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Quantized Redshifts and the Zero Point Energy

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ABSTRACT: Section I of this paper traces the history of redshift research and its associated problems, including the quantized measurements. The breakdown in the redshift/distance relationship at high redshifts and the problem of "missing mass" or "dark matter" is discussed. Narliker and Arp's model of a static, slightly oscillating, cosmos is also noted. Section II examines a possible resolution of these problems if the energy density of the electromagnetic fields making up the vacuum Zero Point Energy (ZPE) is increasing with time. The origin of the ZPE and the reason for its increase with time is elucidated, and data trends in atomic quantities are presented to support this. Section III examines the link between the ZPE and the redshift via atomic orbit energies. It is shown that the redshift can occur because atomic orbit angular momenta increase with increasing ZPE. This gives rise to a redshift in emitted light as we look back in time. The possible redshift quantization results from the known quantization of atomic orbit angular momenta. Section IV shows that the redshift/distance formula is an approximation that derives from the action of known physical processes that produced the ZPE rather than originating with space-time expansion or the motion of galaxies. This derivation readily allows an alternate explanation for the deviation from the standard redshift formula at high redshifts without recourse to the action of a cosmological constant, accelerating expansion, or so-called "dark energy".

KEYWORDS: Redshift quantization, redshift/distance formula, Zero Point Energy, Planck's constant, speed of light, variable atomic constants, atomic orbits, quantized angular momentum, "missing mass", "dark energy".

I. EXAMINING THE REDSHIFT AND ITS PROBLEMS

A. Introduction

One of the key pieces of evidence that cosmologists use to indicate universal expansion is the increasing redshift of light from distant galaxies. "Redshift" is an astronomical term that describes the shifting of the spectral lines of elements towards the red end of the spectrum when compared with a laboratory standard here on earth. The redshift, z, is then defined as the measured change in wavelength, when compared with the standard, divided by that laboratory standard wavelength. If the change in wavelength is given by $\Delta\lambda$ and the laboratory standard wavelength is given by λ, then the redshift is defined as [1, 2]

$$z = \Delta\lambda / \lambda \qquad (1)$$

This is the quantity that is actually measured. Notice that z is a dimensionless number, as the units of wavelength cancel out. One might reasonably ask how this dimensionless number came to represent the expansion of the universe.

B. Historical background

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The historical development of the idea began with the work of Vesto Slipher and Francis Pease between 1912 and 1922 at the Lowell Observatory in Flagstaff, Arizona. They measured the redshift of forty-two galaxies [3]. In 1919, Harlow Shapley noted that the vast majority of those redshifts were positive, with the only exceptions being those in our own galactic neighborhood. Then, during the period 1923-24, Edwin Hubble discovered Cepheid variables in neighboring galaxies [4]. These stars vary in light output in such a way that their intrinsic luminosity and the period of variability are linked. Measuring the period of variability can thereby, in principle, establish their intrinsic luminosity and hence their distance. Hubble used these stars to measure the distances to all forty-two galaxies that Slipher and Pease had examined. In so doing, he discovered that the observed redshifts were proportional to distance. In 1929 he published the law of spectral displacements, which is now called Hubble's Law [5]. If astronomical distance is r and redshift is z, then in mathematical terms Hubble's Law can be written

$$r = z / H \qquad (2)$$

where H is a constant of proportionality.

Essentially Hubble's Law is a redshift/distance relationship, and as such simply notes that the redshift of galaxies is proportional to their distance. That is the hard core of data that astronomers and cosmologists have to deal with. Hubble then suggested something that he was cautious about for the rest of his life [6]. He pointed out that z could be multiplied by the speed of light, c, which transformed the dimensionless number into a velocity, v. The redshift could then be interpreted as a Doppler effect due to recession of the galaxies. This was done by analogy with the effect heard when a police car passes you with its siren going. As it pulls away from you, the pitch of the siren drops. In a similar way, Hubble's procedure suggested that the redshift of wavelengths of light from distant galaxies might indicate they are moving away from us. On this approach to the redshift data, equation (1) was thereby interpreted to read:

$$zc = v \qquad \text{or re-arranging} \qquad z = v / c \qquad \text{which suggested} \qquad v / c = \Delta\lambda / \lambda \qquad (3)$$

This then allowed equation (2) to be re-written as [7]

$$r = cz / H_o = v / H_o \qquad (4)$$

where H_o is the new constant of proportionality called the Hubble constant. This was the situation up until the 1960's. By 1960, the highest value of z obtained was around 0.4. From the interpretation of equation (3) this meant these galaxies were receding at two-fifths of the velocity of light, and an essentially linear relationship was being maintained on the Hubble graph of redshift/distance from (2) or (4) [8, 9].

However, around a redshift of about 0.4, and post-1960, a departure from linearity began to be noted as galaxy 'velocities' became more relativistic. Consequently, by the mid-1960's, the relativistic Doppler formula was applied to redshift data and, even with the advent of the Hubble Space Telescope, it was found to be a reasonably accurate approximation for very distant objects. Thus equation (3) came to be re-written in its relativistic form as [10]:

$$z = \{[1+(v/c)]/[\sqrt{1-(v/c)^2}\,]\}-1 \qquad (5)$$

In many astronomical applications, however, it is more convenient to use the formulation of $(1+z)$ for the description of reality rather than just z, so that (5) becomes

$$(1+z) = [1+(v/c)]/[\sqrt{1-(v^2/c^2)}] \qquad (6)$$

C. Noting some problems

Let us pause right there for a moment. Because of Hubble's multiplication of z by c, a Doppler shift interpretation has been given to the redshift data. This interpretation has led to the impression that galaxies are racing away from each other at speeds which increase with distance. Indeed, near the frontiers of the cosmos, those speeds are thought to be close to the current speed of light. But was Hubble justified in multiplying z by c in the first place? Some professional comment seems desirable. In 1995, Malcolm Longair wrote [11]: *"Thus, redshift does not really have anything to do with velocities at all in cosmology. The redshift is a … dimensionless number which … tells us the relative distance between galaxies when the light was emitted compared with that distance now. It is a great pity that Hubble multiplied z by c. I hope we will eventually get rid of the c."*

Using quasars of high redshifts with $z > 1$ as examples, Misner, Thorne and Wheeler use an argument similar to Schmidt [12] to reject Doppler shifts on different grounds. They state: *"Nor are the quasar redshifts likely to be Doppler; how could so massive an object be accelerated to v ~ 1 [the speed of light] without complete disruption?"* [13]. In thus rejecting the redshifts as Doppler effects, they also point out the problem that exists with one alternative explanation, namely gravitational redshifts. They state: *"Observed quasar redshifts of z ~ 1 to 3 cannot be gravitational in origin; objects with gravitational redshifts larger than z ~ 0.5 are unstable against collapse"* [13]. So in eliminating Doppler shifts and gravitation as the origin of the redshifts, they come to what they see as the only other solution, namely a *"cosmological redshift"* [13].

This cosmological redshift introduces the other interpretation often used to explain the lengthening of wavelengths. About the time that the initial redshift and distance measurements were being made in the mid 1920's, the mathematician Alexander Friedmann was examining Einstein's field equations describing a static universe. Friedmann found that these equations were capable of an infinite number of solutions if Einstein's model of a static universe was abandoned [14]. Then in 1927, the Abbe, Georges Lemaitre, produced equations describing a universe which exploded out of an infinitely dense state and continued to expand ever since [15]. In Einstein's equations, the very 'fabric' of space-time was static with the galaxies moving through it. This meant that the redshift really was due to galaxy motion. By contrast, Friedmann and Lemaitre's universe had this 'fabric' of space-time expanding so that the universe's spatial co-ordinates are time dependent. Importantly, Lemaitre pointed out that if the fabric of space was itself expanding, then photons of light in transit should have their wavelengths stretched in a manner proportional to the expansion. These hypothesized space-time expansion redshifts can then be described by the relationship

$$z = [R_2/R_1]-1 \qquad \text{or} \qquad (1+z) = [R_2/R_1] \qquad (7)$$

where R_1 and R_2 are the values of the space-time expansion factor at emission and reception respectively [16]. It is on this basis that the balloon analogy is often used to describe the redshift. As it is being inflated, the fabric of the balloon expands in the same way that the fabric of space-time is proposed to be expanding. Wavelengths of light in transit through space will be stretched proportionally resulting in a redshift when that light is compared with the laboratory standard.

D. Two further problems

But there are two further problems if the Friedmann - Lemaitre approach is adopted. First, if the expansion of space-time does cause light waves in transit to be lengthened, then atoms might also be expected to undergo such expansion. This should occur since some wavelengths of light approximate to atomic dimensions. However, this expansion should be unobservable since everything would be expanding, from atoms to yard or meter sticks. In order to overcome this difficulty, it is then concluded that the expansion does not occur within the galaxies themselves, but rather is external to them. However, doubts can be raised whether this expansion really would be unobservable since W. Q. Sumner thoroughly examined this matter in 1994. He established that, due to the effects of cosmological expansion on the atom, the results would certainly be observable and would lead to a blue-shift of light received from such atoms [*Astrophysical Journal*, 429:491]. If the Friedmann equations are logically followed through, then the observed redshift implies that the very fabric of space must be contracting rather than expanding. Sumner's analysis thus re-emphasizes the fact that, if cosmological expansion is really occurring, a redshift can only be obtained if galaxies, stars, atoms and matter do not expand also. This proviso therefore becomes a vital necessity to maintain the accord between theory and observation.

There is another problem. Following an examination of the Lemaitre model, Robert Gentry made a pertinent comment on the space-time expansion factor *R* in equation (7). He states: *"Despite its crucial role in big-bang cosmology, the foregoing expression [essentially equation (7)] is unique in that the physical presence of R has never been verified by experiment; the reason is that no method has yet been proposed to measure R, either past or present"* [17]. As a possible explanation for redshifts, (7) should also be compared with (5) or (6). The result is that the quantities within the outer brackets may be equated so that:

$$[1+(v/c)]/[\sqrt{1-(v^2/c^2)}]=[R_2/R_1] \qquad (8)$$

In other words, the space-time expansion factor $[R_2/R_1]$ must be behaving in a way that mimics the relativistic Doppler formula. Therefore, no matter which interpretation of the redshift is used, the relativistic Doppler formula must be considered to be at least an approximation to the actual behavior of the redshift.

On that basis, a graph of redshift *z* on the y-axis against distance, *x*, on the x-axis is usually drawn [2, 18]. Until recently, the precise distance scale was in doubt since the Hubble constant, H_o, which determines the distance scale, had not been accurately delineated. Indeed, there is still ongoing discussion on this topic. To overcome this problem on the horizontal axis, the values there are often arranged to go from *x* = 0 near our own locality in space, to *x* = 1, the furthest distance in space, essentially at the origin of the cosmos. In this case, *x* becomes a dimensionless number since it is then the ratio of the distance of any given object to the furthest distance in space. On this approach, the redshift/distance relationship is expressed as [19]:

$$(1+z) = [(1+x)/(\sqrt{1-x^2})] \qquad (9)$$

The total distance in light years (LY) at $x = 1$ is then dependent upon the value of the Hubble constant. However, two observational anomalies question the whole basis of these equations. The first of these anomalies came into focus with the work of William Tifft at Steward Observatory in Tucson, Arizona starting in 1976. The second became apparent in 1998 with distance measurements based on the light output of Type Ia supernovae at the frontiers of the cosmos. Let us take a moment to examine these anomalies.

E. The quantized redshift

From 1976 onward, Tifft published several papers indicating that redshift differences between galaxies were not smooth but went in jumps, or were quantized [20]. The Coma cluster exhibited this effect in such a way that bands of redshift ran through the whole cluster [21]. Shortly after, Tifft was presented with a list of accurate redshifts using radio measurements of hydrogen. Astronomer Halton Arp reports on the outcome of Tifft's analysis of this data set by stating: *"Not only did the quantization appear in this independent set of very accurate double galaxy measurements, but it was the most clear cut, obviously significant demonstration of the effect yet seen. …The results were later reconfirmed by optical measures in the Southern Hemisphere…"* [22].

These results have important consequences. If the redshift was indeed due to galaxies racing away from each other as the Doppler shift interpretation requires, then these speeds of recession should be distributed like those of cars smoothly accelerating on a highway. That is to say, the overall redshift function should be a smooth curve. The results that Tifft had obtained indicated that the redshift went in jumps from one plateau to another like a set of steps. It was as if every car on the highway traveled only at speeds that were multiples of, say, 5 miles per hour. Acceleration would mean immediate jumps from five to ten miles per hour, then from ten to fifteen miles per hour, etc., with no apparent speeds in between. Even more puzzling was the fact that some redshift jumps actually occurred within galaxies. If the redshift was due to motion of any kind, these jumps would imply that the galaxy concerned would be tearing itself apart, and this was obviously not happening. This result alone indicates that the redshift may not be primarily due to motion. Furthermore, on either the Lemaitre or the Doppler model, it was difficult to see how any cosmological expansion of space-time or, alternatively, the recession of galaxies, could go in jumps. These results did not fit either concept at all.

Then, in 1981, the results of an extensive redshift survey by astronomers Fisher and Tully were published. Their measurements showed no apparent quantization [23]. Three years later, in 1984, Tifft and Cocke published their analysis of the Fisher-Tully catalogue. They noted that the motion of the Solar System through space imparted a genuine Doppler shift of its own to all redshift measurements. When this Doppler shift was subtracted from the survey results, redshift quantization appeared globally across the entire sky [24]. In 1985, there was an unexpected and independent confirmation of this quantization. Sulentic and Arp used radio-telescopes to accurately measure the redshifts of over 260 galaxies from more than 80 different groups. Their work was for an entirely different purpose. But, to their surprise, as they did their analysis, a quantization of 72.4 km/s appeared in their data. This was similar to the quantizations that Tifft and Cocke had discovered. It should be noted that the measurement error was only 1/9th the size of the quantization [25, 26].

F. Attempting to settle the quantization issue

These were disturbing developments. In order to prove Tifft was wrong, Guthrie and Napier of Royal Observatory, Edinburgh, studied redshifts, using the most accurate hydrogen line redshift data. By the end of 1991 they had studied 106 spiral galaxies and detected a quantization of about 37.5 km/s, close to Tifft's quantum multiple of 36.2 km/s [27]. By November 1992, a further 89 spiral galaxies had been examined and a quantization of 37.2 km/s was noted [28, 29]. In 1995 they submitted a paper to *Astronomy and Astrophysics* with the results from a further 97 spiral galaxies showing a 37.6 km/s quantization [30]. The prevailing wisdom said the quantization only appeared because of small number statistics, so the referees asked them to repeat their analysis with another set of galaxies. This Guthrie and Napier did with 117 other galaxies. The same 37.6 km/s quantization was plainly in evidence in this 1996 data set, and the referees accepted the paper [31]. A Fourier analysis of all 399 data points showed a huge spike at 37.6 km/s Statistically, the chance of this happening is about one in a million. The measurement error was about 1/10th the size of the quantization. One comment on the redshift quantization graph stated [32]: *"One can see at a glance how accurately the troughs and peaks of redshift march metronomically outward from 0 to over 2000 km/s."*

Meanwhile others had been at work with more distant objects. In 1992, Duari et al. examined 2164 objects with redshifts ranging out to $z = 4.43$ [33]. In looking for actual quantizations, their analysis did eliminate some suspected periodicities, or quantization peaks in the graph, as not statistically significant. These small peaks were simply noise in the data. There were two other peaks, however; one being *"difficult to detect visually from the histogram"* [33]. The other spike in the graph was mathematically precise at a confidence interval exceeding 99% in four statistical tests. When subjected to the Comb-Template test, the period of this candidate had a quantization of $\Delta z = 0.0565$ or 16,938 km/s. It is important to note that in the study done by Burbidge and Hewitt in 1990, quasars were preferentially distributed at six predominant redshifts. The large peak noted by Duari et al. demonstrated that this preferential distribution was indeed due to redshift quantization and was not a selection effect [34].

Something else also emerged from all these studies. In looking further and further out into space, it had become apparent that the actual size of the redshift quantizations were increasing with distance. Thus, redshifts near the Virgo cluster were about 37.6 km/s. Further out, in the Coma cluster they were about 72.4 km/s. Further out than this, the redshift quantization speed was larger. By the time the distance of quasars is reached, the redshift quantization is of the order of 17,000 km/s. Any explanation of the quantized redshift needed to account for this.

G. The latest evidence

The outcome of the most accurate studies by Tifft indicates a possible basic redshift quantization of about $8/3 = 2.667$ km/s [35] with a claim by Brian Murray Lewis that the redshift measurements used had an accuracy of 0.1 km/s at a very high signal to noise ratio [36]. Tifft suggested that higher redshift quantum values may simply be multiples of this basic figure. More recently, on 5th and 7th May 2003, two articles appeared in *Astrophysics* authored by Morley Bell. The second Abstract read in part: *"Evidence was presented recently suggesting that [galaxy] clusters studied by the Hubble Key Project may contain quantized intrinsic redshift components that are related to those reported by Tifft. Here we report the results of a similar analysis using 55 spiral … and 36 Type Ia supernovae galaxies. We find that even when more objects are included in the sample there is still clear evidence that the same quantized intrinsic redshifts are present…"*

These results are important. On the Lemaitre model, if the fabric of space is expanding, it must be expanding in jumps. This is virtually impossible. On the Doppler model, the galaxies are themselves moving away through static space-time, but in such a way that their velocities vary in fixed steps. This is unlikely. It is important to note that the quantum jumps in redshift values have been observed to go through individual galaxies [20, 21, 37]. If the redshift was due to motion, these galaxies would disrupt. Thus, the redshift can have little to do with either space-time expansion or galactic velocities through space.

One final piece of observational evidence may help settle the matter. Tifft, Arp and others have pointed out that the quantized redshift means that the actual velocities of galaxies in clusters are very low [21, 38]. It is only at the very centers of clusters that high velocities would be expected. This was borne out by evidence mentioned at the Tucson conference on quantization in April 1996. Observations of the Virgo cluster have shown that in the innermost parts of the cluster *"deeper in the potential well, [galaxies] were moving fast enough to wash out the periodicity"* [32]. Here, "periodicity" is the quantization by another name. In other words, if galaxies have a significant velocity, it actually smears out the quantization. What we are seeing at the frontiers of the cosmos are extremely high redshifts. If these really were due to increasing speeds of expansion, we should not be seeing any quantizations in the measurements. They should be washed out. The Virgo cluster shows us this, as actual galaxy velocities in the center do smear out the redshift measurements. These results reveal that redshifts are not basically due to galaxy motion at all, but must have some other primary cause, with Doppler effects from motion merely being a secondary component.

H. The second anomaly

Along with this evidence from the quantized redshift comes the evidence from a second anomaly. This evidence comprises data relating to Type Ia supernovae and the resulting redshift/distance measurements. A supernova essentially is an exploding star, and Type Ia supernovae all explode with a standard brightness, rather like light bulbs with a known wattage. Thus, when these Type Ia supernovae occur in very distant galaxies, their set brightness allows an accurate distance measurement to be made. Between 1998 and 2001, two teams headed by Saul Perlmutter and Adam Riess examined data that measured the brightness of these stellar explosions at redshifts from about $z = 0.83$ to about $z = 1.7$ [39 – 44]. The explosions were about 20% fainter than expected. Their observed change in brightness by 0.2 magnitudes corresponds to a reduction in intensity by a factor of 1.2. This meant that they were evidently further away than their redshift indicated by a factor of $(\sqrt{1.2} = 1.1)$ [45].

This disconcerting result spawned several explanations, but two were predominant. One attributed the dimming of the light from supernovae to the action of interstellar dust. The more distant they are, the fainter they should be compared with predictions from the redshift/distance relation. This (minority) approach was subsequently shown to be incorrect. Dust would have changed the supernovae colors with distance in a different way than was actually observed. The main interpretation was that the results could be accounted for if the Big Bang expansion rate was speeding up with time. Up until then, most astronomers accepted the expansion rate was slowing under the action of gravity until it stopped and then a collapse would begin.

I. Introducing the cosmological constant

If the integrity of Big Bang model was to be maintained, this new result could only be accounted for if cosmological expansion was speeding up. This postulate required the existence of the cosmological constant, something which behaves the opposite of gravity, and pushes things apart. It is represented by *Λ*, and is sometimes called "dark energy." The branch of physics known as quantum electro-dynamics (QED) regards *Λ* as the energy inherent in the quantum vacuum. QED physics views this dark energy as exerting a repulsive force causing the expansion rate of the cosmos to increase. *Science News* Vol. 164:15 notes that science is not sure of the source of this energy, even though it is true that Einstein had postulated the existence of *Λ* for theoretical reasons. Furthermore, X-ray data from the European XMM satellite *"leaves little room for dark energy"* according to Alain Blanchard in a European Space Agency News Release 12 Dec. 2003 [see paper at arxiv.org/abs/astro-ph/0311381 and the ESA news release at: http://spaceflightnow.com/news/n0312/12darkenergy/].

It is also true that many regarded the existence of *Λ* with some skepticism. This reaction came from the fact that its calculated size when compared with observational data results in a large discrepancy. Thus Barrow and Magueijo pointed out in 2000 "*If Λ > 0, then cosmology faces a very serious fine-tuning problem…There is no theoretical motivation for a value of Λ of currently observable magnitude"* [46]. Greene also noted that *"…the cosmological constant can be interpreted as a kind of overall energy stored in the vacuum of space, and hence its value should be theoretically calculable and experimentally measurable. But, to date, such calculations and measurements lead to a colossal mismatch: Observations show that the cosmological constant is either zero (as Einstein ultimately suggested) or quite small; calculations indicate that quantum-mechanical fluctuations in the vacuum of empty space tend to generate a nonzero cosmological constant whose value is some 120 orders of magnitude larger than experiment allows!"* [47].

This remains the situation when QED physics is employed, despite recent developments. Consequently, the QED approach to the problem using the cosmological constant must be questioned. There is, however, another approach to physics, called stochastic electrodynamics, or SED. This approach not only employs classical, intuitive physics, but has verified something called the Zero Point Energy (ZPE) which is actually present throughout space. Quantum physics admits the existence of the ZPE but considers it to be the dark energy driving matter apart. The measured and verified Zero Point Energy of the SED approach acts very differently from the QED cosmological constant (or 'dark energy'). While it imparts energy to subatomic particles, it does not drive anything apart or exert any other directional force. This is discussed in detail in reference [48], which reviews the ZPE and its associated phenomena in some depth.

Despite the controversy about the existence of the cosmological constant, the Big Bang model also needed to be revised to account for the new data that was interpreted as being caused by an increasing expansion rate. The explanation offered was that, in the early universe, expansion was slowing under gravity. However, at some point, as yet uncertain, but suspected by Reiss to be near $z = 2$, the action of the cosmological constant became greater than the pull of gravity, and the expansion of the universe started to accelerate as a result [49 – 51]. The data from which accelerating expansion is inferred is still being examined to a redshift of $z = 6.3$ using techniques that include gamma ray bursters.

J. Redshift values decrease with time

Tifft's 1991 data challenges the idea of accelerating expansion. He found that a number of galaxy redshifts had actually decreased (become bluer) by one quantum jump in the years he had been studying them. *"The actual time interval in any individual comparison [of redshifts] could be as short as seven years or as long as fifteen years; the exact distribution of time intervals has not yet been determined"* [35]. If the redshift really is due to the expansion of the cosmos, then a decrease in the redshift indicates a decreasing expansion rate, not an accelerating one. In turn, this means that the supernova data gathered by Perlmutter and Reiss are being incorrectly interpreted as indicating accelerating expansion. All that the basic observations show is that the supernovae are more distant than expected. The straightforward implication is that the relativistic Doppler formula for the redshift is breaking down at large distances. This in itself calls into question the actual cause of the redshift. All the discrepant data, including the quantization of the redshift, suggest the redshift is not due to galaxy recession or cosmological expansion as has been assumed. This one assumption is the basic cause of all these problems, and this assumption flows on from the unquestioning acceptance of Hubble's insertion of *c* into the redshift equation. There is one other major problem that this assumption has caused, one that entirely disappears if the redshift is not a measure of velocity or due to expansion.

K. Redshifts and missing mass in galaxy clusters

As astronomers examine clusters of galaxies, they assume that the redshift of those galaxies is a measure of their individual velocities. On this basis, the velocities of the outer members of the cluster are assigned relative to the galaxies near the center. When these velocities, which have been determined by redshifts, are noted, it appears that those of the outer members are so high that they should long since have escaped the gravitational pull of the cluster. Because they are still there, it is then assumed that the gravitational mass of the cluster must be significantly higher than expected from the visible matter in the cluster. Since the source of the mass is not obvious, it is called the "missing mass" or "dark matter". On this basis, it appears that over 90% of the mass needed to hold most clusters together is "missing." As a result, the search for "missing mass" has gone on for a number of decades, yet the mass is still "missing." There have been a number of candidates: cold dark matter, hot dark matter, massive compact halo objects (MACHO's), weakly interacting massive particles (WIMP's) and others. Despite the extensive search, there has been no success in determining the nature of this "missing mass" or "dark matter". It is not considered to be a redshift problem, yet the problem evaporates if the redshift of galaxies is not due to velocity.

It is in this context that Halton Arp makes some interesting comments. He points out that with the measurements of redshift are highly accurate for the Local Group of galaxies, the Sculptor group, and the Coma cluster and some more distant groups. He goes on to state that the spread in redshift measurements around each quantized value is very small. For the most distant groups, the velocity spread is ± 17 km/s. In the closer groups, the average spread is of the order of ± 8 km/s. As he points out in reference [22], pp.118-119, this makes for very "quiet" galaxy groups, with any actual motion apart from the quantization being very small. If this is indeed the case, there is no mass "missing" in these galaxy groups at all. Their motion is well within that required to stay attached to the cluster. In other words, the whole problem of dark matter and missing mass is due entirely to the mis-interpretation of the redshift as a velocity.

It might be objected that the rotation rate of galaxies also suggests that there is mass "missing." The flat rotation curves of galaxy spiral arms, where the rotational speed of stars remains basically the same as the distance from the galaxy center increases, seems to require "dark matter" to account for them. This is true if the galaxies are being held together gravitationally. There is a branch of physics which is currently investigating this, however. When plasma filaments are studied in the laboratories, every galaxy formation we see in the universe can be replicated very quickly from the filament interactions. If galaxies are formed by plasma filament interactions on a cosmic scale, analysis of the experimental results indicate that their rotation curves will indeed be "flat" because they are acting under plasma dynamics, not gravity. There is then no need for missing mass in the spiral arms – they are behaving exactly as they should if they are due to plasma interactions. This is discussed in more detail in "Reviewing a Plasma Universe With Zero Point Energy" in *Journal of Vectorial Relativity,* JVR **3** (2008) **3**, pp.1-29. So these flat rotation curves do not necessarily require "missing mass" or "dark matter." On this basis, then, it appears that there is probably not any mass "missing." Instead, we should be examining an alternative cause for redshifts.

L. A static universe?

First, something else needs to be examined. The quantized redshift indicates that the universe is probably not expanding, and the recent drop in redshift values by one quantum contradicts the idea of an accelerating expansion. Until the early 1990's, expansion or contraction were the only two viable options. In 1993 the situation changed. Narliker and Arp demonstrated that a static, matter-filled, universe was stable against gravitational collapse without the action of a cosmological constant, provided that atomic masses increase with time [52]. They point out that *"stability is guaranteed by the mass-dependent terms… Small perturbations of the flat Minkowski spacetime would lead to small oscillations about the line element rather than to a collapse"* [52]. The increase in atomic masses with time has been documented [53] and receives support from the increase in officially declared values of electron rest-masses. This is graphed in Figure 3 following the discussion about atomic quantities later in this paper. Therefore, the possibility that we live in a static universe is certainly feasible.

Theirs is not the only possible model. In 1987, V. S. Troitskii from the Radiophysical Research Institute in Gorky, presented a concept in which the radius of curvature of space remained constant. Stability in this static cosmos occurred because "*agreement with the fundamental physics laws is achieved by introducing the evolution of a number of other fundamental constants synchronously with the variation of the speed of light"* [54]. Three years earlier, Van Flandern from the US Naval Observatory in Washington, made a similar observation. He said *"For example, if the universe had constant linear dimensions in both dynamical and atomic units, the increase in redshift with distance (or equivalently, with lookback time) would imply an increase in c at past epochs, or that c was decreasing as time moves forward"* [55]. In these scenarios, stability was maintained by variation in some atomic quantities. These three theories show that a static cosmos can be stable against collapse even without the action of a cosmological constant.

Given the possibility of a static cosmos, the outstanding issue then becomes the origin of the redshift itself. With galactic motion and space expansion ruled out, there seems to be only one option left – one first mentioned by John Gribbin [56]. He suggested that the quantized redshift is inherent to the atomic emitters of light within the galaxies themselves. If this is the case, there would be no need to change the wavelength of the light in transit as the wavelength would be fixed at the moment of emission. This avoids a difficulty Hubble perceived in 1936, namely that *"… redshifts, by increasing wavelengths, must reduce the energy in the quanta. Any plausible interpretation of redshifts must account for the loss of energy"* [6]. The conservation of energy of light photons (quanta) in transit has been a problem for cosmologists ever since. In fact some openly claim that this is one case where energy is not conserved [57]. Here is what they are faced with: if the expansion of the universe means the light waves are being stretched so that they become redder, then they are losing energy. This is because the redder light waves are, the longer and 'lazier', or less energetic, they are. But if the light waves themselves have not changed in transit, but are the result of something to do with the atomic emitters themselves, then the problem disappears.

Changes in the redshifts of light with distances are a universal phenomenon. If the redshift of light from distant galaxies is due to the behavior of atomic emitters within those galaxies, then there must be something in the changing properties of the vacuum of space itself which is connected. The key property of the vacuum that is universal and implicated here is the Zero Point Energy (ZPE). The outcome of this line of investigation is that the behavior of the ZPE allows a formula for the redshift to be derived that is the same as the relativistic Doppler formula, but without relation to space-time expansion or the motion of galaxies. Furthermore, the reason why quantization occurs can be discerned. An exploration of these possibilities now follows.

II. EXAMINING THE ZERO POINT ENERGY ALTERNATIVE

A. Properties Of The Vacuum

A complete Review of the Zero Point Energy (ZPE) and its effects can be found in reference [48]. The ZPE derives its name from the fact that it is present in the vacuum even when there is no temperature radiation, or in other words, at zero degrees Kelvin [58]. This energy exists as a universal "sea" of electromagnetic radiation, a bath in which every atom in the cosmos is immersed. The energy density of the ZPE that permeates every cubic centimeter of the universe was recently estimated by Davies as around 10^{110} Joules per cubic centimeter, a fairly typical figure [59]. We are unaware of the presence of the ZPE for the same reason that we are unaware of atmospheric pressure on our bodies – its presence is balanced both inside and outside our bodies, and it permeates our instruments as well.

Nevertheless experimental evidence confirms the presence of the ZPE in a number of ways. These include the Casimir effect, where two metal plates brought close together in a vacuum experience a measurable force pushing them together [58, 60-62]. The two plates exclude all ZPE wavelengths except those that fit exactly between the plates. The force originates from the pressure exerted by these excluded electromagnetic waves. The same effect at the atomic and molecular level is the origin of the feebly attractive Van der Waals forces. The ZPE is also the cause of random "noise" in electronic circuits that puts a limit on the levels to which signals can be amplified no matter how good the technology [63]. This same vacuum energy also explains why cooling alone will never freeze liquid helium. Unless pressure is applied, the jiggling of the helium atoms as they are battered by the impacting waves of the ZPE prevents these atoms from getting close enough to trigger solidification [63].

B. Quantum 'uncertainty' and the ZPE

Both SED and QED physics agree that subatomic particles, like electrons or quarks, are massless, point-like charges often called partons. ZPE waves impact on partons causing them to jitter randomly. This 'jitter motion' was called the *Zitterbewegung* by Schroedinger. It is relativistic because, as Dirac noted, the charges move at velocities close to that of light and oscillate about 10^{20} times per second. These impacting waves of the ZPE are therefore the cause of both quantum 'uncertainty' in position and momentum due to this *Zitterbewegung* jiggling. In 1911, Planck indicated that Planck's constant, *h*, is measure of the strength of the ZPE and hence a measure of this jiggling as the two are directly related. If the strength of the ZPE increases, then the resultant increased jiggling would lead to an increased quantum 'uncertainty.'

C. Mass, gravity and the ZPE

Initial work on the ZPE, mass and gravity was done in 1968 by the Russian physicist Andrei Sakharov. In 1989 Puthoff developed it further. Later, Haisch, Rueda and Puthoff formulated a quantifiable theory of gravitation. This basis of this approach is that the *Zitterbewegung* jiggling imparts kinetic energy to all partons; the actual kinetic energy for a particular type of parton being dependent upon its resonance frequency. This kinetic energy appears as mass because of the inter-convertibility of mass and energy that Einstein quantified. Puthoff states "*It is therefore simply a special case of the general proposition that the internal kinetic energy of a system contributes to the effective mass of that system*" [64]. The detailed mathematical treatment reinforces this conclusion [see: http://www.calphysics.org/sci_articles.html]. In a similar way, parton inertial mass comes from the retarding force the ZPE waves exert on the parton as it accelerates through these waves [65, 66].

Haisch, Rueda & Puthoff explain the origin of gravity in these terms: *"Now a basic result from classical electrodynamics is that a fluctuating charge emits an electromagnetic radiation field. The result is that all charges in the universe will emit secondary electromagnetic fields in response to their interactions with the primary field, the ZPF. The secondary electromagnetic fields turn out to have a remarkable property. Between any two [charged] particles they give rise to an attractive force… whether the charges are positive or negative. The result is that [this weak attractive force] may be identified with gravity. …Since the gravitational force is caused by the trembling motion [Zitterbewegung], there is no need to speak any longer of a gravitational mass as the source of gravitation. The source of gravitation is the driven motion of a charge, not the attractive power of the thing physicists are used to thinking of as mass"* [67].

The calculations of those physicists verify these concepts. One important point for our purpose here is that, on the SED approach, the mere existence of the ZPE does not of itself result in either a cosmological constant or gravitational force. The problems, mentioned earlier, that are caused by these forces being directly associated with the ZPE in General Relativity (GR) and QED physics are thus avoided. Therefore, on the SED approach, gravity is a force that is already unified with the other forces of physics.

D. Discerning the origin of the ZPE

Stochastic electrodynamics (SED) physics also suggests an origin for the ZPE independent of the cosmological constant. This line of investigation is followed here. We begin by noting that there were two current explanations for the origin of the ZPE [68]. They were assessed as follows: "*The first explanation … is that the zero-point energy was fixed arbitrarily at the birth of the Universe, as part of its so-called boundary conditions"* [69]. A second school of thought proposes that *"the sum of all particle motions throughout the Universe generates the zero-point fields"* and that in turn *"the zero-point fields drive the motion of all particles of matter in the Universe … as a self-regenerating cosmological feedback cycle"* [69]. On this second explanation the ZPE plus atomic and virtual particles require the existence of each other. Several papers on the topic have capably demonstrated that this mechanism can maintain the presence of the ZPE once it had formed, but this avoids the question of its origin. Further, Puthoff has shown that the ZPE is required to maintain atomic structures across the cosmos [70]. This will be discussed in more detail below, but we note it becomes difficult to envisage how atomic structures emerged in the first place by the feedback mechanism. A closer look at conditions at the inception of the universe is therefore pertinent.

The model accepted here is that the cosmos underwent rapid expansion or inflation at its origin. This rapid expansion is attested to by the presence of the Cosmic Microwave Background Radiation (CMBR). Following this expansion, it became stable and static at its present size, but undergoing small oscillations in several modes simultaneously as Narliker and Arp suggest. The expansion process fed energy into the vacuum. Gibson, Hoyle and others have shown that this expansion energy manifested as showers of the smallest particles the cosmos is capable of producing, namely Planck particle pairs (PPP) [71, 72]. PPP have a unique property; their dimensions are the same as their own Compton wavelengths [73]. Each pair is positively and negatively charged so that an electrically neutral vacuum is the result. According to SED physics, quantum uncertainty is the result of the battering caused by the Zero Point Energy. Because Planck Particle Pairs are smaller than the smallest ZPE wavelengths, they cannot be influenced by the ZPE itself. This means there was no initial time limit for these particles to remain in existence as a physical reality. Furthermore, since the Planck length is the cutoff wavelength for the ZPE, these particles were unaffected by the ZPE as it built up during the expansion process. As the cosmos continued to expand, the separation between particles increased, and the resultant turbulence among the PPP resulted in spin. The separation between these charges gave rise to electric fields, while their spin created magnetic fields. This may be considered to be the origin of the primordial electromagnetic fields of the ZPE. By this means, the energy of the expansion was converted into the Zero Point Energy. But the story does not end there.

E. ZPE strength increased with time then oscillated

Gibson has pointed out that the expansion of the fabric of space will generate separation, spin and intense vorticity/turbulence between the Planck Particle Pairs [71]. He demonstrated that this vorticity feeds energy into the system, which allows the production of more PPP. Therefore, additional PPP are spawned by this vorticity and turbulence and PPP numbers will thereby increase. This in turn will cause an initial increase in the strength of the primordial ZPE.

There are three stages to turbulence, or vortex activity: formation, persistence, and decay. Gibson has pointed out that the PPP system is characteristically inelastic [71], while Bizon has established that such inelastic systems have stronger vortices and longer persistence times [74]. In these persistence and decay stages, the vorticity in the fabric of space would have continued, and hence more PPP would form via this ongoing process. This would result in an increase in the primordial ZPE strength until the vorticity died away completely. Since the cosmos is a very large system with immense energies, the persistence and decay stages for these vortices may be expected to be relatively long. As the strength of the ZPE built up by this process, it would have been maintained by the feedback mechanism mentioned earlier [68, 69]. This is the first mechanism for the build-up of the ZPE. But there is a second factor also at work.

It is important to note that under the conditions being considered here, PPP will have a tendency to re-combine due to electrostatic attraction. Once recombination occurs, a pulse of electromagnetic radiation is emitted with the same energy that the Planck particle pair had originally [75]. These energies will vary due to different separations and spin. The resulting energy further augments the primordial electromagnetic ZPE fields. This recombination process will eventually eliminate the majority of the PPP, although the initial production of PPP from turbulence would partly offset that. The strength of the ZPE will thereby increase until all these processes cease. Once that happens, the ZPE strength would be maintained by the feedback mechanism noted above involving the formation and annihilation of virtual particle pairs. Current observations suggest that the PPP have now probably all recombined, leaving the ZPE as the evidence for their original existence.

Thus the ZPE is an intrinsic feature of the physical vacuum due to the conversion of energy from the initial expansion of the cosmos into Planck Particle Pairs. Their separation and spin formed the first electromagnetic fields. Their recombination then emitted further electromagnetic radiation, building the Zero Point Energy. The ZPE was then maintained by the feedback mechanism. When the origin of the ZPE is considered in this fashion, its existence apart from the cosmological constant becomes a viable option. The modeling here also has the advantage that the mathematical form of the behavior of the ZPE can be reproduced from the physics involved. Furthermore, it can be shown that the ZPE strength built up with time in a mathematically predictable way. The strength of the ZPE has then oscillated as the universe has undergone its various modes of vibration. Thus, as the cosmos contracts slightly, the ZPE is forced into a smaller volume and therefore has a greater strength per unit volume. Conversely, when the universe expands slightly, the same energy exists in a larger volume, and the energy density is thereby lower.

This ZPE variation may be complex, depending on the interaction of the universe’s oscillation modes. A graph of the strength of the ZPE might therefore be expected to contain flat points in a manner similar to that described by E.A. Karlow in the *American Journal of Physics,* **62:7** (1994), 634. Thus, even after the ZPE built up to its maximum value, it would be expected that there will be cosmological oscillations in its strength. The build-up in the ZPE, plus any oscillations and flat points in its strength, should therefore be echoed in the experimental values of ZPE-dependent quantities. The question then arises as to whether we have evidence for this variation.

F. Statistical trends in atomic constants

In 1911 Planck predicted the existence of the ZPE and indicated that what is now Planck’s constant, h, was a measure of its strength [76, 77]. If the strength of the ZPE is expressed as U, then we can write:

$$h \propto U \qquad (10)$$

where the symbol $\propto$ means ‘proportional to’ throughout this paper. Importantly, both experimentally obtained and officially declared values of Planck’s constant have increased with time up until 1970 when the trend reversed or at least flattened out. This behavior of declared values of h is graphed in Figure 1. The trend has been the subject of some comment. In 1965, Sanders noted that the increasing value of h could only partly be accounted for by improvements in instrumental resolution and changes in listed values of other constants [78]. Thus, it is quantitatively inadequate to blame the increase in h on these factors. Since h is a measure of the strength of the ZPE, this means the ZPE itself has increased with time. This is emphasized since other quantities such as e/h, where e is the electronic charge, $h/2e$ or magnetic flux quantum, and $2e/h$ or Josephson constant, all show synchronous trends centered around 1970 even though measured by different methods from those used for h. Figure 2 gives the data trend for h/e.

But this is not the only evidence. It can be shown that the speed of light, c, is inversely related to the strength of the ZPE [48, 53, 79]. One basis for this comes from the fact that the ZPE waves peak and crest in a manner similar to ocean waves. On the ocean, white-caps are formed as a result of this interaction. In the vacuum, a local increase in the strength of the ZPE occurs. This momentary peak in energy results in the formation of virtual particle pairs, like electron/positron pairs or positive and negative pions. There is in fact a whole zoo of these virtual particle pairs and it has been estimated that within the volume of a human body there is, at any instant, some 100 billion billion particle pairs flashing into and out of existence. For this reason, space has been called 'the seething vacuum'.

As a photon of light goes through the vacuum, it encounters a virtual particle pair, is absorbed, and then re-emitted when the pair annihilates a moment later. The path of a light photon is thus like a runner going over hurdles. The more virtual particles in its path, the longer the photon takes to arrive at its destination. Since the number of virtual particle pairs in a given volume is directly proportional to the strength of the ZPE, the speed of light is thereby inversely proportional to U. We can thereby write:

$$c \propto 1/U \qquad (11)$$

Consequently, it is important to note that the measured values of lightspeed, c, have shown a systematic decrease with time. This confirmatory evidence was a topic of discussion by important physicists in key journals that ranged from Newcomb's article [80] in 1886 to that of Birge in 1941 [81]. In 1927, M.E.J. Gheury de Bray was responsible for an initial analysis of the *c* data [82]. Then, after four new determinations by April of 1931, he said *"If the velocity of light is constant, how is it that, INVARIBLY, new determinations give values which are lower than the last one obtained. … There are twenty-two coincidences in favour of a decrease of the velocity of light, while there is not a single one against it"* [83]. Later in 1931 he said, *"I believe that in any other field of inquiry such a discrepancy between observation and theory would be felt intolerable"* [84]. With the inverse link between the strength of the ZPE and c, the measured decline in the values of c also indicates an increase in the strength of the ZPE. Again the trend flattened out around 1970 [53], and c was declared an absolute constant in 1983 [85]. A graph of the speed of light values recommended by Birge in 1941 is in Figure 3.

The analysis of the origin of mass by Haisch, Rueda and Puthoff indicate that atomic rest masses, m, are proportional to the square of the ZPE strength and inversely proportional to the square of the speed of light. Therefore we can write:

$$m \propto U^2 \propto h^2 \propto 1/c^2 \qquad (12)$$

Thus in Einstein's equation $E = mc^2$ energy E is conserved. An increasing ZPE is also supported by officially declared values of electron rest mass, m, which have increased with time up to 1970 when the trend again flattened out (see Figure 4). It should then be noted that gravitational or orbital clocks can be shown to tick at a constant rate. This follows since the quantity Gm appears in all orbital equations. Since the units of the Newtonian gravitational constant, G, contain mass, m, in the denominator, then the combination Gm cancels out any ZPE dependency. For a changing ZPE scenario we can then write

$$Gm = \text{constant} \qquad (13)$$

Therefore, the rate of ticking of all orbital or gravitational clocks remains unchanged as the strength of the ZPE varies. In contrast, analysis indicates that atomic clocks, including radiometric clocks, tick at a rate inversely proportional to the ZPE strength and proportional to *c*. In other words, atomic time intervals, t, were increasing as the ZPE increased. Therefore we write in summary that

$$t \propto U \propto h \propto 1/c \propto \sqrt{m} \qquad (14)$$

This relationship is verified by a comparison of atomic clocks with orbital clocks, which shows a declining atomic clock rate up to 1970. A graph of observations of the orbital behavior of Mercury in atomic time compared with orbital time is given in Figure 5. For other graphs similar to this, see Y B Kolesnik (2005) online at: http://www.estfound.org/analysis.htm retrieved 5 September, 2007. Again a change in trend occurred about 1970. A much longer orbital time-base is obtained if the known historical date of archaeological artefacts is compared with the radiometric (atomic) dates for those same artefacts. This has been done in Figure 6, where the form of the oscillation is apparent. There it can be seen that atomic clocks ticked fastest about 850 AD and was at a minimum about 1600 BC. From Figure 6, the main part of the curve appears to begin prior to 2600 BC when the atomic clock rate was about the same as today.

The statistical trends in the atomic constants, and the 638 measurements by 41 methods upon which they are based, were documented in August of 1987 in a Report for Stanford Research Institute (SRI) International (online at http://www.setterfield.org/report/report.html) by Norman and Setterfield [53]. The data trends were confirmed in 1993 with an independent statistical examination (available online at the following URL: http://www.ldolphin.org/cdkgal.html) by Montgomery and Dolphin [86]. A fuller study of this topic can be found in References [48, 53]. This present paper suggests that these data all point to the conclusion that the strength of the ZPE has been increasing with time cosmologically, but underwent a change in 1970, which may be a flat point in the oscillation modes or it may become a complete reversal. In either case, the suggestion by Narliker and Arp about a static, gently oscillating cosmos is fully supported. With this scenario in mind, we now return to matters directly affecting atomic behavior and the redshift.

III. THE ZERO POINT ENERGY AND THE REDSHIFT

A. Zero-Point Energy and atomic stability

This all-pervasive ZPE ‘sea’ appears to maintain atomic structures throughout the whole cosmos. In 1987 a key paper by Hal Puthoff was published on this topic [70]. He explained that, according to classical physics, an electron in orbit around a proton should be radiating energy and so spiral into the nucleus. Obviously this does not happen, and QED physicists invoke quantum laws as an explanation. Their ‘law’ however does not explain, or attempt to explain, why the electrons do not radiate energy in their movements. An actual physical explanation is still desirable, and this is what Puthoff dealt with in his paper. He assumed that classical physics was correct and also that the ZPE existed. The power that electrons radiated as they orbited around their protons was then calculated along with the power that such electrons received from the all-pervasive ZPE. It turns out that the two were identical. In the Abstract, Puthoff summarizes the results thus: *"the ground state of the hydrogen atom can be precisely defined as resulting from a dynamic equilibrium between radiation emitted due to acceleration of the electron in its ground state orbit and radiation absorbed from the zero-point fluctuations of the background vacuum electromagnetic field"* [70].

In the same way that a child on a swing receives resonantly times pushes from an adult to keep the swing going, so also the electron received resonantly timed "pushes" from the ZPE. Puthoff elaborated on this explanation as follows: *"The circular motion [of an electron in its orbit] can be thought of as two harmonic oscillator motions at right angles and 90 degrees out of phase, superimposed. These two oscillators are driven by the resonant components of the ZPE just as you would keep a kid swinging on a swing by resonantly-timed pushes. The oscillator motion acts as a filter to select out the energy at the right frequency (around 450 angstroms wavelength for the hydrogen atom Bohr orbit ground state)"* [87]. Power is therefore transferred from the Zero Point Fields (ZPF) to maintain electrons in their atomic orbits by this resonance mechanism.

It has also been explained another way. If an electron is orbiting too far out from the nucleus, it radiates more energy than it receives from the ZPE and spirals inwards to the position of stability. However, if the electron is orbiting too far in, it receives more energy from the ZPE than it is radiating, and so moves outwards to a stable position [88]. The concluding comment in Puthoff's paper 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"* [70]. Therefore, the very existence of atoms and atomic structures depends on this underlying sea of the electromagnetic ZPE. Indeed, without the ZPE all matter in the universe would undergo instantaneous collapse.

B. ZPE and the redshift

On this basis, then, it appears that atomic orbit stability is sustained by the ZPE. If, then, the energy density of the ZPE were to vary significantly, we should expect to see some effect on atomic orbit characteristics. Since the ZPE is universal, any change in it should affect all atomic orbit energies simultaneously. Puthoff's paper demonstrated that the power radiated and absorbed by the electron actually governed its orbit angular momentum, which is proportional to h. According to everything currently known about the atom, distances of the electrons from the nuclei, although different for every element, are definite. An electron may jump from one orbit to another, but there is no orbiting in between -- orbit angular momenta go in quantum jumps. Redshift measurements also go in quantum jumps. If the red shift is not due to universal expansion, but instead is due to something going on with the emitters of light, then there may be a connection between what is happening with the ZPE and the red shifting of light at distances.

Atomic orbits are quantized because the de Broglie wavelength, λ, of the orbiting electron must be such that the wave pattern links up and does not destructively interfere with itself. The allowed orbits are then those where the circumference of the circle that makes up the orbit $(2\pi a)$ is equal to a whole number of wavelengths, $n\lambda$, where n is an integer. Mathematically, this is expressed in the following equation as

$$2\pi a/\lambda = n \qquad \text{so that} \qquad \lambda = 2\pi a/n \qquad (15)$$

where the orbit radius is a. Since the de Broglie wavelength of the orbiting electron is given by $\lambda = h/mv$ then it follows that:

$$2\pi a/\lambda = 2\pi a/(h/mv) = n \qquad \text{so that} \qquad mva = nh/(2\pi) \qquad (16)$$

Here m is the electron rest mass and its orbit velocity is v, so that mva is the orbital angular momentum. The dependency of m on the ZPE is given in (12). Furthermore, since kinetic energy $(mv^2/2)$ is conserved with varying ZPE, then from (12) it follows that atomic particle velocities, v, will behave thus:

$$v \propto 1/U \propto 1/h \propto c \qquad (17)$$

It is for this reason that atomic clock rates are inversely proportional to the ZPE strength. Therefore from (12) and (17) it can be seen that as the strength of the ZPE increases, and h increases, orbital angular momenta (mva) must also increase.

It is one of the laws of physics that angular momenta must be conserved. But from (12) and (17) we have

$$mv \propto h \propto 1/c \qquad (18)$$

Therefore, the angular momentum can only be conserved if the orbit radius, a, decreases as the ZPE strength and h increase. That is, orbit radii are inversely proportional to h and U, so we write

$$a \propto 1/U \propto 1/h \qquad (19)$$

But from (15), the orbit radius and the wavelength of the electron de Broglie wave are directly related. This implies that, in order to conserve angular momentum as the ZPE increases and h increases, the de Broglie wavelength shortens and can therefore be accommodated in an orbit of a smaller radius. Since the wavelength of emitted light from a given orbit is related to both of these factors, the emitted wavelengths of light will become successively shorter, and more energetic, with increasing ZPE strength and so will be bluer with time.

This means that as we look further out into space, and therefore further back into time, the wavelengths of atoms will be redder. This gives us the redshift.

This may happen either smoothly, or in jumps depending on how the electron behaves. Therefore, this analysis indicates that both smoothly changing redshifts as well as quantized ones are possible. Given the problems others have had trying to account for the quantization of redshift measurements, further analysis in this area is now necessary.

If angular momentum is to be conserved on the left hand side of equation (16)b, then this must be reflected in the right hand side of that equation. That can only be achieved if we designate a value for $h/(2\pi)$ which is fixed. Let us choose the value of Planck's constant which pertained when atoms first formed and the universe became transparent to radiation, that is, the time of the formation of the cosmic microwave background radiation (CMBR). Let us label that value of h as h_o. The value of h in atomic orbit phenomena will then only increase in steps of $Nh_o/(2\pi)$ where N is an increasing integer related to the strength of the ZPE. Let us now make the Bohr quantum integer, $(n=1)$ for our purposes here so that we are effectively talking about the first Bohr orbit, since all other orbits scale proportionally. We can then insert the new ZPE redshift quantization integer, N, into equation (16) so that It will read

$$mva = Nh_o/(2\pi) \qquad (20)$$

where h_o is a fixed value. From (19) this means that

$$a \propto (2\pi)/(Nh_o) \qquad (21)$$

From (15), this in turn means that the emitted wavelengths get shorter in quantum steps given by

$$\lambda = 2\pi a/n \propto 2\pi[(2\pi)/(Nh_o)]/n = 4\pi^2/(Nh_o) \qquad (22)$$

where we are taking the Bohr integer, n, as equal to one in the final step. Since the redshift integer N increases as time goes forward, the quantized redshift will consider decreasing values of N as we go further out in space and back in time. As we look back into the past, the light emitted would be redder at earlier epochs. In a static universe, this would mean progressively more distant galaxies have their spectral lines shifted to the red end of the spectrum.

Now by definition of the redshift, if the wavelength of the light emitted from a distant galaxy is λ_2, and the light emitted by our laboratory standard is λ_1, then we have

$$\lambda_2 = \lambda_1 + \Delta\lambda_1 \qquad (23)$$

From (23) we then obtain

$$\lambda_2/\lambda_1 = 1 + (\Delta\lambda_1/\lambda_1) = (1+z) \qquad (24)$$

If we now put our laboratory standard wavelength $(\lambda_1 = 1)$ in (24), and substitute the value of λ in (22) as being λ_2, then we have from (24) the result that

$$\lambda_2/\lambda_1 = (4\pi^2/Nh_o)/1 = (1+z) = [1+x]/[\sqrt{(1-x^2)}] \propto 1/h \propto 1/U \qquad (25)$$

which gives us the quantized redshift. As a result of (25), it follows that the redshift factor $(1+z)$ is inversely proportional to the strength of the ZPE. The two conclusions from this are that the mathematical equation describing the behaviour of $(1+z)$ must be the inverse of the behaviour of the ZPE, and that this redshift may be quantized for the physical reasons outlined above.

The other matter this analysis involves is to note from (22) that the redshift quantum change is given by

$$\Delta z = 4\pi^2 / N \qquad (26)$$

From (26) it can be seen that the observed Δz will get smaller as N increases, or comes closer to our own galaxy and time. For example, when $N = 1$ the quantization has a redshift repeat distance of $\Delta z = 39.5$. As we come closer to the present, then the redshift quantization figure reduces in size because N has increased. This effect has been observed. The quantization noted by Duari et al., and Burbidge and Hewitt for very distant quasars, namely $\Delta z = 0.0565$, corresponds to a value of $N = 698$. Arp and Sulentic found that closer objects gave values of $\Delta z = 0.000241$ or 72.4 km/s which gives a value of $N = 163{,}471$. Guthrie and Napier found quantizations of 37.6 km/s or $\Delta z = 0.000125$ where N = 314,768, while Tifft noted even smaller quantizations. Therefore, the redshift quantizations are explicable in terms of the action of an increasing ZPE on the angular momenta of atomic orbits simultaneously across the cosmos. Since atomic orbit angular momenta are quantized, it should come as no surprise that increases in the ZPE bring about quantized changes in the redshift. But this in turn raises another matter. It is apparent that atomic orbits were somewhat larger in the past and have shrunk with time. These orbit radii changes now need discussion.

C. Electron orbits and related quantities

An atom is no longer considered to be a hard, incompressible sphere but a positively charged nucleus surrounded by a cloud of negative electrons. Increasing the number of electrons increases their mutual repulsion so their orbits expand. The reverse is also true since fewer electrons mean less repulsion, and orbits shrink. So electron cloud sizes vary. A metallic cation, or atom with an electron(s) removed, has less electron repulsion and electron orbits shrink to some extent [89]. Anions, or atoms with an additional electron(s), have increased repulsion so electron clouds expand [89]. So an atom may be pictured as an incompressible nucleus surrounded by an electron cloud that compresses or expands depending on existing conditions. Crystals are considered to be nuclei fixed at their final crystalline inter-nuclear separation, and electrons are poured into this force field without crystal sizes changing [90]. This will be discussed in more detail below, but two other items need to be noted first.

Three definitions of an atomic radius come from these considerations [91]. If atoms just touch, yet are "unsquashed" without being bonded, then the Van der Waal's radius results. For chlorine, this is 0.180 nanometers. But, when chlorine atoms are covalently bonded, they become more 'squashed,' as in a chlorine gas, and its covalent radius is 0.099 nanometers. The chloride anion, as in sodium chloride, has an ionic radius of 0.181 nanometers. Thus, the minute quantum decreases in atomic orbit radii with time from (21) should be absorbed by a slightly different degree of cloud "squashing" without any additional effects on the atom itself.

Bonding energy between atoms is similarly unaffected. It is true that completed electron shells will become fractionally smaller with time because of slightly smaller orbit radii, a. It is also true that the quantity e^2/ε remains fixed as the ZPE varies, where e is the electronic charge and ε is the permittivity of the vacuum. This means that the bond energy will be proportional to $1/a$. However, as can be seen from equations (18), (19) and (20), the mass of the particles in both the atomic nuclei and the orbiting electrons are also proportional to $1/a$. Therefore, as time increases, the fractionally greater electrostatic bond energy of attraction is acting to pull together atomic particles whose mass is also fractionally greater in the same proportion, and so are less easily attracted. This means that the bond energy per atomic particle mass remains fixed, and so no change in bonding should occur.

The other matter needing discussion is the so-called electron degeneracy pressure in solids. This is a repulsive force which acts independently of electrostatic effects. If atoms were subjected only to attractive forces, all atoms would tend to coalesce. So some type of repulsive forces must act over short distances to overcome the attractive forces. With covalent and van der Waals forces, the repulsion and attraction can be considered as part of a single mechanism, but an ionic system is somewhat different. Here the attractive force arises from the electrostatic charge as expected, but the repulsive forces are two-fold. First, the penetration of one electron shell by another means that nuclear charges are no longer completely screened. They therefore tend to repel one another. The other effect arises from the Pauli exclusion principle which states that two electrons of the same energy cannot occupy the same element of space. For them to be in the same space, that is overlapping, the energy of one must be increased and this is equivalent to a force of repulsion. A detailed explanation of this effect is given in "The Accidental Universe" by P.C.W. Davies, pp. 44-48, Cambridge University Press, 1987.

In there it is shown that the degeneracy pressure is directly proportional to the average kinetic energy of the electrons. This fact may be partly disguised by the use of a momentum term, but as the mathematical symbolism is followed through, the degeneracy pressure and average kinetic energy of the electrons are the key quantities directly linked. Since electron kinetic energies remain constant within the interval between quantum jumps, the repulsive pressure will remain unchanged, and orbit radii also remain unchanged. Thus no changes are expected in solids during the interval. But changes to orbit radii and kinetic energies occur during the quantum jump. First, as time increases at the jump, orbit radii get smaller, so there may be a tendency for the solid to contract marginally. However, this is offset by the fact that, since electron masses increase at the jump with time increasing, then the kinetic energy of electrons will increase. This means that the degeneracy pressure will also increase, thereby offsetting the tendency for the solid to contract. The final outcome is that solids are expected to remain the same size at the jumps.

IV. THE REDSHIFT EQUATION AND THE ZERO POINT ENERGY

A. Initial comments

From equation (25), it can be noted that the behavior of the redshift is inversely related to the strength of the ZPE. It should therefore be possible to derive this equation for ZPE behavior from physical processes acting at the inception of the cosmos. The two processes acting with Planck Particle Pairs to produce the build-up in the ZPE strength were turbulence and recombination. Since the physical principles involving both these processes have been mathematically defined, let us use them to derive the redshift equation. Other paths to this derivation are possible. Indeed, one was explored in an earlier article in which the derivation started with the redshift equation and proceeded in reverse to establish the mathematical link with the turbulence and recombination of the PPP [92]. In a different derivation employed here, we begin with the turbulence and recombination equations and then proceed in a forward direction to show how the standard redshift equation is an approximation to reality. This is a completely different way of approaching the issue and avoids the problems pointed out by others in the previous paper.

B. Recombination and turbulence

This derivation begins with the standard form of the recombination equation which is [93]

$$dN^* / dt^* = q - rN^{*2} \qquad (27)$$

In (27), N^* is the number of ion pairs per unit volume available for recombination, r is the recombination coefficient, and q is the number of ion pairs created per unit volume per unit time by any given process, such as ionization [93]. In addition, t^* is time measured from the beginning of the interaction. In applying this to the matter in hand, we replace t^* with t, which is time that is measured going forward from the inception of the cosmos, where $(t = 0)$, to the present epoch, where $(t = 1)$. However, astronomically, we also need to use a definition of time, T, where $(T = 0)$ at our present era and $(T = 1)$ at the origin of the universe. Thus we can write $(T = 1 - t)$, and we can replace N^* with N, which is the number of Planck Particle Pairs (PPP) per unit volume available for recombination at time T. We then have the equation

$$dN / dt = q - RN^2 \qquad (28)$$

In the standard form of the equation in (27), the recombination coefficient, $r = 1/(N^* \tau)$, where τ is the recombination time [94]. As such, the recombination coefficient bears the units of *cm^3/(ion-seconds)* as pointed out by Zwaska et al. [95]. In (28) we have replaced r with R. For our purposes, however, the quantity N is the number of PPP per unit volume available for recombination at any given unit of time. We can then make the identification that, in (28), $R = 1/N$ since this then gives the required units for this formula of *cm^3/(PPP-seconds).* When this is substituted in (28) we obtain the following modification:

$$dN / dt = q - (1/N)(N^2/1) = q - N \qquad (29)$$

Let us now make the identification that N_1 is the original number of PPP. If we then allow all possible directions of movement for these PPP, the rate of collision initially is such that $N_1 / 3 = N$, since this situation is similar to the behavior of molecules in deriving the transport constants of physics [96]. We can then proceed in the following fashion:

$$3N = N_1$$

Dividing both sides by two then gives us

$$(3/2)N = N_1 / 2$$

which means that

$$N + (1/2)N = (1/2)N_1$$

Therefore

$$N = [(1/2)N_1] - [(1/2)N] = (N_1 - N)/2$$

If we now insert this result for N back in (29) we obtain

$$dN/dt = q - [(N_1 - N)/2] \qquad (30)$$

For ease of working as we proceed, let us also make the substitution

$$M = (N_1 - N)$$

and insert this in (30) to give us

$$dN/dt = q - (M/2)$$

Let us also absorb the factor of (½) in a constant, k_1, such that

$$dN/dt = q - k_1 M \qquad (31)$$

We now move on to consider the q term in (29) and (31). It is usual for q to represent the ionization rate. This is equivalent, in our case, to the number of PPP formed per unit volume in a given time by the decaying turbulence as a result of the original expansion. Thus, for the PPP system being considered here, the term q is directly related to the decay in turbulence, L. It is generally conceded that the decay in turbulence follows a power law such that for time, t, [97]

$$L = 1/t^n \qquad (32)$$

As such, it might be anticipated that, since the number of PPP forming is dependent upon the turbulence, this means that q is also proportional to $1/t^n$. However the value of n is different for various systems. For example, it is known that, in incompressible systems, the value of n can be much lower than unity. It is further known that for spatially free turbulence the value of n is lower in any given system than for turbulence in a confined system. In confined systems, the value of n in incompressible turbulence can be below $n = 0.66$ [97]. In the case of spatially free turbulence it may therefore not be unreasonable to expect n to drop to a value of $n = 0.5$ or even lower. It can be shown that the process operating here, which is represented by q, is the dominant process that determines the behavior of the ZPE near the origin of the universe. Thus the shape of the redshift graph near the origin is also determined by q. As a consequence, one possible deviation from the standard form of the redshift/distance relationship can be traced directly to the value of n that was actually in operation at the time. This may explain the discrepant results for distant Type Ia supernovas and the whole discussion of accelerating universal expansion that followed. For our purposes here, let us assume that the value of n is precisely 0.5 (which is what the relativistic Doppler formula effectively has done) and go on from there. This means that (31) can be written

$$dN/dt = k_2/(\sqrt{t}) - k_1 M \qquad (33)$$

where k_2 is a proportionality constant.. Now inspection reveals the quantity $(N_1 - N)$ in (30) will increase with time and so is proportional to t. But the build-up of PPP's per unit volume is accompanied by a decrease in turbulence. This situation is very similar to chemical rate equations where the concentration of a reactant decreases while the concentration per unit volume of the end product(s) increases. The equation describing the process may be of the first order if the relationship is direct, while it is of the second order if it is a squared relationship [98]. In other cases, the order of the reaction can be more complex [98]. Our purposes here are satisfied if $(N_1 - N)$ bears a second order relationship with t. We can thus write

$$(N_1 - N)^2 \propto t$$

This, then, means that

$$(N_1 - N) \propto (\sqrt{t})$$

Substituting this result in (33) will therefore give us

$$dN/dt = [k_2/(N_1 - N)] - [k_1 M] \qquad (34)$$

If we now substitute M for $(N_1 - N)$ in (34), we then obtain the outcome that

$$dN/dt = (k_2/M) - (k_1 M) \qquad (35)$$

C. Deriving the redshift equation

In order to proceed towards deriving the redshift equation from the build-up of the strength of the ZPE, we now need to transfer our time-base to one which starts near our own location as time zero and then proceeds out into the universe. This requirement is satisfied by the quantity T rather than that of t. We have noted in the preamble to equation (28) that $T = (1-t)$ or, equivalently, $t = (1-T)$. When we replace t with T in (35) we then obtain

$$dN/dt = -dN/dT = (k_2/M) - (k_1 M) \qquad (36)$$

One further change must be made to accommodate the use of M rather than N. To do this we note that:

$$d(N_1 - N)/dT = dM/dT$$

Since N_1 is the original number of PPP's which remains unchanged, this means that

$$dM/dT = -dN/dT$$

As a consequence of this we can now re-write (36) as

$$dM/dT = (k_2/M) - (k_1 M) \qquad (37)$$

If we ignore the constants of proportionality, we obtain a clean result that directly follows the form of (27)

$$dM/dT = (1/M) - (M/1)$$

$$\therefore\ dM/dT = (1 - M^2)/M \qquad (38)$$

We now need (38) in terms of T and T^2, but we have already defined $T = (1-t)$. Therefore we have

$$T^2 = (1-t)(1-t)$$

Because t lies between zero and one we can now make an approximation such that

$$T^2 = (1-t)/(1+t) \qquad (39)$$

Inspection reveals that this is valid since $(T = 0)$ when $(t = 1)$, and alternatively $(T = 1)$ when $(t = 0)$ which is our prime requirement. Now we have already noted that $(N_1 - N)^2$ is proportional to t. This means that M^2 is also proportional to t. If we now substitute this result for t in (39) then we have

$$T^2 = (1 - M^2)/(1 + M^2) \qquad (40)$$

Now T and t, occupy a range between zero and one. When this is so, there is also a range that N can occupy and a fixed value that N_1 will have that is in accord with this requirement. Calculation and algebra show that when $[N_1 = (3\sqrt{3})/2]$ the following condition is satisfied:

$$T^2 = (1 - M^2)/(1 + M^2) = 1/(1 - M^2) \qquad (41)$$

It is now possible to proceed in the following fashion.

$$T^2 = 1/(1 - M^2) = (1 + M^2 - M^2)/(1 - M^2)$$

$$= [M^2/(1 - M^2)] + [(1 - M^2)/(1 - M^2)]$$

$$= [M^2/(1 - M^2)] + 1$$

Therefore,

$$T^2 - 1 = M^2/(1 - M^2)$$

$$(T^2 - 1)/M = M/(1 - M^2)$$

Then, upon inverting both sides, we obtain

$$(1 - M^2)/M = M/(T^2 - 1) \qquad (42)$$

From (38) and (42) we can now write that

$$dM/dT = (1 - M^2)/M = M/[(T+1)(T-1)] \qquad (43)$$

Now we have noted above that $(T = 1 - t)$ and that M^2 is proportional to t. Therefore we can write

$$T = 1 - M^2 \qquad \text{so that} \qquad M^2 = 1 - T$$

Taking the square root then gives us

$$M = \sqrt{(1 - T)} \qquad (44)$$

Substituting (44) in (43) then results in

$$dM/dT = (1 - M^2)/M = M/[(T+1)(T-1)] = \sqrt{(1-T)}/[(T+1)(T-1)] \qquad (45)$$

If we now multiply the numerator and denominator of (45) by minus one, we obtain

$$dM/dT = \sqrt{(1-T)}/[(T+1)(T-1)] = \sqrt{(T-1)}/[(-1)(T+1)(T-1)]$$

$$dM/dT = (-1)/[(T+1)\sqrt{(T-1)}] \qquad (46)$$

We now note that the denominator contains the term $[\sqrt{(T-1)}]$ and that T goes between zero and one. As a result, the expression within the parentheses, namely $(T-1)$, goes between minus one and zero. The same holds true for the expression $(T^2 - 1)$ which also goes between minus one and zero when T goes between zero and one. In other words, in this particular case, $(T-1)$ and $(T^2 - 1)$ are very good approximations to each other within the range of values that T is restricted to. We thus closely approximate $[\sqrt{(T-1)}]$ with $[\sqrt{(T^2-1)}]$. Here is an additional reason why the relativistic Doppler formula is only an approximation to reality. When this approximation is inserted in (46) it then becomes

$$dM/dT = (-1)/[(T+1)\sqrt{(T^2-1)}] \qquad (47)$$

If we now take the integral of (47) we obtain the result that

$$M = [\sqrt{(1-T^2)}]/(1+T) = (N_1 - N) \qquad (48)$$

But the quantity $(N_1 - N)$ effectively is equivalent to the number of Planck Particle Pairs which have recombined and so is proportional to the strength of the Zero Point Energy. We can therefore state that

$$U \propto (N_1 - N) = [\sqrt{(1-T^2)}]/(1+T) \qquad (49)$$

But equation (49) is the inverse of (9) which is the standard redshift equation. Therefore we can state that

$$U \propto [\sqrt{(1-T^2)}]/(1+T) = 1/(1+z) \qquad (50)$$

Thus the redshift is a manifestation of the fact that the strength of the ZPE has increased with time so that (50) therefore gives an approximation to its behavior. The only difference between the inverse of (50) and equation (9) is that distance, x, in (9) has been replaced with look-back time, T, in (50). However, since looking out into the vast distances of space is equivalent to looking back in time, this should not be surprising. We may therefore write the final outcome from (14) as

$$(1+z) = [1+T]/[\sqrt{(1-T^2)}] \propto 1/U \propto 1/h \propto 1/t \propto 1/\sqrt{m} \propto c \qquad (51)$$

Equation (51) describes the behavior of all these quantities dependent on the strength of the ZPE which is graphed in Figure 7. Also, the years elapsed on the atomic clock, t_e, or its equivalent, the distance in light years that light has traveled, is given by substituting for T in the integral of (51) which is given as follows:

$$t_e = K[\arcsin T - \sqrt{(1-T^2)} + 1] \qquad (52)$$

The final term of unity in (52) is included as this gives $t_e = 0$ when $T = 0$. At the origin of the universe, when $T = 1$, the terms within the square brackets in (52) total 2.5708. As the cosmos is 10 to 14 billion atomic years old, and light has traveled 10 to 14 billion light years, then the numerical value of *K* must be about $K = 4 \times 10^9$.

This shows the relativistic Doppler formula for redshifts may be approximated by the behavior of a universal Planck Particle Pair system in a way which has nothing to do with the expansion of space-time or galaxy motion. Rather, it has everything to do with turbulence in the early cosmos and the production and recombination of Planck particle pairs. Given the approximations included in the above procedure, it is now possible in principle to obtain a better fit to the data for redshifts greater than $z = 0.8$. This allows a resolution of the distance discrepancy at high redshifts without a cosmological constant or dark energy.

V. SUMMARY

This review examined the historical development of redshift measurements. It was seen that Hubble's insertion of the speed of light, *c*, into the redshift equation has been responsible for many problems. It was shown that these problems disappear if the redshift is not primarily due to motion, but due to a consistent change in the properties of the vacuum which uniformly affected atomic emitters throughout the universe. This change is shown to be the result of an increasing Zero Point Energy (ZPE) and the reason for its increase is explained. This option allows the quantized redshift noted by Tifft and others to be accounted for in terms of the quantization of atomic orbit angular momenta. The change in orbital angular momentum for atoms is shown to derive from the increasing energy density of the vacuum ZPE. An analysis of this option reveals that the increase in the ZPE with time approximately follows an inverse relationship with the standard relativistic Doppler formula for the redshift/distance graph. This formula therefore can be derived without any reference to the expansion of space-time or galaxy recession velocities. As a result, the necessity for a cosmological constant and/or dark energy can be avoided and the necessity for missing mass or dark matter also vanishes.

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FIGURE 1: Recommended values of Planck's constant, hx10^{-34} J-s

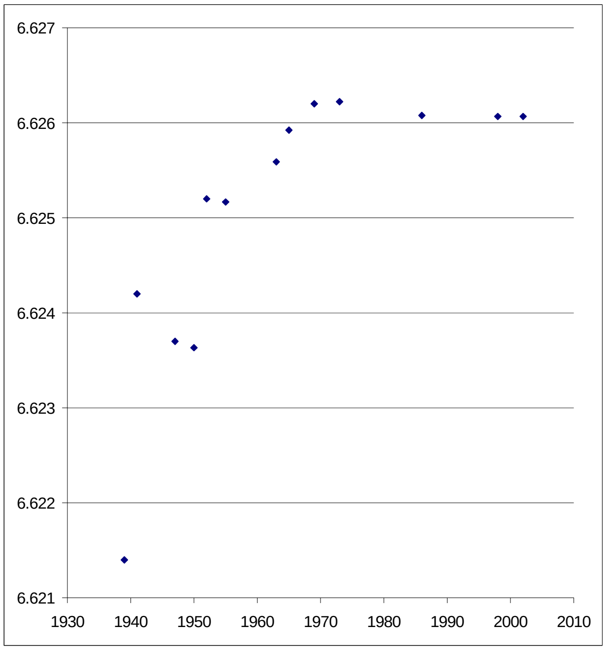


FIGURE 2: Recommended values of h/e x 10-15 J-s/C

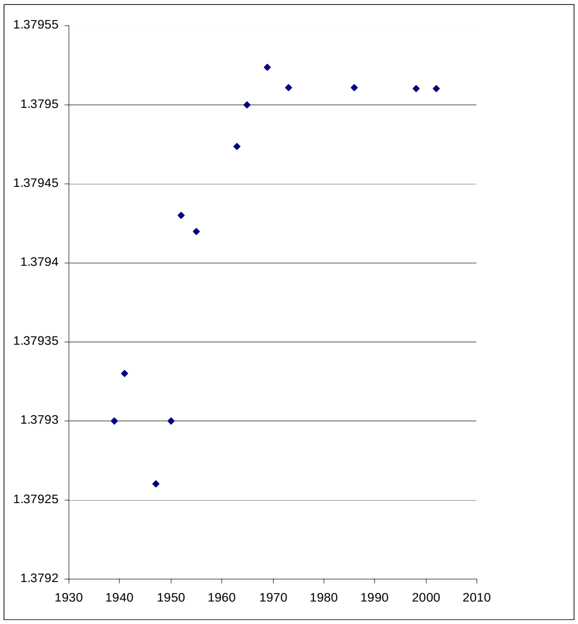


FIGURE 3: Birge's recommended values of light velocity, c x 10^5 km/s

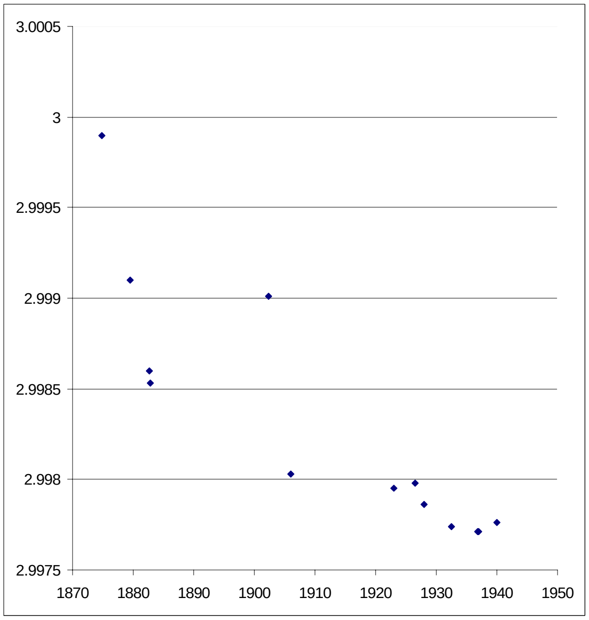


FIGURE 4: Recommended values of electron rest-mass, m x 10^{-31} kg

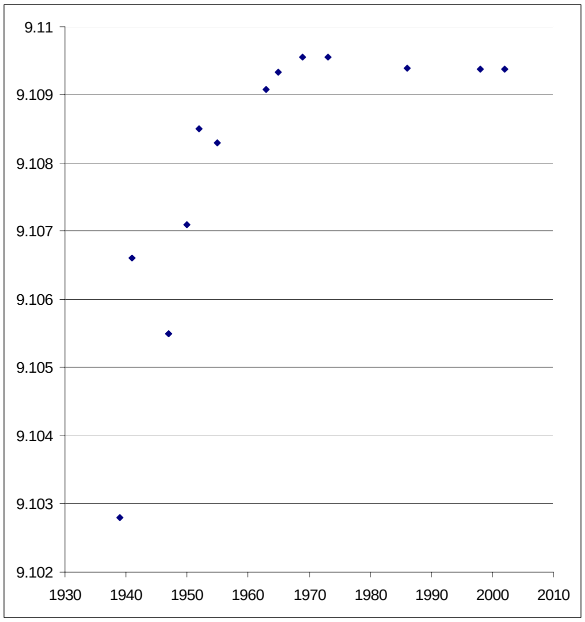


FIGURE 5: Atomic clock rates (vertically) compared with clock rate (horizontally) using the planet Mercury (after ik)

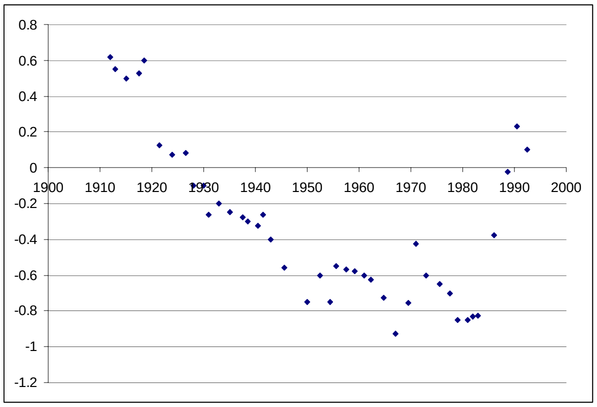


Figure 6: C-14 Atomic Dates compared with Orbital Dates

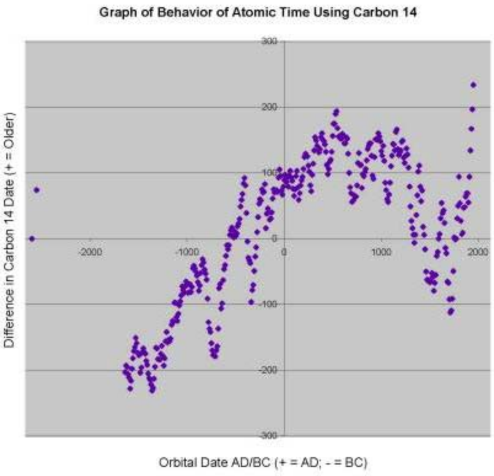
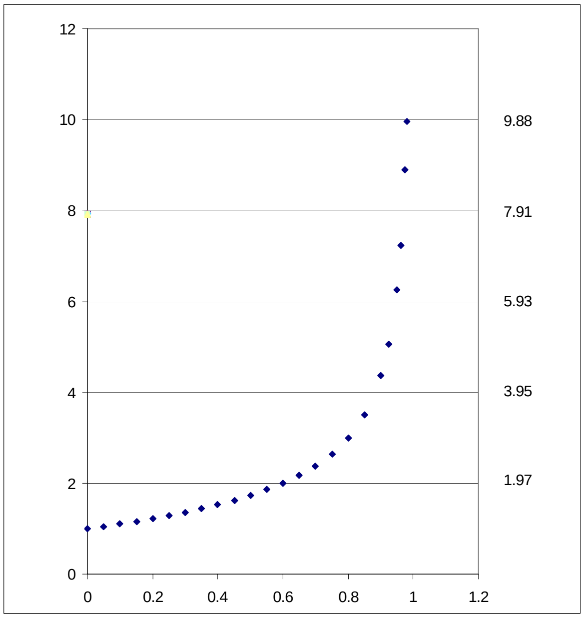


FIGURE 7: Graph of (51) the inverse of ZPE behavior and *h*. Behavior on left axis and *c* x 10^7 on right.



Horizontal axis: *Time T = 0 now, and T = 1 at origin of cosmos.*