compensate for the relativistically distorted electric field that the non-local observer sees such that the end result is that the local field is recovered. Note that the local and non-local observers are connected by Lorentz transformations of space-time coordinates so just by rearranging terms the Lorentz transformation is made to perform some (unknown) physical process, which is (*unrelated to the signal velocity*) whereas in SR it is just a mathematical tool. The present approach is different from that of SR where the field components are frozen in the Faraday tensor merely to show that 'SR is right' [5] and no effort has ever been made to find out what actually happens. In the present case one must select the emitter to be the local observer since the emitter can not know ahead of time the relative velocity of the signal-absorbing end. This leaves the absorbing

[4] $\beta = v/c$

[5] If there are laws of Nature than *any* geometry should reflect them in some way so SR has a non-exclusive right to be right

matter immersed in the non-local field forced to process the signal such as to make the terms on the right hand side equal to the emitted signal's electric field on the left side of eq. 27. One must conclude that these processes take place at the matter-field interface at the moment of absorption of the signal because the receiving observer has some velocity *relative to the signal.* This is again different from SR where the focus is on the *observers'* relative velocity. In SR the observer who receives the signal has no way of distinguishing if its field components are relativistically distorted or not whereas in the present geometry the undistorted signal is readily accessible to the receiving observer at the field-matter interface. In order to reach a conclusion about what thus happens when the signal is absorbed one can benefit from that

$$tan\ \theta = \frac{v}{c\sqrt{1-v^2/c^2}} \tag{28}$$

expresses the tangent of the angle an orbiting point seems to be delayed from the perspective of an observer at the origin, which is known from stellar aberration (cf. e.g. [26], p. 250): Namely, the electromagnetic signal is a wave characterized by two important maxima. One of them is at the antinodes where the electric and magnetic fields are maximal[6] and the other is at the nodes where the rates of change of the fields are maximal. Lengths (field components) perpendicular to the velocity of propagation are relativistically inert but the electric field of eq. 27 also receives a contribution from the magnetic field through the latter's rate of change. Rates of change of both magnetic and electric fields (currents) are known to produce curls of respectively electric and magnetic nature. These curls are maximal at the nodes and provide a natural environment for the non-local observer [28] who infers the circulating point (eq. 28) in the geometry of eqs. 1 - 5 and senses the rates of change of the field components. This agrees with empirical findings based on the so called Aharonov-Bohm-Eherenberg-Siday effect [29], one of the known bench-top manifestations of non-locality (some are listed in Table II), which has previously been linked to the nodes of the electromagnetic wave and to the magnetic vector potential there.

Table II List of Physics Phenomena Related to 'Nonlocality'
Superpositions, entanglement
Path integrals, permutations
'Teleportation'
Aharonov-Bohm - Eherenberg-Siday effects
Double-slit interference patterns of
a) single photons b) electrons and particles
Scalar potential in the Coulomb gauge
'Tunneling', discontinuous particle displacements

Because of the aberration effect, now applied to the node, the non-local observer will see the field maximum delayed by a certain angle as can be expressed by solving for the non-local observer in terms of the local one (in brackets, right side below, Fig. 2),

$$\overline{E_y} = \frac{c\sqrt{1-v^2/c^2}}{v}\Big[\frac{v}{c\sqrt{1-v^2/c^2}}\ E_y\Big] - \frac{v}{c}\ \overline{B_z} + \frac{v}{c}\ \overline{B_z} \tag{29}$$

The bracketed terms thus express a physical process taking place at the matter-field interface (the sensing of the electric field by the matter), which is precisely balanced by the prescribed geometry (first term on the right hand side), but not merely so: One can also imagine there being an observer in the field making complementary observations to the effect that the terms cancel, employing that the

[6]This is where atoms in standing waves tend to settle [27]

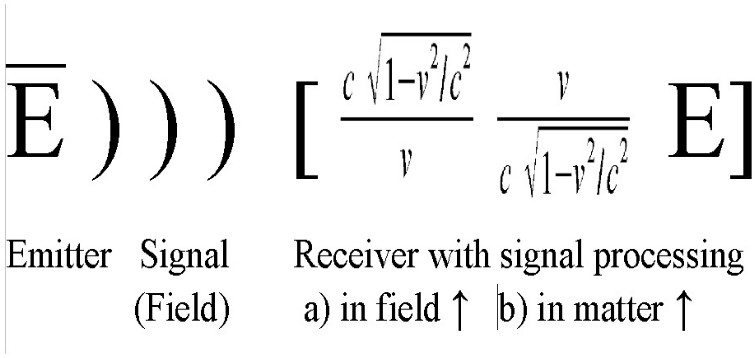

Figure 2: Schematic illustration of the local emitter (left, $\overline{E}$), the signal, ')))', signal processing (square root expressions, cf. eq. 29) at the field-matter interface of the non-local absorber (right, $[E]$)

tangent and the cotangent of an angle are the inverses of each other. This canceling of terms takes place symmetrically around the angle $\pi/4$ (Fig. 3) which corresponds to the velocity $v = 1/\sqrt{2}$ in the local frame and $v = 1 = c$ in the non-local frame (because of time dilatation, eq. 4). - Canceling terms and terms balancing each other to maintain equilibrium are commonplace in physics. In the present case there are additional benefits of this interpretation. First, the velocity of light at the angle $\pi/4$ emerges as that velocity where perpendicular field component (E) and the contribution to that component from the rate of change (of B) at the node together produce their maximal synergistic effect. If the energy of the radiation is to be transferred in its entirety as a quantum of frequency c/λ, then all its contributions [7] along the half wavelength of its wave must be brought into action at the same time. This problem has so far been neglected even though the wave-lengths of light typically absorbed by an atom or molecule is at least of the order of 10^4 longer than the particle itself, not to mention infrared radiation. The perpendicular contributions to the field are not affected by to and fro velocities but the contributions from the curls at the nodes are (the steepness of the wave changes), so the relativistic effects appear because of this asymmetry. These relativistic effects are seen and compensated for by the non-local observer such as to match the emitted signal but the complementary operations performed by the observer in the field are not seen when the signal is turned local in the bracket of eq. 29. In an extension of this argument the observer in the field will rely mainly on curls in the matter (an optimal environment for observing magnetic monopoles?) when interacting with a material observer at rest but will rely more on perpendicular fields if the observer moves at relativistic velocities relative to the signal. The reverse holds for the material observer so, empirically, an observer at rest relative to the signal will see mainly field contributions originating perpendicularly to the signal. Since the relativistic corrections take place symmetrically around the velocity $c = 1$ in the non-local frame at $\pi/4$ [8] it is clear that it is the non-local observer who sees the signal and this agrees empirically with the receiver being non-local in the wave-front and/or the electron cloud - but the emitter remains local as at the outset of the present discussion. Hence, the geometry of eq. 1 - 5 and the mechanism discussed allows Maxwell's equations to explain for themselves the source and sink problem of Maxwell's equations.

Furthermore, the phase shift $\pi/2$ by the aberration effect brought about by the signal velocity of

[7] its potential energy at the antinode and its kinetic energy at the node
[8] the velocity $c = 1/\sqrt{2}$ is also itself canceled by the inverse terms of eq. 29

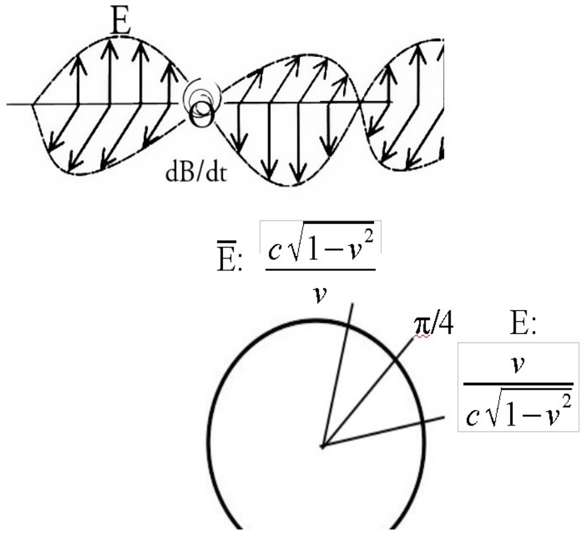

Figure 3: Illustration of how the relativistic effects of eq. 29 and Fig. 2 will cancel around the angle $\pi/4$ if they are interpreted as an 'aberration' of the transverse field antinode seen by the material observer and that computed from the field. The aberration is the angle an orbiting point, here the transverse field component, will be seen to be delayed when viewed from the origin. If the material observer measures velocity v then the field computes the velocity $c - v$ and the symmetry arises from $cot\alpha = 1/tan\alpha$

c relative to the stationary emitter-absorber-observer provides a key to the mechanism of momentum transfer to and from the field: The problem is how to conceptualize a momentum transfer when the radius of the atom *shrinks* upon emitting energy and *lenghtens* when absorbing while the field components are perpendicular to the expected direction of momentum transfer. However, the radially shifting electron cloud embodies both a transient dipole as well as a transfer of electron mass (and of nucleus mass following the electron by electro-neutrality) carrying momentum. If the electron emits and absorbs from the concave side of the electron cloud relative to absorber respectively the emitter, then the electric field component can be explained by the phase shift $\pi/2$ linked to the electrically charged electron jumping from one energy level to another, and a momentum effect is then automatically implied by the mass transfer. Such a momentum transfer is compatible with the concept of a spherical wave-front propagating in all directions *without* momentum. Hence, the photon *particle* concept is not necessary in order to discuss momentum transfer to and from the field in this geometry.

Besides the theoretical considerations above there are practical implications of re-interpreting signal-matter interaction in terms of waves rather than 'photons' in some cases where the understanding of new phenomena in optics has stalled. For example, multi-photon absorption at various frequencies may be explained in terms of field gradients and/or rates of change of the perpendicular field components if the phase of the radiation allows a synergistic effect. The radiation giving away part of its energy like in sub-cycle absorption seems to be at variance with the photon-quantum concept but could readily be understood in terms of *wave*-matter interaction and the decomposition of the Planck length. Finally, self-lasing could be understood in terms of the mechanism of momentum transfer discussed in the preceding paragraph, each absorbing atom acting as the emitting atom's mirror with loss-free momentum transfer back and forth between the field and the atoms at the moment of matter-field interaction. The latter idea is schematically illustrated in Fig. 4.

However, even though all these practical situations can from now on be explained intuitively, the

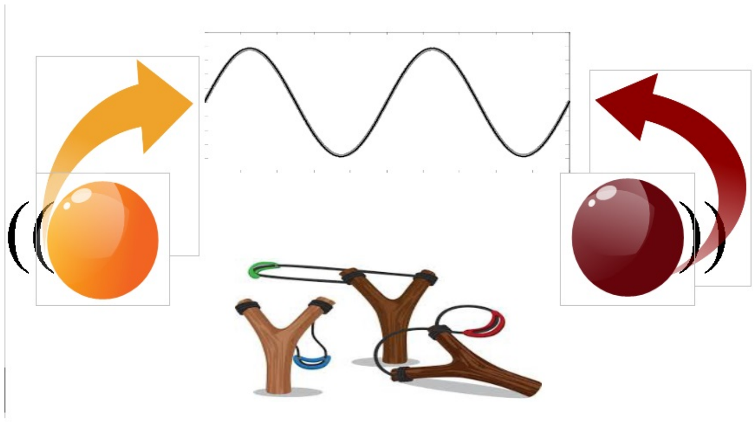

Figure 4: Schematic illustration of the transfer of momentum between two atoms and an electromagnetic field according to the present theory. The figure is intended to show how two atoms may serve as each others' mirrors in 'self-lasing'. Since the momentum-carrying field component has been phase shifted by $\pi/2$ from the contracting electron shell it may spread as a spherical wavefront without momentum and nevertheless transfer some momentum when subsequently absorbed at the receiving end. (This is illustrated by the unloaded slingshots)

greatest benefit of the proposed geometry at the level of Maxwell's equations is at the abstract level. SR is very vague about the cause of the relativistic effects. Originally, the length contractions were at the center of its focus of attention but these have been shown to be dubious [6] [7] and do not explain that relativistic effects are independent of the directions of the to or fro velocities. This leaves the time dilatations as SR's main argument (these are preserved here; eq. 4) but in Maxwell's relativistic equations there are no time components except in the velocity of light since the velocities are measured in the rest frame, and the velocity of light is a constant in vacuum. So SR is cornered into admitting that it must rely on a dogmatic explanation for the relativistic effects in Maxwell's equations, claiming in defense to be *the* natural geometry. In the present theory however [25], the situation is quite different: Here, the relativistic effects are caused by the phase mismatch taking place when the rates of change of the fields at the nodes are altered by to and fro velocities in any direction whereas the perpendicular field components at the antinodes are seen delayed. The receiving non-local observer relates to the field and the field relates to the receiving observer and they both compensate for their relative velocity measured in the rest frame such that the average amounts to a phase shift of $\pi/4$. This applies equally to to and fro velocities since it is almost a mechanical effect at the field-matter interface. Hence, the velocity of light is a limiting velocity in the sense of this mechanism only, and not in the dogmatic sense of forbidding faster than light communication as could already have been guessed above from that a Lorentz transformation *per se* from a non-local frame (and not particle momentum in 4-D SR) forwards the signal into the local frame. Realizing this almost literally opens the door to a yonder world of instant communication already anticipated to exist (cf. Table II, also e.g. ref. [30]) but hitherto largely denied because of 100 years of dogmatic physics theory.

5 Concluding Comments

This paper is justified by building on a geometry that quantifies the concept of non-locality and which has an inherent line increment, both of which are features of the real world that we live in, but are lacking special relativity. It has been shown that the Planck distribution, the Schrödinger equation, and Maxwell's equations all can be cast in forms encoded by the geometry, all providing reasonable scenarios for the physical processes taking place. Also, the line increment could be solved numerically. This makes a good platform for a new perspective on several physics phenomena. It is impossible in one paper to address 100 years of accomplishments based on SR, the Planck constant, and the uncertainty relations in their old, now fossilized theoretical settings. However, in the present, comprehensive theoretical framework, it is not unlikely that measures of physical processes described by using SR could be reproduced based solely on the time dilatation effect provided here. Putting Planck's constant to work by factorizing it must be evaluated in each and every of its ubiquitous contexts, the example of the exponential term of the thermal distribution (eq. 23) will be further examined below. First however, consider how this new framework modulates the concept of vacuum fluctuations based on the canceled left parenthesis in eq. 13, now amplified by c to stretch to the cosmological horizon in this theory and written as

$$\frac{a_0\ (\alpha c M_e)}{\hbar c} \quad \rightarrow \quad \frac{a_0\ p_e}{\hbar c}\ . \tag{30}$$

The magnitude of this oscillation is far to great to be considered a 'classical' Heisenberg vacuum fluctuation, which occur very short-range in 'flat' 3- or 4-D space-time but given that the geometrical framework encodes even up to Kepler orbits and more [5] a possibility arises 'classical' fluctuations may be stabilized by it. In such a case there would be a smooth transition between the quantum world and the classical world as might also be inferred from other calculations, for example in [31], [32] and [33]. The oscillation between local 'existing' and non-local 'elsewhere' seen by a yonder observer immersed in orbits and curls that is encoded by the present geometry offers a new and quantifiable perspective on matter waves and the dual world concept of deBroglie [34] [35]. Not only matter waves but also discontinuous displacements, like in the well-established 'tunneling' across energy barriers, would be amenable to an intuitively acceptable analysis in the present theoretical framework (by way of transitions, just like in the case of black body radiation, from and back to the local frame, teleportation?). Distinguishing between existing-nonexisting *versus* 'being lastingly sustained' reveals the philosophical context of some urgent physics problems, like the one of the cosmological 'Big Bang', the universe being 'created' from nothing.

The exponential term of the Planck distribution offers an opportunity to examine whether or not the substitution by eq. 17 leads to meaningful results regarding 'temperature', which is a measure but not a physical process. Since temperature is not a physical process Boltzmann's constant is not either and the magnetic charge can be dismantled by geometrising its invariant charge contribution of c yielding a new constant, K. From eq. 23,

$$\rightarrow \quad \frac{2}{kT\ \pi\ Ampere^2}\ (\frac{ec}{\alpha})^2 \overline{\Delta q}^2\ \nu = \frac{2}{\pi\ KT}\frac{1}{[\frac{charge}{em}]^2\ (\alpha c)^2}\ \overline{\Delta q}^2\ \nu \tag{31}$$

so there appears to be contributions of charge-potential (square-brackets) and current (αc (=electron velocity in ground state) in the denominator acting on behalf of the temperature, which is intuitively acceptable considering that heat derives from Brownian movement and thermal agitation. It is also possible to look at the denominator as oscillatory contributions from electric field potentials and magnetic curls, like in the case of electromagnetic radiation, or potentials arising from some random distribution of valence electron velocity similarly to what has been discussed in the case of light [23] [24] [34]. Hence, the substitution by eq. 17 provides plausible access to the physical mechanisms of thermal agitation, which has previously been regarded mainly as a nuisance in the important fields of laser optics and superconductivity, a problem so far only possible to avoid by lowering the temperature.

Then, since as was discussed in 2nd paragraph on p. 9 the hydrogen atom can be regarded as a micro-universe so for corroborating the theory one should find a radius and its inverse (cf. eq. 5). If a_0 is the sought radius then an inverse is provided in

$$\frac{a_0}{\pi\ m} = \frac{\pi\overline{\Delta q}}{r_p}\ , \tag{32}$$

$r_p = 1.43 \times 10^{-15} m$, a tentative theoretical value for the proton radius in the present geometry. The value obtained can be compared with actual neutron scattering measurements, ref. [36], estimated here by interpolation of the previously published data to be roughly $1.31 \times 10^{-15} m$. The proton's *charge* radius obtained by various measurements involving negative charges is known to be considerably smaller, almost half, so it shrinks a lot under the influence of negative charge. Since 1) the neutron is known to be slightly negatively charged on its surface because of quark dynamics and 2) there is some particle-particle penetration before the scattering takes place [36] the value measured, 1.31, can reasonably be expected to be somewhat higher so a good agreement between the present theoretical value and experiment is anticipated. Eq. 32 suggests that the curl of the light signal at $c = 1m/s$ interacts with the Bohr radius (like in eq. 30, this is also compatible with signal absorption by the non-local observer at the wave node as in Section 4 and, consequently[9], that the curl of the line increment interacts with the proton radius, the material object having mass that is. So if one normalizes by these physical processes the proton radius and the Bohr radius emerge as plainly the inverses of each other. However, eq. 32 does not seem to represent a physical process.

So pushing aside the somewhat speculative Rydberg-Bohr micro-cosmos in the preceding paragraph a while for a focus on the main results of the present paper: The factorization of Planck's constant in a physics-encoding geometry lacking spatial measures in its non-local frame leads to a bias for electromagnetic wave *versus* particle mechanisms at the radiation-matter interface and an active role of the local intensity of the radiation. Above a frequency threshold involving oscillatory line increments however (eq. 31), the radiation behaves as a particle and this may provide a clue to the equivalence of matter and energy in its thermodynamic context as originally derived from the oscillatory line increments in a black cavity [37], perhaps leading to future engineering applications. The theoretical takeaways from a better understanding of the nature of palpable matter in terms of the elusive energy is likely to reach into cosmology sooner or later anyway.

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[9] as has been discussed previously the resonance bosons may be involved in stabilizing the proton by way of quark dynamics and the latter are related to axial and vector currents so matter may have a similar dual composition like the electromagnetic radiation discussed here, however this is not the topic of this paper

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