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Cosmic background radiation due to the cherenkov radiation from the zero-point field of vacuum

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Abstract

Instead of the Big Bang model, which considers the cosmic background radiation (CBR) as the afterglow of the Big Bang, a Zero Point Field (ZPF) model is proposed, in which cosmic background radiation is generated by the Cherenkov effect from superluminal particle pairs created in a zero-point fluctuation of vacuum. The calculated result of CBR by this model shows that spectrum and the mass density of energy due to the Cherenkov radiation closely coincides with of the cosmic background radiation observed. Such a ZPF model eliminates any requirement for abstract notions such as dark energy and dark matter and leads to the much broader concept of an Infinite Holographic Universe.

Keywords

Cosmic background radiation; Zero-point field; Cherenkov radiation; Superluminal particle.

INTRODUCTION

Big bang theories today rely on a growing number of hypothetical, abstract entities, entities which we have never observed directly, dark matter and dark energy being the most prominent examples. Without these hypothetical constructions, there would be a fatal contradiction between the observations made by astronomers and the predictions of the Big Bang theory. In every direction, there is a very low energy and very uniform radiation that we see filling the Universe. This is called the 3 Degree Kelvin Background Radiation, or the Cosmic Background Radiation (CMB). These names come about because this radiation essentially gives to all background regions of space a black body temperature slightly less than 3 degrees Kelvin, which peaks in the microwave portion of the spectrum. The existence of this background radiation is the strongest evidence for the validity of the hot big bang model. Conventionally cosmic background radiation is considered to be the afterglow or a remnant of the Big Bang of the Universe, however it was pointed out by W.C.Mitchell[1] that there were many flaws in the present Big Bang theory. From the COBE (Cosmic Background Explorer) satellite observational data, it can be shown that highly isotropic cosmic background radiation at the temperature $T = 2.725°K$ fills the Universe, the equivalent mass density of which becomes $4.6 \times 10^{-31}\ Kg / m^3$. This indicates that early stages of the universe were almost completely uniform and it raises two problems for the Big Bang theory. The first is the horizon problem, which claims that regions of microwave background coming from widely separated parts of the sky are too separated to have been able to communicate with each other even with signals traveling at light velocity. The second is the irregularities of the Universe on very large scales, such as voids and walls, which are not homogenous nor isotropic. To solve these problems numerous inflationary theories of the universe have been proposed, but these ignore the conflicting data which has come from satellite studies of the cosmic microwave background radiation. Without this hypothetical inflationary field, the big bang theory cannot predict the homogenous, isotropic cosmic background radiation that is observed, because there would be no way for parts of the Universe that are now more than a few degrees away in the sky to come to the same temperature and thus emit the same amount of microwave radiation.

DISAGREEMENT OF ANGULAR CORRELATION FUNCTION OBTAINED FROM OBSERVATIONS

Inflation theory predicts that the amplitude of each of the CMB radiation modes is random and the distribution of probabilities follows the shape of a bell curve, known as a Gaussian. According to the inflation theory, the amplitudes of all the modes should have Gaussian distributions of very nearly the same width[2].

From the cosmic microwave background (CMB) correlation analysis of the WMAP (Wilkinson microwave Anisotropy Probe) and COBE satellite data, using the angular correlation function given by[3];

$$C(\vartheta) = \left\langle \frac{\Delta T}{T}(\vec{n}_1)\frac{\Delta T}{T}(\vec{n}_2) \right\rangle \quad (1)$$

where T is the temperature of the background radiation and $\cos\vartheta = \vec{n}_1 \cdot \vec{n}_2$ ($\vec{n}_1, \vec{n}_2$: unit vector to arbitrary direction on the sky), the calculation result shown in Figure 1, was obtained[2].

This angular correlation function measures the extent to which the two points are collated in their temperature fluctuations, averaged over all the points in the sky. From which, it can be seen that the correlation function is nearly zero at angles greater than about 60 degrees, which means that fluctuations of the background radiation separated by more than about 60 degrees are completely uncorrelated, which contradicts the theoretical curve predicted from the inflation theory of the Big Bang model. Using real data we can see the correlation function is nearly zero at angles greater than about 60 degrees, which means that any fluctuations of the background radiation separated by more than about 60 degrees are completely uncorrelated. This result is not consistent with inflationary theories of the Big Bang model and supports the conclusions of W.C.Mitchell[1]. Hence, we are forced to consider other models to explain the uniformity and the lack of correlations in the angular spectrum of the CMB. Tremendous insight into this data can be gained by considering the CMB as the result of a zero-point field (ZPF) in empty space.

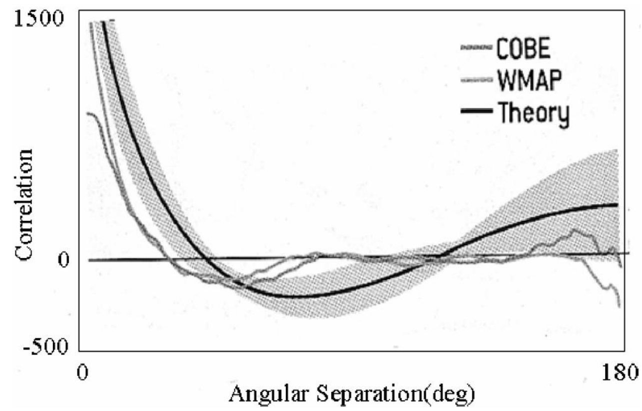

Figure 1 : Angular correlation function of the power spectrum from the data of COBE and WMAP

POSSIBILITY OF VIRTUAL SUPERLUMINAL PARTICLES CREATED IN EMPTY SPACE

T.Musha presented an idea in his article[4] that highly accelerated particles have the possibility to penetrate through the light barrier in a finite length of time and appear as a superluminal particle called a tachyon. From the bosonic string world-sheet action given by

$$S = \frac{1}{4\pi\alpha'}\int d^2\sigma\sqrt{-g}g^{ab}\partial_a X^{\mu}\partial_b X_{\mu} \quad (2)$$

the spectrum of bosonic strings contains a tachyonic mode for open strings[5] shown as

$$m^2 = -\frac{1}{\alpha'} \;,\; 0 \;,\; \frac{1}{\alpha'} \;,\; \frac{2}{\alpha'}, \cdots \quad (3)$$

which shows the existence of negative energy, allowing the existence of a tachyon as an unstable particle, that can appear for only a short period of time in empty space.

From the Klein-Gordon wave function for the accelerated particle given by

$$\frac{\partial\psi}{\partial p} = -\frac{i}{m\alpha\hbar}\sqrt{p^2c^2 + m^2c^4}\,\psi \quad (4)$$

where p is the momentum of the accelerated particle, m is its proper mass, α is a proper acceleration $\hbar$ is a Plank's constant divided by 2π and c is the light speed, he has shown the possibility of virtual particles created temporarily out from ZPF field as a superluminal particle by quantum tunneling effect[6], as shown in Figure 2.

From Eq.(4), the probability of which is given by[6];

$$T \approx \exp\left[-\frac{\omega}{c} l\sqrt{\beta^2 - 1}\left(\frac{\beta}{\beta^2 - 1} - \log(\hbar\omega / c) - \log(\beta + 1)\right)\right] \quad (5)$$

where l is the size of the quantum domain where tachyon is created and β is the ratio of the particle velocity divided by the light speed.

Quantum electrodynamics shows that empty space to be filled with zero-point fluctuations of electromagnetic field which have an energy density given by

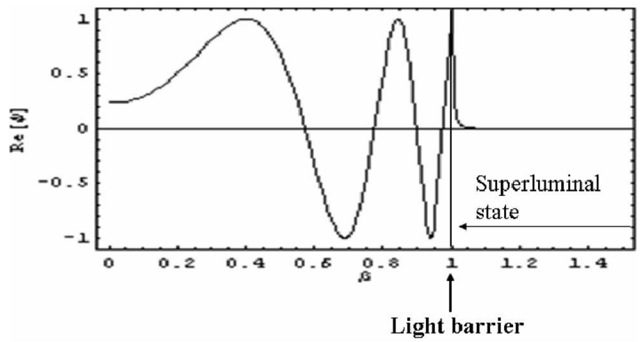

Figure 2 : Wave function of the accelerated particle beyond the light barrier

$$\rho_E = \frac{\hbar}{2\pi^2 c^3}\int \omega^3 d\omega \quad (6)$$

where ρ_E is an energy density of the ZPF and ω is an angular frequency of the ZPF spectrum.

In empty space, virtual elementary particles, most of which are low energy photons, are created from the ZPF background. The pair of a tachyon and an anti-tachyon created from the ZPF background satisfies the energy conservation law as follows;

$$\frac{2m_* c^2}{\sqrt{v_*^2/c^2 - 1}} = \hbar\omega \quad (7)$$

where m_* is an absolute value of the imaginary mass of the tachyon, v_* is its velocity and $\hbar\omega$ is the energy of the virtual photon created in a ZPF background.

The shift of the momentum of the particle beyond the light speed by quantum tunneling effect is given by

$$\Delta p = \frac{2m_* v}{\sqrt{v_*^2/c^2 - 1}} - \frac{\hbar\omega}{c} \quad (8)$$

By introducing the shift of momentum into the uncertainty principle for the tachyon[7] given by

$$\Delta p \cdot \Delta t \approx \frac{\hbar}{v_* - c} \quad (9)$$

the velocity of a tachyon created from ZPF background can be roughly estimated as $v_* \approx 2c$, where Δp is the uncertainty of the momentum and Δt is the time interval of a particle moving in a superluminal state.

From the assumption that virtual photons are created inside a region, the size of which almost equals the Plank length l_p, the probability of a virtual tachyon created from the ZPF becomes

$$T \approx \exp\left[-\frac{\omega}{c} l_p \sqrt{3}\left(\frac{2}{3} - \log(\hbar\omega/c) - \log 3\right)\right] \quad (10)$$

which can be roughly approximated as

$$T \approx \exp[-\gamma \cdot l_p \omega] \quad (11)$$

in which, $\gamma = -\frac{3\log 3 - 2 + 3\log(\hbar/c)}{\sqrt{3c}} \approx 5.62 \times 10^{-7}$.

CHERENKOV RADIATION FROM VIRTUAL SUPERLUMINAL PARTICLES

If a superluminal particle created from the ZPF background has an electric charge, it radiates photons at the angle of $\theta_c = \cos^{-1}(1/\beta n)$, where θ_c is the half-angle of the Chrenkov radiation from a particle moving at speed of $\beta = v_* / c$ and n is the index of refraction, which equals to unity in a vacuum.

The number of photons at an angular frequency $\omega = 2\pi\nu$ radiated by Cherenkov effect[7] can be roughly estimated from

$$\frac{dN}{dl} = 2\pi\alpha\left(1 - \frac{1}{\beta^2}\right)\cdot\int\frac{d\lambda}{\lambda^2} = \frac{3\pi\alpha}{2c}\Delta\nu \quad (12)$$

by using the relation $v_* \approx 2c$, where α is a fine structure constant, λ is a wavelength and $\Delta\nu$ is a band width of the Cherenkov radiation.

From the uncertainty principle of energy and momentum, the traveling distance of the virtual particle in a superluminal state yields $l = c / \omega$, thus the number of photons radiated by Cherenkov effect becomes

$$N \approx \frac{1}{183}\frac{\Delta\nu}{\nu} \quad (13)$$

which is negligible when compared to unity for the case when satisfying $\nu > \Delta\nu$.

Thus we must consider the electromagnetic radiation field created through Cherenkov effect can be regarded as a system in thermal equilibrium filled with non-radiating electromagnetic waves. As a small fraction of this non-radiating ZPF electromagnetic field energy can be radiated as a blackbody radiation according to stochastic electrodynamics, the energy density of which can be estimated as

$$\langle\rho_E\rangle = \frac{\hbar\omega^3}{2\pi c^3} T_*(\omega)\frac{\sum_{k=0}^{\infty} k e^{-k\hbar\omega/k_B T}}{\sum_{k=0}^{\infty} e^{-k\hbar\omega/k_B T}} = \frac{\hbar\omega^3}{2\pi^2 c^3} \times \exp\left(-\frac{\gamma\, l_p}{c}\omega\right)\cdot\left[\exp\left(\frac{\hbar\omega}{k_B T}\right) - 1\right]^{-1} \quad (14)$$

where k_B is the Boltzmann constant and T is the absolute temperature of radiation, which gives the spectrum of the Cherenkov radiation from the vacuum as shown in Figure 3[8].

From this equation, the mass density of Cherenkov radiation from the pair of virtual superluminal particles can be given by[8];

$$\rho_r = \frac{2}{c^2}\int_0^\infty \langle\rho_E\rangle d\omega = \frac{\hbar}{\pi^2 c^5}\int_0^\infty \omega^3 \exp\left(-\frac{\gamma\, l_p}{c}\omega\right) \times \left[\exp\left(\frac{\hbar\omega}{k_B T}\right) - 1\right]^{-1} d\omega = \frac{6k_B^4 T^4}{\pi^2 c^5 \hbar^3}\zeta(4, 1+\alpha) \quad (15)$$

where $\zeta(m,n)$ is a Hurwitz zeta function and $\alpha = \frac{\gamma\ l_p k_B}{c\hbar}T$.

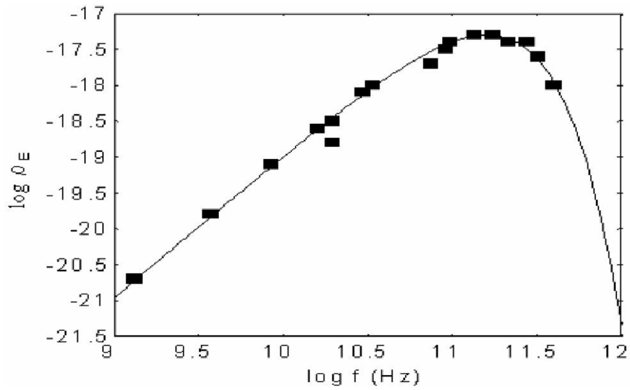

Figure 3 : Spectrum of the calculation and the observed result of cosmic background radiation

According to Fang Li Zhi et al[9], the mass density of radiation from stars by nuclear fusion of hydrogen nuclei into helium can be estimated as $\rho_r > 2.0 \times 10^{-31}\ Kg/m^3$, the temperature of which becomes $T > 2.21°K$. By introducing this value into Eq.(14), the mass density in a space becomes $\rho_r > 4.0 \times 10^{-31}\ Kg/m^3$ which is consistent of the observed result given by $4.6 \times 10^{-31}\ Kg/m^3$.

R.TomaschitzB[10] also calculated the spectral density of tachyon background radiation in a space, based on a vectorial equation for tachyons of the Proca type via the usual box quantization procedure, shown as

$$\rho(\omega)d\omega = \frac{\hbar\omega^3}{\pi^2 c^3}\frac{\sqrt{1+m_*{}^2 c^4/\hbar^2\omega^2}}{\exp(\hbar\omega/(k_B T))-1}d\omega \qquad (16)$$

From this, the mass density of tachyon radiation can be given by

$$\rho_t = \frac{1}{c^2}\int_0^\infty \frac{\sqrt{7}\hbar\omega^3}{2\pi^2 c^3}\left[\exp\left(\frac{\hbar\omega}{k_B T}\right)-1\right]^{-1} d\omega$$
$$= \frac{\sqrt{7}\pi^2}{30}\frac{k_B^4}{c^5\hbar^3}T^4 \qquad (17)$$

which yields $6.15 \times 10^{-31}\ Kg/m^3$, that is close to the value obtained by Eq.(15).

Supposing that almost all of the energy from cosmic background radiation is emitted by Cherenkov effect from the ZPF vacuum, the mass density of the radiation in a vacuum yields a value which is very close to the observed value by the COBE satellite. Thus, we can consider most of energy of the CMB comes from electromagnetic radiation due to Cherenkov effect of superluminal particle pairs created in a ZPF background, then we see the amazing uniformity of the cosmic microwave background may result from the CMB radiation of cosmic space itself.

As the angular scale ϑ which corresponds to fluctuations of the cosmic background radiation given in Eq.(1) can be approximated by the mode number l given by[2];

$$\vartheta \approx \frac{60°}{l} \qquad (18)$$

thus the Doppler shift induced by the movement of the solar system relative the CMB radiation corresponds to the dipole mode $l = 1$ as shown in Figure 4.

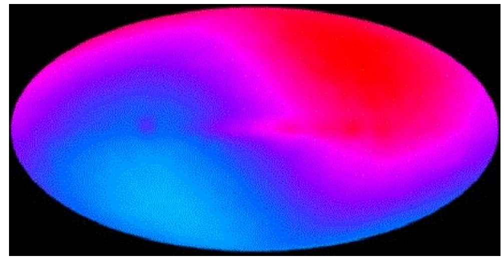

Figure 4 : CBR radiation which possesses a dipole anisotropy due to the motion of the Earth

Because the ZPF originated background radiation is totally uncorrelated except the dipole mode below 60 degrees, thus the correlation of the CMB at an angle of more than $\vartheta = 60°$ becomes nearly zero, as obtained from the observations by satellites.

W.C.Michel claimed that it seemed more reasonable to postulate that the source of CMB is due to natural radiation from matter or energetic processes in relatively nearby space from the considerations of the available evidence by observations[12]. If the origin of the CMB is due to the ZPF radiation from a vacuum, we can satisfy W.C.Michel's claim of a nearby, natural radiation source for the CMB in the Universe.

CONCULSION AND DISCUSSUON

In this article, the electromagnetic radiation from the ZPF background due to Cherenkov effect is estimated with theoretical calculation. The calculated result of CMB from this model shows the spectrum and mass density of energy due to the Cherenkov radiation closely coincides with the observed cosmic background radiation. Hence we must accept that cosmic background radiation may not be due to the after glow of a Big Bang that happened 15 billion years ago. From the observations by NASA's Great Observatories, the Spitzer and Hubble Space Telescopes, one of distant galaxies among the most distant ever seen, appears to be unusually massive and mature for its place in the young universe as shown in Figure 5, which represents an era when the universe was only 800 million years old after the Big Bang[13].

That is about five percent of the Universe's age of 15 billion years. This is against to common thought that galaxies have been much smaller associations of stars that gradually merged to build large galaxies like our Milky Way. Hence it is considered that the age of the Universe must be much older than the estimated value obtained by

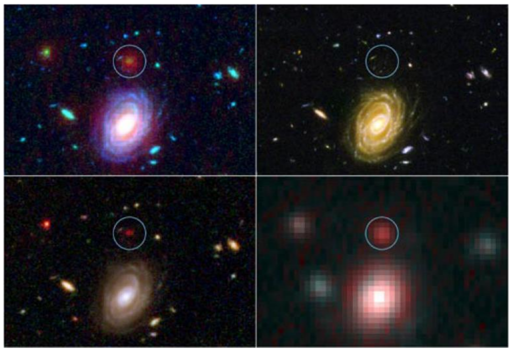

Figure 5 : Unusually massive and mature galaxy observed in the circle.

the Big Bang theory. In view of many problems with the big bang theory, we must postulate alternative cosmologies from the standpoint of the electromagnetic zero-point field of the vacuum. To further interpret this result, we consider S.Berkovich suggestion of a "cloud computing paradigm", in which is given an elegant constructive solution to the problem of the organization of mind. Within his article, he defines a situation where individual brains are not stand-alone computers but collective users whom have shared access to portions of a holographic memory of the Universe[14]. He proposed that the CMB has nothing at all to do with the residual radiation leftover from the Big Bang.

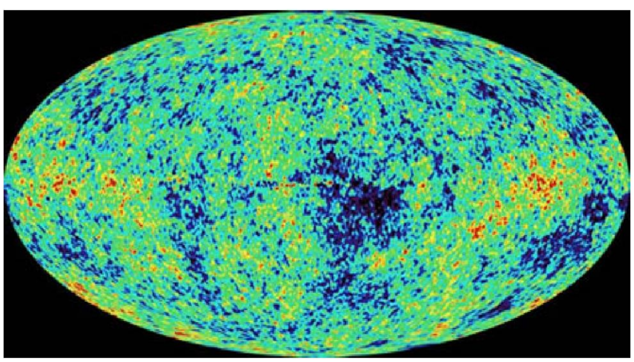

Figure 6 : Is CBR an activity of ZPF vacuum which relates to the writing operations in the holographic memory of the Universe?

Instead, he claimed that CMB is nothing but noise from writing operations in the holographic memory of the Universe. Such holographic write operations would require some type of universal clocking rate for these operations. Since the virtual superluminal particle pairs are created and annihilated in the vacuum within a short, finite period of time according to the uncertainty principle, we could logically consider this duration as the clock rate for these operations. Hence we can conclude viewing the cosmic background radiation as an activity of ZPF vacuum may be more accurate and have broader implications than the current inflation model of the Big Bang.

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