The Cosmic Neutrino Background as Aether

By Graeme Heald
14th June 2015

Abstract

Following an historical review of the concept of the aether, it will be shown that the Cosmic Neutrino Background (CNB) shares many of its characteristics. Formed in the first seconds of the big bang, the CNB is a dark, invisible candidate for the seat of electromagnetic phenomena. Like the Cosmic Microwave Background, the CNB can provide a universal rest frame and, at a temperature of 1.95 K°, the CNB forms a frictionless superfluid that permeates space.

Recent experiments suggest that the electronic neutrino is a tachyon. In accordance with relativity, the speed of particles and fields within the CNB are limited to less than or equal to the speed of light. Due to the CNB, an energy density, $\rho_{\Lambda\upsilon} = 5.989 \times 10^{-11}$ erg/cm^3, a cosmological constant value of $\Lambda_{\upsilon} = 4.145 \times 10^{-59}$ cm^{-2} and a contribution of 0.931 % to the total mass-energy of the universe have been posited in this paper. These values fall within expectations set by observation. Exerting a cosmological negative pressure, a tachyonic CNB is also a dark energy candidate; while, at the same time, analogous to cosmology's 'quintessence'.

Keywords: aether, cosmological constant, cosmic neutrino background, superfluid, dark energy

1.1 A history of the Aether

The word aether derives from the Greek 'aiθηp' or 'aither' meaning 'pure fresh air' or 'pure sky'. Aristotle, the ancient Greek philosopher and scientist circa 384 to 322 b.c., added aether to the system of four classical elements of Ionian philosophy, designating the fifth element as the '*quinta essentia*,' in Medieval Latin or '*quintessence*' in English.

The four classical elements: earth, water, air and fire closely resemble the contemporary phases of matter: solid, liquid, gas and energy. As a fifth element, aether made up the heavenly spheres and bodies. In addition, Aristotle proposed that the celestial bodies were held in crystalline spheres composed of aether, with the notion of crystalline spheres and natural circular motion of the aether leading Aristotle to observe the orbits of stars and planets [1].

In the medieval era, scholastic philosophers granted aether changes of density where the bodies of the planets were considered to be denser than the medium filling the rest of the universe. Robert Fludd, a prominent mathematician and cosmologist circa 1574 to 1637, stated that the aether was of a character, 'subtler than light'. According to Fludd, the aether was both penetrative and non-material [2].

Possibly anticipating quantum theory, Rene Descartes, prominent French philosopher and mathematician 1596 to 1650, considered the physical universe to be made of tiny 'corpuscles' of matter. Descartes maintained that there could not be a vacuum. As corpuscles moved through other matter they were constantly swirling to prevent the void [3]. Space, in the universe, was thought to be a plenum, not empty as a void or a vacuum, but full of particles. Interactions could take place only via pressure and impact; that is, through the tangible action of some intermediary agent or matter [4].

Christian Huygens, a prominent Dutch mathematician and scientist 1629 to 1695, proposed that light waves were propagated as disturbances through a tenuous, highly elastic medium or aether [4]. Huygens considered light to be a longitudinal wave. Later, Young and Fresnel, found that light could be a transverse wave and, consequently, Huygens idea of an aether gas permeating space gained support as wave theory. Light waves required a medium of propagation and, it was considered, that the aether provided that medium.

1.2. Newton's Gravitational Aether

Isaac Newton, English scientist and mathematician 1643 to 1727, completed the first great unification of physics with the Law of Universal gravitation published in *Philosophiae Naturalis Principia Mathematica* in 1687. To achieve this result, he combined Kepler's laws of planetary motion, observational data and mathematical reasoning.

The gravitational force, F, is proportional to the product of two masses and is inversely proportional to the square of the distance between them:

$$F = G.\, m_1.\, m_2 / r^2 \qquad (1)$$

Where F is force between masses, $G = 6.67 \times 10^{-11}$, m_1 is mass 1 and m_2 is mass 2 and r is the distance between the centres. The gravitational force is typically regarded as being an attractive force with negative energy, the convention being to designate it with a minus sign.

If there were no medium for the gravitational force between two bodies, Newton's theory of gravitation would be implausible. Newton did not accept action-at-a-distance; instead, supporting an aether medium for the gravitational force. In his letter to Robert Boyle 1679 [5] Newton wrote *'.. it is about the cause of gravity. For this end I will suppose aether to consist of parts differing from one another in subtilty* by indefinite degrees: that in the pores of bodies there is less of the *grosses* aether, in proportion to the finer than in open spaces; and consequently in the great body of the earth there is much less of the *grosser* aether in proportions to the finer, than in the regions of the air.*'* According to Newton, the elasticity of the aether produces a variation in the cosmic density, resulting in the gravity that attracts the moon toward the earth, and the earth toward the sun [6].

1.3. The Luminiferous Aether

James Clerk Maxwell, Scottish mathematical physicist 1831 to 1879, achieved the second great unification of physics with the publication of *A Dynamical Theory of the Electromagnetic Field*, in 1865. Maxwell described mathematically, electrical and magnetic forces thought to be distinct. The electromagnetic aether was termed the 'luminiferous aether'.

In his 1861 paper, Maxwell modelled the magnetic lines of force using a sea of molecular vortices that he considered to be partly aether and partly matter [7], deriving expressions for the dielectric constant and magnetic permeability in terms of the transverse elasticity and density of the aether. He then equated the ratio of the dielectric constant and magnetic permeability using Newton's speed of sound formula, to obtain a result that was close to the measured speed of light. Maxwell concluded that light subsists in the undulations of the medium causing electric and magnetic phenomena.

The Maxwell formula for the speed of light:

$$c = {}^{1}/\sqrt{\mu_0 \varepsilon_0} \qquad (2)$$

c is the speed of light
μ_0 is the magnetic permeability of free space
ε_0 is the permittivity of free space

In the nineteenth century the aether drag hypothesis dealt with the question of whether the luminiferous aether was dragged by or entrained within moving matter. More specifically, could the velocity of the earth be measured as it moved through the aether? If the aether were entrained within moving matter, the speed of light should depend on the speed of this motion and an 'aether wind' should be measurable by instruments at rest on Earth's surface.

Augustin Fresnel, 1788 to 1827, was a French engineer and physicist who contributed significantly to the establishment of the theory of wave optics. Fresnel in 1818 invented an aether model and proposed that the aether was partially entrained by matter and remained stationary. Whereas George Stokes, in 1845, suggested a model in which the aether was completely entrained within or in the vicinity of matter. In 1851, Fresnel's stationary aether was confirmed by the Fizeau experiment. Conversely, the Michelson Morley experiments in 1881 and 1887 confirmed the contradictory Stokes theory!

The Michelson Morley experiment of 1887 was reported in a paper entitled, *On the Relative Motion of the Earth and the Luminiferous Ether* [8]. In conclusion states 'it appears that, from all that proceeds, reasonably certain that if there be any relative motion between the earth and the luminiferous ether, it must be small; quite small enough to refute Fresnel's explanation of aberration.' In this famous interferometer experiment to detect absolute motion Michelson and Morley saw no rotation induced fringe shifts: it was a null experiment.

The speed of light was thus measured as a constant in the moving inertial frame of the earth and as a response the Lorentz transformations were proposed by H.A. Lorentz in 1904 [9] and subsequently in the theory of relativity by Albert Einstein in 1905 [10]. Einstein raised as a postulate that the speed of light was constant in all inertial frames, and time and length variation of moving bodies were adjusted accordingly. However, the Michelson interferometer experiment has become one of the most failed experiments to date.

The absolute speed of the earth has been detected as shown in contemporary papers entitled *The Michelson and Morley 1887 Experiment and the Discovery of Absolute Motion* by Cahill in 2005[11] and Gift in 2006 [12]. Cahill used a Michelson interferometer technique with appropriate calibration to obtain earth's velocity at > 300 km/s. Cahill states that 'A 2002 post relativistic effects analysis for the operation of the device [Michelson interferometer] however gives a different calibration leading to a speed > 300 $km.s^{-1}$.' Gift used an alternative method and states 'Recent measurements indicate a velocity of 390 ± 30 $km.s^{-1}$ in the direction of the constellation Virgo'.

Returning to the question of aether drag, if the Michelson experiment was in error then the Stokes theory of aether entrainment cannot be supported, while the Fresnel model of aether drag has been validated by the Fizeau experiment. The Fresnel drag coefficient gives a formula for the velocity of light to vary in a moving body such that:

$$c'' = c_1 + v(1 - 1/\eta^2) \quad (3)$$

c'' is the velocity of light measured by an observer in the stationary frame.
v is the velocity of the body

$\eta = c/c_1$ is the refractive index with respect to light

In 1907, Max Von Laue found the aether drag coefficient formula to be equivalent to the composition of velocities in special relativity. Einstein's and Lorentz's theories of dynamics share similar formulas, but differ in their assumptions. Einstein assumed there was no aether and Lorentz assumed that it was undetectable. According to Cahill 'Contrary to the Einstein assumptions, absolute motion is consistent with relativistic effects, which are caused by the actual dynamical effects of dynamical motion through the quantum foam, so that it is Lorentzian relativity that is seen to be essentially correct.'

With the success of both the special and the general theories of relativity in the twentieth century, the luminiferous aether came to be viewed as a relic of nineteenth century physics. In relativity theory all motion is relative, only the speed of light is an absolute. Moreover, an absolute rest frame is not required. Today, however, the Cosmic Microwave background (CMB) can be treated as the rest frame of the universe, allowing the absolute motion of the earth, or any celestial body, to be calculated.

1.4. The Rest Frame of the Universe

Discovered in 1964 by Penzias and Wilson, Engineers of Bell Telephone laboratories, the *Cosmic Microwave Background* (CMB) radiation is the microwave radiation relic from the big bang. Microwave radiation is isotropic in the universe, with a temperature of 2.77 K^O.

It is the isotropic nature of the CMB radiation that allows it to be utilised as the rest frame of the universe. For example, the absolute velocity of the earth, V_{earth}, is the sum of the cosmic, tangent and solar inflow:

$$V_{earth} = V_{cosmic} + V_{tangent} - V_{solar\ inflow} = 365 + 30 - 42 = 353 \text{ km/s} \quad (4)$$

The absolute velocity of the earth is 353 km/s towards the constellation Virgo. It should be noted that Marinov has found earth's absolute velocity is 360 ± 40 km/s with equatorial coordinates of the apex $\delta = -24^\circ \pm 7^\circ, \alpha = 12.5h \pm 1\ h$, in a paper entitled 'New Measurement of the Earth's Absolute Velocity with the Help of the "Coupled Shutters" Experiment'[13].

As a result some authors have claimed that the CMB is the aether or the aether's radiation. In conclusion Gift [11] writes 'The discovery of what may be the ether's blackbody radiation-the isotropic CMBR - that provides an observable absolute frame of reference for determining absolute speeds as does the ether.' Sorell in 2008 writes 'The low frequency electromagnetic radiation emitted by the aether is called the cosmic background radiation'.

1.5. Quantum Physics

Max Planck, 1858 to 1947, German theoretical physicist who originated quantum theory. In 1900, quantum physics came into being with a paper by Planck, entitled *On the Theory of the Energy Distribution Law of the Normal Spectrum* [14]. It represented an expansion of the classical laws of physics to the microscopic level. The quantum concept of the discreteness of energy contrasts with the continuous range of energies for classical systems.

An array of exotic elementary and fundamental particles have been discovered in the twentieth century. From 17 elementary particles, there are 6 quarks (composing protons and neutrons), 6 neutrinos, the gluon, the photon, the Z boson, the W boson and a Higgs boson. Albeit, most of the

fundamental particles are unstable and quickly decay in lifetimes of between $6x10^{-20}$ and 2.2×10^{-6} seconds [14]. Even the neutron is unstable, with a lifetime of 925 seconds when not confined within a nucleus. Only four particles are stable: the photon (light particle), the electron, the proton and the neutrino. Consequently, these particles compose the majority of the observable universe.

Wolfgang Pauli, 1900 to 1958, was an Austrian born Swiss theoretical physicist and one of the pioneers of quantum physics. In 1931 Pauli postulated the existence of the anti-neutrino, $/\gamma$, to describe the energy deficiency in the beta decay, specifically energy would not have been conserved in the interaction. Beta decay involves a nucleus Z, A (Z is the atomic number and A the mass number) for radioactive series, emitting an electron and being transformed into the nucleus Z+1, A. For example, a neutron decaying into a Hydrogen atom is represented as such:

$^{0}n^{1} \rightarrow {}^{1}H^{1} + e + /\gamma$

Pauli's conjecture was confirmed, and the neutrino he postulated had (1) zero charge (2) intrinsic spin, s = ½ and (3) zero rest mass and (4) travels at the speed of light. Down to 10^{-18} metres, neutrinos have no measured spatial extent, compared to the proton measured at around 10^{-15} metres. Because their interaction with matter is extremely weak, neutrinos are seldom detected but these point-like leptons are considered to be a truly fundamental particle [14].

Paul Dirac, 1902 to 1984, was an English physicist who made fundamental contributions to quantum mechanics and quantum electrodynamics. In 1930, Dirac hypothesized the existence of the positron, the electron's anti-particle that, in turn, predicted anti-matter. Discovered in 1932, the positron has negative energy and exists in the 'Dirac sea': a theoretical model of the vacuum as an infinite sea of particles with negative energy. In 1951 Dirac suggested, in a paper entitled *Is there an Aether?*[15] that the quantum vacuum, fluctuating and generating particle pairs, may be the equivalent of a particulate aether.

The *Cosmic Neutrino Background* (CNB) is a remnant from the early expansion of the big bang, according to the standard model. Created in the first second of the universe, the CNB has cooled to a temperature of 1.95 K^{0}. It is currently estimated that there are 339 neutrinos per cubic centimetre throughout the universe.

As the CNB is isotropic it can also be employed as the rest frame of the universe when measured accurately. Although low energy neutrinos are difficult to detect, interacting only weakly with matter, so the CNB might never be observed directly. A number of methods have been suggested to detect the CNB, including the annihilation of ultra-high energy cosmic neutrinos with relic anti-neutrinos [16].

Stars produce neutrinos while converting hydrogen to helium, in the fusion process. As the cosmos is approximately 14 billion years old, a significant background of 'hot' neutrinos have been generated. Eventually these hot neutrinos will cool and add to the CNB.

There are three known species of spin ½ fermions: the electronic, muonic and tau neutrinos—denoted γ_e, γ_μ and γ_τ respectively. It is estimated that each species, including particle and anti-particle, today has a number of 113.27 neutrinos per centimetre squared throughout the universe. Other species have also been hypothesised, including the 'sterile' or right handed intrinsic spin and the 'Majorana', at once is its own particle and anti-particle. In particular, sterile neutrinos have been estimated to have a mass of 0.4 to 0.5 eV [17]. At present, the quantity of the hypothesised neutrinos is unknown, but the density estimate may be higher if the background of hot neutrinos is added.

The *quantum vacuum* is generally thought of as being 'free space' and, ideally, it contains no physical particles. It is the quantum state with the lowest possible energy. Notwithstanding, the actual quantum vacuum is not an absolutely empty void with zero energy, nor is it the empty void of free space as per the kinematics of special relativity. In the physical space of the universe, the quantum vacuum contains many particles per unit volume, including: the photons of the CMB, virtual particle pairs, the neutrinos of the CNB, the Higgs field, as well as ordinary particles. As a consequence, the quantum vacuum is closer to the plenum suggested by Descartes.

1.6. A Cosmic Superfluid

Described as a fifth state of matter, the superfluid or *Bose-Einstein condensate* (BEC) is reminiscent of the 'quintessence' conceived by Aristotle. The other four observable phases of matter are solid, liquid, gas and plasma. In a BEC, matter stops behaving as independent particles, and collapses into a single quantum state that can be described with a single, uniform wave function. It occurs at a temperature near absolute zero degrees Kelvin and its effect causes the complete loss of electrical resistance (it becomes a super-conductor) and zero viscosity. Magnetic fields are also excluded from the body of the superconductor.

At a sufficiently low temperature, a gas of degenerate fermions undergoes a phase transition to a superfluid state and, thus, the neutrinos of the CNB at a temperature of 1.95 K° would form a superfluid type condensate for any non-zero mass. The cooper pairs of the cosmological condensate are formed by left and right handed neutrinos of low energy and large wavelength. A CNB superfluid has been postulated in papers by Caldi and Chodos in 1999 [18] entitled *Cosmological Neutrino Condensates* and Kapusta in 2004 entitled *Neutrino Superfluidity* [19] and also by McElrath in 2008 in a CERN report entitled *Emergent Electroweak Gravity - New Instruments for Neutrino Relics and Mass* [20].

In 1975, K. P. Sinha, C. Sivaram and E. C. G. Sudarshan published a series of papers that suggested a new model according to which the aether is a superfluid state of fermion and anti-fermion pairs, describable by a macroscopic wave function [21]. The paper, entitled *Aether as a Superfluid State of Particle Anti Particle Pairs,* also suggested a solution to the mass deficiency of the universe in the dark energy of the superfluid vacuum. This became known as the superfluid vacuum theory (SVT). Sinha et al originally conceived the aether to be Dirac's negative energy sea of electrons; however, it is conceivable that these are neutrino particle and anti-particle pairs.

The superfluid condensates of the CNB could explain why matter is frictionless in space and, also, why bodies operate according to Newton's first law of motion.

1.7. CNB, the Luminiferous Aether?

If the CNB were not virtually transparent to photons, there could be no accurate astronomical observations. As noted by Sabbata there is, however, an effect of torsion on electromagnetic waves [22], '..an hypothetical neutrino sea could influence the propagation of em waves by the production of a torsionic background throughout our universe'.

Maxwell's equations show that both the impedance of space and the speed of light are dependent upon the permittivity, ε_0, and permeability, μ_0, of 'free' space according to (2) and (5). The question is: whether the CNB affects and/ or causes the permittivity or permeability of 'free' space. If, for instance, the permittivity of free space in a neutrino-less space is zero, the impedance of true free space would be infinite—or open circuit, where no electromagnetic waves could propagate.

$$Z_0 = \sqrt{\mu_0 / \varepsilon_0} = 376.7\ \Omega \qquad (5)$$

Z_0 is the impedance of free space
μ_0 is the magnetic permeability of free space
ε_0 is the permittivity of free space

Similarly, if the permeability of free space is altered in neutrino-less space the propagation of electromagnetic waves would be attenuated.

This suggests an experimental test: to determine the propagation of electromagnetic waves in a neutrino-less space. If neutrinos can be evacuated from a given volume, would electromagnetic waves propagate at all? If this were the case, then the seat of electromagnetic phenomena would have been discovered in the cosmic neutrino background, CNB.

According to the neutrino theory of light, the photon is a composite particle formed by a neutrino-antineutrino pair. In 1965, Perkins demonstrated that transversely polarized photons can be obtained from longitudinally polarised neutrinos [23]. The theory is based on the idea that the emission and absorption of a photon corresponds to the creation and annihilation of a particle and antiparticle pair, such as fermions.

Louis De Broglie, 1892 to 1987, was a French physicist who made ground breaking contributions to quantum theory. In 1932, De Broglie proposed, in the neutrino theory of light, that the photon is a composite particle formed by a neutrino-antineutrino pair, each with energy ½ hf. His theory was studied intensively in the 1930's and was re-evaluated by Perkins in the 1960's, and reassessed again only recently [24][25]. If it can be shown that the photon is not an elementary particle, but a composite of a neutrino pairing, then the seat of the electromagnetic phenomenon will have been discovered. And, if the neutrino theory of light is validated, the CNB would be the luminiferous aether.

As low energy neutrinos are difficult to detect, the CNB is practically invisible. While neutrinos do not react with matter, they do interact via the weak force and, at high energies, the weak force is identical with the electromagnetic force. Accordingly, neutrinos do not interfere with the progress of electromagnetic waves in space.

1.8. Could the Neutrino be a Tachyon?

Recently the recognition of flavour oscillations in neutrinos—over time a specific flavour such as electronic, muonic or tau oscillates to a different flavour—indicates that neutrinos must have a small mass, as was shown in the Super Kamiokande collaboration [26]. According to special relativity a particle with mass must travel at less than the speed of light; however, recent experiments suggest neutrinos may be travelling near or at the speed of light.

A number of neutrino speed tests including MINOS (2007), OPERA (2011, 2012), ICARUS (2012) and MINOS (2012) found that neutrino speeds have shown no deviation from the speed of light within the margin of error. Observations of Supernova 1987A had a result $| v\text{-}c | / c < 2 \times 10^{-9}$ at 1.000000002 times the speed of light [27]. At present it cannot be determined accurately whether the neutrino is travelling at, less than or greater than the speed of light.

Although reactions have been mixed, several authors have suggested that the neutrino could be a superluminal particle or tachyon. Papers entitled 'The Neutrino as a Tachyon' by Chodos [28] in 1985 and 'Neutrinos must be Tachyons' by Jeong [29] in 1997 have been gaining support.

In 1967, Gerald Feinberg [30] wrote the original tachyon foundation paper, entitled *Possibility of Faster than light particles*. In it, the mass of a particle is given by the relativistic energy equation and m can be imaginary if $p^2 > E^2/c^2$:

$$m^2c^2 = E^2/c^2 - p^2 \quad (6)$$

m is the rest mass
E is the energy
$p = \gamma mv$ is the momentum and c is the speed of light

Tachyons must always travel at greater than the speed of light. If the rest mass is imaginary then the particle would be a tachyon; if the rest mass were real it would be a bradyon. If the imaginary mass particle loses energy it becomes greater in superluminal speed. And, at zero energy the neutrino has infinite speed.

The largest known particle, the Higgs boson with a mass of 126 GeV/c^2, discovered on 4th July 2012, can also be regarded as a tachyon. In its uncondensed phase the Higgs field has a negative mass squared [31]. Due to the instability caused by its imaginary mass the Higgs boson will, however, spontaneously decay into quarks, leptons and W and Z particles having real mass.

In January 2015, Robert Ehrlich published a paper entitled, *Six observations consistent with the electron neutrino being a tachyon with mass:* $m^2 = -0.11 \pm 0.016\ eV^2$ *or* $\mu_{ve} = 0.33 \pm 0.024\ eV$ [32]. Ehrlich collected 6 experiments determining the average mass of the neutrino squared and found a negative value, thus concluding that the electronic neutrino is a tachyon. Accordingly, the other flavours, muon and tau neutrinos, might also be considered to be tachyons. If the neutrino is a tachyon then the mass will have an upper bound, which can vary between a maximum and zero. Henceforth, this paper will join Ehrlich and take the view that the neutrino is a tachyon.

If the electronic neutrino were a tachyon, the universe would be embedded in a homogeneous tachyonic field. As the tachyon field is superluminal, the speed of fields and particles within it might be expected to be superluminal also. However, this is not the case. In 1969, a paper by Aharanov entitled, *Superluminal behaviour, Causality and Instability*, [33] has shown that fields and particles in a tachyonic field are limited to less than or equal to the speed of light. As a consequence, the particles and fields within the CNB must be similarly limited.

1.9. The Cosmological Constant and Dark Energy

Recalling that Newton's Law of Gravitation (1) applies at cosmological scales, and the cosmos is spatially flat, an unexpected result has been found for tachyons. Two imaginary masses will produce a negative force, reversing normal gravitational attraction [34]. Gravity, acting as a negative pressure, becomes repulsive for tachyonic masses.

The Einstein field equations for cosmology appear as:

$$R_{\mu\nu} - \tfrac{1}{2} R g_{\mu\nu} + \Lambda g_{\mu\nu} = (8\pi G/c^4).T_{\mu\nu} \quad (7)$$

$R_{\mu\nu}$ is the Ricci curvature tensor
$g_{\mu\nu}$ is a symmetric metric tensor
Λ is the cosmological constant
$T_{\mu\nu}$ is the energy-momentum stress tensor
G is the gravitational constant and c the speed of light

In equation (7) the cosmological constant, Λ, exerts an overall repulsive gravitational force, forming the energy density of the vacuum [35]. The homogeneous energy of the CNB would, therefore, be analogous to the cosmological constant in the present cosmological era.

Using Ehrlich's figure for the mass of the electronic neutrino, the energy density of the CNB, ρ_{ve}, can be found as 0.33 eV [32] and given as 113.27 electron neutrinos per centimetre cubed. In total, the mass of the electronic, tau and muon neutrino has been estimated to be $\Sigma\, m_e + m_\upsilon + m_\mu = 0.320 \pm 0.08$ eV [17]. This result suggests that the total mass of known neutrinos is equal only to the mass of the electronic neutrino.

Neglecting tau and muon neutrinos, the calculated figure for the energy density of the CNB is $\rho_{\Lambda ve} = 5.989 \times 10^{-11}$ erg/cm^3. This compares closely to the observed value of the dark energy density of, approximately, $\rho_{\Lambda obs} \approx 10^{-9}$ to 10^{-10} erg/cm^3 [36][37]. If the calculation of the number density of neutrinos is underestimated, or other types of neutrinos exist, then the figure for the energy density for the CNB would then be revised upwards.

As tachyons, the neutrinos of the CNB could contribute to a cosmological anti-gravity force leading to the accelerated expansion of the universe— as has been observed recently— and the tachyonic CNB could, conceivably, compose the dark energy that causes the accelerated expansion of the cosmos. In 2003, Bagla et al, in a paper entitled *Cosmology with Tachyon Field as Dark Energy* [38] showed that, 'it is possible to construct viable models with tachyons contributing significantly to the energy density of the universe', and 'a subset of these models satisfy the constraints on the accelerating expansion of the universe.' Accordingly, matter, radiation and tachyons can coexist to produce the observed acceleration in the universe.

The evidence that the CNB could contribute to the total amount of mass-energy in the universe is compelling. Ordinary particles are found to be 4.9 % and dark matter and dark energy the remaining, 26.8 % and 68.3 %, respectively. And, it is reasonable to consider that the CNB mass-energy contributes to dark energy [39].

Assuming homogeneous distribution, the density of the CNB, ρ_υ, can be calculated for the electronic neutrino from the 0.33 eV result and 113.27 neutrinos per cm^3. This density is found to be $\rho_\upsilon = 6.663 \times 10^{-32}$ g/cm^3.

Due to the CNB, Λ_υ, the cosmological constant can be calculated using the equation given below:

$$\Lambda_\upsilon = \rho_\upsilon (8\pi G/3c^2) \qquad (8)$$

$$\Lambda_\upsilon = 4.145 \times 10^{-59} \text{ cm}^{-2}$$

Thus, the cosmological constant due to the CNB, Λ_υ, is 4.145×10^{-59} cm^{-2} falls within expectations set by the observed value of $< 10^{-56}$ cm^{-2} [36].

As the critical density of the universe is $\rho_c = 3H^2/8\pi G = 7.150 \times 10^{-30}$ g/cm^3 [40], the ratio of the density of the CNB to the critical density would be $\Omega_\upsilon = \rho_\upsilon / \rho_c = 0.009314$, making the contribution by the CNB to the total mass-energy of the universe of 0.93 %.

Other possible sources of dark energy are the Higgs field sterile neutrinos and Majorana neutrinos. Approximately 70 % of the total mass-energy is due to dark energy in the present cosmological era.

Given the asymmetry between neutrino particles and anti-particles, and fusion and hypothetical neutrinos, the density of the CNB may be higher than present estimates [41].

1.10 Quintessence

Quintessence takes its namesake and has its basis in the Aristotelian notion of the aether. According to Steinhardt, *Quintessence* is a dynamic, time evolving and a spatially dependent form of energy with negative pressure that drives the accelerating expansion of the universe [42]. Unlike the cosmological constant, quintessence encompasses a wide class of possibilities for dark energy.

Due to the additional flux of neutrinos from fusion and the expansion of the universe, the density of neutrinos in the CNB would be anticipated to vary. In addition, there are small inhomogeneities in the CNB [43]. As it is proportional to the density of the CNB, the cosmological constant would vary over time in this instance (8), and the tachyonic scalar gravitational field of the CNB would, therefore, be analogous with 'quintessence'.

The quintessence is a scalar field with an equation of state, w_q, the ratio of pressure p_q and density ρ_q and is given by the potential energy and the kinetic term:

$w_q = p_q / \rho_q = ½ (dQ/dt)^2 – V(Q) / ½ (dQ/dt)^2 + V(Q)$

For cosmologies, quintessence has, $-1 \leq w_q \leq 0$, as compared to the cosmological constant with $w_q = -1$. Recent astronomical measurements place w_q in the range $-1 \leq w_q \leq -0.6$ [44]. The present dark energy density given as 6.9×10^{-27} kg/m^3, or $\approx 10^{-47}$ GeV^4, compares to the density of CNB for the electronic neutrino, 6.63×10^{-29} kg/m^3, that is, 0.964 % of the required value [45]. If hot and hypothetical neutrinos were to be included, the density of the CNB would be higher.

2. Conclusion

Scientists and mathematicians including Newton, Descartes, Maxwell, Fresnel and Dirac have all formulated laws on the basis of an aether, and the CNB shares many of those properties. It is invisible, it permeates space and it resembles Aristotle's '*quinta essentia*'. While, space and the quantum vacuum have been shown to be a plenum rather than a vacuum.

Although, the rest frame of the universe has been discovered and could either be the CMB or the CNB. The CNB is consonant with the concept of an aether, and an experiment has been outlined to test it as a luminiferous aether.

Comparing within the range of observed values, the CNB energy density has the value of $\rho_{\Lambda\upsilon} = 5.989 \times 10^{-11}$ erg/cm^3 and a cosmological constant value of $\Lambda_\upsilon = 4.145 \times 10^{-59}$ cm^{-2}, with a contribution of 0.931% to the total dark energy of the universe. However, the density of the CNB would be higher if hypothesised neutrinos and hot neutrinos were added, and there was an asymmetry between neutrinos and anti-neutrinos.

Supporting the superfluid vacuum theory of the aether, the CNB forms a superfluid at a temperature of 1.95 K°. Accordingly, the cosmic superfluid body can be likened to the fifth state of matter.

As a tachyonic field, the CNB would produce a cosmological anti-gravity force, accelerating the expansion of the universe. While, a universe embedded in a superluminal tachyon field may exhibit the effects of SRT and GRT.

With dark energy as a visualisation of the aether, the CNB is a dark energy candidate, and the gravitational scalar field of the CNB is analogous to the 'quintessence' of contemporary cosmology.

References

[1] G.E.R. Lloyd, "Aristotle, the Growth and Structure of his thought", Camb.Uni Press, ISBN 0-521-09456-9, 1968, pp 133-139.

[2] Robert Fludd, "Mosaicall Philosophy", London, Humprey, Mosely, 1659.

[3] Rene Descartes, "The World", 1633.

[4] J.T. Cushing, "Philosophical Concepts in Physics", Cambridge Uni Press, pp 183-184, Feb 13 1998.

[5] Isaac Newton, Letter to Robert Boyle, 1679.

[6] L. Kraus, "The fifth essence: the search for dark matter in the Universe", Vintage, 1989, ISBN 0-099786508, pp 23.

[7] J.T. Cushing, "Philosophical Concepts in Physics", Cambridge Uni Press, pp. 190-196, Feb 13 1998,

[8] A. Michelson, E. Morley, "On the Relative Motion of the Earth and the luminiferous ether", *Amer Phys Soc,* Vol 34, No. 203, Nov 1887.

[9] H.A. Lorentz, "Electromagnetic Phenomena in a system with any velocity less than that of light", *Proc of the Acad of Sci of Amsterdam,* 6, 1904.

[10] A. Einstein, "On the Electrodynamics of Moving Bodies", *Annal der Phys,* 17, 1905.

[11] R. Cahill, "The Michelson and Morley 1887 Experiment and the Discovery of Absolute Motion", *Prog in Phys 3*,pp. 25-29, arXiv:physics/0508174, 2005.

[12] S. Gift, "The Relative Motion of the Earth and the Ether Detected", *Journ Sci Expl*, Vol. 20, No. 2, pp. 201-214, (2006).

[13] S. Marinov, "New Measurement of the Earth's Absolute Velocity with the Help of the "Coupled Shutters" Experiment", *Prog in Phys,* Vol 1, Jan 2007.

[14] R. Eisberg, R. Resnick, "Quantum Physics of atoms, molecules, solids, nuclei and particles" Second Edition, John Wiley and Sons, © 1985, ISBN 0-0471-87373-X, pp 2, 650.

[15] P.Dirac, "Is there an Aether?", Nature, Vol 168, No 4282, pp 906-907, Nov 24 1951.

[16] A. Ringwald, "How to Detect the Cosmic Neutrino Background?" arXiv: hep-ph/0301157v1 20 Jan 2003.

[17] R.Battye, A.Moss "Evidence for massive neutrinos from CMB and lensing observations", arXiv:308.58070v2 [astro-ph.co] 7 Jan 2014.

[18] D. Caldi, A. Chodos , "Cosmological Neutrino Condensates", arXiv: hep-ph/9903416v1,19 Mar 1999.

[19] A. Kapusta, "Neutrino Superfluidity", arXiv: hep-th/0407164v1, 19 Jul 2004.

[20] B. McElrath "New Instruments for Neutrino Relics and Mass", CERN report, Dec 8, 2008.

[21] K. P. Sinha, C. Sivaram and E. C. G. Sudarshan, "Aether as a Superfluid State of Particle Anti Particle Pairs", *Found of Phys, 6*(1), pp. 65-70, Jan 1975.

[22] V. Sabbata, "On the Propagation of Electromagnetic waves in a Cosmological Neutrino Sea", *Lett Nou Cim,* Vol 28, No. 5, Apr 1980.

[23] W.A. Perkins, "Interpreted History of Neutrino Theory of Light And Its Future", arXiv: hep-ph/0107122v1, 11 Jul 2001.

[24] V. Dvoeglzov , "Again on the possible compositeness of the photon", arXiv: hep-th/9908057v1 7 Aug 1999.

[25] V. Berezinskii, "Pryce's Theorem and the Neutrino Theory of Light", *Sov Phys JETP,* Vol. 24, No. 5, pp. 927-933, May 1965.

[26] S. Sankar, "Three flavour oscillation interpretation of neutrino data", *Pramana Jour phys,* Vol. 54, No. 4, pp. 603-609, Apr 2000.

[27] L. Stodolsky, "The speed of light and the speed of neutrinos", *Phys Lett B**201**,* Vol 3, pp. 353–354, 1988.

[28] A. Chodos, A. Hauser, V. Kostelecky , "The Neutrino as a Tachyon" , *Phys Lett B150,* 431 LA-UR-84-3372, 1985.

[29] E. Jeong, "Neutrinos must be Tachyons", arXiv: hep-ph/9704311v4, 1 May 1997.

[30] G. Feinberg, "Possibility of Faster than light particles", *Phys Rev 159,* pp. 1089-1105, 1967.

[31] F.A. Wolf, "Time Loops and Space Twists: How God created the Universe", ISBN -13-1938289002, 2011.

[32] R. Ehrlich, "Six observations consistent with the electron neutrino being a tachyon with mass: $m^2 = -0.11 \pm 0.016$ eV ^{2} or $\mu_{ve} = 0.33 \pm 0.024$ eV", *Astropart Phys,* 66, pp. 11-17, January 2015.

[33] Y. Aharanov, A. Komar, L.Susskind," Superluminal behaviour, Causality and Instability*",* *Phys Rev. 182(5*), pp. 1400-1403, 25 Jun 1969.

[34] E.Puscher, "Faster -than-light particles: A Review of Tachyon Characteristics", United States Air Force, N-1530-AF, Rand Corporation, Oct 1980.

[35] B. Greene, "The Fabric of the Cosmos", Penguin books, pp. 275-279, © 2004.

[36] S.E.Rugh , H.Zinkernagel "The Quantum Vacuum and the cosmological constant problem", Studies in History and Philosophy of Modern Physics, Vol 33, pp 663-705, 2002.

[37] F. Darabi, "A note on the cosmological constant problem", arXiv:1107.3307v1[hep-th] 17 Jul 2011.

[38] J. Bagla, H. Jassal, T.P admanabhan, "Cosmology with Tachyon field as dark energy*",* arXiv: astro-ph/0212198v2, 5 Mar 2003.

[39] U.D. Jentschura, B.J. Wundt "From Generalised Dirac Equations to a candidate for Dark Energy", arXiv:1205.0521 [hep-ph], 12 Dec 2012.

[40] Uni Mass. "The Universe", *people.cs.umass.edu/~immerman/~Stanford/universe.html*

[41] D. Schwarz1, M. Stuke "Does the CMB prefer a leptonic Universe?", arXiv: 1121.6721v3 [astro-ph.CO] 11 Mar 2013.

[42] I. Zlatev, L.Wang, P.Steinhardt “Quintessence, Cosmic Coincidence and the Cosmological Constant”, arXiv: astro-ph/9807002v2, 2 Oct 1998.

[43] S. Bashinsky, U.Seljak, “Signatures of Relativistic Neutrinos in CMB Anisotropy and Matter Clustering”, arXiv: astro-ph/0310198v3 6 Jan 2004.

[44] L.Wang, R. R. Caldwell, J. P. Ostriker, P. J. Steinhardt “Cosmic Concordance and Quintessence”, Astro. Journ, 530, pp 7-35, Feb 10 2000.

[45] P.J. Steinhardt , “A quintessential introduction to dark energy”, Phil. Trans. Roy Soc. A: Math, Phys &Eng Sci, vol 36, no. 82, pp 2497-253, 2003.