A Transluminal-Energy Quantum Model of the Cosmic Quantum

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An internally transluminal model of the hypothesized unique cosmic quantum of the very early universe is proposed. It consists of a closed-loop photon model, which has the total mass-energy of the atomic matter and dark matter of our observable universe that will develop from it. The closed-loop photon model is composed of a rapidly circulating point-like transluminal energy quantum (TEQ). This TEQ circulates in a closed helical path with a maximum speed of $\sqrt{5}\ c$ and a minimum speed of c around the photon model's one-wavelength closed circular axis. The transluminal energy quantum model of the cosmic quantum is a boson. The cosmic quantum model may help shed some light on several fundamental issues in cosmology, such as the nature of the cosmic quantum, the predominance of matter over antimatter in our universe, the possible particles of dark matter, the quantum interconnectedness of the universe, and the very low entropy of the very early universe. The cosmic quantum may be the first particle of dark matter, from which all other particles are derived.

Keywords: Cosmogony; Big Bang; Quantum; Dark Matter; Superluminal

1. Introduction

In 1931 Lemaître[1] hypothesized that a single quantum particle (*primeval atom*) composed the universe at the beginning stage: "If we go back in the course of time we must find fewer and fewer quanta, until we find all the energy of the universe packed in a few or even in a unique quantum." (p. 706)

According to this hypothesis the primeval atom transformed into many other particles. The system of particles and the volume of space expanded according to Einstein's general theory of relativity to produce our current universe. This hypothesis later came to be known as the Big Bang theory of the universe.

In 1956 Goldhaber[2] built on Lemaître's hypothesis in an attempt to explain why anti-matter is much less abundant in our universe than matter. He proposed that a single particle, a "universon", existed before the Big Bang. The universon decayed into a "cosmon" and "anti-cosmon". The cosmon then decayed to produce our universe whose atomic matter is ordinary matter (as opposed to anti-matter).

In 1975, Tryon[3] proposed that the universe could have resulted from a quantum fluctuation (in the sense of quantum field theory) from the vacuum state of space. This could have happened without violating the conventional laws of physics, such as conservation of energy and conservation of electron and baryon number. The universe formed would have to be on the border of being open or closed (because the quantity of negative gravitational potential energy would exactly balance the quantity of positive mass energy) and also contain an equal amount of matter and anti-matter. Tryon does not give a model of the quantum fluctuation that produced the universe.

In 1989 Dehmelt[4] built on Lemaître's hypothesis. He suggested that a "cosmon, an immensely heavy lower layer subquark, is *the* elementary particle. The world-atom, a tightly bound cosmon/anticosmon pair of zero relativistic total mass, arose from the nothing state in a quantum jump. Rapid decay of the pair launched the big bang and created the universe."

The recent Wilkinson Microwave Anisotropy Probe's (WMAP)[5] detailed measurements of the very nearly uniform (to about 1 part in 100,000) cosmic microwave background radiation (CMBR) coming from all directions in space, with a black body radiation temperature of 2.725 Kelvin, have yielded strong support for what has become the Standard Model of cosmology, the Lambda Cold Dark Matter (ΛCDM) with Inflation model. To briefly summarize this model, the very early universe was a rapidly expanding hot, dense physical state (the Big Bang). This was followed very quickly by a period of extremely rapid inflationary expansion, followed by normal expansion. This inflationary period is supposed to have wiped out all physical evidence of particles that existed before it. There are however physical models for the pre-inflationary era that try to describe this era and explain the cause of inflation.

After the inflationary period there were small variations in mass/energy densities in the universe produced by quantum fluctuations of energy during the inflationary period. The post-inflationary matter and energy evolved into an extremely hot concentration of elementary particles, which later formed atomic nuclei of hydrogen, helium and lithium. Later hydrogen, helium and lithium atoms formed, and still later stars and galaxies formed in the regions of greater mass densities caused by the quantum fluctuations of the inflationary period. The universe continued to evolve into our current universe. According to the WMAP data, our universe now consists of about 4.6% atomic matter, 22.7% dark matter composed of relatively slow (cold) unknown particles, and 72.8% dark energy also of an unknown nature. Currently our universe appears to be geometrically flat and has an accelerated spatial expansion (related to Lambda or the cosmological constant of Einstein's equations of general relativity) that may be caused by the dark energy.

There is an active search for a theory of quantum gravity to describe the very early universe, where the micro-scale realm of quantum physics and macro-scale realm of general relativity converge. A leading approach to the development of quantum gravity is Hawking's[6] "no boundary condition" of the very early universe. The expansion of the universe would have begun from a state that was very smooth and ordered. "There had to be small fluctuations in the density and velocity of particles. The no boundary condition, however, implied that these fluctuations were as small as they could be, consistent with the uncertainty principle." (p.148)

In 2010 Wayte[7] proposed that a single particle, with its internal material circulating coherently at speed *c*, formed the primeval particle of our universe. That first particle transformed into the energy configuration known as the hot big bang of cosmological theory.

The present article, based on the author's[8] work on internally transluminal models of the photon and the electron, proposes that the hypothetical first particle of our universe may have been an internally transluminal single quantum particle—a closed-looped photon. This article also proposes two varieties of the internally transluminal closed photon model as candidates for particles of dark matter.

2. Previous Work on Transluminal Energy Quantum Particle Models

The proposed transluminal energy quantum (TEQ) model for the cosmic quantum, or first quantum particle of our universe, grew out of an attempt to model the photon and the electron physically and geometrically in a way that would contain the main physical properties of these particles (8). The TEQ photon model contains an uncharged TEQ moving helically with a constant speed of $\sqrt{2}\ c$, with a forward angle of 45-degrees and with a helical radius equal to the photon's wavelength (the pitch of the photon model's helical trajectory) divided by 2π. (See Appendix.)

For the TEQ electron model, one Compton-wavelength ($\lambda_C = h/mc$ where m is the electron's mass) of the TEQ photon model's helical axis is formed into a double circular loop and then closed on itself so that the axis of the closed double-looping helix forms a double-looping circle with a radius $R_o = \hbar/2mc$. The electron TEQ's trajectory closes after its helical axis makes this one-Compton-wavelength double loop. The circulating TEQ photon model's forward momentum is $p = h/\lambda_C = mc$. The helically moving point-like TEQ has the charge of the electron. The closed double-looping of the TEQ photon model gives the TEQ electron model the electron's spin

$$s = R_o \times p = (\hbar/2mc) \times mc = \hbar/2 .$$

The helical radius of the TEQ electron's closed helical trajectory is chosen to be $\sqrt{2}R_o$ so that the TEQ electron model has the pre-quantum-electrodynamics magnetic moment of the electron--one Bohr magneton ($M_B = e\hbar/2m$). Increasing this helical radius slightly in the TEQ electron model would give the current experimental value of the electron's magnetic moment. With these size parameters, the TEQ moves in a closed trajectory along the surface of a spindle torus. The maximum speed of the electron model's TEQ is $1.516...c$ and the minimum speed is $\sqrt{0.5}c$ or $0.707...c$.

3. The Proposed TEQ Closed Photon Model for the Cosmic Quantum

Several other close-looped TEQ particles with different spins and different helical radii were analyzed mathematically to compare their physical and geometrical properties. One model for a particle with rest mass stood out for its simplicity—the single-looped closed photon model. In this model, a one-wavelength open-helix TEQ photon model is formed into a closed-helix photon model by turning the one-wavelength axis into a circle and turning the open-helix trajectory of the uncharged TEQ into a closed helix. The TEQ in this closed photon model now follows a closed helical trajectory along the surface of a horn torus, with a maximum speed calculated from the model to be $\sqrt{5}c$ and a minimum speed of c, independent of the energy of the photon being modeled.

The TEQ closed photon model is a boson, with spin $1\hbar$ due to its single-closed-loop structure. The TEQ photon's closed helical axis length is a circle of one wavelength circumference. Based on the parameters of the TEQ open helix photon, the radius of the circular axis of the closed helix and the radius of the closed helix itself are both equal to the TEQ photon's wavelength divided by 2π, creating the mathematically simple horn torus surface on which the TEQ moves.

4. Mathematically Generating the TEQ Closed Photon Model of the Cosmic Quantum

The TEQ closed-helical photon model is generated geometrically and mathematically in the following way. A mathematical generating point moves at the speed of light *c* around a closed horizontal circular path of radius $R = \lambda / 2\pi$. The TEQ is on a vertical mathematical circle, also of radius *R*, whose center is the moving generating point and whose plane is perpendicular to the direction of movement of the generating point around the horizontal circle. The speed of the TEQ along the vertical circle is also the speed of light *c*. The combined motion of the generating point around the horizontal circle and the TEQ around the vertical circle creates a 3-dimensional TEQ trajectory that closes after the generating point completes one circuit around the horizontal circle. The coordinates of the TEQ's trajectory can be given parametrically as follows:

$$x(t) = R(1+\cos(\omega t))\cos(\omega t)$$
$$y(t) = R(1+\cos(\omega t))\sin(\omega t)$$
$$z(t) = R\sin(\omega t)$$

where $R = \hbar c / E$ is the radius of both generating circles, and $\omega = E/\hbar$ (where ω is the angular frequency of a circulating photon with energy E and wavelength $\lambda = hc/E$). The radius *R* of the horizontal circle is the radius of the circle whose circumference is the wavelength of the circulating photon, so $R = (1/2\pi)(hc/E) = \hbar c / E$.

The radius R of the vertical circle used to generate the TEQ trajectory is equal to the radius of the closed helical path of the TEQ photon. This radius in the TEQ open-helix photon model is equal to the photon's wavelength of the photon $\lambda = hc/E$ divided by 2π, so again $R = (1/2\pi)(hc/E) = \hbar c / E$.

It will be noticed that the equations for the closed TEQ photon correspond to the parametric equations used to generate a horn torus. Based on the above three coordinate equations, the TEQ is found to move along the surface of this mathematical horn torus with a maximum speed of $\sqrt{5}c$ and a minimum speed *c*, independent of the energy of the photon. The TEQ closed photon model of the cosmic quantum looks like Figure 1.

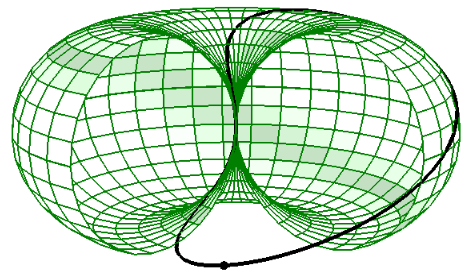

Fig. 1. The transluminal energy quantum closed photon model of the cosmic quantum. The mathematical horn torus surface on which the transluminal energy quantum travels is cut away to show the interior. The black closed curve on the surface of the horn torus is the trajectory of the transluminal energy quantum (indicated by the black dot.)

The TEQ's maximum speed occurs when the TEQ is farthest from the center of the torus, while the minimum speed occurs when the TEQ passes down through the center of the torus.

5. Parameters of the TEQ Closed Photon as a Model of the First Quantum in the Very Early Universe

The closed photon model permits estimates of various physical parameters of the initial cosmic quantum, based on the estimated positive mass-energy of the very early universe. (An equal amount of negative mass-energy is associated with the gravitational potential energy of the very early universe.)

5.1 *Mass*

The geometry and velocities of the closed photon TEQ model are independent of the energy of the photon in the model. The radius *R* of the model varies inversely with the closed photon's energy *E*. The TEQ closed photon model, with the appropriate energy E and radius R given above, is proposed to be a model of the cosmic quantum, the hypothesized first quantum particle of the very early universe.

First, estimate the mass $M = E/c^2$ of the closed photon by estimating the mass-energy of the very early universe. According to the 7-year WMAP[5] results, about 4.56% of today's universe is considered to be atomic matter, the rest being dark matter at 22.7% and dark energy at 72.8%. WMAP found that the universe is very nearly "flat" or Euclidian (to within 0.6%) and so its density for all mass-energy would be the critical density of $9.30 \times 10^{-27} \text{kg}/\text{m}^3$. The spherical volume of the observable universe is $(4/3)\pi R_o^3 = 3.55 \times 10^{80} \text{m}^3$, where R_O = 14,238 Mpc (Megaparsecs) = 46.4 billion light years = 4.39×10^{26}m is the radius of the observable universe. The total mass-energy is thus found to be $9.30 \times 10^{-27} \text{kg/m}^3 \times 3.55 \times 10^{80} \text{m}^3 = 3.30 \times 10^{54} \text{kg}$. But according to the current cosmological standard model (the Lambda cold dark matter (ΛCDM) with inflation model), the dark energy portion of this total mass-energy was mostly produced as the volume of the universe expanded from its volume at the time of light decoupling at 379,000 years after the Big Bang to its volume at the present time. The positive mass (excluding dark energy) of the present universe is the current atomic mass plus the current mass of dark matter, or (4.56% + 22.7%) $\times 3.30 \times 10^{54} \text{kg} = 9.00 \times 10^{53} \text{kg}$. But according to the 5-year WMAP[9] data, the mass energy density of the universe at the time of light decoupling consisted of 25% photons and neutrinos (both of which today contribute a negligible percentage to the total mass energy density) and 75% atomic matter and dark matter). The mass energy M at the time of decoupling is therefore larger than mass calculated above by a factor of 4/3. So a better estimate M of the total positive mass-energy of the universe at the time of decoupling or recombination, including atomic matter, dark matter, photons and neutrinos is $M = (4/3) \times 9.00 \times 10^{53} \text{kg} = 1.2 \times 10^{54} \text{kg}$. This is the value used to estimate the mass energy M of the cosmic quantum.

5.2 *Radius*

This leads to a radius estimate of the first TEQ closed photon to be

$$R = \hbar c / E = \hbar c / Mc^2$$
$$= \hbar / Mc = 1.05 \times 10^{-34} / (1.2 \times 10^{54} \times 3 \times 10^8)$$
$$= 2.9 \times 10^{-97} \text{m}$$

5.3 *Frequency*

The corresponding frequency ν of the closed photon is

$$\nu = E / h$$
$$= Mc^2 / h$$
$$= 1.2 \times 10^{54} \times (3.00 \times 10^8)^2 / 6.63 \times 10^{-34}$$
$$= 1.6 \times 10^{104} \text{Hz}$$

5.4 *Period*

The period T of the TEQ closed photon would be

$$T = 1/\nu = 1/(1.6 \times 10^{104}) = 6 \times 10^{-105} \text{ sec.}$$

5.5 *Mass Density*

The TEQ closed photon model allows an estimate for the initial mass density of the very early universe. This would be approximately the mass density of the first closed photon. The mass of the first closed photon was estimated above to be $M = 1.2 \times 10^{54}$kg while the estimated radius of the photon model is $R = \hbar / Mc = 2.9 \times 10^{-97}$m. If the volume of the closed photon is estimated as R^3, the mass density of the closed photon would be

$$\rho_{mass} = M / R^3 = M / (\hbar / Mc)^3 = M^4 c^3 / \hbar^3$$
$$= (1.2 \times 10^{54})^4 \times (3.00 \times 10^8)^3 / (1.05 \times 10^{-34})^3$$
$$= 1.6 \times 10^{344} \text{kg/m}^3$$

5.6 *Energy Density*

The corresponding energy density would be

$$\rho_{energy} = M^4 c^5 / \hbar^3 = \rho_{mass} c^2$$
$$= (1.6 \times 10^{344}) \times (3.00 \times 10^8)^2$$
$$= 1.4 \times 10^{361} \text{Joules/m}^3$$

6. Why is the TEQ Closed Photon Model Proposed as the Cosmic Quantum?

First of all, a photon is a basic constituent quantum particle of the universe. Second, a photon might be able to travel in a short closed path, even of a single wavelength. At the earliest stage of the universe, a first photon has nowhere to go, since the space-time structure of the universe has presumably has not yet begun to expand as long as only the first particle exists. Third, a closed photon has a rest mass corresponding to its energy content, which an open photon does not have a rest mass.

The primeval atom proposed by Lemaitre was described as a super-large radioactive atom that upon decomposing could have become all of the other particles of the universe and formed the expanding hot mass-energy system that has come to be called the Big Bang. But the question of course would remain: from where did the primeval atom come? If there were a first cosmic quantum particle for our universe, it would likely have been very simple. It could possibly have emerged as a quantum fluctuation from a cosmic quantum field.

7. A Cosmic Field Theory for the Cosmic Quantum Boson?

The primordial closed photon's properties are at a convergence of a radius $R = 2.9 \times 10^{-97}$ m quantum-sized particle (so quantum theory should apply) with an estimated mass $M = 1.2 \times 10^{54}$ kg (so general relativity theory should apply). It is well known that quantum theory and general relativity theory are mathematically inconsistent under combined conditions of extremely small sizes and extremely large masses. A synthesis of quantum theory and general relativity theory into a quantum gravity field theory is much needed and much sought. Such a theoretical synthesis would be expected to lead to new and surprising predictions. Quantum gravity field theory could describe a cosmic field that produces cosmic quanta such as the first quantum particle of our universe. Quantum gravity field theory could reasonably be called cosmic field theory.

The TEQ closed photon model is a boson, because its spin is one quantum unit of angular momentum: $s = \hbar = h/2\pi$. This spin around the particle's vertical axis is calculated in the TEQ model from the formula for calculating the angular momentum of a circularly moving object (the photon):

Spin = (radius of photon model) × (momentum of the photon model)

$s = R \times p$

$s = R \times (Mc)$ where Mc is the momentum of a photon carrying energy corresponding to a mass *M*.

$s = (\hbar / Mc) \times Mc$ since $R = \hbar / Mc$ is the radius of a one-wavelength closed photon model corresponding to a mass *M*.

$s = \hbar = h/2\pi$

8. A Second Very Early Universe Particle—a Closed-Photon Fermion?

At some very early time (perhaps at the beginning of time itself) the original TEQ closed photon is proposed to start generating other particles in the process of the Big Bang. The TEQ closed photon might sometime during this process generate a new particle—a TEQ closed photon fermion—that could lead to the production of other TEQ fermions such as electrons, positrons, quarks, antiquarks and neutrinos. These are all particles with spin $\hbar/2$. The way to generate a TEQ closed-photon fermion from a TEQ photon is for the straight one-wavelength λ axis of a TEQ open photon to wrap itself around into a double circular loop before closing on itself. The associated helical TEQ trajectory also closes on itself to form a closed, double-looping helical trajectory. If this TEQ single-wavelength double-looping closed helical photon keeps the same helical radius $R = \lambda / 2\pi$ as that of the TEQ open helical photon, the TEQ closed trajectory that is formed is a path along the surface of a self-intersecting torus (technically a spindle torus) whose central spindle's width is the radius *R*. In this double-looping closed TEQ photon, the TEQ's maximum speed is calculated from the TEQ coordinate equations for this model to be 3.162 *c*, which is larger than the maximum speed for the TEQ single-loop closed photon of $\sqrt{5}c$ or 2.236 c , while its minimum speed is still *c*, the same as for the TEQ single-loop closed photon. The double-looped TEQ photon's trajectory and associated torus surface are shown in Figure 2.

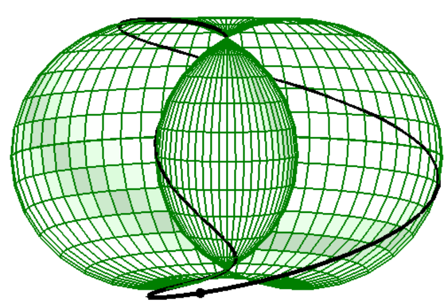

Fig. 2. The transluminal energy quantum model of the double-looped closed-photon fermion. Some of the outer part of the mathematical spindle torus on which the TEQ moves is cut away to show the spindle inside. The black closed curve on the surface of the spindle torus is the trajectory of the TEQ (indicated by the black dot).

The coordinates for this second TEQ particle are:

$$x(t) = 0.5R(1+2\cos(\omega t))\cos(2\omega t)$$
$$y(t) = 0.5R(1+2\cos(\omega t))\sin(2\omega t)$$
$$z(t) = 0.5R\sin(\omega t)$$

where $R = \lambda / 2\pi$ is the radius of the photon helix for the TEQ's double-looped helical trajectory of wavelength λ, $0.5R = 0.5\lambda / 2\pi$ is the radius of the circular axis of the double-looped helical trajectory, and $\omega = 2\pi c / \lambda$ is the angular frequency of the photon. This particle is a fermion with spin $s = 0.5\hbar$. The calculation of its spin around its vertical axis follows:
Spin = (radius of circular axis of double-looped photon model) × (momentum of the photon model)

$s = (0.5R) \times p$

$= (0.5R) \times h / \lambda$ where h / λ is the momentum of a photon of wavelength λ.

$= (0.5\lambda / 2\pi) \times h / \lambda$

$= 0.5h / 2\pi = 0.5\hbar$

9. The production of further particles from the original TEQ closed photon

Once the Big Bang gets started from the original closed photon, there is hypothesized to be a rapid increase in the number and types of TEQ elementary particles such as TEQ electrons and TEQ photons produced from the original closed photon, as well as a rapid expansion of the space in which the particles are formed.

TEQ models for the electron and the photon have already been developed (8). The TEQ electron model is a fermion and so is based on a double-looped TEQ photon model. In the TEQ electron model the circulating TEQ is charged with the negative electric charge of the electron. A TEQ positron would have a positively charged TEQ and an oppositely turning closed double-looping helical trajectory compared to that of the TEQ electron. The circulating of the negatively charged TEQ in the electron model gives the TEQ electron model its magnetic moment so that the TEQ electron acts like a tiny magnet. The parameters of the TEQ electron were selected so that the TEQ electron has the main parameters of an actual electron—its mass, charge, spin and magnetic moment. The TEQ model of the electron is shown in Figure 3.

The TEQ model of the electron differs somewhat in shape from the double-looped closed photon model. The helical radius of the TEQ electron model is smaller than the helical radius of the corresponding closed double-looped TEQ photon model. This shortening of the electron model's helical radius is done to give the TEQ electron model a magnetic moment equal to the double-looped TEQ photon model. This shortening of the electron model's helical radius is done to give the

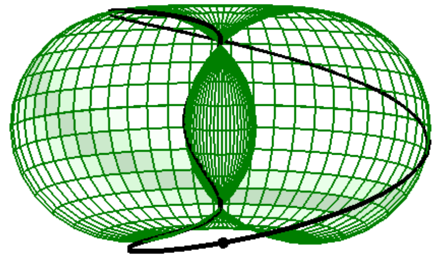

Fig. 3. The transluminal energy quantum model of the electron. Some of the outer part of the mathematical spindle torus on which the TEQ moves is cut away to show the spindle inside. The black closed curve on the surface of the spindle torus is the trajectory of the TEQ (indicated by the black dot).

TEQ electron model a magnetic moment equal to the magnetic moment of the actual electron (which in pre-quantum-electrodynamics is found from the Dirac equation for the relativistic electron to be one Bohr magneton or $e\hbar / 2m$. A slightly larger helical radius will give to the TEQ electron model the slightly larger experimental value of the electron's magnetic moment.) The result is that the maximum speed of the TEQ in the electron model is 2.516 c, smaller than the maximum TEQ speed of 3.162 c for the double-looped closed photon model but larger than $\sqrt{5}c$ or 2.236 c for the single-looped closed photon model. The electron TEQ's minimum speed is less than the speed of light, at $\sqrt{0.5}c$ or 0.707 c, compared to the minimum speeds of exactly c for both the double-looped and single-looped closed photon models. The electron model's TEQ passes through the speed of light twice during each closed trajectory. Since the TEQ is not a particle with rest mass like the electron as a whole, the TEQ can pass through the speed of light as it internally circulates to form the electron, while the TEQ electron moving as a whole cannot reach the speed of light, due the limitation on its external speed prescribed by Einstein's special theory of relativity.

The coordinates for the TEQ in the TEQ electron model are:

$$x(t) = R_o(1+\sqrt{2}\cos(\omega t))\cos(2\omega t)$$
$$y(t) = R_o(1+\sqrt{2}\cos(\omega t))\sin(2\omega t)$$
$$z(t) = R_o\sqrt{2}\sin(\omega t)$$

where $R_o = \lambda_{compton} / 4\pi = \hbar / 2mc = 1.931 \times 10^{-13}$ m is the radius of the double-looped circular axis of the TEQ's closed helical trajectory, $\sqrt{2}R_o$ is the radius of the helix of the TEQ's closed double-looped helical trajectory, and m is the mass of the electron. $\omega = 2\pi c / \lambda_{compton} = 7.77 \times 10^{20}$ radians/sec is the angular velocity of the TEQ in its internal trajectory in the TEQ electron model. Like the closed double-looped TEQ photon model, the TEQ electron model is a fermion.

10. Possible Relevance of the TEQ Closed Photon Model to Cosmology

The proposed TEQ closed photon model is closely related to earlier TEQ models of the photon and electron[8] (also see Appendix of the present article). Cosmological considerations were not included in the development of these models. But when the TEQ closed photon model was later considered as a model for the first quantum entity in the very early universe, the model was seen to be possibly relevant to several currently unanswered major cosmological questions.

10.1 *Could a Single Quantum Particle Produce Our Universe?*

If this is possible, then the question becomes, what could that first quantum have been? The proposed TEQ closed photon model of this hypothesized cosmic quantum is postulated to contain in its circulating TEQ the entire mass of ordinary matter and dark matter of the very early universe (where there was apparently relatively little dark energy due to the small volume of the very early universe).

The universe is currently understood to have an associated negative gravitational potential energy that could mathematically cancel out the total positive physical energy of the universe to give a net energy of the universe to be exactly zero. This seems to be the currently scientifically accepted view of the total energy content of the universe. Both these positive and negative energies of the universe could be built into a theory of quantum gravity that would describe the first TEQ closed photon or other initial quantum particle or particles of the universe leading to the Big Bang. Current quantum theory and general relativity theory cannot make meaningful predictions for lengths and durations that are less that the Planck length $l_P = 1.616199 \times 10^{-35}$ m and Planck time $t_P = 5.39106 \times 10^{-44}$ s. Clearly the radius $R = 2.9 \times 10^{-97}$ m and period $T = 6 \times 10^{-105}$ s of the proposed closed photon model for the very early universe are well below these limits. Since quantum theory and general relativity theory are acknowledged to be inconsistent, a new quantum gravity theory could lead to physical descriptions that go well beneath the current Planck length and time values.

What initial hypothesized state of the universe would have the smallest quantum fluctuations, consistent with the Heisenberg uncertainty principle? The position and momentum parameters of the circulating TEQ composing the closed photon model are near the minimum limit set by the uncertainty principle, as seen below.

The uncertainty of the x coordinate is defined as the root mean square (rms) value Δx for the x component of a particle. For the TEQ in the closed photon model, the rms value for x, calculated from the TEQ position coordinate equations presented above, is $\Delta x = 1.87\lambda / 4\pi$ where λ is the wavelength of the closed photon.

The uncertainty of the x component of momentum Δp_x is defined as the rms value of the x component of the momentum. For the circulating TEQ, the momentum $p = h / \lambda$ rotates in a horizontal circle (for the x-y dimensions) and in a vertical circle (for the z dimension) for the closed photon model. So Δp_x is found to be

$$\Delta p_x = p / \sqrt{2} = \sqrt{0.5}h / \lambda \ .$$

And so

$$\Delta x \times \Delta p_x = (1.87\lambda / 4\pi) \times \sqrt{0.5}h / \lambda = 1.32(\hbar / 2) \ .$$

A similar calculation of $\Delta y \times \Delta p_y$ for the y components of the position and momentum of the closed photon model gives

$$\Delta y \times \Delta p_y = (1.58\lambda / 4\pi) \times (\sqrt{0.5}h / \lambda) = 1.12(\hbar / 2) \ .$$

A similar calculation of $\Delta z \times \Delta p_z$ for the z components of the position and momentum of the TEQ closed photon model gives

$$\Delta z \times \Delta p_z = (\sqrt{2}\lambda / 4\pi) \times (\sqrt{0.5}h / \lambda) = 1(\hbar / 2) \ .$$

Compare the three results for the x, y and z components of position and momentum of the TEQ closed photon model with the Heisenberg uncertainty relation for the position and momentum coordinates of a particle:

$$\Delta x \times \Delta p_x \geq \hbar / 2$$
$$\Delta y \times \Delta p_y \geq \hbar / 2$$
$$\Delta z \times \Delta p_z \geq \hbar / 2$$

The variability of the position and momentum of the TEQ in the closed photon model of the cosmic quantum are nearly equal to the conditions for minimum uncertainty in the Heisenberg uncertainty relations for a single elementary particle.

A single quantum particle such as the proposed TEQ closed photon, formed by a circulating sub-quantum particle (the TEQ) with the calculated variation in its position and momentum, may be a candidate for the most highly ordered (and therefore lowest entropy) state of the very early universe, consistent with the Heisenberg uncertainty principle and the total positive energy content of the early universe. Evolution of that single quantum entity could lead to a "hot Big Bang" of many particles and the associated extremely high temperature of the early universe. This "hot Big Bang" evolving from the single closed photon could then evolve to the very smooth and ordered state that is apparent in the universe today, as seen in the extremely but not completely smooth, low temperature cosmic microwave background radiation (CMBR)[5] observed coming from all directions in the sky today. This CMBR is some of the best current scientific evidence for the Big Bang.

10.2 *Why Does Matter and not Antimatter Dominate in the Atomic Matter in Our Universe?*

The proposed TEQ closed photon model has a closed helical form. A helix has the property that it turns either clockwise or counterclockwise along its axis, as seen from behind. Clockwise in the TEQ closed photon model of the cosmic quantum might correspond to the TEQ closed helical structure of ordinary matter particles such as the TEQ electron model, and counterclockwise might correspond to the opposite helicity, that of antimatter particles such as the TEQ positron model. If the helicity of the original cosmic quantum closed-photon model's TEQ corresponded to that of TEQ-composed ordinary matter (as opposed to antimatter), this would provide an initial bias in our closed-photon-evolved universe towards ordinary matter. This bias towards ordinary matter in our universe's cosmic quantum might then help explain why almost all of the observed atomic and subatomic matter in our present universe, which would have evolved in stages from the original closed photon's TEQ, appears to be ordinary matter.

If the proposed TEQ closed photon model, a boson having spin $\hbar$ and determined by its helicity to be matter (as opposed to antimatter), emerged from a cosmic field to become our very early universe, an equally massive TEQ closed photon model with spin $-\hbar$, and described as antimatter due to its opposite helicity, could have also emerged from this cosmic field at the same time. This assumes that the laws of conservation of total angular momentum and matter-antimatter pair production are valid for the cosmic field. If so, what happened to the original TEQ antimatter spin $-\hbar$ closed photon that was paired with our cosmic quantum? Could it have formed a mainly antimatter universe, perhaps in a different space-time dimension?

10.3 *Could Dark Matter Be Composed of Closed Single or Double-Looped TEQ Photons?*

According to the WMAP[5] results, about 22.7% of the matter-energy content of the universe appears to consist of cold (relatively slow moving) dark matter, whose main presumed feature is that its particles have a relatively large mass and are mainly affected by gravity, but so far have shown no other identifying physical features. The second proposed very early universe TEQ particle, the closed double-looping photon model, is a fermion, composed of one wavelength of a photon, wrapped around twice before it joins itself. This gives the uncharged TEQ particle ½ unit of quantum spin as well as a mass that depends on its internal wavelength according to $E = hc/\lambda$.

The fundamental particles of matter are all fermions—the electron, muon, and tau particles, the neutrinos and the quarks, and all their antiparticles—while the fundamental particles of force for electromagnetism, the strong and the weak nuclear interactions are bosons—photons, gluons, W and Z particles and the Higgs boson and their antiparticles. (Gravity is not included here since a gravity force particle or graviton has not been observed.)

Perhaps dark matter consists of uncharged closed, double-looped TEQ photon fermions. Such particles could qualify as cold dark matter particles if they would interact with other particles mainly through the gravitational force. Uncharged single-looped closed TEQ photon bosons could also be possible candidates for cold dark matter, or for force particles associated with cold dark matter particles.

If an uncharged closed double-looping TEQ photon, with the helicity of a TEQ electron, has a mass slightly less than the mass of an electron, it could be a very stable particle. It would mainly interact with other matter-energy particles through gravitation. It could only be annihilated to produce photons by its corresponding dark matter anti-particle, an uncharged closed double-looped TEQ photon of opposite helicity to this proposed dark matter particle. For the same (currently unknown) reason that there seems to be very little anti-matter in our observable universe, there would also presumably be in our universe very little dark anti-matter consisting of closed double-looped TEQ photons of opposite helicity to this proposed dark matter particle.

If this proposed neutral double-looped photon dark matter particle has the lowest mass of a possible family of related double-looped photon fermions, it might only be able to decay into one or more low mass neutrinos, that are also hard to observe. Since this proposed dark matter particle could also only annihilate with its dark matter anti-particle, which is very scarce, it would like the electron be a very long-lived particle. Further, since this proposed dark matter particle is a fermion, it would not clump closely together with other like dark matter fermions due to the Pauli exclusion principle and the related Fermi-Dirac statistics for fermions. Single-looped closed TEQ photons bosons however could clump close together, according to Bose-Einstein statistics.

Fermions and bosons have already been proposed as candidates for dark matter particles. Boehm and Fayat[10] found two theoretical possibilities: "Either dark matter is coupled to heavy fermions … or dark matter is coupled to a new light gauge boson U."

Astrophysical research is ongoing in search of gamma ray photons that could result from the annihilation of dark matter particles with their corresponding antiparticles. One proposed type of dark matter particle is the Weakly Interactive Massive Particle (WIMP) that is proposed to be able to annihilate with its antiparticle, producing pairs of gamma ray photons. A tentative positive result has been found by Weniger[11] using data from the Fermi Large Area Telescope. The proposed TEQ dark matter particles could also be sought using this approach. TEQ matter-antimatter annihilations would be rare though, due to the relatively low presence of TEQ antimatter in our universe, as explained above.

10.4 *Does the Universe Have Quantum Non-Local Interconnectivity Due to an Original Quantum Particle?*

With the TEQ closed-photon model of the cosmic quantum, all the hypothesized TEQ-based atomic (or baryonic) matter and dark matter expressions of the universe would evolve from the cosmic quantum during and after the Big Bang. According to quantum theory, confirmed by many recent experiments, objects that are quantum-entangled when they separate can retain this quantum interconnectivity even when separated over vast distances. This implies that all of the particles derived from the hypothesized cosmic quantum, i.e. all the atomic matter and dark matter in our universe, could retain quantum non-local interconnectedness to some degree. This would be the case despite even intergalactic distances separating many elementary particles and energetic structures today. In a quantum-theoretic as well as experimental sense the atomic and dark matter portions of our universe could still remain a single vast quantum entity.

10.5 *Did Time Begin with the Original Quantum Particle?*

One of the unsolved problems about our universe is why our early universe, consisting of a nearly uniform dense, hot state of matter and energy, had such a low entropy compared to its entropy today, and how this relates to the origin and nature of time. Carroll[12] estimates the entropy of our early, post inflationary universe (the part that developed into our observable universe—our "comoving patch") to be $S_{\text{early}} \approx 10^{88}$. This is based on there being an estimated 10^{88} freely moving particles in our comoving patch in our young and smooth universe. He estimates the entropy of our comoving patch of universe today to be $S_{\text{today}} = 10^{101}$. This is based on an estimate of 10^{11} supermassive black holes (estimated at one per galaxy in our observable universe) and an amount of entropy of 10^{90} per supermassive black hole, calculated according to the Bekenstein-Hawking formula for the entropy of a black hole.

The entropy of our universe, consisting of a single TEQ cosmic quantum before it subdivided into other energy particles, would have been $S_{\text{cosmic quantum}} \approx 1$ according to this particle-count method. Since the entropy of a closed system generally increases with time, in our observable universe time could have begun when the TEQ cosmic quantum particle started to subdivide into other quantum particles and the entropy of this system began to increase. Time has apparently been flowing in a positive direction (towards increasing entropy) in our observable universe from then until now.

11. Can Quantum Mechanics and General Relativity Be Unified through Transluminality?

Transluminal energy quanta move superluminally and sometimes through luminal to subluminal speeds as they hypothetically form different force and matter particles such as TEQ photons and TEQ electrons. Although particles with mass such as electrons always travel through space at less than the speed of light, according to the special theory of relativity and with much experimental confirmation, the hypothetical TEQ that composes the TEQ electron model is not so limited. An electron's TEQ travels from superluminality through the speed of light to subluminality and back with a frequency $\nu = mc^2 / h = 1.24 \times 10^{20}$ Hz. According to the TEQ hypothesis, an electron is the average motion of a rapidly circulating TEQ. Gravitational waves are proposed in the general theory of relativity to travel at the speed of light. But if the proposed graviton also has a TEQ structure, these graviton TEQs may also travel superluminally like the TEQ composing a photon.

The hypothesis that fundamental particles are composed of transluminal energy quanta could provide a different approach to the evolution of the very early universe. At earlier and earlier cosmological times, the four interactions of physics (the strong nuclear interaction, the weak nuclear interaction, the electromagnetic interaction and the gravitational interaction) are projected to lose their distinguishing features and merge or nearly merge into a single force at or near the end of the "Planck era" around 10^{-43}s after the Big Bang, according to the traditional (non-inflationary) cosmological standard model.

According to the TEQ approach, during this era of unified interactions, which would also occur in inflationary cosmology, all positive energies could have been carried by TEQs moving at transluminal speeds. The original cosmic quantum, a TEQ single-looped closed-photon, would have transformed into an expanding volume of superluminal TEQs collectively carrying the total energy of the original cosmic quantum. This would have been a volume of purely TEQ-carried energy, whose total energy content was proportional to the sum of the frequencies of vibration of all the TEQs carrying this energy. This would be the original "hot big bang". As this volume of TEQs expanded with the expanding very early universe, the number and types of TEQs would multiply as the gravitational interaction separated from the electro-nuclear interaction. The types of TEQs would further multiply as the electro-nuclear interaction separated into the strong nuclear interaction and the electro-weak interaction. More types of TEQs would evolve as the electro-weak interaction separated into the electromagnetic interaction and the weak interaction. Finally all types of TEQs would exist and would form the fundamental particles such as photons, quarks, gluons, electrons and neutrinos.

Perhaps the cosmic field theory for the origin and evolution of the cosmic quantum, that combines quantum theory and general relativistic theory, will be based partly on the proposed internal transluminality of the cosmic quantum and other transluminal energy quanta derived from it.

12. Conclusions

The transluminal energy quantum (TEQ) model of a closed photon is a new approach to answering the question "Could the universe have been formed from a single quantum?" The TEQ model of the cosmic quantum exists well below the Planck length and Planck time values that currently restrict models of the very early universe to greater than about 10^{-43}s .

The TEQ model of the cosmic quantum suggests a value of the positive energy density of the cosmic quantum of about 10^{361} Joules/m^3 , based on the baryonic matter and dark matter content of the observed universe and the radius of the proposed TEQ closed photon model of the cosmic quantum.

The TEQ closed photon model of the cosmic quantum is a boson, whose helical geometry creates a bias in favor of matter over antimatter in our universe. Conservation of angular momentum suggests that another closed photon model of opposite spin would have been formed at the same time as our cosmic quantum, if the first closed photon was formed as a quantum fluctuation in a cosmic field obeying physical conservation laws.

The TEQ single-looping (boson) and double-looping (fermion) closed photon models provide two possible candidates for particles of dark matter having masses perhaps similar to the mass of an electron. Since both of these proposed dark matter particles have their corresponding anti-particles, they could possibly be detected by observing photons produced from particle-antiparticle annihilation. Finding such TEQ dark matter particles could provide indirect support for the TEQ cosmic quantum hypothesis as well. An experimental approach for detecting TEQ dark matter particles was suggested, which is in line with a current approach to detecting dark matter particles through trying to detect pairs of photons created from dark matter – anti-dark matter particle annihilation. Testing of the TEQ cosmic quantum hypothesis may have to await the development of a theory of quantum gravity. In the meantime, possible cosmic evolutionary scenarios leading from the proposed cosmic quantum to the current Big Bang standard model can be explored.

Appendix

The parameters of the transluminal energy quantum model of the photon

From "Superluminal quantum models of the photon and electron", http://superluminalquantum.org/superluminal17Oct2005

A photon is modeled as a superluminal pointlike quantum traveling along an open helical trajectory having a straight axis. The radius of the helix is R and the pitch (wavelength) of the helix is λ. The helical trajectory makes an angle θ with the forward direction. The circumference of the helix is $2\pi R$. Using the superluminal quantum model, the result is:

1) The forward helical angle θ is found to be 45°, for any photon wavelength.
2) The photon helix's radius is found to always be $R = \lambda / 2\pi$.
3) The speed of the superluminal quantum is $\sqrt{2}c = 1.414..c$ along its helical trajectory.

These results are derived below.

The superluminal quantum, with total momentum $\vec{P}$ directed along its helical trajectory, has a forward component of momentum $P\cos(\theta)$ determined by the wavelength λ of the helix, and a transverse component of momentum $P\sin(\theta)$ that is used to calculate the spin of the photon. The superluminal quantum's longitudinal component of momentum is

$$P\cos(\theta) = h/\lambda \, , \tag{1}$$

the experimental longitudinal or linear momentum of a photon. The total momentum $\vec{P}$'s transverse component of momentum is $P\sin(\theta)$. This transverse component is perpendicular to the helical radius vector $\vec{R}$ to the superluminal quantum from the helical axis. The magnitude S of the angular momentum or spin of the superluminal quantum model is then

$$S = RP\sin(\theta) = h/2\pi \tag{2}$$

the experimental spin or angular momentum of the photon. Combining equations (1) and (2) gives

$$\sin(\theta)/\cos(\theta) = \tan(\theta) = \lambda/2\pi R \tag{3}$$

Now look at the helical geometry. As the superluminal quantum advances along the helix a distance λ (one wavelength) in the longitudinal direction, the superluminal quantum travels a transverse distance $2\pi R$, i.e. once around the circle of radius R of the helix. From the way the helix's angle θ is defined,

$$\tan(\theta) = 2\pi R/\lambda \tag{4}$$

We now have two equations (3) and (4) for $\tan(\theta)$. Setting them equal gives

$$\tan(\theta)=2\pi R/\lambda=\lambda/2\pi R$$

This will only be true if

$$\lambda = 2\pi R$$

that is,

$$R = \lambda/2\pi \quad \text{and} \quad \tan(\theta) = 1$$

and since $\tan(\theta) = 1$ we have $\theta = 45^{\circ}$

These results are for any photon in this superluminal quantum model of the photon. Since $\theta = 45^{\circ}$ and the forward speed of the superluminal quantum along its straight helical axis is postulated to be *c*, then the forward speed of the photon model is also *c*, and the speed *v* of the superluminal quantum along its helical trajectory is

$$v = c/\cos(45^{\circ}) = \sqrt{2}c \, .$$

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