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“A Case for Compatibility of Speed of Light Variance with Atomic Physics”

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Abstract

The speed of light, c, is not a fundamental constant. It is dependent on other parameters, magnetic permeability and electric permittivity of a vacuum, parameters that are dependent on quantum fluctuations. I intentionally refer to these as parameters, and not constants, since they are dependent on the temporal and spatial characteristics of electromagnetic dipoles (e.g., density), virtual particle pairs, known to be prevalent in the vacuum quantum field through such experiments such as Casimir’s [1,2]. This model strongly supports the notion of a physical mechanism that best describes the nature of light as consisting of virtual particle pair dipoles serving to propagate light as well as retard it via collective Van der Waal torque contributions. However, since the usage of “c” is ubiquitous throughout physics, especially atomic physics, the idea of changing its value is highly unwelcome, resistance to c variance is most often the case. With all this in consideration, I have explored ways to reconcile variable speed of light with key equations and to shed light on the underlying physical mechanisms from an atomic physics perspective. This new codification, I call “dynamically tuned atomic physics” (DTAP) naturally maintains atomic stability through harmonious balancing of key atomic parameters. The driver that appears to cause this natural dynamic tuning is a variant electromagnetic quantum field density of polarized dipoles.

Key words: speed of light, quantum field theory, atomic physics, ZPE, Casimir effect

1. Introduction

Mainstream physicists reject the idea of variable speed of light due to the notion that established atomic physics equations are so finely and statically tuned to the current c value that they will collapse with any variance in c. The main purposes of this paper are to address the latter consensus and to raise some understanding of the nature of light as being dependent on the instantaneous quantum fluctuations of the electromagnetic quantum field physically, as opposed to a geometric mathematical construct of empty space, governed by gravity. In support of the DTAP paradigm, a new parameter, P_μ, is introduced that relates instantaneous vacuum magnetic permeability to the current value. To study its potential effects, I developed and utilized software to support DTAP simulation and analysis, utilizing empirical data to demonstrate the validity of this approach. The results of this work are encouraging and are included in the paper.

2. Speed of Light is Not a Fundamental Constant

It has been observed consistently that light speed is not constant. For example, c is observed to slow down when passing through a medium, such as glass, and yet resumes the same prior velocity once it exits the medium. This is difficult to explain with the photon (particle) model. When light propagates through a vacuum there is still a medium in which it propagates. This medium is the electromagnetic quantum field.

From Maxwell's Laws, we get the following relationships (1). Notice that c is not fundamental because it depends on vacuum electric permittivity, ϵ_0 , and vacuum magnetic permeability, μ_0. My assumption is that ϵ_0 is constant. There is a physics-driven rationale for this assumption but is beyond the scope of this paper and will hopefully be addressed in a future paper. A key result of this assumption is that μ_0 is inversely proportional to the square of c.

$$c = \sqrt{\frac{1}{\epsilon_0 \mu_0}} \quad \Rightarrow \quad c \propto \frac{1}{\sqrt{\mu_0}} \quad \Rightarrow \quad \mu_0 \propto \frac{1}{c^2} \tag{1}$$

Light is an electromagnetic wave, propagated through a medium. This medium has been given many names over time -- names such as ether, quantum field, vacuum energy field, dark energy, and zero point energy (ZPE) field. Whatever the name one desires to use, the medium provides an impedance, Z_0, much like that of an electric circuit. Z_0 is also dependent on ϵ_0 and μ_0 as follows:

$$Z_0 = \frac{\mathrm{E}}{H} = \sqrt{\frac{\mu_0}{\epsilon_0}} \tag{2}$$

where *E* and *H* are vacuum electric field and magnet field strengths, respectively. The following equation for μ_0 is derived from one of the many expressions for the fine structure constant, α. Also shown are other parameters: e, electron charge, $\hbar$, Planck's constant (h and $\hbar$ are used interchangeably in this paper since they only differ by the constant, 2π), and c, the speed of light.

$$\mu_0 = \frac{4\pi\alpha\hbar}{e^2 c} \tag{3}$$

3. Variant c Effects on Planck's Constant

For the wavelengths of light, λ, observed in the emitted atomic spectra,

$$E = \frac{hc}{\lambda}. \tag{4}$$

Consequently, assuming atomic energy levels, E, and wavelengths are invariant, hc (and $\hbar c$), must also be constant. This leads to the relationships:

$$\hbar \propto \frac{1}{c} \tag{5}$$

$$\text{and } \hbar \propto \sqrt{\mu_0} \tag{6}$$

Coulombs Law of electrostatic force between two charged particles states:

$$F = k\,\frac{q_1 q_2}{r^2}$$

where q_1 and q_2 are magnitudes of electric charge for two objects, r is the distance between them, and k is Coulomb's constant, as defined below:

$$k = \frac{1}{4\pi\epsilon_0} \tag{7}$$

Since electric permittivity, ϵ_0 is assumed constant, k is constant as well.

4. Dynamically Tuned Atomic Physics (DTAP)

Since c is dependent on μ_0, and μ_0 is considered by the author to be variant, as will be explained later, it is helpful to introduce a new parameter, P_μ , defined as the ratio of a dynamic vacuum magnetic permeability, μ_0', and the current value, μ_0. In this paper, the prime symbol (') is used to denote the instantaneous, or variant, value of the given parameter.

$$P_\mu = \frac{\mu_0'}{\mu_0} \tag{8}$$

This parameter will also be referred to in this paper as the dynamic magnetic permeability ratio (DMPR).

Since it has been established that $\hbar$ is directly proportional to the square root of μ_0 we get:

$$\frac{\hbar\prime}{\sqrt{\mu_0{}'}} = \frac{\hbar}{\sqrt{\mu_0}} \tag{9}$$

$$\hbar' = \frac{\hbar\sqrt{\mu_0{}'}}{\sqrt{\mu_0}} = \hbar\sqrt{\frac{\mu_0'}{\mu_0}}$$

$$\hbar' = \hbar\sqrt{P_\mu} \tag{10}$$

It follows, from the relationship already established between $\hbar$ and c (5) that:

$$c' = cP_\mu^{-1/2} \tag{11}$$

Frequency, ν, of a radiator such as light emitted from an electron dropping to a lower energy state is related to the speed of light and the associated radiation wavelength as:

$$c = \nu\lambda \tag{12}$$

Since the author assumes the atomic energy state transitions generally remain invariant, λ must be independent of changes in c. This results in changes in frequency being proportional to changes in c. The effective frequency, ν', can be derived as:

$$\nu \propto c \Rightarrow \nu \propto \frac{1}{\sqrt{P_\mu}} \tag{13}$$

$$\therefore \nu' = \frac{\nu}{\sqrt{P_\mu}} \tag{14}$$

This is further confirmed with the assumption that the radiated energy is unaffected by c variance.

$$E = h\nu = h'\nu' = h\sqrt{P_\mu}\frac{\nu}{\sqrt{P_\mu}} = h\nu \tag{15}$$

As the following expression indicates, fine structure constant is dependent on Planck's constant.

$$\alpha = \frac{e^2}{2\epsilon_0 hc} \tag{16}$$

Applying equation 10,

$$\alpha' = \frac{e^2}{2\epsilon_0 \hbar' P_\mu^{-1/2} c' P_\mu^{1/2}} = \alpha \tag{17}$$

Hence, α remains unchanged by the effects of the instantaneous magnetic permeability by application of the DMPR as shown. Applying this technique to the Rydberg constant, *R*. The DMPR factor must be used to compensate for the changes in Planck's constant and the speed of light.

$$R = \frac{k^2 e^4 m}{4\pi\hbar^3 c} \tag{18}$$

$$R = \frac{k^2 e^4 m}{4\pi\left(\hbar' P_\mu^{-1/2}\right)^3 c' P_\mu^{1/2}} = \frac{k^2 e^4 m}{4\pi\left(\hbar' P_\mu^{-1/2}\right)^3 c' P_\mu^{1/2}} = \frac{k^2 e^4 m}{4\pi\hbar'^3 c'} P_\mu$$

The orbital speed of an electron around its associated nucleus is determined by the following equation:

$$v = \frac{ke^2}{\hbar} \tag{19}$$

Since $\hbar$ is assumed by the author to be variant, so must the uncompensated instantaneous value. We see that the proper compensation factor is $\sqrt{P_\mu}$.

$$v' = \frac{ke^2}{\hbar'} = \frac{ke^2}{\hbar\sqrt{P_\mu}} = vP_\mu^{-\frac{1}{2}} \tag{20}$$

The same fine structure constant of (16) possesses several expressions. One of these is the ratio of electron orbital speed to the speed of light.

$$\alpha' = \frac{v\prime}{c\prime} = \frac{vP_\mu^{-\frac{1}{2}}}{cP_\mu^{-1/2}} = \frac{v}{c} = \alpha \tag{21}$$

This is in direct agreement with (17).

Atomic energy levels must also be dynamically compensated for by the DMPR.

$$E_n = \frac{m_e e^4}{2(4\pi\epsilon_0)^2\hbar^2 n^2} \tag{22}$$

$$E_n' = \frac{m_e e^4}{2(4\pi\epsilon_0)^2(\hbar')^2 n^2} = \frac{m_e e^4}{2(4\pi\epsilon_0)^2\left(\hbar\sqrt{P_\mu}\right)^2 n^2} = \frac{E_n}{P_\mu} \tag{23}$$

Therefore, to preserve the atomic energy levels, we must compensate, once again by the DMPR factor.

$$E_n = E'_n P_\mu \tag{24}$$

Bohr radius impact and required compensation:

$$a = \frac{\hbar}{\alpha m_e c} \tag{25}$$

$$a' = \frac{\hbar'}{\alpha m_e c'} = \frac{\left(\hbar\sqrt{P_\mu}\right)}{\alpha m_e c P_\mu^{-1/2}} = aP_\mu \tag{26}$$

5. Vacuum Magnetic Permeability and Zero Point Energy

This DMPR factor, P_μ, may appear to be merely a mathematical construct to preserve atomic physics as we have come to understand it. However, the author proposes that it arises from a physical, though very difficult to measure, ZPE, or the other terms for the same entity listed earlier. When Max Planck developed his first radiation law [3,4] for average radiation energy, ε, of an atomic source with wavelength, λ, can be computed as:

$$\varepsilon = \frac{h\nu}{e^{\frac{h\nu}{kT}} - 1} \tag{27}$$

Where k is the Boltzmann constant and T is the absolute temperature of the matter generating the energy. It has already been shown that the product, $h\nu$, is insensitive to changes in the speed of light. Therefore, it follows that ε is as well. In 1911, Planck made an addition of another term to equation (27) as shown below.

$$\varepsilon = \frac{h\nu}{2} + \frac{h\nu}{e^{\frac{h\nu}{kT}} - 1} \tag{28}$$

The second term in Max Planck's equation (28) for the quantum oscillator energy disappears when T goes to zero, leaving only the first term, hence the name zero point energy [5], also representative of the ground state for the most fundamental element, hydrogen. This modification introduced a new physics phenomenon, as mentioned earlier, ZPE, also known as the quantum field or vacuum energy. ZPE has been a center of controversy among physicists for the last one hundred years. Einstein was initially excited and accepted it [6]. Shortly after, finding it did not agree with an experiment he was involved in at the time, he recanted his support for ZPE existence. However, he changed his mind again when he realized it supported his cosmology model and folded it into his cosmological constant. Other physicists (and chemists) supported the existence of ZPE and served to develop it further. They include theoretical and experimental scientists such as Debye [7], Nernst [8], Bennewitz [9], Simon [9], Mulliken [10], Heisenberg [11], Jeans [12], Schrodinger [13], Seiringer [14], Casimir [1,2], Lamb [15], and many others.

Now we address the physical effects of ZPE on the speed of light. Note that equation (28) is for one atom (or more generally, one oscillator). It is the energy required to keep the electron orbit from collapsing into the nucleus. As shown earlier, when the DMPR is applied to each of the two variables, the product, $h\nu$, remains unchanged. The quantum field stores this ZPE in a "sea" of virtual particle pairs [16] in the form of electromagnetic dipoles. These dipoles have been observed to exert van der Waals forces and torques, as in Casimir's famous experiment. The Casimir effect, as illustrated below, is best described as an attractive force between two neutrally charged objects. This force is neither gravitational nor electromagnetic. ZPE is a combination of energy waves, formed by the dipoles, with wavelengths varying from atomic to extremely large dimensions. When two plates are placed near each other, they basically exclude the longer waves from the space between them. This creates an imbalance of energy (and force) between the interior and the exterior of the plates. So, the space between the plates collapses. This is seen in experiments in which the forces can be measured.

Many physicists have related the speed of light to interactions within this medium, as well as to effects of gravity. This partial list of such physicists includes Einstein [17] (for much of his career), Dicke [18], Urban [16], Latorre [19], Unzicher [20], and Fleming [21]. We can determine the ZPE energy density, ρ, as shown below [22]:

$$\rho = \frac{\hbar\left(\omega_2^4 - \omega_1^4\right)}{8\pi^2 c^3} \tag{29}$$

The quantum field is modeled with respect to a hyper extensive frequency spectrum of electromagnetic energy represented in terms of angular frequencies (ω_n). Consequently, the vacuum energy density is a function of the range of quantum fluctuations present and the speed of light. For a given set of frequencies, from (29), we see the relationships between ρ , c, and $\hbar$ are:

$$\rho \propto \frac{\hbar}{c^3} \tag{30}$$

It has already been established that:

$$c \propto \frac{1}{\sqrt{\mu_0}} \text{ and } \hbar \propto \sqrt{\mu_0}$$

Substituting into (30) yields:

$$\rho \propto {\mu_0}^2 \tag{31}$$

Therefore, the vacuum magnetic permeability relates to the ZPE density as:

$$\mu_0 \propto \rho^{1/2} \tag{32}$$

Taking relationships defined in (2) and (32), we can conclude that the ZPE impedance, Z_0 is directly proportional to the energy density:

$$Z_0 \propto \sqrt{\mu_0} \tag{33}$$

$$\mu_0 \propto {Z_0}^2 \tag{34}$$

$${Z_0}^2 \propto \rho^{1/2} \tag{35}$$

$$Z_0 \propto \rho^{1/4} \tag{36}$$

A possible set of physical mechanisms have now been established that result in a variance of light speed over time. Changes in ZPE density affect changes in electromagnetic quantum field impedance which changes the magnetic permeability, thereby varying the speed of light. Relationship (32) shows that, since the energy density affects μ_0 so directly, it could be what is motivating the introduction of the DMPR tuning parameter, P_μ. Table 1 provides a summary of the required DTAP compensation factors for the various parameters mentioned herein. It must be clarified that electron mass invariance, for now, has been assumed. Later in this paper, the impact of electron mass variance is analyzed and discussed.

6. Atomic Energy Level Sensitivity to ZPE

Consider the effects of ZPE quantum field fluctuations, or lack thereof, on the hydrogen atom. As the electron orbits the nucleus at a steady orbital radius (assuming on state transition). There must be a force to maintain this radius. The accepted theory that supports this is the presence of the ZPE. If the ZPE density were different than what we experience in our time and space, Z_0 would also be different, as well as c. The electron orbital velocity, v, would also be affected proportionally. Therefore, the angular momentum, kinetic energy, and centrifugal force would be impacted. These are the physical entities that make up the change in the value of R and E_n (assuming electron mass invariance) and as seen in equations (18) and (23), respectively. This is illustrated in Figure 1. The underlying mechanism beyond ZPE density variation that affects c is Van der Waals torque applied by the plethora of dipoles that make up the surrounding electromagnetic quantum field.

Parameter	*Symbol*	*Required DTAP Compensation*
Speed of light	c	$P_\mu^{1/2}$
Frequency of light	ν	$P_\mu^{1/2}$
Rydberg constant	R	P_μ
Electron orbital velocity	v	$P_\mu^{1/2}$
Hydrogen energy levels	E_n	P_μ
Planck's constant	h	$P_\mu^{1/2}$
Bohr radius	a	$1/P_\mu$

Table 1. Summary of key DTAP parameters assuming electron mass is a constant.

$$\rho \Rightarrow \mu_0 \Rightarrow c \Rightarrow v$$

$$\rho \Rightarrow h \Rightarrow \nu$$

$$\rho \Rightarrow Z_0 \Rightarrow c$$

$$\begin{tikzcd} h \arrow[dr, Rightarrow] & & \\ & R \arrow[r, Rightarrow] & E_n \\ c \arrow[ur, Rightarrow] & & \end{tikzcd}$$

Figure 1. Theoretical causal effects on key parameters assuming electron mass invariance.

7. Einstein's Mass-Energy Conversion Equation

Until this point in the paper, I have considered electron mass to be a constant. However, measurement of this parameter could also subject to ZPE density so now, such a possibility is addressed. This begins by deriving the relationship between particle mass and c through application of Einstein's mass-energy conversion equation:

$$E = mc^2 \tag{37}$$

where E represents the energy of a particle of rest mass, m, (for particles with speeds much less than c). From (37) and assuming energy conservation, we have:

$$m \propto \frac{1}{c^2} \tag{38}$$

8. Sauter-Schwinger Energy Limit

It is also interesting to acknowledge the harmony between DTAP and the Sauter-Schwinger energy limit [23], above which quantum field fluctuations are greatly increased. The equation is:

$$E_{crit} = \frac{m^2c^3}{e\hbar} \tag{39}$$

When the relationships (5) and (38) are applied to (39) the value for E_{crit} changes through variations in ZPE strength by the factor of $P_\mu^{-1/2}$. This is the derived energy limit, beyond which the quantum field effects go nonlinear. So as vacuum magnetic permeability decreases, the Sauter-Schwinger energy limit increases. Schwinger derived nonlinear corrections to the fields and then calculated the rate of electron-positron pair production in a strong electric field [24]. Changes in electron-position pair production rates translate directly into changes in ZPE density.

9. Simulation and Analysis of Related Observational Data

To test the DTAP hypothesis, the author analyzed existing empirical data from c, h, h/e, and m/e measurements over time. It is unfortunate that the earliest reliable observations are somewhat limited but what does exist is still helpful to shed light on plausibility of speed of light variance. Additionally, there is understandably a lack of data related to time histories of measurements of ϵ_0 , μ_0 , and ZPE density.

The author has performed Monte Carlo analysis of historical measurements of the speed of light from the 1700's to the mid 1900's [25]. A more detailed discussion of this analysis will be included in a future paper. Figure 1 shows these c measurements. The data selection was based upon the following inclusion criteria:

1) c values less than 300500 km/sec,
2) at least 200 observations per value,
3) reasonably consistent with trend derived from the other selected data,
4) error bars less than 200 km/sec, and
5) laser method excluded.

This served to minimize Monte Carlo run and analysis time, provide objectivity, and filter out experiments with excessive error bars and/or variance, hence focusing on what should be the most accurate results. Laser-based data were not included due to the lack of c-variance observability associated with the atomic nature of such circularly natured measurements. The resulting set of data is shown in Table 2. The selected data was comprised of eighteen values for c, eight different methods, and nearly 50,000 measurements.

The solid curve in Figure 1 represents the mean of c over all the 100 Monte Carlo runs. Here we see a downward trend in c. Accuracy results for the estimated mean relative to the measurement mean was 0.000561 % (mean of all simulated speed of light estimates relative to mean of all measurements). The RMS estimation error with respect to measurements was 45.5 km/sec.

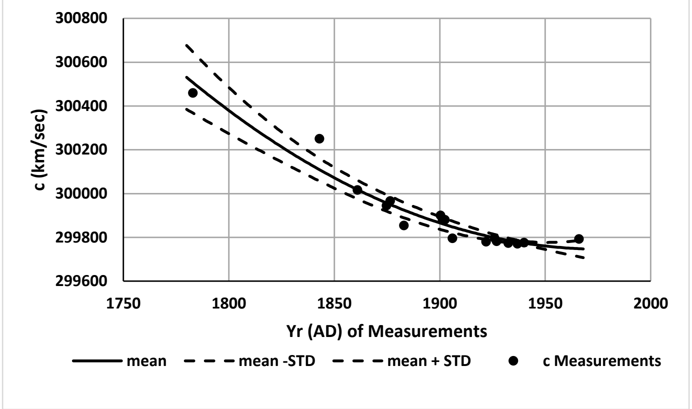

Figure 1. Simulation c results plotted with observational data [25].

The 100 simulated c trajectories from the Monte Carlo analysis were generated by randomizing each observational data point according to their designated STD's with a Gaussian distribution. Each run was curve-fitted with a variety of functions. Those functions that yielded the highest R^2 values were considered for the final analysis. More details of this analysis will be provided in future papers.

	Date	Observers	Method	c (km/sec)	STD (km/sec)	N of Measurements
1	1783.0	Lindenau	Aberration	300460.0	160	330
2	1843.0	Struve	Aberration	300250.0	160	200
3	1861	Glasnape	Moons of Jupiter	300016.7	150	320
4	1874.8	Cornu / Helmet / Dorsey	Toothed Wheel	299945.0	200	208
5	1876.5	Harvard / Sampson	Moons of Jupiter	299966.0	13	500
6	1883	Newcomb, Michelson/Nyred	Rotating Mirror	299854.3	60	2629
7	1900.4	Perrotin	Toothed Wheel	299900.0	80	770
8	1901.4	Perrotin	Toothed Wheel	299880.0	50	2002
9	1902.4	Perrotin / Prim	Toothed Wheel	299880.5	84	2464
10	1906	Rosa / Dorsey	E and M	299795.5	20	1638
11	1922	Kulikov	E and M	299780.0	60	28542
12	1926	Michelson / Birge	Polygonal Mirror	299797.0	15	1600
13	1927	Mittelstaedt / Birge	Kerr Cell	299782.0	10	775
14	1932.5	Pease / Pearson	Polygonal Mirror	299774	10	2885
15	1936.8	Anderson / Birge	Kerr Cell	299771.0	10	651
16	1940.0	Anderson	Kerr Cell	299776.0	10	2895
17	1966.0	Karolus	Modulated Light	299792.4	0.2	278

Table 2. Details of speed of light measurement data used for the Monte Carlo analysis.

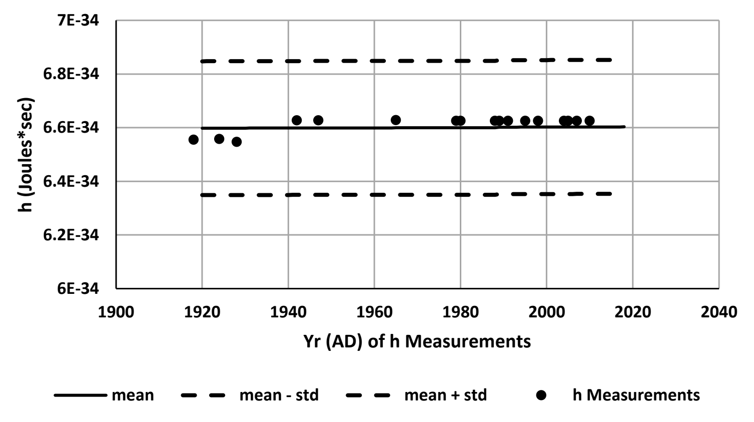

Figure 2. Simulation h results plotted with observational data [].

For the current study, the same computer model and stored c trajectories were used to estimate such parameters as h, h/e, and m/e and compare these results to empirical data. Planck's constant measurements were extracted from [26] and are shown in Figure 2, along with the simulated results. Estimates for h at each epoch were generated by application of the inverse relationship between h and c (5). Notice the slight upward trend of the h observations. The plot of the h mean from the Monte Carlo simulation appears to be a curve fit to the data but it is actually the inverse of the c mean as stated previously. The relative error of the overall simulated mean with respect to the mean of the measurements is 0.22% and the RMS error is 2.89x10^{-36} Js. The dashed plots represent the 1σ simulation boundaries.

Similar simulation and analysis were performed with historical h/e empirical data [27]. The results are shown in Figure 3. Once again, the (5) was applied in the simulation and once again, there was accurate prediction of the observational data. This time the relative error of the overall simulated mean with respect to the mean of the measurements is 0.25% and the RMS error is 3.53x10^{-19}erg*s/ESU.

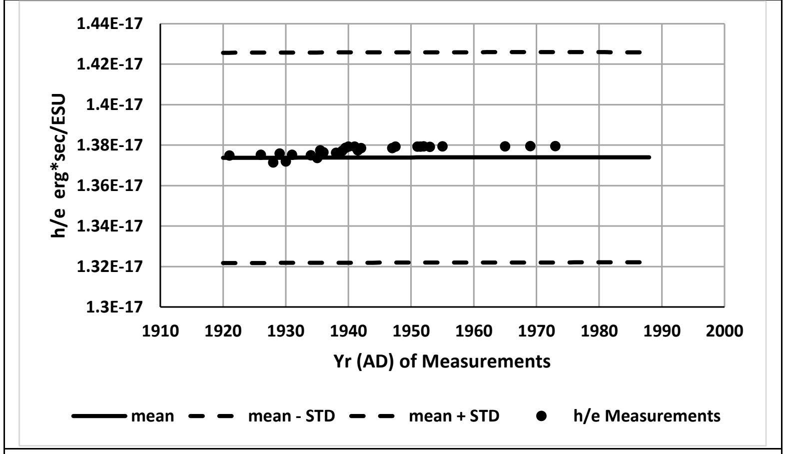

Figure 3. Simulation h/e results plotted with observational data [27].

A third set of Monte Carlo simulation runs were then executed in which the electron mass variance was modeled via the relationship described in (38). The observational data used for this was provided in [27]. Figure 4 shows the empirical data plotted against the mean (solid curve) and STD (dashed curve) from the simulation. The relative error of the overall simulated mean with respect to the mean of the measurements is 0.01% and the RMS error is 6.22x10^{-11} gm/EMU. For each year of data, either the simulation mean is well within 3σ measurement uncertainty or the measurement is well within the mean plus/minus 3σ of the estimate. Since the author adheres to the assumption of electron charge invariance based upon observational data [27], any change in the e/m (or m/e) ratio is driven only by changes in electron mass.

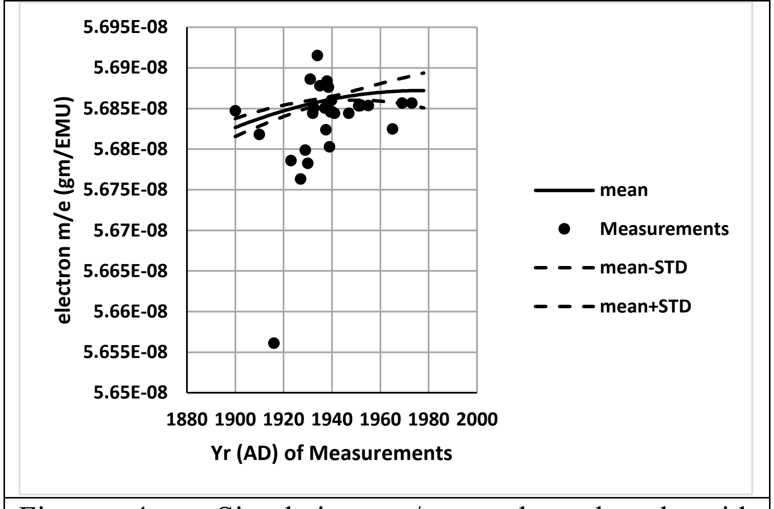

Figure 4. Simulation m/e results plotted with observational data [27].

10. Application of Electron Mass Variance to DTAP

With the accurate prediction of electron mass as a function of time by applying relationship (38) to my Monte Carlo simulation, I was motivated to revisit Table 1 and the equations with which it was derived. This exercise revealed that there is no longer a required DTAP compensation factor (other than unity) for the Rydberg constant, atomic energy levels, and Bohr radius. The trade for this is the variance of electron mass. Table 3 summarizes the results. This change in DTAP compensation leads to a deeper understanding of physics, in that it is not static but adjusts to variations in ZPE density. Recall that the DMPR factor, P_μ, is not absolute but is a mechanism that relates the parameters in Table 3 to their locally and currently measured values.

Parameter	*Symbol*	*DTAP Compensation*
Speed of light	c	$P_\mu^{1/2}$
Frequency of light	ν	$P_\mu^{1/2}$
Electron orbital velocity	v	$P_\mu^{1/2}$
Planck's constant	h	$P_\mu^{1/2}$
Electron mass	m_e	P_μ^{-1}

Table 3. Summary of key DTAP parameters with electron mass variance.

11. Electron Mass Measurements

The ratio of charge-to-mass of free electrons was originally measured by J. J. Thomson [28,29] with a cathode ray tube in which the velocity of the electrons was regulated by the relative voltages applied between the cathode and the anode. Deflection of the electron trajectories was controlled by the applied magnetic field perpendicular to the plane in which they traversed the tube. The same principle is still being used to measure particle masses but with much more massive, sophisticated, and accurate equipment (e.g., mass spectrometers, particle accelerators). Another method is that of measuring the electron/mass ratio by the Zeeman effect [30] with a Fabry-Perot interferometer. This approach relies heavily on the assumed speed of light. Application of the Stark effect is a similar approach but involves an external electric field [31].

12. Further Discussions Regarding Electron Mass

It is important to remember that particle mass measurements are performed in the presence of ZPE at the given time and location. With the inclusion of the quantum field, there is little or no distinction between increase in particle mass and ZPE density increase. In other words, if a particle, moving at high speeds, begins to decelerate, those that adhere to SR claim it is due to increased relativistic particle mass. However, it could just as well be due to the effects of ZPE damping due to Van der Waals forces from virtual particle pair dipoles. With the latter model in mind, measurements of electron mass are dependent on ZPE density with both types of measurement approaches. With the Zeeman approach such measurements are further influenced by the local and current speed of light.

13. Vacuum Birefringence

It has been demonstrated that the insertion of a strong external magnetic field to a vacuum influences the interaction of virtual electron-positron pairs with light [32]. Such interactions have been found to enhance some polarization modes while leaving other modes unchanged. Consequently, photon phase velocity in this externally magnetized vacuum becomes dependent on the polarization. This polarization dependence of the refractive index is known as vacuum birefringence. It relates to the topic of this paper because it demonstrates the effect of externally applied magnetic fields on ZPE and the speed of light.

14. Conclusion

The premise or assumptions by which the nature of light is regulated are fundamental to the understanding of how it relates to atomic physics. If light is merely composed of photons being propelled through empty space with no medium at a constant value of c, in lock step with mainstream physics, unless they approach a massive object and then somehow regain the same velocity as they recede. Such a model is purely mathematical and, at best, is incomplete because it does not provide a physical cause but only action at a distance. Light needs a medium. This medium: ZPE, quantum field, vacuum field, etc., best explains the nature of light propagation and hence, speed. The author has attempted, in this paper, to describe what seems to be a better model. Key atomic physics equations were included to show how there could exist not only compatibility, but also a different level of constancy in nature, such as atomic energy levels. This physics includes the potential and causal effects of the known medium, which appears to serve as the regulator, or tuner, of atomic physics: a process I have dubbed DTAP. Such natural tuning, as shown in the relationships derived herein, keeps everything balanced dynamically. As shown, when actual c data is used to predict h, h/e, and m/e, the accuracy of results is encouraging. This hypothesis should not be considered unfalsifiable. Indeed, it should be pursued in the laboratory. Since it is known that we can create changes in local ZPE density through the application of strong magnetic fields[32] and other approaches using high energy lasers, these DTAP relationships can be tested. However, care must be taken to eliminate circular processes such as those including atomic clocks, for example, in measuring the speed of light.

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