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Reviewing Zero Point Energy Developments Plus some Unexpected Outcomes

State

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Reviewing Zero Point Energy Developments Plus some Unexpected Outcomes

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ABSTRACT

This review begins with Max Planck's papers of 1901 and 1911 which resulted in Quantum Electro-Dynamics (QED Physics) and Stochastic Electro-Dynamics (SED physics) respectively. The second paper introduced the Zero Point Energy (ZPE), as a real physical entity, which is intrinsic to the vacuum, and whose strength is given by Planck's constant 'h'. The evidence suggested that the ZPE originated with universal expansion, and, as expansion continued, its strength increased. It has since been shown that the ZPE controls the electric and magnetic properties of the vacuum, so these properties are uniformly affected by cosmic expansion. Data from 6 different physical quantities, which are ZPE related, support this contention. In addition, four unexpected outcomes are explored that also support this approach, and may potentially resolve some related scientific puzzles.

Historical Introduction to the Zero Point Energy (ZPE)

In 1901, Max Planck published his first paper, which overcame a persistent problem that physics had in describing the behavior of radiation. Planck did this by introducing an arbitrary factor, 'h' into his equations [1]. At this time, the quantity 'h' had no physical significance. It was just a mathematical abstraction, even though this factor gave the "right" answer. This was a conceptual problem for Planck. After giving it much thought, Planck published his so-called "second paper" in 1911 [2]. This gave the same outcome as the first paper, but with a key difference. In this 2nd paper, the quantity 'h' represented a real physical entity, which indicated the presence of an energy intrinsic to the vacuum. Because his equations indicated this energy was still present when the temperature of the vacuum was absolute zero degrees Kelvin (about minus 273 degrees C, or near minus 460 degrees F), this intrinsic energy became known as the Zero Point Energy or, simply, the ZPE. Planck's equations revealed that the quantity 'h,' (now called Planck's constant) was a measure of the strength of the Zero Point Energy.

In a follow-up paper in 1913, Einstein and Stern using classical physics came to the same conclusion as Planck. They pointed out that if dipole oscillators [sub-atomic particles] were immersed in a field of this irreducible zero point energy, "the Planck radiation formula would result without the need to invoke quantization at all" [3]. In 1916, after assessing the validity of these developments, Walther Nernst concluded that the whole cosmos must be filled with vast amounts of this ZPE. In turn, he pointed out that this necessarily required the ZPE to have an intrinsic, cosmological origin [4]. However, despite this beginning and the ongoing discussion for the next 9 years, no further advance was recorded.

The next development occurred in 1923, when Louis de Broglie presented his paper. This paper set the course for quantum mechanics (Quantum Electro-Dynamics or QED physics) using only the basis of Planck's

first paper. This meant the ZPE was only a virtual quantity with no physical meaning [5]. Because ‘h’ had no physical meaning in these equations, it was concluded that the various outcomes from this approach represented some strange properties inherent within matter itself [6].

Nevertheless, about the same time as de Broglie published his paper, the first experimental proof of the existence of a real, physical ZPE, was obtained experimentally by Robert Mulliken in 1925 [7]. A very similar proof was obtained by Willis Lamb in 1947 [8]. In each case, the impacting ZPE waves were perturbing the ‘orbiting’ motion of electrons sufficiently in those atoms to slightly change the color of light they emitted on the rainbow spectrum. Yet both these results were side-lined because science preferred other theoretical explanations at the time. Some pioneering physicists are in Figure 1.

Image



Figure 1

Experimental Proofs and a New Approach

After the discussion about the reason for the Lamb Shift of spectral lines, Hendrik Casimir designed an experiment in 1948 to prove one way or the other whether the ZPE was a real entity, or, alternately, only a virtual mathematical abstraction [9]. In effect, it was determining whether it was Planck’s 1901 paper or his 1911 paper that was correct. In the experiment, it was found that two metal plates in a near-perfect vacuum, at a temperature close to absolute zero, were pushed together by the zero point waves acting outside the plates. The carefully conducted experiment had excluded all other forces that could act to push the plates together. Only the real ZPE was left to do that. When the experiment was finally concluded by M.J. Sparnaay in 1957, the Casimir effect proved the ZPE was definitely a real physical phenomenon [10].

As a result of this experimental outcome, Louis de Broglie wondered if physics had made a wrong turn back in the 1920’s. In 1962, he published a cautiously worded book, New Perspectives in Physics, in which he pointed out that Planck’s 1911 approach in the 2nd paper had embraced classical theory plus a real intrinsic cosmological ZPE. He noted that this 2nd paper with the ZPE had a degree of acceptance in the following years, even though many were now following the path from Planck’s 1st paper, [11]. De Broglie’s book initiated a re-examination of this alternate approach since it showed that quantum processes actually had viable explanations in terms of classical physics, as long as the real Zero Point Energy was included. His book started a re-examination of the issue.

In 1966, this led Edward Nelson to publish a landmark paper. There, he derived the Schrodinger equation from a purely classical physics approach by using the action of a real ZPE on particles of matter in a manner similar to Brownian motion [12]. Then in 1975, Timothy Boyer, using a classical physics approach plus a real ZPE, demonstrated that the continual battering of the ZPE waves on sub-atomic particles produced exactly the same uncertainty in position and momentum at any instant as the Heisenberg Uncertainty Principle tried to explain [13]. This also showed that the number of ZPE waves impacting on electrons, causing them to oscillate at the Compton frequency, really did hit the electron some 1.23 x 10^20 times per second. These hits on sub-stomic particles caused the so-called “zitterbewegung,” or ‘jitter motion,’ that turned out to be the physical origin of quantum uncertainty. Previously, this had simply been attributed to a property inherent within subatomic matter itelf [6].

Precise experimental verification for the Casimir effect being due entirely to the ZPE was obtained in 1998 by Mohideen and Roy, thereby removing all doubt on this issue [14]. A similar verification for the physical truth of the ZPE wave impacts causing the Compton frequency was obtained in an experiment using calcium ions by Gerritsma, Roos and colleagues in 2010 [15]. Finally, an analysis by Bernard Haisch and Alfonso Rueda demonstrated that when the Compton frequency ‘jitter’ is combined with the motion of an electron, there is a beat frequency superimposed on the oscillation which proves to be exactly the same as the de Broglie wavelength [16]. So, essentially, it has only been since 1998, and finally in 2010, that solid theoretical and physical evidence has proven unequivocally that a real, all-pervasive, physical ZPE does exist that controls sub-atomic particle behavior. The branch of physics dealing with the action of this real ZPE is now known as Stochasic Electro-Dynamics (SED physics), because of the stochastic or random waves of the ZPE. Figure 2 has images of some physicists who were involved in promoting SED concepts. We will

follow their lead here to see what other results may emerge.

Image



Figure 2

Taking this a Step Further

Recent work indicates that the ZPE originated with universal expansion, in line with the 1916 comments by Nernst [4]. Two papers about this proposal, the data supporting it, and the consequences, may be found in “A Plasma Universe With Changing Zero Point Energy” [17], and “Zero Point Energy, Light and Time” [18] including the references listed in both those articles as well as in others [19,20]. It is pointed out that this energy originated in a manner similar to the way that the expansion of a rubber band, or the inflation of a balloon, imparts an energy to their fabric. Possible mechanisms were discussed from a variety of cosmologists in a more complete presentation in the Conference Monograph in [21]. In that same presentation, it was shown that, as universal expansion continued, the Zero Point Energy continued to build up in strength. This may be seen as similar to the increasing tensional energy residing in the fabric of a balloon as its inflation continues.

The conclusion is that, as the expansion of the universe went on, the strength of the vacuum ZPE systematically increased. In turn, this brought about a systematic change in the electric and magnetic properties of the vacuum as the vacuum became “thicker” with energy [20]. These conclusions are illustrated in Figure 3.

In order to conceptualize what is happening with the electric and magnetic properties of the vacuum, let us consider an everyday analogy. At the beach, we notice that, when ocean waves meet, they peak, crest and form whitecaps, foam or spray, which soon disappears and returns back to ocean waves. Similarly, when the energy waves of the ZPE collide in this ‘cosmic ocean,’ the concentration of energy forms particle pairs, positive and negative. This happens because energy and matter are inter-convertible as modern physics has shown. These particle pairs are called Virtual Particles (VP), because they quickly slam back together, annihilate, and return to energy.

Image

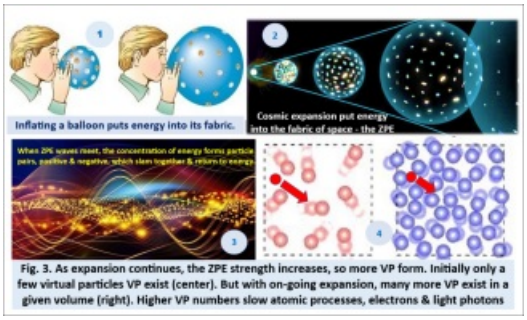


Figure 3

Because these Virtual Particle pairs (VP) are positively and negatively charged, their movement produces magnetic fields. Examples of the VP are electron-positron pairs, proton-antiproton pairs, positive and negative pions, and so on. In fact, studies show that there is a whole range of virtual particles of at least 21 different types. Thus, along with the ZPE waves, they also control the electric and magnetic properties of the vacuum of space. Since universal expansion means that more energy is being invested in the fabric of space, the vacuum then gets “thicker” with virtual particle pairs over time. In turn, this changes the electric and magnetic responses of a number of quantities.

An additional effect described in “Reviewing the Role of Virtual Particles in the Vacuum” shows how the

strength of the ZPE controls the electric and magnetic properties of the vacuum and how this originates with cosmic expansion [20]. This verifies Nernst's early analysis.

Summary of Experimental Data

(a). Planck's Constant

In his 1901 paper, Planck introduced 'h' simply as a factor which gave the 'right' answer, but had no physical significance. As such, this factor was not expected to change over time. This has been the position taken by many physicists over the last century of science. However, in his 1911 paper, Planck demonstrated the existence of a real, physical ZPE [2]. This paper differed from his 1901 paper in that the additional term containing 'h' was independent of temperature. This indicated that a uniform, isotropic background radiation existed. In his 1911 paper, Planck's constant, 'h,' appeared in the Zero-Point term without any quantum interpretation. This meant that if the ZPE strength was greater, the value of 'h' would be correspondingly larger. Thus, 'h' is a measure of the strength of the ZPE. The graph of the recommended value of Planck's Constant, 'h,' over orbital (gravitational) time appears below in the left panel of Figure 4, colored green. The data and their references are tabulated in Cosmology and the Zero Point Energy chapter 2 entitled "An introduction to Planck's constant, 'h,' and the speed of light, 'c,' pages 53-71 [21].

Some 60 values, that have been recommended internationally, support this trend for an increasing value of 'h,' involving h/e, h/2e, and 2e/h. Each of these values was the result of hundreds of individual experiments [21], [22]. These data have presented some problems to the scientific community. For example, in 1965, John H. Sanders pointed out that the increasing values for 'h' could only partly be accounted for by the improvements in instrumental resolution [23]. One reviewer who maintained instrumental improvements as his explanation, nevertheless remarked that this "may in part explain the trend in the figures, but I admit that such an explanation does not appear to be quantitatively adequate" [24]. In other words, without the ZPE explanation, these data do present something of a conundrum.

(b). The Speed of Light, 'c.'

The virtual particle (VP) approach to lightspeed and the ZPE was initially explored in detail in a paper by Gerd Leuchs and his team in 2010 [25]. Using a very similar mechanism in 2013, Marcel Urban and a team of astrophysicists from the University of Paris were able to reproduce the current speed of light from the interaction times of light photons with virtual particles in the vacuum. They write specifically: "When a real photon propagates in the vacuum, it interacts with and is temporarily captured by an ephemeral [virtual particle] pair. As soon as the pair disappears, it releases the photon to its initial energy and momentum state. The photon continues to propagate with an infinite bare velocity. Then the photon interacts again with another ephemeral pair and so on. The delay on the photon propagation produced by these successive interactions implies a renormalisation [change] of this bare velocity to a finite value. … We then derive the photon velocity in the vacuum by modeling its propagation as a series of interactions with these [particle] pairs" [26]. It was pointed out, just below their equation (27), that interaction times were independent of photon energies. If they were not, space would be a dispersive medium, bending different wavelengths by different amounts. They also state that for vacuum permittivity and permeability, "the electric charges and the number of species are the only important parameters." The Urban team concluded that "A consequence of this description is that the permittivity and permeability of free space and the vacuum speed of light are not fundamental constants, but observable parameters of the quantum vacuum: they can vary if the vacuum properties vary in space or time" [26]. This important conclusion by the Urban team in 2013 seems to have been lost on the metrologists who set lightspeed as a fixed constant in 1983, and who reiterated that directive in their 2019 re-assessment.

With cosmic expansion causing an increase in ZPE strength, it should then be expected that lightspeed would decrease over time. Data from 163 determinations of 'c' (each involving hundreds of individual experiments), by 16 methods over a period of 300 years confirmed this trend. Some 475 values of 11 other atomic quantities by 25 methods in orbital time support this scenario [21,22]. Soon after, an independent re-analysis of all the 'c' data by A. Montgomery and L. Dolphin produced the graph in the center panel of Figure 4, that plots the best 144 values of 'c' data with errors below 0.1% [27]. Full experimental details are recorded in Cosmology and the Zero Point Energy chapter 3, pages 72-137 [21].

Image

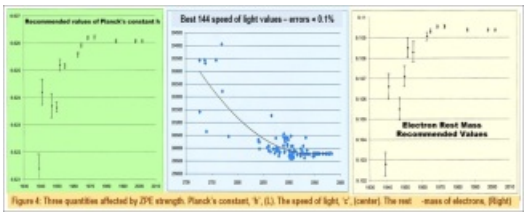


Figure 4

These data have also been a problem to physicists. A vigorous discussion about the trend went on from the mid 1800's to the mid 1940's. In 1886, Simon Newcomb reluctantly concluded that the values of 'c' obtained around 1740 were in agreement with each other, but were about 1% higher than in his own time [28]. In 1941, Raymond T. Birge made a parallel statement when writing about the 'c' values obtained by Newcomb and others around 1880. Birge conceded that "…these older results are entirely consistent among themselves, but their average is nearly 100 km/s greater than the eight more recent results" [29]. In many fields of scientific endeavor this data trend would be considered disastrous to prevailing theory.

(c) Sub-Atomic Particle Masses

In the early 1900's, quantum pioneers Planck, de Broglie and Schrödinger proposed that all sub-atomic particles were massless, point-like charges [30]. That conclusion emerged because it was the only mathematical modelling that produced the correct observational results for all forms of radiation. Much later, in May 2011, proof that these subatomic particles were certainly point-like came when New Scientist reported that experiments had proven the electron was not only completely point-like, but spherical, to about one part in 10^18 [31]. The Quantum Electro-Dynamic (QED) line of enquiry that initially emerged from this in the mid-20th century became the 'standard model.' It was due to this model that a "Higgs boson" was postulated in order to give these subatomic particles their mass. The energy from a cloud of Higgs bosons around each particle is meant to impart mass to these particles on the basis of the equation E = mc2. The mass of these particles, however, depends on how well those Higgs bosons "stick" to the various types of particles. But, as Wilczek, of the Massachusetts Institute of Technology, points out, nobody knows what governs the amount of "sticking" [30]. Furthermore, it has been pointed out that "the Higgs mechanism does not explain why mass, or its energy equivalent, resists motion or reacts to gravity" [30].

In contrast, these and other problems are basically overcome by SED physics (stochastic electrodynamics), which opened up after 1962. Whereas QED physics depends on the Higgs boson to give mass to subatomic particles, SED physics considers the ZPE itself as the agency that imparts mass to all the particles and electrons. Haisch and his team noted that the randomly fluctuating waves of the ZPE impinge upon all charged, mass-less particles, causing them to randomly jitter at the Compton frequency. They then demonstrated that this random jitter imparts a kinetic energy to these particles. Finally, because of the established relationship between mass and energy, this kinetic energy appears as mass. This has been quantified by SED physicists, and seems a far simpler option than the postulated Higgs interaction [32].

This approach also answers two other questions. First, it can be shown that the different resonant frequencies of the various sub- atomic particles will result in different masses because "Photons in the quantum vacuum with the same frequency as the (particle) jitter are much more likely to bounce off that particle (and impart kinetic energy). …Higher resonance frequencies … probably mean a greater mass, as there are more high frequency vacuum photons to bounce off [because of the frequency cubed spectrum of the ZPE]." [32]. As noted above, physicists Haisch, Rueda, and Puthoff have quantified this approach and shown to be in agreement with the data, [32]. They also note that this approach gives us the origin of inertial mass, 'm', as we have in the equation F = ma. As an electron accelerates through the vacuum's electromagnetic fields, it will experience a pressure, a retarding force, 'F'. This force is proportional to its acceleration, 'a', through these ambient ZPE fields, resulting in inertial mass, 'm' [32].

Strict analysis has shown that, in a situation with an increasing ZPE strength given by "h," the masses of all atomic particles should increase in proportion to "h^2." Since it has been pointed out above that "hc" is a constant, which means that as one increase, the other has to decrease proportionately. It then follows that mc^2 is also a constant, and energy is conserved in this process. The graph of the recommended values of electron rest-masses is shown in the right-hand panel in Figure 4. There, it can be seen that the changes in mass in the right-hand image, closely follow concurrent changes in "h" on the left. The full details of electron mass and other data and their references can be found in Cosmology and the Zero Point Energy, chapter 4, pp. 138-160 [21].

(d). Atomic and gravitational clock comparisons:

There are two ways we can measure the passage of time. The ancient, and most well-known, is gravitational -- the movements of bodies through space: the rotation of the earth, the moon around the earth, the earth around the sun. The most recent way of measuring time uses various forms of atomic clock. Atomic time was initially developed in the early 20th century from the period taken for an electron to move once around in its orbit. Today, that quantity is defined as the time for the electron to make 1/(2pi) revolutions in the 1st Bohr orbit, namely (2.418 x 10^-17) seconds. In essence, this clock is electromagnetic in character. This is detailed in Cosmology and the Zero Point Energy, chapters 4, 8 and 9 (pages 138-160, and 298-356) [21]. The gravitational clock was the universal standard until 1967 when the atomic standard was introduced using the cesium clock. Dirac and Kovalevsky both pointed out that if the two clocks ran at a different rate, “then Planck’s constant, as well as atomic frequencies would drift.” [33]. The observational evidence already noted does suggest the two clocks are running at different rates.

From 1955 to 1981, Van Flandern and others, using a variety of methods (including radar and laser ranging), compared gravitational and atomic clocks. Lunar and planetary planetary orbital periods were used as the gravitational clocks. Assessing the evidence in 1984, Van Flandern wrote: “the number of atomic seconds in an orbital interval is becoming fewer. Presumably, if the result has any generality to it, this means that atomic phenomena are slowing down with respect to orbital phenomena….” [34].

As the gravitational equations are examined in detail in a changing ZPE context, it emerges that the key entity governing orbits and their timing is the quantity GM [35]. Here G is the Newtonian gravitational constant, and M is the mass of the central body in the gravitating system (like the Sun in our solar system, or the Earth in the earth-moon system). As the equations are followed through, it emerges that the mass of the secondary object (like the planet going around the sun, or the moon circling the earth) drops out of the equation, only leaving “GM” to be considered in a ZPE context. The full analysis is done in references [21] and [35], but is too lengthy to reproduce here. Therefore, as ‘GM’ does not change for any given system, it means that gravitational or orbital time runs at an unchanging rate despite ZPE changes, and it is therefore a steady, consistent clock. This conclusion is summarized by the first frame in Figure 5.

Since Van Flandern’s work, other observatories have continued to monitor this trend. One analysis stated [36]: “Recently, several independent investigators have reported discrepancies between the optical observations and the planetary ephemerides [which are based on atomic time]. The discussions by Yao and Smith (1988, 1991, 1993) [37 - 39], Krasinsky et al. (1993) [40], Standish & Williams (1990) [41], Seidelman et al. (1985, 1986) [42- 43], Seidelman (1992) [44], Kolesnik (1995, 1996) [45, 46], and Poppe et al. (1999) [47] indicate that [atomic clocks had] a negative linear drift [slowing]…. A paper by Yuri Kolesnik (1996) reports on positive drift of the planets relative to their ephemerides based on optical observations covering thirty years compared with atomic time. This study uses data from many observatories around the world, and all observations independently detect the planetary drifts. … [T]he planetary drifts Kolesnik and several other investigators have detected are based on accurate modern optical observations and they use atomic time. Therefore, these drifts are unquestionably real” [36].

Image

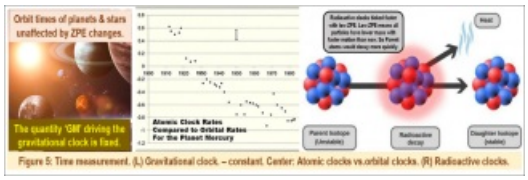


Figure 5

The center graph in Figure 5 plots the data for the planet Mercury with the behavior of atomic timing of events for that planet on the vertical axis. The stable gravitational (orbital) time from optical observations of the same actual planetary events, is recorded horizontally. Similar plots can be made for other solar system objects. In all fairness, it should be mentioned that Kolesnik and Masreliez propose that these data are explained by their theory of “expanding time.” However, the explanation given here is completely consistent with a wide range of other data in a ZPE context, and no unusual properties of orbital time are required to account for them as these authors propose.

The final frame in Figure 5 summarizes the form of atomic clock called radiometric dating. It works by the radioactive decay of certain atoms, which have a specific time-period for the process. In Cosmology and the Zero Point Energy, chapter 8, pp. 298 - 318, the analyses revealed that the decay constant was dependent upon the velocity of particles in the nucleus of the atom [21]. Therefore, higher velocities meant faster decay. When the ZPE was lower in the early universe, atomic masses were also lower. Because particle energies are conserved in the process of ZPE variation, lower masses mean higher velocities for all

particles, and hence faster decay rates. The analyses show that all forms of radioactive decay are uniformly affected by this mechanism. So, while the results are consistent among themselves, the indication is that all radioactive processes were much faster in the past, thus showing increasing differences as compared to gravitational time.

When atomic clocks were introduced, Kovalevsky predicted in 1965 that if the atomic and orbital (or gravitational) clocks were running at different rates, then atomic frequencies would drift [33]. This was actually picked up observationally by Van Flandern in 1984 [34]. Later, in the 1990's, it was shown to be true when atomic times for planetary events were graphed against the unchanging gravitational (or orbital) times for the same events [36-46].

(e) Atomic processes and the speed of light

Up until 1941, hundreds of different measurements of the speed of light had indicated a persistent, if slight, slowing. This was discussed in many physics journals and meetings. However, in 1941 Raymond T. Birge, the "keeper of the constants" in Berkeley, simply declared the speed of light to be constant, saying any changes were against the spirit of science itself [29]. And so, despite the hundreds of years of data, light speed was declared a constant. This made many other mathematical equations much easier.

In 1967, atomic clocks (the measurement of time via atomic processes) became the official global standard for labs worldwide. Primarily as a result of this, it did appear that the speed of light was a constant. But it was being measured by using other atomic processes.

The problem is that all are electromagnetic and are changing in conjunction with each other. That is a bit like trying to measure the change in a piece of elastic by another piece when they are both being stretched together. One will not appear changed compared to the other. Therefore, measuring lightspeed by atomic clocks will always give a constant result as both are uniformly affected by the strength of the ZPE. When the atomic clocks tick more slowly, the speed of light is correspondingly slower, and no change in speed can be determined by such experiments. A different system would have to be employed to detect any variation.

(f) Atomic orbits emit bluer light as ZPE increases

According to standard electrodynamics, an electron orbiting a proton will be radiating energy. This presents a problem in classical physics. If the electron radiates energy, then it must, at some point, spiral into the nucleus. This does not happen. Quantum Electrodynamic (QED) physics simply invokes the action of 'quantum laws' to prevent it from happening. But the actual physical reason why it does not happen comes from SED physics and the ZPE. Classical physics is correct in considering the electron to be radiating energy, but this must be coupled with the effects of the real ZPE. The energy that electrons radiate as they orbit their protons can be calculated, but this must be paired with the energy that these electrons absorb from the ZPE.

Quantitative analyses were done, and the results were summarized by de la Pena (left image Figure 6). De la Pena stated that "Boyer and Claverie & Diner have shown that if one considers circular orbits only, then one obtains an equilibrium [orbit] radius of the expected size [the Bohr radius]: for smaller distances, the electron absorbs too much energy from the [ZPE] field…and tends to escape, whereas for larger distances it radiates too much and tends to fall towards the nucleus" [48].

In 1987 Puthoff examined this further in an SED context (center image Figure 6). His conclusion carries unusual significance. It reads: "Finally, it is seen that a well-defined, precise quantitative argument can be made that the ground state of the hydrogen atom is defined by a dynamic equilibrium in which the collapse of the state is prevented by the presence of the zero-point fluctuations of the electromagnetic field. This carries with it the attendant implication that the stability of matter itself is largely mediated by ZPF phenomena in the manner described here, a concept that transcends the usual interpretation of the role and significance of zero-point fluctuations of the vacuum electromagnetic field" [49].

Image



Figure 6: Left: Luis de la Pena. Center: Hal Puthoff. Right: Angular momentum model of atoms

Figure 6

Puthoff's equations also demonstrate that the ZPE controls the angular momentum of atomic orbits. This appears in the equation for orbital angular momentum as the quantity *h*, or Planck's constant. As the ZPE strength increases with time, so, too, does the numerical value of *h*, and with it the angular momentum of every atomic orbit. This means that as the ZPE strength increases with cosmic expansion, atomic orbits gain energy. But analysis also reveals that atomic orbit radii remain fixed as their energy changes. This is illustrated on the right in Figure 6 where the angular momentum approach with 'h' is used.

Light is emitted when an electron, forced out of its position by incoming energy (such as another photon) snaps back. The energy released in the snap-back is a photon of light. But it is not "white" light - the degree of energy involved determines the color of light. The more energy, the bluer the light. Therefore, as ZPE strength increases, along with atomic orbit energy, the light emitted from those orbits will be more energetic, or bluer, with time. Thus, as we look back in time to increasingly more distant galaxies, we should see their emitted light shifting progressively to the red end of the spectrum, since the red end is the low energy end.

That is exactly what is observed, and astronomers, looking out in space - and thus further back in time -- call it the 'redshift.' Although the redshift had first been noted by Vesto Slipher in 1912 and its relationship to distance quantified by Hubble in 1929, the quantization or 'jumps' were first noted by William Tifft in 1976 [50-52]. Tifft's observations of galaxy clusters seemed to indicate that the redshift jumped from one plateau to another, like a set of steps going through the clusters of galaxies. What was even more puzzling for astronomers was the fact that some jumps in redshift went through the middle of some galaxies; this did not fit any of the current explanations of the redshift being due to either the actual galaxy motion or due to cosmological expansion of space-time. In fact, the redshift should increase in 'jumps' instead of being a smoothly changing entity, as mass will resist a change until it can no longer be resisted.

Image

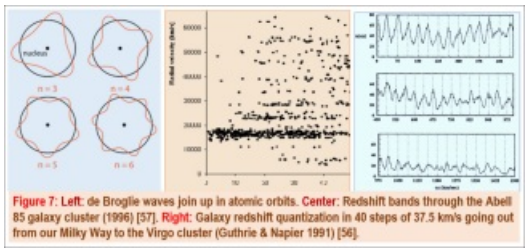


Figure 7: Left: de Broglie waves join up in atomic orbits. Center: Redshift bands through the Abell 85 galaxy cluster (1996) [57]. Right: Galaxy redshift quantization in 40 steps of 37.5 km/s going out from our Milky Way to the Virgo cluster (Guthrie & Napier 1991) [56].

Figure 7

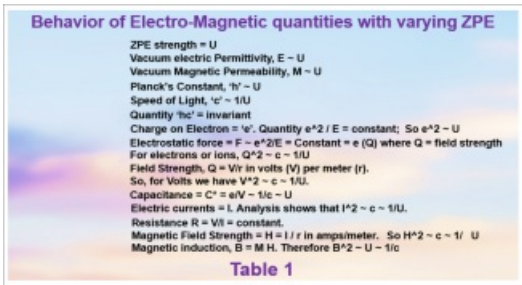
There is a reason for this quantization. With any ZPE increase, there will be an increase in both Planck's constant 'h' and atomic particle masses 'm'. This means atomic orbit energies will also increase, even though orbit radii remain fixed. However, electrons can only circle the nucleus in orbits which accommodate their de Broglie waves exactly, as in the Left segment in Figure 7. The waves may have varying numbers of nodes, but they must all fit the orbit exactly. If they did not, the waves would cancel out. Thus, as the ZPE smoothly increases, and orbit energies increase, no change in the emitted light will occur until the energy builds sufficiently for the wave pattern to jump to the next node number. Since the orbit wave pattern governs the emitted wavelength of light, that emitted light will become bluer, yet not smoothly, but in jumps; that is to say it will be quantized. As we look farther and farther out in space, and therefore back in time, we see this process in reverse which was called the quantized redshift with the results shown in the center and right-hand panels in figure 7.

Astronomers like Halton Arp and associates became involved in the controversy [53 - 55]. Guthrie and Napier initially set out to disprove the quantized argument. However, their observations convinced them, and many others, that the quantization was genuine [56]. The right hand panel of Figure 7 shows there are over 40 steps of 37.5 km/s going out from our own Milky Way to the Virgo cluster with virtually no galaxies showing intermediate redshifts between the quantization values. In 1996, a study of over 500 galaxies in the Abell 85 cluster by Durrett et al., revealed bands of redshift going through the cluster and beyond [57]. This is shown in the center panel in Figure 7 where redshift values are increasing on the vertical axis. It is apparent that the galaxy redshifts go in 'bands' or 'jumps' as we look progressively farther out into the cluster. While other explanations have been offered, this effect is seen consistently as we look out into the cosmos. In addition, Tifft gave his final assessment in 2014, which supported the quantization approach to the redshift [58]. These observational developments lend support the reality of ZPE and its physical effects in the cosmos.

(g). Electro-Magnetic quantities.

Because of the effects that a changing ZPE strength has on the vacuum, and its charged virtual particle pairs, it follows that many electric and magnetic quantities will undergo variation. This has been examined in detail in several major conference presentations [17,18]. One important quantity involves the square of the electronic charge (that is e^2) divided by the electrical permittivity of the vacuum (which we will designate as E). As the theoretical approach is worked through, and the observational data checked, we find that the quantity (e^2/E) is a constant quantity throughout the universe. This conclusion is supported to an accuracy of parts per million by observations of quantities like the fine structure constant out to the most distant regions of the cosmos. These data have been extensively detailed in some published papers [17-22] and are summarized in Table 1, where the symbol (~) means “proportional to”.

Image



Some Unexpected Consequences

(a). New astronomical possibilities:

Astronomy has huge time problems with galaxy formation by gravitational means. A mature galaxy, like our Milky Way system, is estimated to take in excess of one billion years to form. Despite this, the images from the James Webb Space Telescope (JWST) show mature galaxies existing in only a fraction of that time -- 250 million years -- from the inception of the cosmos. This problem has been discussed in detail in a recent paper and references therein [59]. There, it was noted that the early universe was 99.9% plasma, and that plasma processes under laboratory conditions had shown that, at their point of interaction, plasma filaments consistently formed galaxies of all types very quickly, but in miniature. When the lab data was upscaled to the size of objects in the universe, formation times for galaxies by plasma processes driven by electro-magnetism were of the order of 30 to 50 million years.

There is an additional, and unexpected fact involved here as well. The complete rotation profiles of the miniature plasma galaxies developed in the lab have been imaged, timed, and noted. Amazingly, the rotation profiles of the lab galaxies exactly matched the rotation profiles of galaxies out in space. The stars in the outer arms were swinging around the core just as fast as the inner arm stars were. This is impossible with gravity.

Gravity, such as in our solar system, would indicate the inner arm stars were swinging around much faster than the stars in the outer arms in the same way that little Mercury orbits our sun in 88 days, but it takes some outer planets hundreds of years to make the same circuit. But that is not what is seen with the galaxies. The outer arms are spinning around the center as fast as the inner section. It was these rotation profiles that led to the assumed problem of “missing matter” or “dark matter.” Something needed to be out there to give the gravitational pull making those outer arms rotate so fast. Despite the best part of 75 years of searching for exactly what makes up this “missing matter,” it still remains missing, and every attempt to identify it has failed. In contrast, the published results of the laboratory experiments make it plain that galaxies formed under electricity and magnetism, not gravity, will automatically have the same rotation profiles as we see out in space [60], [61]. It strongly suggests that the galaxies in outer space also formed under electro-magnetism, not gravity, and that the plasma approach under the action of the ZPE may be offering promising solutions to a number of persistent problems.

One example of a spiral galaxy forming from two interacting plasma filaments under electric and magnetic forces in laboratory- controlled conditions at LANL is shown in Figure 8.

Image

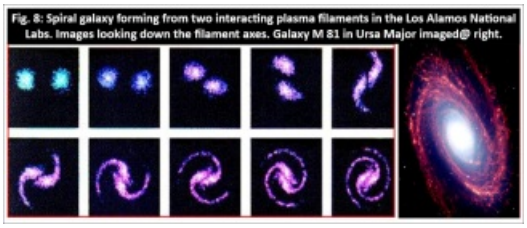


Figure 8

The ZPE and related data discussed above indicate that, in the early universe as expansion was only beginning, electric currents were intrinsically stronger, voltages were higher, capacitances were lower, ion drift velocities in plasma filaments were faster, as were all filament interaction times when compared with present conditions. In other words, the closer to the 'Big Bang' we look, the current plasma galaxy formation times of 30 to 50 million years could be reasonably reduced. The price we would have to pay is a re-examination of our currently accepted formation mechanisms, but we would have a viable explanation for what are becoming increasingly embarrassing photos and images from the James Webb Space Telescope (JWST).

(b). The importance of bio-electro-magnetism:

Could biological systems be affected by any of this? The electro-magnetic aspect of an increasing ZPE strength really holds the potential to affect many forms of life and may account for some otherwise problematical fossils. Before we introduce the problem, some background information may be needed. Creatures around the world transmit information to their brains, and then the brain's responses are transmitted back to their bodies, all by nerve impulses. It can be shown that these nerve impulses are electrical in nature since they involve the movement of charged particles or ions under the action of a potential difference or voltage, and this is the classical definition of an electric current. The nerve fiber that transmits this current is called an axon. A typical nerve cell is shown in Figure 9 on the left.

In our daily lives, we know that electrical signals are propagated by voltage differences. Regarding voltages in a biological context, J. Malmivuo and R. Plonsey in reference [62], page 33, state: "All cells exhibit a voltage difference across the cell membrane. Nerve cells and muscle cells are excitable. Their cell membrane can produce electrochemical impulses and conduct them along the membrane." They go on to point out that, in glands and a variety of other cells, "the membrane voltage is important to the execution of the cell function." The voltage difference in cells arises from the action of ionized atoms. The main ions involved with nerve conduction are the sodium Na+ ion and potassium K+ ion, with the sodium ion being more mobile than the potassium because of mass and size considerations.

Voltage builds up at the axon root, or axon hillock (see Fig. 9), when tiny chemical signals open channel gates in the cell body. Positive sodium ions rush inside. This changes the interior electrical charge to something much less negative. When the charge exceeds about 55 millivolts, the sodium channels burst open at the axon root, and a wave of positive charges travel down the axon as a nerve impulse. Malmivuo and Plonsey describe this in reference [62] page 42 as follows: "Activation in the form of the nerve impulse (the 'action potential' or voltage) is first seen in the root of the axon (the axon hillock) when the voltage builds. From there it propagates along the axon. ... The conduction velocity depends on the electric properties and the geometry of the axon." [emphasis added].

Malmivuo and Plonsey then point out that the electrical properties of the axon are two-fold. The first is the electrical capacitance of the axon per unit length. When the capacitance of the axon is low, the flow of electric current is faster. As shown in Table 1, capacitances are intrinsically lower with a lower ZPE strength. Second, the diameter of the axon also determines how fast the electric signal propagates; the greater the diameter, the faster the speed of electrical transmission through the nerve fiber. Thus, the three major factors defining speed of the electric current through the axon are the capacitance and diameter of the axon, as well as the initiating voltage. Table 1 suggests that all 3 factors will give intrinsically faster currents with the lower ZPE strength in the early universe. Without going further, an initial assessment might suggest that faster nerve transmission could possibly support larger bodily sizes across a whole spectrum of creatures on the early earth, and all due to a lower ZPE strength.

Yet, there is one other important detail. In our homes, the electric wiring is encased or shielded, in a plastic sheath to stop the current or signal from being dissipated. In a similar way, over 99% of all vertebrates, have a similar shielding feature; yet none of the invertebrates do. (Note: a vertebrate is an animal with a spinal column or backbone. An invertebrate does not have a backbone or spine, but these invertebrates make up over 95% of all creatures on our planet). This shielding feature is a fatty layer called myelin. The

myelin layer does two things simultaneously; (1) it effectively increases the axon diameter and (2) decreases the capacitance. Both of these properties increase the rate at which the nerve signal is conducted. The myelin coating thereby allows the nerve impulse to travel at high speed without dissipating in all directions. This coating is modular with gaps which allow the signal to go quickly in jumps.

In contrast, the invertebrates such as insects, spiders, worms, millipedes, dragonflies etc. do not have this layer around their nerve fibers. Instead, the fiber uses continuous conduction where every tiny part of the membrane must open its ion channels to the process. As a result, the signal travels like a slow wave down the invertebrate axon. The speed of the electrical impulse rises from about 1 or 2 meters per second for a bare nerve fiber, which is about 10 microns in diameter, up to about 50 meters per second for the same axon sheathed in myelin. (A micron is a millionth of a meter). Consequently, electric currents are transmitted faster in most vertebrates than in the invertebrates. The right-hand pair of images in Figure 9 visibly illustrate the difference in the signal conduction rate in the same time period.

Image

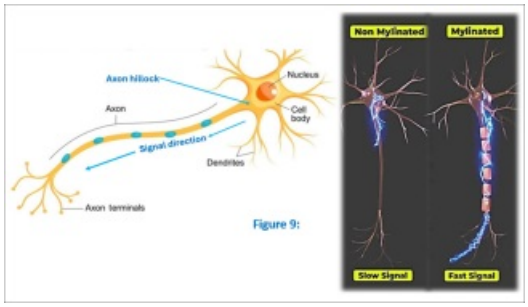


Figure 9

It is at this point that the physical speed of the resulting nerve signal transmission has an importance which must be emphasized. Dr. David Colman, Director of Montreal Neurological Institute and Hospital explains why, by considering a dinosaur - a vertebrate - if it did NOT have a myelin sheath: "Imagine a giant sauropod (a dinosaur like Apatosaurus) whose nerves were not myelinated. Bitten in the tail by a predator, it would take a full 40 seconds for action potentials [nerve impulses] to ascend the length of the tail, body and neck to reach the brain, and another 40 seconds for the signal to return to the tail muscles. Is there any doubt that this reaction time would be incompatible with a successful defensive or escape response?" [63].

It has been stated that the total axon lengths in such dinosaurs was of the order of 150 feet and that to get a response back from the brain within a few seconds requires signal speeds near 150 miles per hour. From these considerations, it is usually concluded that dinosaur axons must have been myelinated. Being vertebrates that is probable, but we may be permitted to wonder if a low ZPE strength may also have played a part. This may be relevant since professional comment also notes that there is no widely agreed fossil evidence that dinosaur axons were actually myelinated. The only claim that they were can be found in an article by Armitage and Anderson [64]. This evidence is widely disputed and is usually attributed to either fungal contamination or mistaken provenance.

The physical data become important here. From this example, and others like it, it is usually concluded that unmyelinated nervous systems restrict creatures to a practical maximum size near three feet (about a meter), with an average size about 30 centimeters (about a foot) long. Theoretically, if it was any larger than a meter, it would become functionally unsustainable because of the response times as David Coleman’s example proves. And yet, in the geologic record, we see something amazing: gigantic invertebrates who did not have any myelin sheathing. In Figure 10 there are, among other possibilities, three impressive examples of giant fossil invertebrates: a dragonfly with a wingspan of almost 3 feet; a millipede 8 feet long; and a ‘sea-scorpion’ up to 8.5 feet in size.

Image

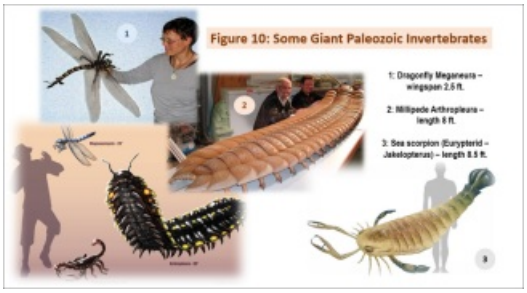


Figure 10

These giant creatures have additional problems. It is generally conceded that the unmyelinated fibers of the invertebrates typically conduct signals slower than 2 meters per second. In practical terms, this means that a signal traveling across a multi-meter animal would experience debilitating transmission delays of tens to hundreds of milliseconds. The only solution that has been offered is the proposal that some kind of “brute force” widened the unmyelinated axons. However, these types of axons continuously leak ions across the entire membrane surface during an action potential, or voltage build-up, event. As a result, up-scaling the axon system may be unworkable because the ion-pumping energy required to maintain voltage gradients can be shown to be far greater than the creature’s baseline capacity to sustain them.

It is possible to obtain a handle on this proposal from another direction. When the relevant data are considered, it is found that axon width increases in proportion to the bodily length. In comparison with the average 1-foot-long invertebrate, this 8.3-foot sea-scorpion had an average length increase by a factor of 8, so the axon diameter must also have increased by this factor. Although this seems to be a move in the right direction, that is not enough. The field data indicate that the conduction velocity of the nerve signal in unmyelinated axons does not scale linearly with the axon diameter increases. Rather, it is found that conduction velocity scales with the square- root of the axon diameter increase. Thus, even if axon diameters were increased by a factor of 8, the transmission signal speed will only increase by the square-root of 8, or roughly 2.5 times that of the smaller versions existing today. This means it would still be impossible to maintain functional reflexes. So, currently, science seems to have no really effective answer to this apparent dead end.

However, if a lower ZPE was the normal condition in the early history of our planet, this problem may disappear. The low ZPE strength meant that the transmission velocity of nerve signals in the giant arthropods of the Paleozoic would be significantly higher. This would make these creatures not only functional but a source of terror to other creatures. Consequently, these giant fossil invertebrates may well be key evidence of a lower energy level in the ZPE earlier in cosmic history as cosmic expansion was continuing to ramp up.

From this we may conclude that electro-magnetism and the ZPE may yet supply answers to other problems in paleontology and biology. Further exploration in this area, where biology and the laws of physics and electro-magnetism coincide, may therefore prove fruitful.

(C). The Effect on Photosynthesis

We have noted that the fossil record of fauna seems to indicate that a lower Zero Point Energy (ZPE) in the earlier days of our cosmos may have allowed gigantism through its bio-electro-magnetic effects. Similarly, a lower ZPE strength, with the resulting faster lightspeed, may also have resulted in the gigantism of Paleozoic flora. Since plants, algae, bacteria and phytoplankton either grow or proliferate by various forms of photosynthesis, then fossil floral gigantism, and their differences compared with the present, may in some way be related to this. Examples of Paleozoic flora are in Figure 11.

Image

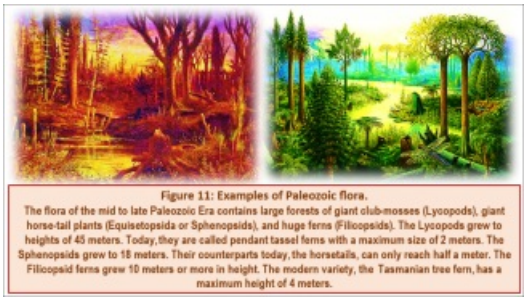


Figure 11

Photosynthesis is the conversion of light, water, carbon dioxide, and some chemicals, into living materials and stored energy. This process is affected by the amount of light the plant is receiving. This involves photon energy, as well as light intensity or brightness. What is interesting is that the brightness of the light is not nearly as important and the wavelength, or color, of the light the plant receives. The energy is in the wavelength, not the brilliance. It is in these areas that the ZPE may have played an important part. Examination of this option reveals some key facts [65].

Early work had demonstrated that, when the ZPE was lower, the production rate of light waves (or photons) by the sun and stars was higher. It was an inverse proportion, whether nuclear or electric processes were involved [66-68]. Thus, when the ZPE strength was 1/10th of what it is today, lightspeed was 10 times higher, and the earth received 10 times as many waves or photons per second as it does now. Initially the thought was that this would burn everything up. Using Maxwell's equations (and the cgs units and definitions he used), analysis shows that this was not a problem since the electromagnetic properties of the vacuum counteracted the difficulty [68]. It was shown that if the photon speed is high, then the amplitude of the light wave would be lower, as shown in the diagram below.

Thus, for light waves, the intensity is the brightness or brilliance of the light, which is controlled by the wave amplitude (or height) as in Figure 12. A basic formula in such cases states that, for any given wave, the square of the wave amplitude (or height) multiplied by the wave velocity is a constant [68], [69]. So initially, when the speed (the velocity) of light was high, the heights or amplitudes of light waves would have been quite small, yet there were more photons or waves per second. The result is that the total overall intensity or brightness would be basically similar to today's value. (The same holds true for the intensities of radiation from radioactive decay, which is also ZPE-controlled.)

Image

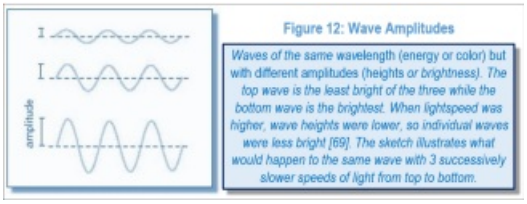


Figure 12

As far as the early plants were concerned, the outcome was that the strength of each photon's impact on a leaf was less, as the individual photon's light intensity was less, even though photon energy was closely related to today's value. So, while there were more photons hitting each leaf at any given time, it was like something being bathed in this 'soft' light. Today the overall brightness of the light is about the same. However, instead of the bathing effect with many photons of low intensity, today's light is concentrated in fewer photons of high intensity.

As indicated above, a lower ZPE strength in the early universe would have resulted in the emitted light being somewhat redder -- that is, less energetic -- as noted in the discussion around Figures 6 and 7 above. Therefore, with a lower ZPE strength, plants received more photons (of somewhat redder light), per unit area per second than they do now, though total light intensity was similar.

In addition, the photosynthetic processes would have been more efficient when the ZPE was lower, so that plants would have grown more rapidly and to enhanced sizes. Photosynthesis occurs when the energy in photons of light is converted to chemical energy by the organism. This conversion occurs in two separate stages called the "light" and "dark" reactions. In the first stage, the "light" reactions occur only during daylight hours. During this stage, photons are collected by the plant's "antenna complex." This antenna

complex is embedded in what is called the “Thylakoid Membrane”. An incoming photon will elevate an electron from an orbit in a chlorophyll b or carotene molecule to an excited position so that electron now carries the photon energy. A series of electron transfers then takes place down a potential gradient to the thylakoid reaction centers. With a lower ZPE, electron masses were also lower, and potentials were greater. Thus, the electron transfer process was also faster, and also ZPE dependent.

The energy supplied by the electrons is stored in the bonding of ATP and NADPH molecules. More energy means that there was more bonding. With more stored energy, the plant was able to grow more rapidly and luxuriantly.

The electron transport chain is fast enough to utilize the majority of incoming photons. Today, the rate of energy transfer between antenna pigments on the way to the reaction centers via the electron current is very rapid. It ranges from 10-15 seconds to 10-9 seconds. In the reaction centers themselves, the charge separation occurs in times ranging from 3 x 10-12 down to 3 x 10-11 seconds. Electron transportation, that is electric currents, would be even faster with a low ZPE, so it is anticipated that this process would be even more efficient.

In every cellular process there is something called a limiting factor - something which is the slowest part of the series and thus controls the rate of that series of actions or reactions. In photosynthesis it is the formation of the ATP and NADPH molecules. Today, this process takes from 10-6 down to 2 x 10-3 seconds [70].

Today, the process of ATP and NADPH production is known to be slowed significantly by what had been called “photo inhibition.” It turned out that the plant shuts down part of the electron transport chain due to the formation of an oxygen radical. These oxygen atoms damage proteins, and that damage then slows down the formation of ATP and NADPH. Experiments have since shown the problem can be countered when carotenoids are in close proximity to the chlorophyll molecules. This counter-action occurs because carotenoids efficiently "quench" the states of chlorophyll which allow the formation of the oxygen radical. These experiments have also found that plants automatically produce carotenoids in response to exposure to light. Indeed, the more the light, the more the carotenoid production occurs (up to the limits imposed by the experiment) [71], [72]. These experiments and other research also show that ATP and NADPH production increases when more light photons are available. Thus, a low ZPE with its higher photon flux may have overcome the slow-down by increasing both carotenoid and the resulting ATP & NADPH production.

The second stage of the conversion, the Calvin Cycle, is sometimes called the “dark reaction” as it does not need light. This series of reactions takes carbon dioxide from the air and, using the energy stored in ATP and NADPH, convert that energy to sugars. This cycle is labelled as the C3 pathway. The catalyst that is used in this process is the enzyme ribulose biphosphate carboxylase oxygenase, which is usually referred to (for obvious reasons) as Rubisco. This Calvin Cycle depends on Rubisco as the catalyst.

When carbon dioxide concentrations are low, the plant reverses everything and makes its own carbon dioxide. Rubisco enables this different reaction, called photo-respiration, in which oxygen is taken from the air and combined with carbon from the plant to give carbon dioxide. This effectively reverses all the hard work the plant has done using carbon dioxide to form sugars and grow. So, it is desirable that high carbon dioxide concentrations are available for the usual C3 pathway reactions to occur, instead of the inhibiting process of photo- respiration. [Side Note: F.R. Tabita et al. have noted that Rubisco today has four forms with different properties. It is this 4-way split which is also causing a slowing of its activation and action as a catalyst. However, they point out that the data indicate the ancestor from which all four Rubisco forms were derived, was probably free from these difficulties, which developed later [73]. If this conclusion is correct, then the original form of Rubisco which catalyzed Paleozoic plant reactions may not have been a delaying factor as the modern forms of Rubisco can be.]

The fossil record indicates the concentrations of carbon dioxide were about 0.3% of the total atmospheric content at the time of plant gigantism. This is about seven times the amount in our atmosphere today (which is 0.043%). When carbon dioxide was at that high a level, photorespiration would have been extremely rare or absent. This can also help explain the gigantism in fossil plants.

Early in the Cenozoic Era, the CO2 concentration began dropping until it had reached the current atmospheric concentration. During that time about 10,000 species of flowering plants, or angiosperms, in 19 different families, became prominent, including some 4500 species of grasses. There is a reason for this that helps us understand some strange plant behavior of the Paleozoic era.

The situation with the Paleozoic giant horsetail and club-mosses becomes relevant here. They have very little leaf surface to capture the light and provide energy to the plant. These modern angiosperms all have

an additional mechanism to the usual C3 pathway which increases their CO2 concentrations before the Rubisco catalysis occurs, enabling them to thrive in a low CO2 environment like today. In this case, the CO2 from root respiration diffuses into the sap at concentrations considerably higher than from air. The CO2 rises up in the plant, and is fixed, using Rubisco into the stems and leaf stalks rather than diffusing out to the atmosphere. The data obtained by Hibberd and Quick in their investigation indicated a rapid fixation rate as the concentration in stems and stalks was 18 times higher than in the leaves. Their only proviso was that large quantities of light are needed for this mechanism to be activated and begin operation [74]. Since a low ZPE would mean high photon counts in the Paleozoic Era, we have a plausible explanation for the sizes of fossil club mosses and horsetails.

(d). Redshifts and Early Life:

Among the earliest forms of life in the fossil column are various types of algae, and two in particular prefer red light. The first are the green algae or chlorophytes, for whom red light of 650 - 680 nanometers (nm) wavelength is absolutely preferred, as their chlorophyll a and b molecules absorb these wavelengths with maximum efficiency to produce biomass. The second are the so-called “blue-green algae,” which are more correctly known as cyanobacteria. These photosynthesizing bacteria use chlorophyll a as their preferred standard antenna pigment as well. However, they also have an accessory pigment, phycocyanin which captures orange and red light (610-640 nm) and pass that captured energy directly to chlorophyll a to boost photosynthesis. Additionally, these cyanobacteria have a remarkable property which was only recently discovered by lab experiments. If they are bathed in deep red light for 24 hours or so, a photo-sensitive gene switches on which causes them to structurally remodel their entire photosystems to synthesize alternate pigments chlorophyll d and f which allows them to absorb light in the deep red 700 - 800 nm range [75,76].

In the fossil record, these same cyanobacteria produced structures considered to be the earliest signs of life in the geological column. They are called stromatolites and date from the Archean through to the end of the Proterozoic (pre-Cambrian) eras. These microbial structures were the dominant carbonate reef builders on earth at that time. They began in a limited way in the Archean, such as the structures found in the Dresser Formation in Northern Australia (see Fig.13) [77,78]. By the end of the Archean, and then on through the following Proterozoic Era, the structures were so massive that this era is sometimes called the Age of Stromatolites. An image of part of the reef in the Proterozoic Bitter Springs Formation is in Figure 13. In some cases, reef systems like this extended over 100 miles (160 km) [79]; some have widths of 15 miles (25 km) with thicknesses up to 1500 feet (550 meters) [80]. Some individual stromatolite fossil domes or columns have been measured with diameters up to 33 feet (10 meters) [79]. It has puzzled scientists as to why these stromatolites were so giant for a time and then disappeared, leaving only the relatively tiny ones we see today.

It is here that the Zero Point Energy (ZPE) enters the discussion again with a possible solution to this stromatolite conundrum. When we look out into space, the farther away from us these distant galaxies are, the farther back in time we are viewing these objects. We also find that emitted light was significantly less energetic (redder) since the ZPE strength was much lower earlier in time. Thus, when we view galaxies at a distance that corresponds with the time when these massive stromatolites were prominent, we get data that tells us about the cosmos-wide conditions imposed on the universe by the increasing ZPE.

These ZPE and astronomical data indicate that that all emitted light waves were longer by a factor of 1.33 at the oldest date for massive stromatolite formations. This factor had already dropped to 1.04 by the end of the Proterozoic. The current peak radiation for the Sun’s output today occurs at 500 nm (the blue-green region) as compared with the earlier redder 610-665 nm range. These data really favor the early stromatolite production mechanism that effectively utilized red light and may explain why their output was so prolific in those eras.

Image

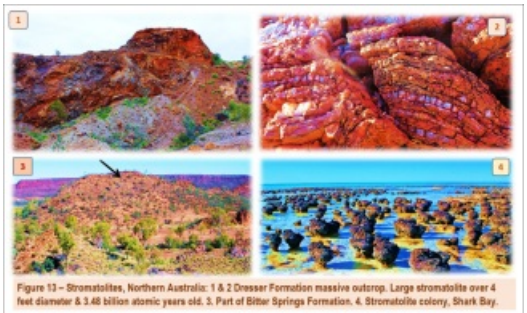


Figure 13 – Stromatolites, Northern Australia: 1 & 2 Dresser Formation massive outcrop. Large stromatolite over 4 feet diameter & 3.48 billion atomic years old. 3. Part of Bitter Springs Formation. 4. Stromatolite colony, Shark Bay.

Figure 13

It appears to have all come to an end in a rather short time, after which today's more diminutive forms appeared (and only in hypersaline ocean environments, such as Shark Bay in Western Australia, the Bahamas, and the Red Sea region). Compared to today's small stromatolites, the early stromatolites emitted 30% more oxygen into the early atmosphere as part of their photosynthesis reactions. In addition, stromatolites today generally grow layer by layer, using the daily accumulation of debris from the ocean floor and tides on their mucous topping. More mucous is formed on top, after which a new layer of accumulated material is layered, and so on. In contrast, the vast majority of the Archean and Proterozoic stromatolites used a very fine-grained crystal carbonate cement in between layers of mucous, which the cyanobacteria generated within themselves, and which helped form the massive carbonate reefs and platforms [81]. These data suggested that conditions were more favorable for this burst of activity early on, but then somehow changed.

A clue came from experiments in 2023. It emerged that the far- red light adaption is fully reversible in the cyanobacteria and their resulting stromatolites. The production mechanism switches from one mode to the other depending only on the wavelength of the ambient light [82]. Yet, in comparison with the blue-light conditions of today, the far-red light adaption has a 30% greater output of oxygen and 40% greater production in other areas when the same cells are fully operational [82,83].

The increasing shift towards the blue end of the spectrum may have forced a change. Thus, it is likely that an alternate stromatolite mechanism favoring bluer light would have switched on near that time. This alternate blue mechanism is the one operating today, producing the structures that we are familiar with, such as those in Shark Bay. It seems, then, that the differences in wavelength also fueled the two different building mechanisms. If this is indeed the case, then the fossil column has just delivered further support for a ZPE, which is becoming more energetic, resulting in bluer emitted wavelengths, and thereby controlling the form of stromatolites being built.

Final Conclusions

We have traced the historical development of the concept of the Zero Point Energy and its behavior from Planck's second paper of 1911. The important experimental proofs have been identified. Then, the results of those developing further SED physics research, and establishing further important concepts, were reported. The experimental evidence verifying these concepts were then outlined in 6 key areas of study, along with 4 unexpected results. In each case, Planck's 1911 concept of a Zero Point Energy originating with universal expansion, which then increased in strength as expansion went on and affected the electric and magnetic properties of the vacuum, has been fully supported.

Image

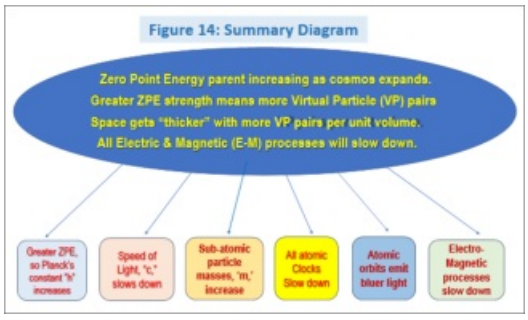


Figure 14

In each of these cases, there were problems that had appeared earlier, all of which seemed to require separate, individual explanations. However, in each of these cases this article has shown that the ZPE, increasing in strength from cosmic expansion, along with associated changes in the electric and magnetic properties of the vacuum, completely resolves each issue. The probability of these items having a common origin, if it were not true, is so low as to be virtually impossible. It is to be hoped that consensus science moves in the direction of this probability.

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