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Explanation of the Cosmological Red Shift

by

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Abstract

A simple explanation is given of the cosmological red shift using the ECE equations of the classical electrodynamics of a non-conducting medium and the Planck law. The resulting equation shows that the cosmological red shift is due to the nature of inter-galactic space-time, and not due to the incorrect metric of big bang, the Friedmann Lemaitre Robertson Walker (FLRW) metric. The FLRW metric is incorrect because of its neglect of space-time torsion, a fundamental error which was demonstrated in paper 93 of this series.

Keywords: Cosmological red shift, ECE equations, big bang.

25.1 Introduction

It is well known that the conventional idea of an expanding universe ("big bang") is based on the Friedmann Lemaitre Robertson Walker (FLRW) metric [1]. In this model the observable red shift of objects is explained by the Einstein equation of gravitational general relativity, of which the FLRW metric is a solution in the presence of canonical energy-momentum density. During the course of development of the Einstein Cartan Evans (ECE) unified field theory [2–12], the Einstein field equation has been shown conclusively to be incorrect because of its arbitrary neglect of space-time torsion. In tensorial notation, the dual identity of geometry states that:

$$D_\mu T^{\kappa\mu\nu} = R^{\kappa}{}_{\mu}{}^{\mu\nu} \tag{25.1}$$

where $T^{\kappa\mu\nu}$ is the torsion tensor and $R^{\kappa}{}_{\mu}{}^{\mu\nu}$ is a well defined type of curvature tensor. Summation occurs as usual over repeated indices. It was found in paper 93 and following papers that Eq. (25.1) is not obeyed by the Einstein equation in the presence of energy momentum density because the equation omits torsion by using a symmetric connection:

$$T^{\kappa}_{\mu\nu} = \Gamma^{\kappa}_{\mu\nu} - \Gamma^{\kappa}_{\nu\mu} = 0. \tag{25.2}$$

Unfortunately this omission by Einstein has been repeated uncritically, leading to gross errors in standard physics and cosmology. ECE theory has not repeated this error and has developed [1–12] a torsion based physics and cosmology.

Therefore nothing can be concluded about gravitational physics and cosmology from the Einstein equation, in which the omission of torsion is a basic error which came about from Einstein's limited knowledge of geometry and tensor analysis. It appears that the torsion was omitted by mathematicians prior to Einstein in order to simplify the problem. This procedure has simply been repeated throughout the twentieth century, but at the same time, careful scholarship has repeatedly criticised the Einstein field equation during the same century. These criticisms were initiated [13] in 1918 by Bauer and Schroedinger independently, but were apparently ignored by Eddington et al., who incorrectly claimed to have verified the flawed Einstein equation – an early example of media hype. By repeatedly ignoring valid criticism, standard physics has been reduced to unscientific dogma, dogma which is regularly propagated by unscientific and unscholarly methods. The evaluation of the tensor on the right hand side of Eq. (25.1) was carried out in paper 93 by computer, however, the equation itself is simple in structure, it shows immediately that the covariant derivative of torsion is the non-zero curvature. Therefore to assert that torsion vanishes will lead to a gross error (i.e. to zero torsion, but non-zero curvature). Essentially no textbooks in standard gravitational relativity develop torsion, but ECE has shown conclusively that torsion is the central idea of physics on all scales. Additionally, the so called "precision tests" of the Einstein equation have been revised and the data explained to high accuracy with the orbital theorem of ECE paper 111. Crothers [14] has shown that the so-called Schwarzschild metric was not obtained by Schwarzschild in 1916, whose procedure was to solve a geometrical problem in which the Ricci tensor was identically zero by construction. Therefore energy-momentum density and mass M were eliminated by construction by Schwarzschild and cannot appear therefore in the final metric. Schwarzschild was aware of this and mass M indeed does not appear in his two 1916 papers. The mass was inserted into the metric by others as a means of forcing the Schwarzschild solution to fit orbital data via the Newtonian limit. Therefore the Einstein equation does not predict data at all, it follows data by adapting geometry phenomenologically to the Newtonian limit. This

geometry is now known to be basically incorrect because it directly violates Eq. (25.1). Numerous flaws in black hole mathematics have been pointed out in clear and unambiguous terms by Crothers [14] and others [15].

In Section 25.2 a review is given of the experimental data which refute big bang independently of any other theory – the Baconian principle. There are many instances known for example of objects or clusters being far older than big bang (the instant at which the universe is asserted to have "begun"). These data are well known but are ignored by the dogmatists who masquerade as scientists in the standard cosmology. Ignoring experimental data is by definition unscientific, and ignoring mathematics such as Eq. (25.1) is equally culpable. It is shown in Section 25.2 that much of big bang is empty speculation, it is merely an incorrect mathematical contrivance, not a theory of physics. In Section 25.3 a simple outline explanation is suggested for the cosmological red shift by using the ECE equations of classical electrodynamics in a non-conducting medium combined with a simple use of the Planck law. These procedures give the main properties of the cosmological red shift, and also allows for blue shifts, for which big bang can have no explanation.

25.2 A Summary of Experimental Data that Refute Big Bang

There are observable objects or clusters of galaxies that are far older than big bang [15], for example long chains of galaxies requiring hundreds of billions of years to have formed, while big bang is about ten billion years old theoretically. In other words there are formations of galaxies that are ten TIMES older than the "start" of the universe. Globular clusters in our galaxy are older than big bang, and the uranium content of stars is about twelve billion years old, again older than big bang. The most ancient spiral galaxies have already developed two or three arms, meaning that they are evolved and are older than big bang. If the universe started ten billion years ago, as asserted by big bang, then there could be no objects older than this. The most distant observable objects would ALL be defined by ten billion years multiplied by the speed of light in metres per year, and we would expect these most distant objects to be densely packed together in the part of the universe in which big bang "started". The observational truth is that the most ancient spiral galaxies are not clustered together at all, and have two or three arms, meaning that at that point in time (supposedly the start point of the entire universe) they were already evolved and therefore much older than big bang. If the latter were true they should be densely packed together in a given point, because the initial event of big bang is asserted to be a state of effectively infinite density and no volume. There is no sign of this mythical genesis in any data. The most ancient and distant objects are as far apart as near objects, implying an unbounded universe with no beginning or end. The unbounded universe was actually advocated by Einstein himself, also by Hubble and by

many others, notably Hoyle. Another conclusive piece of evidence against big bang is that galaxies collide, they are not flying away from each other at an ever expanding rate as asserted by big bang.

As developed in paper 49 of the ECE series (www.aias.us), the 2.7 K background radiation temperature is easily calculated by elementary thermodynamics from an unbounded universe. This was the procedure adapted by Regener, Nernst, Herzberg, Finlay-Freundlich, Born, Assis and many others. The existence of the background radiation does not imply an expanding universe. Crothers [14] has cited work that suggest that the background radiation may merely be an artifact of observation. If the background radiation is artifact free as claimed in the standard physics, it is almost perfectly homogeneous, has only slight inhomogeneities, photons from opposite regions of the sky were never in contact with each other, contrary to big bang. This means that the background radiation is black body radiation which has always existed. The second law of thermodynamics requires entropy to increase following big bang, so that the universe would be disordered and very inhomogeneous contrary to observation in the almost completely homogeneous background radiation. Therefore there is no observational support for big bang, the background radiation is in fact strong evidence AGAINST big bang. This is a major and well known flaw of big bang, one of many. The other obvious conflict is with the first law of thermodynamics, because total energy in the universe must be conserved, the total energy is never observationally infinite, and therefore could not have been infinite at a speculative initial event of zero volume and infinite energy. Another major problem for big bang is that the universe is composed overwhelmingly of matter, indeed anti-matter can only be produced artificially in particle colliders. This observation has to be explained by speculation, the unsupported assertion of baryon asymmetry. This necessity leads in turn to more speculation, notably the speculation of cosmic inflation. The latter is asserted quite arbitrarily to be a phase transition, a simplistic speculation that after 10^{-35} secs the universe suddenly and without cause expanded exponentially to give a quark gluon plasma. It is then speculated without data that conservation of baryon number was violated, leading to the great predominance of matter over anti-matter in the current universe. In big bang a series of symmetry breaking phase transitions is speculated without data. A few minutes after the speculated initial event we are told that neutrons combined with protons to give deuterium and helium in big bang nucleosynthesis. However, Hoyle is well known to have had developed a successful and well known theory of nucleosynthesis prior to the empty speculation of big bang, with many arguments of his own against big bang. Pinter [16] in a scholarly multidisciplinary treatise, has argued that nearly all aspects of big bang nucleosynthesis are contested currently by scientists of various disciplines. Another severe weak point of big bang is the speculation that rest mass energy density gravitationally dominated over photon radiation. There is no clear mechanism for this, and some scientists such as Alfven argued for a universe that evolved from plasma. At 379,000 years after

big bang it is speculated that radiation somehow "decoupled" from matter to give the background radiation. Another major weak point of big bang is that the homogeneity of the background radiation is speculated to be homogeneity of some kind prior to the inflation, and in violation of the second law of thermodynamics, this primordial homogeneity somehow persisted without entropy increase for ten billion years following exponential expansion at 10^{-35} secs. This is wildly unscientific and contrary to thermodynamics. Commonplace experience shows that an explosion scatters matter in an inhomogeneous manner. So the big bang argument starts to degenerate into speculation piled upon empty speculation, data to the contrary being ignored, and now, mathematics to the contrary (Eq. (25.1)) also being ignored.

Another major weakness of big bang is that it is unable to describe the structure of spiral galaxies without the introduction of yet more speculation, known as cold and hot dark matter and dark energy. The composition and mechanism of dark matter is unknown, and it is irrationally speculated that it causes the universe to "accelerate". In ECE theory [2–12] the structure of spiral galaxies is a direct consequence of geometry as required by relativity, the spiral galaxy vividly shows the underlying torsion, and the theory of this effect is simple and therefore preferred by Okham's Razor and by the philosophy of relativity. Above all, the lambda CDM model of big bang is based on basically incorrect mathematics, the FLRW metric that violates Eq. (25.1), i. e. basic geometry. One cannot violate Eq. (25.1) any more than one can violate the Pythagoras Theorem.

Other explanations for the cosmological red shift are available in the literature [17], notably explanations based on the Compton effect, and explanations based on optical theory as in paper 49. Hubble himself rejected the idea of the FLRW metric, as did Einstein, Vigier, Hoyle and many others. The sun's red shift for example is a Compton effect of the order of one part in a million. The sun is not receding from the earth, so this property is not a cosmological red shift and not a relativistic Doppler shift or a gravitational red shift. The sun's red shift can become as high as one part in a hundred in gamma rays emitted by a solar flare [17]. This suggests that there may be shifts of wavelength due to the Compton effect in inter-galactic space, which is by no means devoid of matter such as electron plasma, hydrogen molecules and so on. There would not be much scattering because the inter-galactic matter is very dilute, quite obviously.

We can therefore entirely discard big bang as obsolete and incorrect dogma. In the next section a simple optical explanation is suggested for the outline properties of the observable red shifts of cosmology.

25.3 ECE Explanation of the Cosmological Red Shift

In this section the main features of the cosmological red shift are calculated from the ECE equations [2–12] of plane waves propagating in a

nonconducting, ponderable medium with polarizability and magnetizability. The starting point is the ECE Ampère Maxwell law written as:

$$\boldsymbol{\nabla} \times \boldsymbol{B} - \frac{1}{c^2}\frac{\partial \boldsymbol{E}}{\partial t} = \mu_0 \boldsymbol{J} \tag{25.3}$$

where $\boldsymbol{B}$ is magnetic flux density, $\boldsymbol{E}$ is electric field strength, c is the vacuum speed of light, μ_0 is the vacuum permeability in SI units, and $\boldsymbol{J}$ is the interaction current of light propagating through inter galactic space. The electric displacement $\boldsymbol{D}$ and the magnetic field strength $\boldsymbol{H}$ are defined in general [18, 19] by the polarization $\boldsymbol{P}$ and the magnetization $\boldsymbol{M}$ where ϵ_0 is the permittivity of the vacuum in SI units. In general:

$$\begin{aligned} \boldsymbol{D} &= \epsilon_0 \boldsymbol{E} + \boldsymbol{P}, \ \boldsymbol{B} = \mu_0(\boldsymbol{H} + \boldsymbol{M}), \\ &= \epsilon \boldsymbol{E} \qquad\qquad = \mu \boldsymbol{H} \end{aligned} \tag{25.4}$$

and in SI units:

$$\mu_0 \epsilon_0 = \frac{1}{c^2}. \tag{25.5}$$

Therefore in Eq. (25.3):

$$\boldsymbol{E} = \frac{1}{\epsilon_0}(\boldsymbol{D} - \boldsymbol{P}), \boldsymbol{B} = \mu_0(\boldsymbol{H} + \boldsymbol{M}) \tag{25.6}$$

and eq. (25.3) becomes:

$$\boldsymbol{\nabla} \times \boldsymbol{H} - \frac{\partial \boldsymbol{D}}{\partial t} = \boldsymbol{J} - \left(\boldsymbol{\nabla} \times \boldsymbol{M} - \frac{\partial \boldsymbol{P}}{\partial t} \right). \tag{25.7}$$

It is enough for our present purposes to consider the case

$$\boldsymbol{J} = \boldsymbol{\nabla} \times \boldsymbol{M} - \frac{\partial \boldsymbol{P}}{\partial t} \tag{25.8}$$

where the current is defined by the polarization and magnetization. In this case:

$$\boldsymbol{\nabla} \times \boldsymbol{H} - \frac{\partial \boldsymbol{D}}{\partial t} = \boldsymbol{0} \tag{25.9}$$

where $\boldsymbol{D}$ and $\boldsymbol{H}$ are expressed in terms of $\boldsymbol{E}$ and $\boldsymbol{H}$ by the permittivity ϵ of the inter-galactic ponderable medium, and by its permeability μ. From eqs (25.4) and (25.9):

$$\boldsymbol{\nabla} \times \boldsymbol{B} + i\omega\mu\epsilon\boldsymbol{E} = \boldsymbol{0} \tag{25.10}$$

if a harmonic time dependence of type $e^{-i\omega t}$ is assumed [18, 19] in the solution.

Consider a plane wave with phase [18, 19]:

$$\phi = \omega t - \kappa Z \tag{25.11}$$

where ω is its angular frequency at instant t and κ is its wavenumber at point Z for propagation along the Z axis. From Eq. (25.10) the wavenumber and frequency are related by:

$$\kappa = (\mu\epsilon)^{\frac{1}{2}}\omega. \tag{25.12}$$

The phase velocity of the wave is [19]:

$$v = \frac{\omega}{\kappa} = \frac{c}{n} = \frac{1}{(\mu\epsilon)^{\frac{1}{2}}} \tag{25.13}$$

where the refractive index is:

$$n = \left(\frac{\mu\epsilon}{\mu_0\epsilon_0}\right)^{\frac{1}{2}} = (\epsilon_r\mu_r)^{\frac{1}{2}} \tag{25.14}$$

and where the relative permittivity and permeability are:

$$\epsilon_r = \frac{\epsilon}{\epsilon_0}, \mu_r = \frac{\mu}{\mu_0}. \tag{25.15}$$

In the presence of absorption [19] the wavenumber is in general a complex number, conventionally denoted:

$$\kappa = \beta + i\frac{\alpha}{2}. \tag{25.16}$$

Here α is the power absorption coefficient defined by the Beer Lambert law:

$$\alpha = \frac{1}{z}\log_e\frac{I_0}{I} \tag{25.17}$$

where I is the power density and I_0 the initial power density. Therefore in the presence of absorption the angular frequency may be developed as a complex number:

$$\omega = \omega' + i\omega'' = \left(\frac{c}{n}\right)\left(\beta + i\frac{\alpha}{2}\right). \tag{25.18}$$

In some texts the angular frequency is kept constant and the wavenumber developed as a complex number. In a medium in which the phase velocity of the wave is v, the relation between angular frequency and wavenumber is:

$$v = \frac{\omega}{\kappa}. \tag{25.19}$$

Consider for simplicity of argument a relative permeability of unity:

$$\mu_r = 1 \tag{25.20}$$

then:

$$\omega = \frac{c}{{\epsilon_r}^{\frac{1}{2}}}\left(\beta + i\frac{\alpha}{2}\right) \tag{25.21}$$

where ϵ_r is the complex relative permittivity:

$$\epsilon_r = \epsilon_r' + i\epsilon_r'' \tag{25.22}$$

made up of dielectric dispersion ϵ_r' and dielectric loss ϵ_r''. Therefore:

$$\begin{aligned}\omega^2 &= \frac{c^2}{\epsilon_r' + i\epsilon_r''}\left(\beta + i\frac{\alpha}{2}\right)^2 \\ &= \frac{c^2(\epsilon_r' - i\epsilon_r'')}{\epsilon'^2 - \epsilon_r''^2}\left(\beta + i\frac{\alpha}{2}\right)^2 \\ &= (\omega' + i\omega'')^2 = \omega'^2 + 2i\omega'\omega'' - \omega''^2.\end{aligned} \tag{25.23}$$

and:

$$\begin{aligned}\omega'^2 - \omega''^2 &= \frac{c^2}{\epsilon_r'^2 - \epsilon_r''^2} = \left(\epsilon_r'^2\left(\beta^2 - \frac{\alpha^2}{4}\right) + \alpha\beta\epsilon_r''\right), \\ 2\omega'\omega'' &= \frac{c^2}{\epsilon'^2 - \epsilon_r''^2}\left(\epsilon_r'\frac{\alpha}{2} - \epsilon_r''\beta\right).\end{aligned} \tag{25.24}$$

In general, in the presence of absorption, the frequency is by no means constant, so light travelling through the inter galactic medium is governed by

these equations. We already see that there are optical explanations for the cosmological red shift.

If the problem is developed in terms of fixed ω and varying wavenumber then:

$$\epsilon_r^2 = n = \kappa\left(\frac{c}{\omega}\right) \tag{25.25}$$

i.e.:

$$(\epsilon_r' + i\epsilon_r'')^2 = n' + in'' = \frac{c}{\omega}(\kappa' + i\kappa''). \tag{25.26}$$

This means that the relative permittivity changes the wavenumber for constant ϵ_r or given ω. In the case of no absorption:

$$\kappa = \left(\frac{\omega}{c}\right)\epsilon_r^2. \tag{25.27}$$

The standard SI unit of wavenumber is $\bar{\nu}$ (Neper cm^{-1}), and is defined [20]:

$$\omega = 2\pi\bar{\nu}c = \kappa v. \tag{25.28}$$

Therefore:

$$\bar{\nu} = \frac{\kappa}{2\pi} \tag{25.29}$$

and

$$\bar{\nu} = \frac{\omega}{2\pi c}\epsilon_r^2 = \frac{f}{c}\epsilon_r^2 \tag{25.30}$$

where f is the frequency in hertz. Sometimes this is assumed to be the fixed frequency of the source, so $\bar{\nu}$ is the observed wavenumber of light after it has travelled through a nonconducting medium. In the absence of absorption α:

$$\bar{\nu} = \left(\frac{f}{c}\right)\epsilon_r^2 \tag{25.31}$$

where ϵ_r is frequency independent, but in the presence of absorption there is dielectric dispersion and dielectric loss as is well known [18–20].

In the presence of absorption the dependence of $\bar{\nu}$ on ϵ_r is given by:

$$\bar{\nu}' + i\bar{\nu}'' = \frac{f}{c}(\epsilon_r' + i\epsilon_r'')^2 \tag{25.32}$$

i.e.:

$$\bar{\nu}' = \frac{f}{c}(\epsilon_r'^2 - \epsilon_r''^2) \tag{25.33}$$

and:

$$\bar{\nu}'' = \frac{2f}{c}\epsilon_r'\epsilon_r''. \tag{25.34}$$

The power absorption coefficient and dielectric loss are related by [20]:

$$\alpha = \frac{\omega\epsilon_r''}{n'c} \tag{25.35}$$

so:

$$\bar{\nu}'' = \frac{n'\epsilon_r'}{\pi}\alpha. \tag{25.36}$$

Therefore the imaginary part of the complex wavenumber is proportional to the power absorption coefficient.

From Eqs. (25.33) and (25.36) it is seen that the medium regarded as nonconducting ponderable matter, changes the observable wavenunber of the light. This shift depends only on the medium (inter galactic space) so is such that:

$$\frac{\bar{\nu}'}{f} = \frac{1}{c}(\epsilon_r'^2 - \epsilon_2''^2) \tag{25.37}$$

is relatively the same for each spectral line, as observed in the cosmological red shift because

$$\Delta\epsilon^2 := \epsilon_r'^2 - \epsilon_r''^2 \tag{25.38}$$

is a property of the inter galactic matter only. By observation it is seen that $\Delta\epsilon^2$ is on average a constant property. The quantity:

$$\frac{\bar{\nu}'}{f} = \frac{1}{c}\Delta\epsilon^2 \tag{25.39}$$

must be greater than one, otherwise the observed wavenumber would be negative. This is observed in dielectric spectroscopy of a non-conducting medium.

The second main feature of the cosmological red shift is that it is observed to be proportional to distance, or sample length of the Beer Lambert law, denoted Z in Eq. (25.17). This feature is explained in the simplest way by

considering a monochromatic beam made up of one photon. The Planck law for the photon is:

$$E = hf \tag{25.40}$$

where E is its quantum of energy and h is the Planck constant [18]. The energy density of the photon is:

$$U = \frac{E}{V} \tag{25.41}$$

where V is the volume it occupies. Its intensity or power density in watts per metre squared is:

$$I = cU = \left(\frac{hc}{V}\right) f. \tag{25.42}$$

From eqs. (25.17) and (25.42):

$$f = f_0 \exp(-\alpha Z) \tag{25.43}$$

so the energy or frequency of the photon decreases with distance. If the light is completely absorbed no energy emerges at the detector and there is no measurable frequency at all. This is the ultimate red shift. The average energy of n oscillators of a monochromatic beam of light of frequency f is given by [18]:

$$E = \sum_n p_n E_n \tag{25.44}$$

where p_n is the probability of finding it in a state with energy E_n. Using the Boltzmann distribution [18]:

$$p_n = \exp(-E_n/(kT))/\sum_n \exp(-E_n/(kT)) \tag{25.45}$$

and this choice leads to thermodynamic equilibrium as is well known. The mean energy of an oscillator of frequency f may then be calculated [18]:

$$\langle E \rangle = hf\left(\frac{x}{1-x}\right),\ x = \exp\left(-\frac{hf}{kT}\right). \tag{25.46}$$

This is the mean energy of a monochromatic beam at frequency f containing n photons. It is calculated in the limit [18]:

$$hf \ll kT. \tag{25.47}$$

When this quantity is much less than unity Eq. (25.46) reduces to Eq. (25.40).

Combining Eqs. (25.37) and (25.43):

$$\frac{\bar{\nu}'}{f} = \frac{f_0}{c} \exp\left(-\frac{\omega \epsilon_r'' Z}{n' c}\right)(\epsilon_r'^2 - \epsilon_2''^2), \tag{25.48}$$

so the way in which the real part of the observed wavenumber is shifted depends on the relative values of the dielectric permittivity and dielectric loss of intergalactic space, or deep space. In general this is not a simplistic red shift as in Big Bang. There may be blue shifts as well as red shifts. Finally if there is an electron plasma in deep space the medium develops a conductivity, and the optical properties change. In general all the optical properties of light may be changed on its long inter galactic journey from source to observer. As in any spectrum there may be several absorption and dispersion features, and for plasma, the highly developed theory of plasma [19] is needed.

As argued in Section 25.2, Compton shifts also occur as the photons interact with inter galactic electrons. In this development it is seen from eq. (25.29) that it is one in terms of wavenumber, which may be related to wavelength by:

$$\bar{\nu} = 2\pi\omega c, \lambda = 2\pi\frac{V}{\omega}. \tag{25.49}$$

In the absence of absorption the refractive index is a constant greater than unity, so the phase velocity v is lower than c. In the presence of absorption the refractive index is complex as argued.

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References

[1] S. P. Carroll, "Spacetime and Geometry: an Introduction to General Relativity" (Addison Wesley, New York, 2004).

[2] M. W. Evans, "Generally Covariant Unified Field Theory" (Abramis, 2005 onwards), volumes 1–4, volumes 5 and 6 in prep.

[3] L. Felker, "The Evans Equations of Unified Field Theory" (Abramis 2007).

[4] K .Pendergast, "Crystal Spheres" (Abramis in prep., preprint on www.aias.us).

[5] M. W. Evans, Omnia Opera section of the British Civil List Scientist's website www.aias.us.

[6] M. W. Evans et al., Adv. Chem. Phys. Vol. 119 (Wiley 2001); ibid vol. 85 (Wiley 1992, 1993, 1997).

[7] M. W. Evans and J.-P. Vigier, "The Enigmatic Photon" (Kluwer, Dordrecht, 1994 to 2002, hardback and softback), in five volumes.

[8] M. W. Evans and L. B. Crowell, "Classical and Quantum Electrodynamics and the B(3) Field" (World Scientific, 2001).

[9] M. W. Evans et al., fifteen papers on ECE theory in Found. Phys. Lett., 2003 to 2005.

[10] M. W. Evans, Acta Phys. Polonica, **33B**, 2211 (2007).

[11] M. W. Evans and H. Eckardt, Physica B, **400**, 175 (2007).

[12] M. W. Evans, Physica B, **403**, 517 (2008).

[13] C. Alley, Wheeler Conference at Princeton, 2006.

[14] S. Crothers, papers on www.aias.us and paper 93 of the ECE series.

[15] J. Dunning-Davies, "Exploding a Myth", (Horwood, 2007)

[16] P. Pinter, www.originoflife.org.uk and book published by Abramis.

[17] http://www.angelfire.com/az/Bigbangiswrong/index.html

[18] P. W. Atkins, "Molecular Quantum Mechanics (Oxford, 2^{nd} ed. 1983 and subsequent editions).

[19] J. D. Jackson, "Classical Electrodynamics" (Wiley, 1999, 3^{rd}. Ed.).

[20] M. W. Evans, G. J. Evans, W. T Coffey and P. Grigolini, "Moelcualr Dyanmics (Wiley, 1982, no 108 on the Omnia Opera of www.aias.us)