Intrinsic Redshift in Quasi-Stellar Objects (QSOs) – Mass Dependence and Quantization?

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I tackle the topic of quantization of intrinsic QSO redshifts, especially based on the lifetime work of Halton Arp, examining first the potential relationship between intrinsic QSO redshift and QSO mass, then the phenomenon of quantization for both QSO mass and redshift. My approach is primarily a mathematical one, as developing a theory for intrinsic QSO redshift, let alone its quantization, is beyond my expertise. I postulate a geometric explanation of intrinsic redshift given a possible dependence on mass to the 2/3 power, related to possible attenuation of light energy (and therefore frequency) within the "emitting nucleus" of a QSO, compounded by a further "dilution," and therefore energy (and frequency) decrease due to spread over the surface area. To do the quantization aspect justice, I summarize three theories by other experts and examine the plausibility of the two within my realm of knowledge. Finally, I offer at least a mathematical representation of the quantization aspect as "food for thought."

1. Introduction

"Viktor A. Ambartsumian suggested the idea that new galaxies are formed through ejection from older active galaxies (1958). This idea has had a certain continuity in the research carried out over the last 40 years based on the hypothesis that some extragalactic objects, and in particular high redshift [quasi-stellar objects] QSOs, might be associated with low redshift galaxies, thus providing a non-cosmological explanation for the redshift in QSOs (e.g., Arp 1987, 2003; Narlikar 1989; Burbidge 2001; Bell 2002, 2006, 2007; Lopez-Corredoira & Gutierrez 2006) [Refs. 1-9]; that is, a redshift produced by a mechanism different from the expansion of the Universe or the Doppler effect. Ambarsumian never accepted the idea of non-cosmological redshifts; however, the scenario of QSOs ejected by galaxies is a common theme of the Armenian astrophysicist and in proposals of discordant QSO-galaxy redshift associations." [10] More recently, this has been advocated by Tifft – "There appears to be little doubt that redshift is a quantized and variable quantity" – who has been pursuing this since his dissertation in 1963. [11]

Redshift (z) periodicity has been observed at z = 0.3, 0.6, 0.96, 1.41 and 1.96, with two others predicted at z = 2.63 and 3.46. [12] An additional preferred peak at z = 0.061 has been observed by several others as well. [13] Various explanation have been proposed for this phenomenon, including: (1) strictly Dopplerian redshifts; (2) partial Dopplerian and non-Dopplerian redshift; "tired light" (non-Dopplerian) redshift; (4) periodic oscillation of physical constants (e.g., the gravitational constant); (5) interaction between radiation and cold Rydberg material in intergalactic space close to the observed parent galaxy of the QSOs; (6) three-dimensional quantized time; (7) oscillating atomic lines (due to temporal changes of the fine structure constant); (8) oscillating luminosity of galaxies; [12] (9) Quantum Temporal Cosmology (QTC), which assumes time is three-dimensional with matter flowing out radially from a near-singular time origin such that, as energy decays, doubling processes produce quantization [11]; (10) local ether theory with gravitational redshift [14]; and variable particle mass that changes in discrete steps [15]. And, while I do not have a pet theory of my own as to why these QSO redshifts should be quantized, it occurred to me that perhaps a simple explanation might be based on gravitational effects, something that might be examined at least for plausibility given the measured redshift peaks and estimates of QSO masses.

Reference [16] provided a tabulated source of data for QSO masses that has already considered over 50,000 QSO observations. For redshift increments of z = 0.2 from z = 0.2 to z = 2.0, Table 1 lists the observed values, which includes combining those for the 3a and 3b increments into one for convenience. Increments 3a and 3b were combined into one (Increment 3) with 3665 + 4727 = 8392 data, weighting the log of the mass ratio as follows: $(3665\,x\,8.69 + 4727\,x\,8.59)/_{8392} = 8.63$. Conveniently, the z range covers all but the lowest observed peak at z = 0.061.

Table 1. QSO Data for z from 0.2 to 2.0 [14]

<table>
<tr><th>#</th><th>Z
Range</th><th>Z
Midpoint</th><th>Number
of QSOs</th><th colspan="2">Log of Mass Ratio
(to Sun's Mass)</th><th>Mass Ratio
(to Sun's Mass)</th></tr>
<tr><td>1</td><td>0.2-0.4</td><td>0.3</td><td>2690</td><td colspan="2">8.27</td><td>1.86E+08</td></tr>
<tr><td>2</td><td>0.4-0.6</td><td>0.5</td><td>4250</td><td colspan="2">8.44</td><td>2.75E+08</td></tr>
<tr><td>3a</td><td rowspan="2">0.6-0.8</td><td rowspan="2">0.7</td><td>3665</td><td>8.69</td><td rowspan="2">8.63</td><td rowspan="2">4.30E+08</td></tr>
<tr><td>3b</td><td>4727</td><td>8.59</td></tr>
<tr><td>4</td><td>0.8-1.0</td><td>0.9</td><td>5197</td><td colspan="2">8.76</td><td>5.75E+08</td></tr>
<tr><td>5</td><td>1.0-1.2</td><td>1.1</td><td>6054</td><td colspan="2">8.89</td><td>7.76E+08</td></tr>
<tr><td>6</td><td>1.2-1.4</td><td>1.3</td><td>7005</td><td colspan="2">8.96</td><td>9.12E+08</td></tr>
<tr><td>7</td><td>1.4-1.6</td><td>1.5</td><td>7513</td><td colspan="2">9.07</td><td>1.17E+09</td></tr>
<tr><td>8</td><td>1.6-1.8</td><td>1,7</td><td>6639</td><td colspan="2">9.18</td><td>1.51E+09</td></tr>
<tr><td>9</td><td>1.8-2.0</td><td>1.9</td><td>4900</td><td colspan="2">9.29</td><td>1.95E+09</td></tr>
</table>

2. Gravitational Redshift?

The fairly smooth trend shown in Figure 1 suggested a correlation between QSO mass and measured redshift, and our first thought was to examine the possibility of a gravitational effect. Gravity is postulated as being capable of redshifting light as the light travels outward from a gravitational mass (such as a star or QSO). The redshift follows this relationship: [17]

$$\lim_{r \to +\infty} z(r) = 1 \Big/ \sqrt{1 - \frac{2GM}{R^* c^2}} - 1 \qquad [1]$$

where:

G = gravitational constant, 6.674E-11 $m^3/kg\text{-}s^2$
M = gravitational mass (kg)
R* = radial coordinate of emission point (analogous to classical distance from center of gravitational mass) (m)
r = radial distance to observer (effectively infinite, since this formula is for a limit) (m)
c = speed of light, 3.00E+8 m/s.

Rearranging Equation [1] as follows yields the unknown R* as a function of z (replacing the limit designation since the observation distance is assumed to be "infinite"):

$$R^* = \frac{2GM}{c^2} \Big/ \left(1 - \frac{1}{[z+1]^2}\right) \qquad [2]$$

Using 1.99E+30 kg as the Sun's mass, M_0, we calculate 1.35E+12 m $\leq$ R* $\leq$ 6.53E+12 m for the range of redshifts in Table 1, based on the incremental midpoints (i.e., $0.3 \leq z \leq 1.9$).

If QSOs are ejections from the nuclei of parent galaxies, we would expect their size to be significantly less than those of these parent nuclei. Reference [18] cites a radius for the nucleus of the Milky Way of 800 parsecs, or 2.47E+19 m, six to seven orders of magnitude greater than the estimated range for R*. If this is typical of galaxies from which ejected QSOs have been observed, then their sizes must be quite small relative to the parent nucleus to generate the observed redshifts solely by gravitational effects. At least one theorist (C.-C. Su) cites gravity as a potential cause for intrinsic redshift: [14]

> *... [T]he high redshift can be due to the gravitational redshift as an intrinsic redshift. Based on the proposed local-ether theory, this intrinsic redshift is determined solely by the gravitational*

potential associated specifically with the celestial object in which the emitting sources are placed. During the process with which quasars evolve into ordinary galaxies, the fragmentation of quasars and the formation of stars occur and hence the masses of quasars decrease. Thus their gravitational potentials and hence redshifts become smaller and smaller … in accord with the aging of redshift during the evolution process. In some observations, the redshifts of quasars … exhibit a series of preferred peaks in their distributions … Based on the local-ether wave equation, it is shown that the quantum-state energies and transition frequencies of atoms or ions placed in a celestial object decrease under the influence of the associated gravitational potential … [I]n the evolution process with quasar fragmentation and star formation, the masses of quasars decrease and their gravitational potentials become weaker. Thus their redshifts become lower and lower, while the starburst makes their luminosities stronger."

However, another has noted that "… the redshift was quantized and not continuous as required by gravitational dynamics." [11] Nonetheless, this does not rule out a gravitational dependence for QSO redshift over a continuous spectrum, although the calculation above suggests that QSOs must be extremely small at "birth" relative to the nuclei of their parent galaxies to exhibit the observed redshifts. I form no conclusion as to the plausibility of a gravitational cause for intrinsic redshift of QSOs, but merely suggest that such would require the QSOs to be relatively extremely small when ejected.

3. "Tired Light" Attenuation?

Another idea as to the dependence of redshift on QSO mass is that, as the light travels outward from inside the QSO, it loses energy through interaction with the matter inside the QSO (presumably plasma) according to the typical formula for attenuation with distance:

$$E(r) = E_0 e^{-\mu r} \quad [3]$$

where:

- E(r) = energy at distance r from the source
- E_0 = energy when emitted at r = 0
- μ = attenuation coefficient (m^{-1} when r is measured in m)

Since redshift at a distance r from the source is defined as $z(r) = (\nu_0 - \nu[r])/\nu_0$, and $E(r) = h\nu(r)$, we can express the redshift in terms of Equation [3] as follows:

$$z(r) = e^{\mu r} - 1 \quad [4]$$

then linearize it and perform a simple regression analysis using the values from Table 1 (using the z midpoints) if we assume:

1. The "emitting nucleus" of the QSO has a relatively constant size (assume spherical) that does not change but loses mass as material emanates outward, i.e., its density decreases with age.
2. Attenuation is a function of this density, decreasing with decreasing density, thereby reducing redshift by attenuation as the QSO ages.

Note that this does not suggest that the QSO ceases to "grow" in size with age, but only that the "emitting nucleus" remains relatively constant in size as its mass spreads outward and density decreases. Since density and mass are directly proportional for a constant volume, we can rewrite Equation [4] in the following linear form suitable for regression:

$$\ln(z[r] + 1) = a_0 + a_1({}^{M}/_{M_0}) \quad [5]$$

Reference [19] is an online tool for various forms of regression analysis. For this equation, it yields the following result with an R^2 coefficient of 89.1%: $a_0 = 0.3328, a_1 = 4.349E - 10$. As might be expected from the less than ideal R^2 value, the fit to the observed data is not satisfactory, showing a different trend (see Figure 1).[a]

4. Other Explanations?

The next trial was to perform non-linear regression using Reference [19] to see what correlations might fall out and see if any might suggest a physical model for the dependence of QSO redshift on mass. The following three were the "simplest" that also exhibited a high value of R^2:

$$z = 5.367E - 5\sqrt{M/_{M_0}} + 0.3171, R^2 = 99.3\% \quad [6]$$

$$z = 0.6952\ln\left(M/_{M_0}\right) - 13.038, R^2 = 98.3\% \quad [7]$$

$$z = 1.256E - 6(M/_{M_0})^{0.6676}, R^2 = 98.2\% \quad [8]$$

A simple linear fit, $z = 9.053E - 10\left(M/_{M_0}\right) + 0.3171$, yielded an R^2 of 94.9%. All these are plotted in Figure 1 along with the observed values from Table 1 (using the z midpoints).[b]

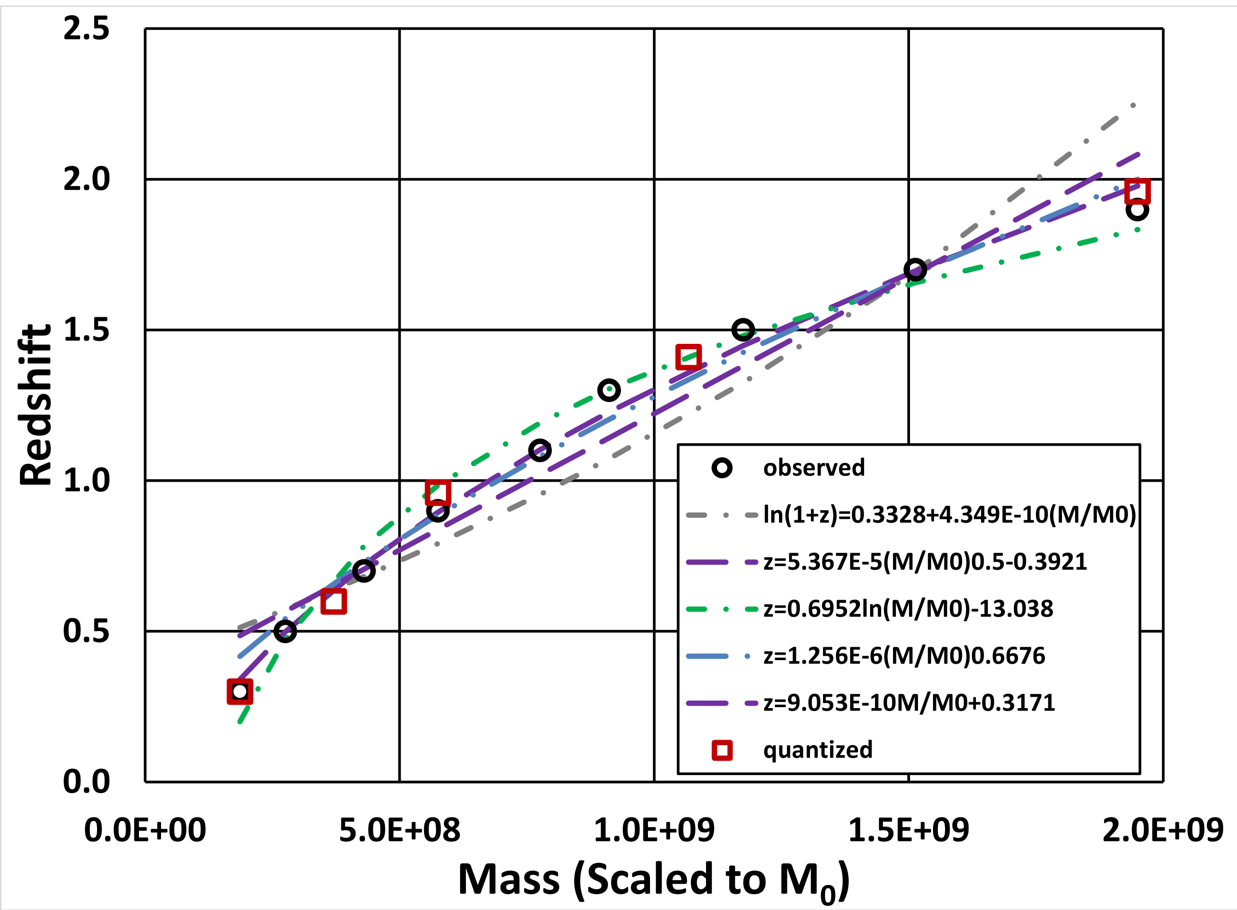

Figure 1. QSO Redshift vs. Mass (Scaled)

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a While both redshift trends increase with mass, the observed redshift shows a slightly descending rate of increase while Equation [5] shows a slightly ascending rate of increase.

b Also shown are the quantized redshifts, discussed in the following section.

Equations [6] through [8] show the best fits vs. the observed data, although none passes through all of those points. The linear fit is better than the previous (Equation [5]) for the attenuation assumption, but is noticeably weaker than the best three. Of the three, Equation [8] with its dependence on the scaled mass to essentially the 2/3 power suggests a possible physical phenomenon for the dependence of QSO redshift on mass, given the previous assumptions.

Light presumably is emitted at the "surface" of the QSO, taken as an approximate sphere such that its surface area is proportional to the square of its radius. We have assumed the radius of the "emitting nucleus" portion of the QSO remains relatively constant. Therefore, any decrease in mass is the result of a decrease in density as mass emanates outward with the growing QSO (but not the growing "emitting nucleus). Since the radius is proportional to the cube root of the mass (given the relatively constant volume as well), the surface area is proportional to mass to the 2/3 power. While I do not know what physical phenomenon might cause redshift to be directly proportional to the area of the emitting surface (possibly some sort of "dilution" of the light energy, corresponding to both energy and frequency decrease?), IF this relationship is true, then the correlation with mass to the 2/3 power follows – for a relatively constant emitting volume and surface area, as the density decreases, so does the redshift. One possible mechanism again returns to the attenuation effect, albeit somehow directly proportional to the radius, i.e., the distance through which the light must pass to reach the emitting surface. With decreasing density and relatively constant radius, the attenuation decreases, allowing light to pass through more readily with less energy loss and, therefore, less decrease in frequency and less redshift.

If all this seems implausible, remember that the mainstream cosmological explanation requires a Big Bang with an ever expanding universe where QSOs observed to be relatively close to "parent galaxies" is purely coincidental. Halton Arp and others have estimated the probability of such a purely coincidental occurrence to be astronomically small ("less than one in ten million" [15]). Therefore, is my speculation any more implausible?

5. <u>Redshift Quantization?</u>

At the Kronia Group Conference in Portland, Oregon, on Sept. 23, 2000, Halton Arp presented his theory on "Intrinsic Redshift." [15]

> *... [I]n the early 1950s ... they saw these thin connections [between galaxies and radio lobes] going from the central galaxy out to the radio lobes on either side ... [T]his material is actually being ejected (that's about the only way you could get this configuration) ... [T]his large amount of material is coming from this very small active spot ... [I]f the galaxy is going to eject something, it's going to eject along the path of least resistance, which is out the poles ... [Y]ou have this nice relationship that as the quasars ... proceed out as time goes past, they age and drop in redshift... [T]hey don't drop smoothly ... [but] in preferred quantized redshifts ... What I have interpreted this to mean is that these quasars move out, evolving to low redshift ...*

Arp's theory is that QSOs are ejected at high redshift and, as they travel outward from the ejecting galaxy, experience a decrease in redshift but in discrete increments.

We can use Equations [6] through [8] to estimate the QSO mass at each of the redshift peaks 0.30, 0.60, 0.96, 1.41 and 1.96. The estimates and averages from the three are presented below.

<u>Table 2. QSO Mass (Scaled) vs. z Peak</u>

Z Peak	M/M_0			
	Equation [6]	Equation [7]	Equation [8]	Average
0.3	1.66E+08	2.15E+08	1.14E+08	1.65E+08
0.6	3.42E+08	3.31E+08	3.21E+08	3.31E+08

Z Peak	M/M_0			
	Equation [6]	**Equation [7]**	**Equation [8]**	**Average**
0.96	6.35E+08	5.55E+08	6.50E+08	6.13E+08
1.41	1.13E+09	1.06E+09	1.16E+09	1.11E+09
1.96	1.92E+09	2.34E+09	1.89E+09	2.05E+09

Now, if there is some sort of quantization phenomenon as the QSO is ejected and travels outward, with redshift decreasing in specific increments, we expect some relationship between redshift, and therefore mass, of the QSO with time and/or distance, with time or distance increment 1 being associated with the newly ejected QSO (redshift = 1.96 and mass [scaled] = 2.05E+9) and increment 5 associated with the oldest QSO (redshift = 0.30 and mass [scaled] = 1.65E+8). As before, we exercise the online non-linear regression program [18] to generate the following five correlations between scaled mass and time or distance increment (i.e., t = 1, 2, 3, 4, 5):

$$M/M_0 = (3.775E+9)e^{-0.6106t}, R^2 = 100.0\% \qquad [9]$$

$$M/M_0 = (-1.189E+9)\ln t + (1.992\mathrm{E}+9), R^2 = 99.1\% \qquad [10]$$

$$M/M_0 = (2.095E+9)t^{-1.163}, R^2 = 97.2\% \qquad [11]$$

$$M/M_0 = (-1.525E+9)\sqrt{t} + (3.410E+9), R^2 = 95.7\% \qquad [12]$$

$$M/M_0 = (-4.549E+8)t + (2.219E+9), R^2 = 89.9\% \qquad [13]$$

All these are plotted in Figure 2 along with the averaged values from Table 2.

Equations [12] and [13] have the undesirable property that, at time or distance increment 5, the scaled mass drops below zero, an impossibility. Clearly Equation [9] fits the data best, passing through all the quantized values. Equation [10] is nearly as good, just missing at time or distance increment 5. Equation [11] is slightly weaker, but still acceptable within the limits of accuracy assumed. Equations [9] and [11] ae also the simplest, one being a decreasing exponential, the other a decreasing power. Does either suggest a quantization mechanism?

4.1 Variable Particle Mass? Halton Arp's Theory

At the Kronia Group Conference, Halton Arp also presented his theory for quantization of intrinsic redshift for QSOs. He first laid the groundwork for particle mass being variable with time: [15]

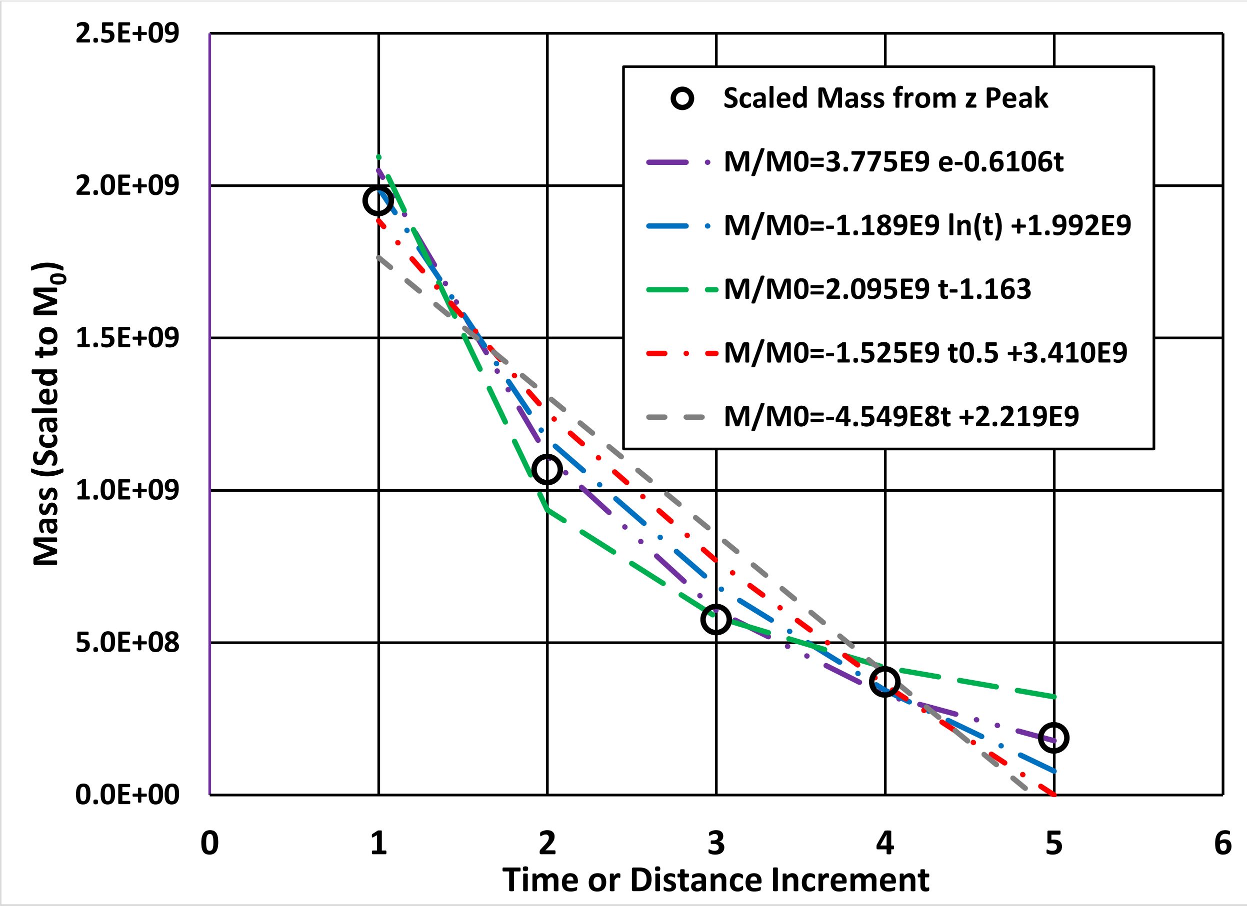

Figure 2. Mass (Scaled) by Quantized Redshifts vs. Time or Distance Increments

> *The conventional theory is the Einstein field equations of general relativity … The solution made [in] 1922 made an approximation, which I think was wrong - … the particle masses were constant everywhere in the universe … They then solved this equation with this approximation and they got that the … scale factor of space varied as the redshift, and so this is the expanding redshift solution; this is the Big Bang solution, and they predict expanding coordinates, singularities at time equals zero, and it demands that all the redshifts are velocities of recession … This whole approach has to be abandoned … Jack Narlikar, who's a student of Fred Hoyle, and Hoyle had investigated the general solution of this equation, which was not to assume that particle masses were constant in time … [T]hey got a very simple solution that the masses varied with the time squared, i.e., in the beginning, when they were first created, there are zero masses, and as time went on they communicated with more and more of the universe and their mass grew (this is a Machian theory), and so, if the electron mass, when it makes its transition in the atom and emits the photon, if the mass is small, the photon is weak and it's redshifted. As the electron grows in mass, the photon which is emitted is stronger and it drops in redshift. So this is a perfect explanation for what we've been seeing that younger objects are high redshift[ed] and … the sacred Hubble constant is just the inverse age of our galaxy … It makes a link between quantum and classical mechanics because the creation of the matter is in very small particles in the quantum regime; there's no more singularities … The most important point is … that this is in flat space-time, Euclidean space-time … You don't need any of these complicated curved space-time coordinates … [T]he conventional solution needed these to account for the incorrect treatment of the mass particles …*

He continued by linking his theory of variable particle mass to redshift quantization: [15]

… [W]e live in a hierarchical universe … [I]f you start in the galaxy nucleus, you get a high density … In the center of this active nucleus, this mysterious engine where the stuff is created, … the new particles are in that environment, and they're gaining mass from their environment very rapidly. When they step out of the nucleus, the go into a different, much lower density, environment into the bulge of the galaxy; and, then, if they come out in the plane [of the galaxy], they go out of here; if they come out along the axis, they drop here [into the local group]. These are enormous drops in density … And finally, when they drop out of the local group, they take another step down [into the local supercluster], and out the local supercluster, they take another drop down … This means that these particle[s] … will be gaining mass very rapidly, and the redshift will be dropping very rapidly on one of these steps; and then it level off; and there goes another step in the drop; and there are just about … six drops, and there are six major quantization levels [1.96, 1.41, 0.96, 0.6, 0.3 and 0.061] … [M]aybe this redshift quantization that we're seeing in the quasars is a reflection of the density hierarchy in the whole universe.

While not the most easily viewed schematic, Figure 3 illustrates Arp's quantization scheme as presented at the conference. The discrete drops in density from galactic nucleus to galactic bulge to galactic plane to local group to local supercluster (Virgo in the case of the Milky Way) and finally into intergalactic space(?), corresponding to the discrete drops in QSO redshift, are clearly evident.

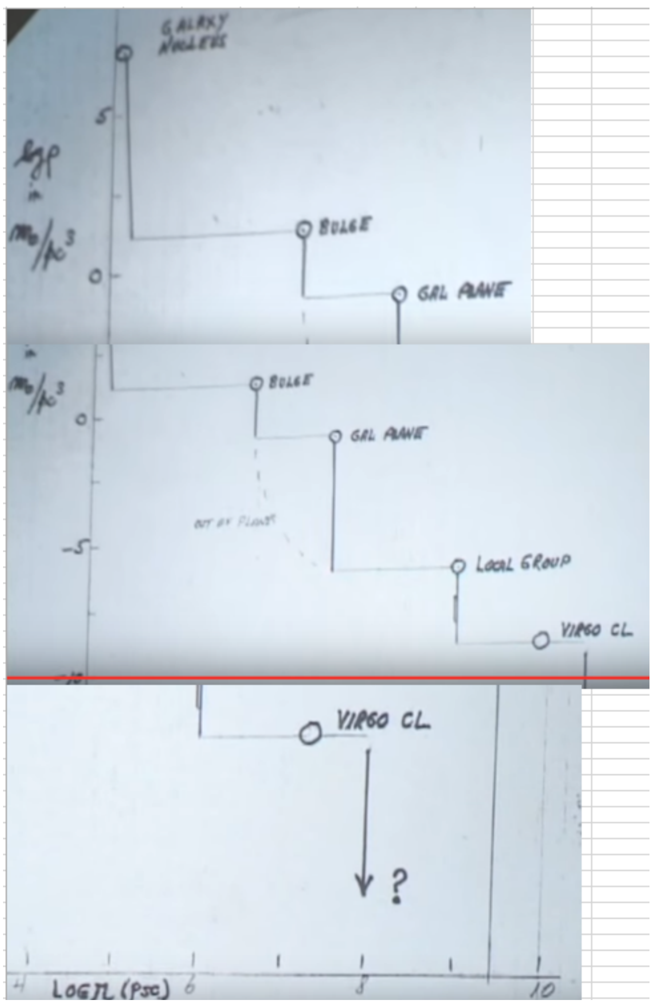

Figure 3. Arp's Redshift Quantization Scheme [15]

4.2 Gravity-Induced Quantization? C.-C. Su's Theory

C.-C. Su's theory that gravitational redshift explains intrinsic redshift was introduced above. Here we continue with his theory explaining the quantization effect (with a minimum of equations, for simplicity): [14]

> *... According to the ejection model, quasars are formed from [the] gas of atoms, plasma and dust ejected from the parent active galaxy ... [S]uppose that the material of the gas cloud together forms a local ether associated with the quasar ... [T]he gravitational potential on the surface of the quasar ... is extraordinarily strong, [although] the gravity of acceleration on the surface of ... a massive quasar is less than one percent of that on the surface of the Earth ... [B]ased on the ejection model and the local-ether theory, the wide variation in redshift can be ascribed to a variation in density and size of the gas cloud, which in turn can be due to the strength of the initial ejection from the parent galaxy, the speed at which the cloud moves away from the galaxy, to the gas expansion, to the fragmentation of gas clouds, and to ... star formation. As the size and density tend to vary widely, it seems that the redshifts of quasars vary in a random way. However, from an analysis of about 600 quasars, it has been found that the redshifts have some preferred values and, thus, the distribution of the redshifts exhibits some preferred peaks ... Due to non-uniformity in particle velocity and density, or to some internal disturbance, a quasar may break into pieces of smaller sizes. By reason of symmetry, it seems to have a good chance to break into pieces of identical or similar sizes. Suppose the fragments are also spherical and the density remains unchanged. Thereby, their radius is shorter than the previous one by a factor of $2^{-1/3}$ and the gravitational potential on the surface of either fragment will decrease by a factor of $2^{-2/3}$ ... [A]fter the n^{th} splitting in half, the gravitation-induced intrinsic redshift ... is given by*
>
> $$1 + z_n = \sqrt{1 + 2^{-2n/3}([1 + z_0)^2 - 1}$$
>
> *Where the quantity $(1 + z_0)^2 - 1$ denotes two times the normalized gravitational potential corresponding to the zeroth redshift z_0. For the cases of very high redshifts, the preceding formula can be approximated as*
>
> $$1 + z_n \approx 1.26^{-n}(1 + z_0).$$
>
> *By adopting the preferred value of 1.956 as the zeroth redshift again, [this] formula leads to the prediction that the preferred intrinsic redshifts are z = 6.08, 4.65, 3.53, 2.64, 1.96, 1.42, 1.02, 0.71, 0.49, 0.33, 0.22, 0.14, 0.09 and 0.06 with n = -4 to 9 ... A redshift distribution around 0.6 may actually be a merger of two close distributions around 0.71 and 0.49, respectively ... [L]ow redshift peaks are expected to be smeared, since other affecting factors of uneven splitting, gas expansion and star formation, will accumulate with time ...*

Unlike Arp's theory, Su's does not postulate that the series of quantized redshifts represents QSO evolution with time and/or distance, although he does agree that QSOs are formed by ejection from a parent galaxy. His quantizations are static for each QSO and dependent upon various initial conditions and interactions until the QSO "stabilizes" and exhibits one of the characteristic, preferred redshift values.

4.3 Quantum Temporal Cosmology? William Tifft's Theory

William Tifft, as mentioned in the Introduction, has been investigating this phenomenon for over 50 years. From his work over the past quarter of a century, he has developed the theory of Quantum Temporal Cosmology (QTC) which "has proven to be consistent with redshift quantization, particle properties and observational evidence." [11]

> *The theory is founded upon time being three dimensional (called tau-space) with matter (in spaces called sigma-spaces) flowing out radially from a near-singular origin in time ... As energy decays, doubling processes produce quantization, define properties of matter and generate observational effects ... The upper left diagram in Figure 11* [Figure 4 below] *is a conceptual picture of tau-space expansion where sigma-spaces (galaxies) flow out radially on timelines. There are* two *expansions from the point of view of galaxies, which are effectively "particles" in tau-space. There is a temporal (radial) and spatial (lateral) expansion as timelines grow and separate sigma-spaces, which seems to resolve the dark energy problem. The diagram*

at lower left shows the dual redshift prediction in QTC appears to fit supernova data. The different structure further indicates that look-back geometry in 3-D time corresponds to a logarithmic spiral. The figure at right illustrates time-time look-back geometry with observed redshifts marked. Present maximum observed redshifts are far from the origin (since the dual expansion in QTC is absent in classical cosmology and ascribed to dark energy).

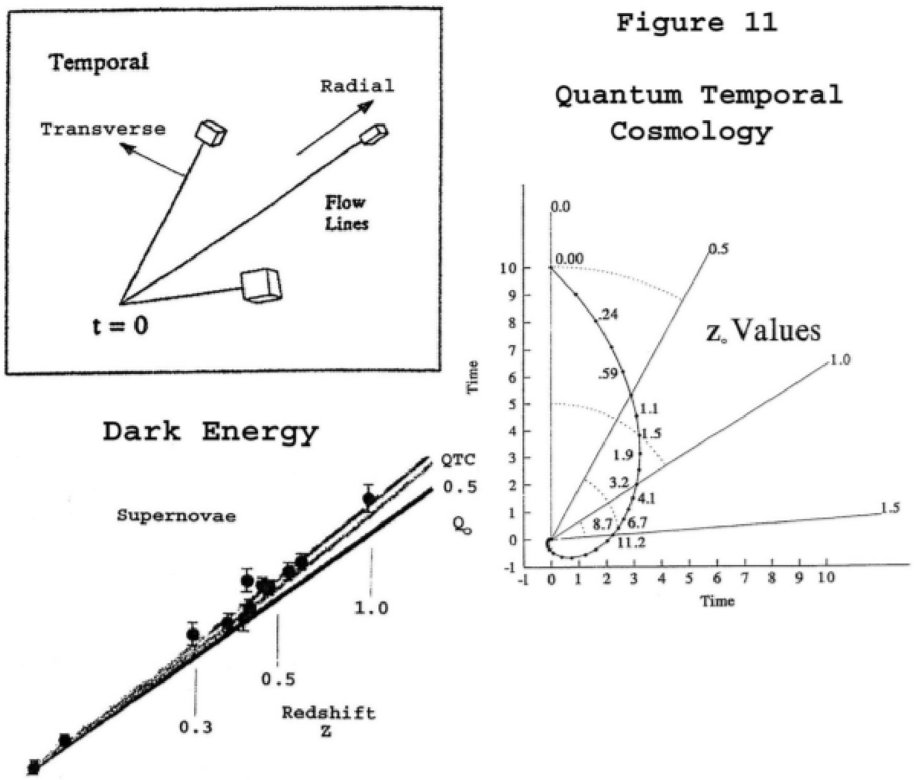

Figure 4. Tifft's Quantum Temporal Cosmology [11]

Commenting on Tifft's QTC is beyond my expertise, other than noting that he derives quantized redshifts at 1.9, 1.5, 1.1, 0.59 and 0.24 which correspond reasonably well with the accepted observed values of 1.96, 1.41, 0.96, 0.6 and 0.3, respectively.

4.4 Speculation on My Part

My efforts have been focused on mathematical representation of the potential relationship between QSO intrinsic redshift and QSO mass, with or without quantization, although the latter phenomenon is so obvious that it cannot be ignored. As Arp indicates, QSO quantized redshift varies with QSO distance from the parent galaxy, which could be either (or both) a time or distance phenomenon. In Arp's theory, QSOs are ejected with high redshift, which appears to correlate well with high mass (density) so long as the "emitting nucleus" of the QSO remains relatively constant in size. Redshift decreases as QSO mass (density) within the "emitting nucleus" decreases, both a time and distance phenomenon in Arp's theory. Arp offers a reason for the observed quantization based on variable particle mass, which increases with time, and correspondingly with distance, as the particles "evolve" and travel outward from higher to lower density regions in a piecewise, not continuous, manner. If you accept Arp's variable mass postulate, this certainly appears reasonable.

Su's theory does not require any time dependence, as he postulates that quantized QSO redshift (and mass) results from initial conditions and subsequent interactions. Presumably, the spatial distribution around the parent galaxy, whereby the higher redshifted QSOs are closest and the lower ones farthest, is the result of the initial energy of the QSO's ejection, its initial size and interactions with surrounding material. The more energetic ones travel outward farther and interact more with material, thereby losing more mass and showing lower redshift with distance. And while he derives a formula that predicts at least some of the quantized values, he does not appear to offer a definitive reason for the quantization. Thus, his theory appears less plausible than Arp's.

As I said previously, Tifft's QTC is beyond my expertise, so I do not comment. What I can offer is another possible mathematical observation for quantization that could have a yet to be identified physical basis. I previously cited my Equations [9] and [11] as the simplest ones that reproduce well the quantized, decreasing QSO redshifts as a function of uniformly increasing time or distance intervals. Equation [9] suggest and exponential "decay," while Equation [11] suggests roughly decay as a function of inverse time or distance.[c] Exponential decay is a fairly common physical phenomenon (e.g., radioactive decay), but the discrete aspect appears unique to QSO redshift. An inverse distance dependence is characteristic of a magnetic or electric field around an infinitely long string of charges, or current-carrying wire, which suggests the possibility of some connection with Electric Universe Theory where intergalactic Birkeland currents are postulated to pervade the universe. Galaxies formed where these currents flow could exhibit surrounding magnetic or electric fields with the inverse distance dependence. What is more difficult to ascertain is the quantization aspect.

While I leave speculation as to the basis for quantization to experts, such as Arp, Su and Tifft, I make the following mathematical observation that the quantization of both QSO mass and redshift can be represented by the following sine curve with decreasing amplitude of the same decaying exponential form as Equation [9], such as shown in Figure 5:

$$^{M}/_{M_0} = |(2.73E+9)e^{-0.6106t}\sin(\pi[t-0.55])| \qquad [14]$$

where | | indicates absolute value, 2.73E+9 has been inserted as a scaling factor to correspond to the quantized masses from Table 2, and -0.55 as a shift factor to set the peaks at integer values.

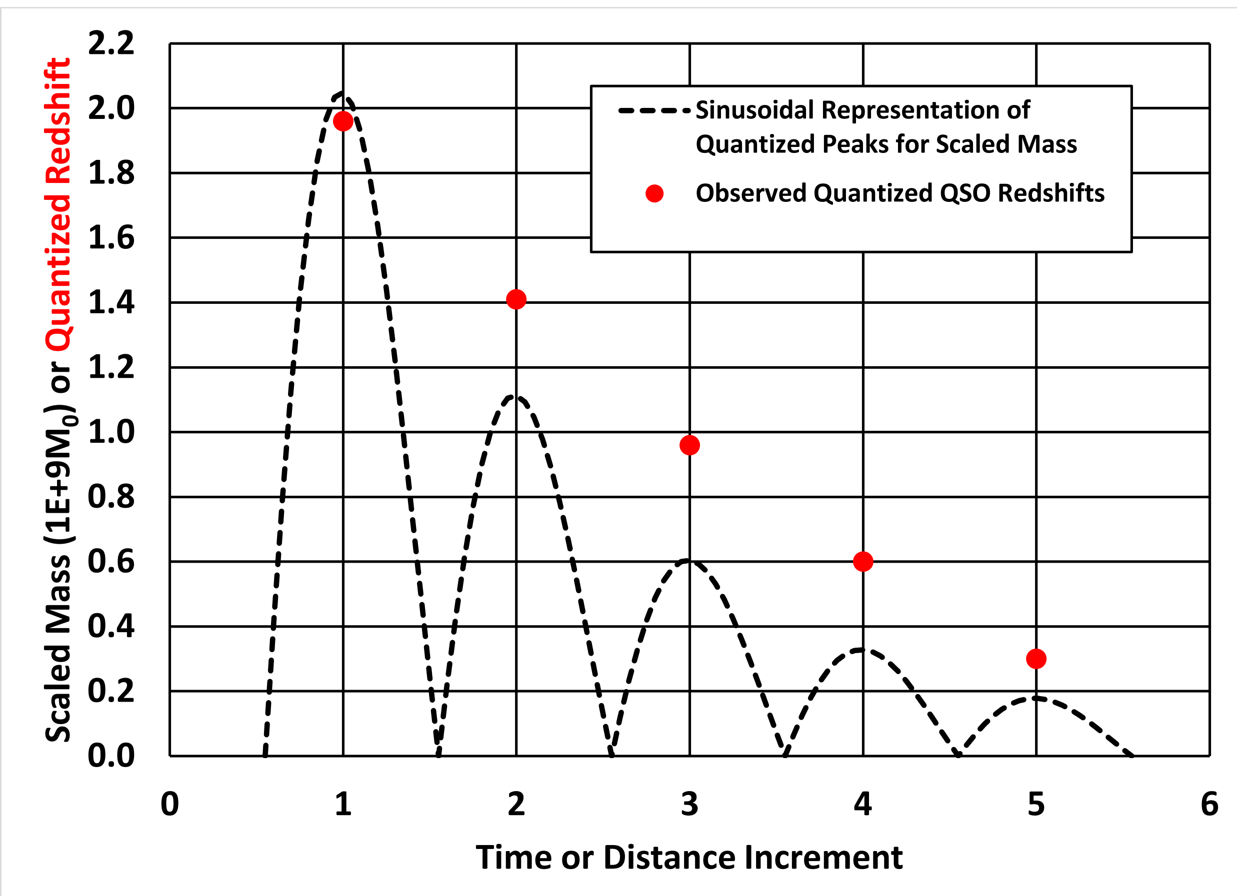

Figure 5. Quantized QSO Scaled Mass as a Sinusoidal Function (Shown with Quantized QSO Redshift)

[c] The $t^{-1.163}$ dependence in Equation [11] can be viewed as a reasonably close representation of a t^{-1} dependence.

The peaks in Figure 5 occur at scaled masses of 2.05E+9, 1.11E+9, 6.04E+8, 3.28E+8 and 1.78E+8 for increments 1 through 5. Comparison with the average values in Table 2 shows excellent agreement to within 10% at worst. What type of phenomenon might exhibit such a sinusoidal behavior with exponentially decaying amplitude is unknown (possibly some form of harmonic dependence?) and beyond my conjecture. I offer it as "food for thought."

6. Summary

I have attempted to tackle the topic of quantization of intrinsic QSO redshifts, especially based on the lifetime work of Halton Arp, examining first the potential relationship between intrinsic QSO redshift and QSO mass, then the phenomenon of quantization for both QSO mass and redshift. My approach has been primarily a mathematical one, as developing a theory for intrinsic QSO redshift, let alone its quantization, is beyond my expertise. Based on my mathematical analyses for QSO mass vs. redshift, I postulate a geometric explanation of intrinsic redshift given a possible dependence on mass to the 2/3 power, related to possible attenuation of light energy (and therefore frequency) within the "emitting nucleus" of a QSO, compounded by a further "dilution," and therefore energy (and frequency) decrease due to spread over the surface area. To do the quantization aspect justice, I have summarized three theories by other experts and examined the plausibility of the two within my realm of knowledge. Finally, I offer at least a mathematical representation of the quantization aspect as "food for thought."

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