Light and Matter Seen With the So Simple Derivation of the Lorentz Factor That Explains (Almost) Everything*

Erik A. Cerwen*

*www.scienceandresearchdevelopmentinstitute.com

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Abstract

The absorption of an electromagnetic signal by the atom is modelled in terms of the electric fields of the signal and the electron adjusting by rotations to compensate for relativistic effects, which to some degree are always encountered by the rapidly orbiting electron. The wave-front and the electron in its 'cloud' are both non-local and it is found by several lines of evidence that the absorption under such conditions starts at 45^o relative to the wave-front. When the absorption of the signal's field is examined in a geometry which defines a non-local observer (in terms of being perpendicular to linear momentum) it is shown to be accompanied by a rotation from the non-local to the local frame, which potentially pulls the nucleus and confers physical momentum. The Lorentz factor is derived mathematically from such rotations while evaluating both the physical processes involved and issues relative to various abstract geometries. The electron's group velocity is expressed in the context of a factorized Planck length and found to be congruent with the physical interpretation of the Lorentz factor made such that the group velocity may be composed of slightly different 'wobbling' currents. The group velocity, deduced previously in the literature to represent energy and matter, herein relates quantitatively to a line increment of the order of the apparent cosmological expansion. This line increment is baked into the Planck length and interpreted as a term of equivalent geometrized energy. The results open a window to the concrete physical mechanisms of signal absorption and offer a new perspective on the nature of matter.

1 Introduction

In the early 20:th century the discovery of the photoelectric effect and scattering of X-rays in the context of the Planck quantum and the Bohr atom lead to the photon quantum particle concept and the energy level description of absorption-emission of electromagnetic (EM) radiation. Although this approach has been successfully applied for a century it does not naturally accommodate instant communication within entangled EM waves or 'multiphoton' absorption. Such shortcomings motivate going back to the forkroad of particle *versus* wave in the early 20:th century and it is the purpose of this paper to restart at that point using the wave description.

The fork-road between particle and wave can be defined very concretely as the threshold for ionization of the hydrogen atom at $\lambda = \mathbf{91.175 \times 10^{-9}\ m}$ in the Lyman series, corresponding to the wave period $\tau = \mathbf{3.041 \times 10^{-16}\ sec}$. The electron's orbit period is $\mathbf{1.52 \times 10^{-16}\ sec}$. Hence,

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a quarter of a wavelength of ionization is sufficient to kick out the electron while it makes half a turn as shown in Table I. For shorter wavelengths this quarter length may act *via* its steeper field gradient, $\Delta E/\Delta t$ or by some mechanism whereby the electron senses the sweep of the quarter-wave. For longer wavelengths than the ionization threshold, however, it is the wave that senses the sweep of the electron in half the latter's orbit. So, the task of this paper is to examine if and how these sweeps, like illustrated schematically in Fig. 1, contribute to signal absorption. This has the potential to replace the photon particle concept and provide a new perspective on the fundamentals of wave-matter dynamics with many practical applications in experimental design. Much of these results has been presented previously in this series of papers by the author but in a rather scattered form and it is now possible to add some new results and put the previous ones in a better perspective.

TABLE I

Wave			Orbit
	$\lambda/2$	$\Longleftrightarrow$	
	$\lambda/4$	$\Longleftrightarrow$	
$\frac{\Delta E}{\Delta t}\uparrow$ or	$< \lambda/4$	$\Longleftrightarrow$	
$\frac{\Delta E}{\Delta t}\downarrow$ or	$> \lambda/4$	$\Longleftrightarrow$	

Table I. Comparison of electromagnetic wavelength and period (left) with the orbit period of the electron in the Bohr ground state (right).

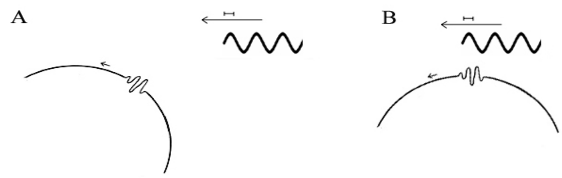

Figure 1: Schematic illustration of how an orbiting electron, depicted as a beat of its group velocity may receive an oscillating electric field, a 'wave packet', approaching from the right. At some point, there is going to be resonance between the dipole oscillations of the electron and the field and it is described in the text how this resonance is sufficient to explain signal absorption.

2 Theory

The reference geometry is, like before, four coordinates of space and time in two dimensions only, one spatial dimension, which harbors length and linear momentum including axial momenta and a dimension perpendicular to this one, which harbors time and which is non-local from the point of view of the momentum observer. This geometry is obtained by performing a Lorentz transformation of the inverse of the x_1 component of the four-velocity[1] at two discrete time cordinates, -1 and 0, in the local frame of observation. The local and non-local coordinates in the same segment of time

[1]special relativity theory, SRT; $\beta = v/c$, v= velocity, c= velocity of light, ds^2= interval, m= unit of length, meter, s= geometrized unit of time

are connected *via* Lorentz transformations, $\mathcal{L}$, with intervals, ds^2, which are invariant provided the units of space (m) and time (s) are equal.The momentum observer can best be identified with a particle that has no other means of evaluating the external world than by sensing the momenta. Hence:

$$\underline{\qquad\qquad\mathcal{L}\qquad\qquad}$$

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

$$\overline{\boldsymbol{\Delta}}_{\mathbf{r-0}} = (-vs, s); \qquad s = \frac{\widetilde{s}}{\sqrt{1-\frac{v^2}{c^2}}} \Leftarrow (0, s\sqrt{1-\frac{v^2}{c^2}}) = \boldsymbol{\Delta}_{r-0} \tag{2}$$

$$\blacksquare\quad (\overline{q}_r, \overline{t}_r) = \underbrace{\left(\frac{1}{v}\frac{m^2}{s} - vs, 0\right)}; \quad (q_r, t_r) = \underbrace{\left(\frac{\sqrt{1-\frac{v^2}{c^2}}}{v}\frac{m^2}{s}, s\sqrt{1-\frac{v^2}{c^2}}\right)} \quad \triangledown \tag{3}$$

$$\underline{\qquad\qquad\mathcal{L}\qquad\qquad}$$

Here, the coordinates are labeled with colored symbols and their assignment to the local frame is indicated by an overline. A tilde over the symbol is also used for indicating assignment to the non-local frame. By convention herein the local coordinates are placed to the left of the equals sign.These equations have the geometric properties that

$$\overline{\Delta q} = -vs \Rightarrow \frac{\overline{\Delta q}}{\overline{\Delta t}} = -v \quad \text{and} \quad \overline{\Delta q} = -\frac{1}{\overline{q_0}} \ : \tag{4}$$

The line increment, $\overline{\Delta q}$, per unit time in the local dimension, is equal to a tangential velocity, v, in the non-local dimension and this line increment is the inverse of a radial length, $\overline{q_0}$, as can be seen by comparing with the unit circle,

$$(cos\ x)^2 + (sin\ x)^2 = 1 \ : \ (\frac{\widetilde{\Delta t}}{s})^2 + (\frac{\overline{\Delta q}}{m})^2 = 1; \ \ q^2 + m^2 = \frac{1}{v^2}\frac{m^4}{s^2} = \overline{q_0}^2 \tag{5}$$

From Eq. 1 - 3 it follows that the local observer can measure length but the non-local one can only measure time. However, the latter observer can measure a velocity based on its radial component (left below), this velocity is also seen by the local observer (right),

$$\frac{\frac{\sqrt{1-\beta^2}m^2}{v\ s}}{s\sqrt{1-\beta^2}} = \frac{c^2}{v} = -\frac{m^2}{vs(-s)}, \tag{6}$$

c^2/v, which is known as the phase velocity. The geometry may be schematically illustrated as in Fig. 2 with the strictly 1-D local observer unable to observe remote curvature as well.

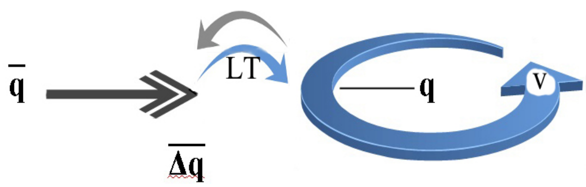

Figure 2: Schematic illustration of the geometry obtained from Eq. 1 - 2. The local frame has a line increment, $\overline{\Delta q}$, and the non-local one a velocity, v. The line increment per unit time in the local frame and the velocity have the same numerical value. The local length, $\overline{q}$, may be interpreted as the radius in a circle.

When comparing the time interval of Eq. 2 with that of SRT they are equal,

$$\left(\mathbf{SRT}: \; \bar{t} = \frac{(\tilde{t} - xv/c^2)}{(\sqrt{1 - v^2/c^2}} \Longrightarrow \overline{\Delta t} = \frac{\Delta\tau}{\sqrt{1 - v^2/c^2}}\right) \quad , \tag{7}$$

but SRT comes with an additional term which reflects its extension into the distorted Cartesian 3-D space whereas this paper only deals with the isolated local particle.

Eqs. 1 - 3 accommodate in the square-root terms a rotation taking place during the observation; $\overline{\Delta q}$. The line increment is relevant to the radii of the orbiting atomic electron and to the momentum transfer from the electromagnetic wave. A closer examination of the propagating electric field shows that its description in the Maxwell-Faraday tensor can be put in a form that agrees with the coordinates of Eqs 1 - 3:

$$E_y = \frac{1}{\sqrt{1-\beta^2}}(\overline{E_y} - \beta \overline{B_z}) \quad \rightarrow \quad \frac{c}{v}\overline{E_y} + \overline{B_z} = E_y \frac{c\sqrt{1-\beta^2}}{v} \tag{8}$$

$$\Updownarrow \qquad\qquad \Updownarrow$$

$$\frac{1}{v}\frac{m^2}{s} \qquad\qquad \frac{\sqrt{1-\frac{v^2}{c^2}}}{v}\frac{m^2}{s} \tag{9}$$

with the phase velocity representing the electric field. From the above one can construct the signal absorption like illustrated in Fig. 3 as

$$\overline{E_y} = \frac{c\sqrt{1-v^2/c^2}}{v} \overbrace{\left(\frac{v}{c\sqrt{1-v^2/c^2}}\;\overline{E_y}\right) - \frac{v}{c}\;\overline{B_z}}^{Non-local\;\; observer,\; E} + \frac{v}{c}\;\overline{B_z} \;, \tag{10}$$

$$\Updownarrow \qquad\qquad \Updownarrow$$

$$\overline{E_y} = \quad cot\;\phi \qquad tan\;\phi \quad \overline{E_y} \Longrightarrow \triangle \quad \bigtriangledown \rightarrow \blacksquare \Leftrightarrow \mathcal{L}$$

where ϕ is the angle by which an observer at the origin sees an orbiting point delayed (cf. e.g. [1]),

$$tan\phi = \frac{\alpha c}{c\sqrt{1-\alpha}} \quad . \tag{11}$$

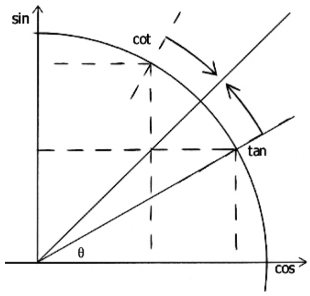

Figure 3: Schematic illustration of the rotation of two non-local observers towards 45^o, representing the non-local electron and the EM wave at the moment of signal absorption, while correcting for a relativistic distortion. Using the colored symbols in Eq. 1, $\triangle \quad \bigtriangledown \rightarrow \blacksquare \Leftrightarrow \mathcal{L}$

The non-local EM field is made local by a rotation towards 45^o while a compensating counter-rotation takes place of the non-local electron's field (Fig. 3). The absorption (emission) may thus be represented by the symbolic expression

$$\blacksquare \rightarrow \triangle \ \ \triangledown \rightarrow \blacksquare \Leftrightarrow \mathcal{L}$$

which makes source and the sink of the signal local while the EM field and the electron are non-local in respectively the wavefront and the electron cloud. At 45^o the non-local radius and the line increment have the same length since from the unit circle, Eq. 5, right:

$$\left(m^2 - \beta^2 m^2\right) + \beta^2 m^2 = m^2. \tag{12}$$

Here, the line increment-momentum is perpendicular to the field. Furthermore, at 45^o relative to the wavefront to-and-fro velocities have the same effect on stretching the time axis, which is consistent with SRT. This is shown in Fig. 4. The angle 45^o (relative to the node or the antinode) is also where the accelerations of the electric and magnetic fields are maximal and it is where the antinode and the node jointly contribute maximally to any physical effect [2]. Usually, in intense laser experiments etc., absorption is shown to be where the fields are maximal at the antinode but there must also be a way for the electron to catch the signal in the wave-front. Herein, the focus is on sensing and catching the signal in the non-local wavefront followed later by absorption while the EM and electronic fields pass each other.

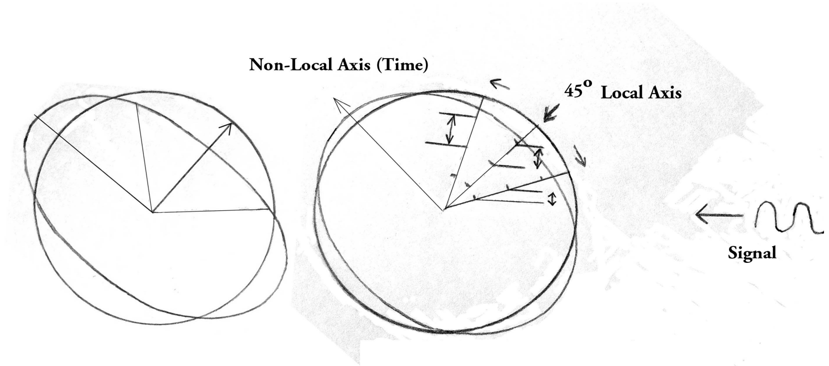

Figure 4: Schematic illustration showing that (drawing at right) when the local line increment, $\overline{\Delta q}$, is represented on the x-axis and positioned at 45^o relative to the wave-front, a rotation of the local axis will either stretch or contract the pitch of the axis. A stretched pitch corresponds to a redshift and a contracted pitch to a blueshift of the signal wave for respectively receding and approaching velocities. However, (drawing at left) when the time axis does not co-rotate and the area of the unit circle and its squeezed ellipse are preserved both receding and approaching velocities will cause a time dilatation.

The geometry indicates that during signal absorption a rotation takes place centering around 45^o relative to the wave front, and by inference, that there may be a corresponding 45^o inclination at the emitting end relative to its local axis along the line of sight even though the emitter has no means of identifying the position of the signal receiver. It is reasonable to think that emission and absorption take place by the same mechanisms in reverse order even though the emitter has no way of positioning the absorber of the signal. These rotations have been used to reinterpret the cosmological redshift in terms of such rotations around 45^o [3]. The rotation will be further anlyzed below but consider first the electron in its nonlocal cloud around the nucleus.

The electron remains in orbit incessantly so it may be regarded as a room temperature superconductor evading the usual descriptions of superconductivity. Since it is not itself stationary within the stationary atom but rotating at a relativistic velocity, in the hydrogen ground state at $\alpha c\ m/s$, the construction above in terms of compensating rotations around 45^o will always be applicable for signal absorption as well as for how the electron sees its environment in the atom. Elaborating on the principle of rotations and counter-rotations described above it is reasonable to assume that it compensates the angle of delay of how it perceives a rotation as given by prescription in Eq. 11, cf. [1], by self rotating in the opposite direction. By doing so it creates for itself a linear world (just like our world) which can be accessed quantitatively by solving the angle in Eq. 11 as shown in Fig. 5A to be $\alpha = \phi = 0.418111^o$ and using the angle to partition its orbit of 360^o. This gives line elements that are $7.723 \times 10^{-13}m$ long [4] but since the electron is non-local these line elements stretch out in all directions, creating curl cells of charge like in Fig. 5B. Many such curl cells covering the spheric atom will by prescription make the electron non-local since their adjacent fluxes are counter-current, canceling each other. In the case that the fluxes carry orbiting charge, which is likely, they will be surrounded by magnetic fields by prescription and when an array of such curl cells move in some direction on the atom's surface their projection around a parallel line will appear like an electromagnetic wave having perpendicular electric and magnetic fields. Since the electron is non-local by definition the wavelength of such a wave is not *a priori* important, it may be, for example, its matter wave moving at speed αc or some resonance with an external perturbation. The matterwave can be solved by factorizing the Planck length out of the Bohr atom ground state as has been described previously[2]:

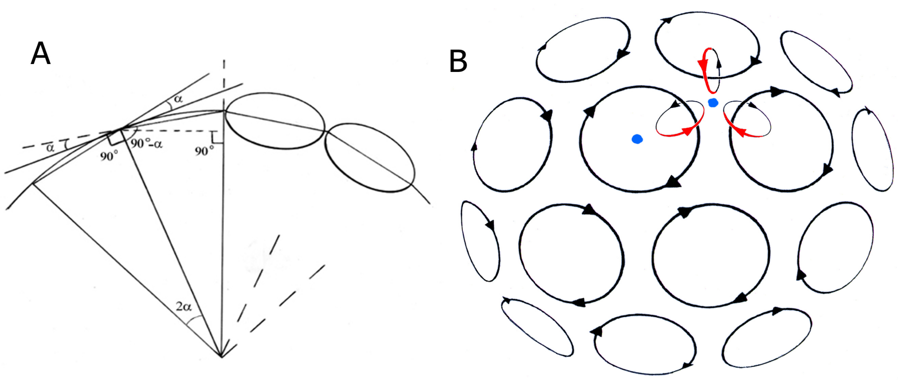

Figure 5: A (left). Geometric construction of circle segments around the angle 2α (2ϕ in the text) in order to obtain the length that the electron travels while adjusting by a rotation to compensate for the delay of observing an orbiting point so that it sees the orbiting point as part of a linear world. This correction also applies towards signals that are comoving in the laboratory frame. B (right). Schematic illustration of curl cells of orbiting charge (circular currents) on the atom's surface arising from an adjustment as in A when the adjustment takes place in all directions parallel to the surface. The shown size of the curl cells is larger than calculated: There is room for 861 such curl cells on the circumference of the Bohr atom ground state.

From the Bohr atom ground state,

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

the line increment is obtained *via* the Planck length,

[2]This derivation can be found for example in [5] and [6] and the background details of Fig. 5 in [4]. The factorization of the Planck length is not mainstream physics but, as shown in the author's previous papers it transforms several quantitative descriptions (formulae) into plausible physical processes. This is an advantage and no-one knows what the Planck length is anyway so there ought to be no objections.

$$\sqrt{\hbar} = \overline{\Delta q}\ 2\frac{e\mathbf{C}}{2\alpha}\ \frac{1}{\pi\ Ampere} \Rightarrow \overline{\Delta q} = 7.7145 \times 10^{-27} m/ms. \tag{13}$$

where geometrized units are used and $\mathbf{C}$ is kept in SI-units as an invariant factor to get magnetic from electric charge. The Planck length is then substituted in an established context of the fine structure constant,

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c} \rightarrow \alpha = \frac{\mathbf{K}e^2}{\hbar c}\ , \mathbf{K} = 7.4246 \times 10^{-35} \tag{14}$$

where $\mathbf{K}$ is a unit conversion constant incorporating the permittivity of space, yielding

$$\overline{\Delta q}^2\ \mathbf{C}^2 = \mathbf{K}\alpha\pi^2 Amp^2 \tag{15}$$

Here, the term $\pi\ Amp$ [3] is interpreted as a circular current like in the curl cells of Fig. 5B. This result will be used later.

It is also possible to apply this construction to the electromagnetic wave of the approaching signal as illustrated in Fig. 6. In SRT, circular currents moving relativistically are deformed and displaced into an upper or lower half of the circle (cf. e.g. [1]) but that is irrelevant since light itself is exempt from relativistic distortions in flat space-time - SRT: the constant velocity of light just serves like a pivot around which the various relativistic effects take place[4]. Therefore, without traversing SRT, one can imagine light being composed of such cells of circulating charge, like in Fig. 6, surrounded by magnetic fields which, when moving and projected around a line, yield the familiar electromagnetic wave with its perpendicular electric and magnetic fields. This has the advantage that the electron and the wave may interact in terms of their common *non-local* structure in this theory while in the mechanistic era of physics it was more natural to think of literal particles interacting, e.g. the 'photon'. The curl cells of Fig. 6 may actually be regarded as a kind of very non-local particle so this description intuitively hints at light's purported wave-particle duality (although it nibbles at SRT as just described, future research on neutrinos may clarify what actually happens very close to the velocity of light).

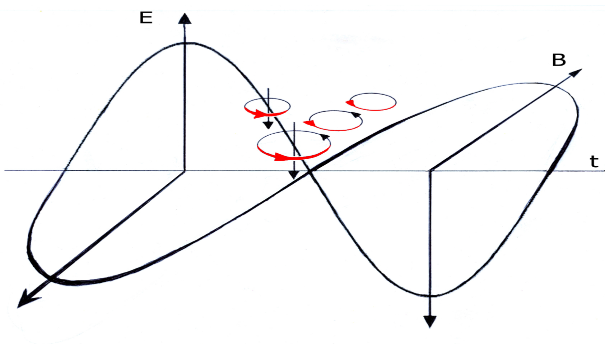

Figure 6: Schematic illustration of an electromagnetic wave with focus on the 'dark' node and its physics. At the node, both the electric and magnetic fields change most rapidly and these vectors of change are, by text-book prescription, surrounded by curls of magnetic field respectively current. This applies even if the 2×2 fields cancel and at least the phase will remain. As a result one obtains a description of the non-local wave-front by analogy with the non-local electron in Fig. 5 B.

Accordingly, along the lines of the present theory, consider one of the curl cells of Fig. 6 that has been emitted from a relativistically approaching or receding source as illustrated in Fig. 7. In order to deliver the projection of an electromagnetic wave around its line of forward movement

[3]Ampere

[4]...made unaccessible by the mathematical structure of SRT, similarly to a singularity in GRT or the impenetrable boundary of a black hole that was opened by the Kruskal-Szekeres coordinates. The idea that a particle of light, or any other particle as well, is like a singularity is not new; [7]

it can be regarded as a rotating dipole or a circulating fractional point charge - (a fluctuation of charge taking place in vacuum yielding a circular current) and both interpretations should yield a forward-directed torque which is contributed jointly by the forward and the backward rotation in the curl cell. Such a torque will have components that depend on both the permeability and permittivity of vacuum which define the velocity of light as

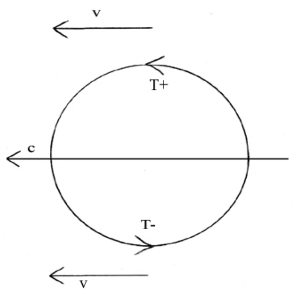

Figure 7: Schematic illustration of a curl cell as in Fig. 6 moving relativistically towards an observer to the left. In addition to the curl cell's inherent circulation of charge giving rise to a torque, the approaching (and likewise but reverse for receding) velocity add (upper half) and subtract (lower half) to the circulation of charge, which increases the torque exerted by the curl by a factor $+v$ in the upper half and $-v$ in the lower half. This scheme is compatible with Eqs. 10 and 12. The absorption should start when the origin in the drawing above with its maximum of electric field meets the electron. Then, as the rotation proceeds, momentum is transferred in the forward direction.

$$\frac{1}{\epsilon_o \mu_o} = c^2 \tag{16}$$

but as a consequence of of the antisymmetric velocity contributions from the upper and lower half of the curl cell (cf. Fig. 7) any physical effect of the velocity of light *via* the permeability and permittivity of space will be distorted as

$$c^2 = \mathcal{L}^2 \ (c+v) \ (c-v) \Rightarrow \mathcal{L} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \ . \tag{17}$$

This is the Lorentz factor:[5] A high velocity leads to a higher torque and amplification of the physical measure associated with the Lorentz factor, this is counteracted by lower permittivity and lower permeability of the interface medium.

Return now to Eq. 15. It too has the same squared terms like above and it may be interpreted in exactly the same manner: The circulating current on the right hand side of the equation like in Fig. 5 and Fig. 6 has an internal velocity of charge and is subject to relativistic effects due to approaching or receding external velocities like in Fig. 7. Since there are two currents in the squared term of Eq. 15, and these currents may be slightly different, they provide the foundation for the group velocity associated with the electron's energy, the 'beat' in Fig. 1 (Such beats generally arise because of a frequency mismatch). Then, because of the connection to the line increment on the left side of Eq. 15 one concludes that the orbiting electron, while wobbling in its beat, possibly with its deBroglie vibration frequency, derives its energy and its mass from the line increment - the latter is (in the present theory) nothing but the geometrized energy of the apparent local cosmological expansion. The interpretation of Eq. 15 as an instance of Eq. 17 in disguise is corroborated by previous results linking the squared line increment to various particle masses [8] [9].

[5]This rather trivial derivation may have been noted previously by some of the pioneers of modern physics, like for example Heaviside, who is recorded to have been a non-believer in SRT (wikipedia as of Feb. 2025) probably for some concrete reasons, and de Broglie, who actively pursued the group-velocity approach to light ($+v$ and $-v$ herein). However, both would have been perplexed by relativistic effects on mass and helpless against the trend of those times to make relativity theory a 'natural' geometry.

3 Context and Conclusions

Every highschool student can now derive and understand the physics of the Lorentz factor, which is the foundation for special relativity theory, borrow a textbook on the topic at the nearest library and wonder at the difficulty its originators had in understanding the Lorentz factor based on length contractions or time simultaneity. What a dream-come-true for the educator!....and what a nightmare for the accountable educator who must 1) navigate in the spider-web of taboos generated by SRT and 2) consider relativistic effects that have been observed in other areas than signal transmission, notably in the apparent mass and decay rates of moving particles and in sound. Among the taboos are, for example, that light's velocity in vacuum is limiting (counter-evidenced by instant communication within entangled superpositions), that light has no rest frame of its own and that it is a quantum particle of specified energy that literally kicks the electron to a higher energy level (recently counter-evidenced by 'multi-photon absorption' of lower energy and experiments on light's wave properties during its self-interaction in fibers etc.). As for relativistic effects on mass, it is possible to construct the mass in terms of the squared line increment as described above in the text. This indicates that similar concrete physical mechanisms may be at play in relativistic matter too rather than ascribing the observed effects to an abstract geometry. Especially solving the electron's orbit velocity in terms of the fine structure constant was an important result enabling the conclusions in this paper but the squared line increment - mass relation had been observed previously [8] [9]. As for the item of time, no-one knows what time is anyway and the theory presented herein is just another framework for trying to find out, perhaps it is just the squeezed unit circle keeping a constant area (Fig. 4). In the case of concrete physical processes, for example particle decay, 'time' might fit into some model of rotations like described herein.

As described in this paper, it is now possible to identify some concrete physical processes (involving rotations) that were previously concealed by SRT (and by the energy level - wave mechanics descriptions too). This paper started out by challenging the photon particle concept but now in the end a small concession can be made: The curl cells of charge in the EM field illustrated in Fig. 6 by analogy with Fig. 5, which when projected around a line yield the appearance of a wave may be regarded as such a particle. Such a particle would be notoriously non-local. As a result, instead of arguing like for centuries before whether light is a particle or a wave, it is now possible to understand why it is both a wave and a particle. A small concession is also due to the vague concept of energy. Up until this series of papers it had been just an abstract figment of the imagination, like a currency of conversion with no extension into anything concrete in physics. If, however, one accepts that the apparent cosmological expansion, the line increment, has an equivalent energy then this line increment is ubiquitous and can always and everywhere serve as the very concrete source of 'energy' since it is baked into the likewise ubiquitous energy-converting Planck's constant.

References

[1] R. Becker and F. Sauter (1964) Theorie der Elektrizität, Erster Band, 18:e Auflage, pp. 259-266 B. G. Teubner Verlagsgesellschaft, Stuttgart. (Most textbooks on special relativity would contain the same information)

[2] E. A. Cerwen (2020) *What Is a Photon and Where Is Light's Momentum In an Onboard Laser?* Proceedings of www.scienceandresearchdevelopmentinstitute.com, Quantum Physics and Cosmology # 28

[3] E Cerwen (2023) *New Light on Old Light - Reinterpreting the Cosmological Redshift as a Rotation at the Observer's Matter - Signalwave Interface* Proceedings of www.scienceandresearchdevelopmentinstitute.com, Quantum Physics and Cosmology # 33

[4] E. Cerwen (2024) *Reshaping the Electron ....Once More.* Proceedings of www.scienceandresearchdevelopmentinstitute.com, Quantum Physics and Cosmology # 36

[5] E. Cerwen (2016, 2024) *From atom to universe in a 1+0 -dimensional world* Proceedings of www.scienceandresearchdevelopmentinstitute.com, Quantum Physics and Cosmology # 20

[6] Erik A. Cerven (2010) *Quantitative Analysis of Atom and Particle Data Yields the Cosmological Expansion Rate in the Form of a Vacuum Instability.* Proceedings of www.scienceandresearchdevelopmentinstitute.com. Quantum Physics Cosmology # 13

[7] L. de Broglie (1987) *Interpretation of quantum mechanics by the double solution theory.* Ann. Fondation Louis de Broglie 12(4) 1-23.

[8] E. Cerwen (2024) *The Remarkable Apparent Stoichiometry of Particle Creation at the Universe's Relativistic Horizon* Proceedings of www.scienceandresearchdevelopmentinstitute.com, Quantum Physics and Cosmology # 35

[9] E. Cerwen (2022) *Exploring the nuclear physics of factorizing the Planck length.* Proceedings of www.scienceandresearchdevelopmentinstitute.com, Quantum Physics and Cosmology # 31