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Free Electrons Compton Scattering Can Produce an Illusion of Expanding Universe

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Abstract

The high-precision measurements of the Hubble parameter make the theory of cosmic expansion more and more confusing, which bolsters the idea that new physics may be needed to explain the mismatch. Astronomical observations show that the Universe is expanding exponentially. Free electron Compton scattering (FEC) can produce the illusion of exponentially expanding Universe: FEC causes photons to redshift exponentially, and the photon beam exponentially expands along the propagation direction. Is this a coincidence? The redshift factor of the FEC is $z=(1+z)$; the beam length stretch factor (time dilation of the supernova curve) of the FEC is $z=(1+z)$; the expansion factor of the beam volume of the FEC is $z=(1+z)^3$, and the FEC effect does not blur the image of distant galaxies. The reason for rejecting the "tired light" does not hold in FEC.

Keywords

Expanding Universe, Hubble Parameter, Free Electron Compton Scattering, CMBR

1. Introduction

In 1927, the Belgian astronomer and cosmologist Georges Lemaître first proposed the Big Bang hypothesis. In 1929, the American astronomer Hubble proposed Hubble's law based on the redshift of galaxies being proportional to the distance, and deduced the theory of the Expanding Universe that galaxies are far away from each other. In 1946, American physicist Gamow formally proposed the Big Bang theory. The Expanding Universe theory believes that the Universe "emerged" from an infinitesimal dimension of space-time that occurred about

13.8 billion years ago. At the end of the last century, observations of the Ia supernova showed that the Universe was accelerating, and the energy for accelerating expansion came from dark energy. The Big Bang theory successfully predicted microwave background radiation (CMBR) and cosmic abundance, which became an important support for the theory of cosmic expansion. The theory of Universe expansion has been widely recognized by the scientific community.

1) The relationship between the redshifts z and the co-moving distance D is $z = \exp\left(H_o D/c\right) - 1$, where H_0 is the Hubble parameter; c is the speed of light.

2) Time dilation of supernova light curves (time dilation) [1] [2].

3) The relationship between the spectrum of CMBR and its energy density [3].

4) "The Tolman Surface Brightness Test for the Reality of the Expansion: the surface brightness of a set of standard (identical) objects will decrease by $z = (1+z)^4$. One factor of $(1 + z)$ comes from the decrease in the energy of each photon due to the redshift. The second factor comes from the decrease in the number-flux per unit time. Two additional factors of $(1 + z)$ come from the apparent increase of area due to aberration" [4].

These support the theory of Expanding Universe: the Universe expands exponentially. The redshift factor is $(1 + z)$; the volume expansion factor is $z = (1+z)^3$.

The Hubble parameter is the most important parameter in modern cosmology, which is the basis of age, size and evolution of the Universe. Measurements over the past century have shown that Hubble parameters are not constant. Riess *et al.* [5], based on observations of 70 long-period Cepheids in the Large Magellanic Cloud, give the latest value of 74.03 ± 1.42 $km \cdot s^{-1} \cdot Mpc^{-1}$ with an error margin of just 1.91%. The Hubble parameter indirectly arising from the CMBR is 67.8 $km \cdot s^{-1} \cdot Mpc^{-1}$. The two most precise gauges of the Universe's expansion rate have recently been in glaring disagreement [6] [7] [8] [9]. Freedman *et al.* [8] give a value of 69.8 ± 0.8 (±1.1% stat) ± 1.7 (±2.4% sys) $km \cdot s^{-1} \cdot Mpc^{-1}$ based on a calibration of the tip of the red giant branch (TRGB) applied to Type Ia supernovae (SNE Ia) with a sample containing about 100 well-observed SNe Ia. The Hubble constant measured by Chen *et al.* [10] based on Quasar is the largest.

The high-precision measurements of the Hubble parameter make theory of cosmic expansion more and more confusing [6] [7] [8] [9], which bolsters the idea that new physics may be needed to explain the mismatch [5] [6] [8] [9] [10].

From the measured values of these Hubble parameters above, we can find: there are systematic discrepancies in the Hubble parameter of different types of stars (types of light sources: Cepheids; CMBR; SNe Ia.; Quasar), which means that the Hubble parameter is not only related to the distance but also to the types of stars considered.

There are also many problems with the theory of expanding Universe, such as the Hubble constant (Hubble parameter) is not a constant; the dark energy is nowhere to be found.

Therefore, Hubble's law may be an approximation, the Universe expansion theory based on Hubble's law may be wrong, and the expansion of the Universe may be just an illusion. The "*new physics*" may be: the Compton scattering of free electrons creates the illusion of the Universe expansion (See **Figure 1**).

Whether the Universe really expands has been controversial, Zwicky [11] made the first alternative proposal ("Tired Light"). He proposed that the redshift is not due to the expansion of the Universe, but the effect of the intergalactic medium that causes the photon energy to decrease [12].

"Tired Light" can explain the redshift, but can't explain the above 2); 3); 4), and the redshift mechanism of the "tired light" causes the blurring of distant galaxies, which is inconsistent with reality. "Tired Light" was denied [3] [12].

Compton models are in the class of "tiled light" cosmic models. But FEC has a clear physical mechanism, will it be the same as "Tired light"? No!

Compton scattering usually refers to the interaction of high-energy photons and bound electrons, which may produce larger scattering angles, resulting in random scattering and blurred images. This leads no one to think that the redshift of cosmology is caused by Compton scattering [3] [11].

2. Methods

2.1. FEC

FEC refers to Compton scattering of free electrons and low-energy (low-frequency) photons. The characteristic spectral lines mainly exist in low-frequency band. The electron is free, not bound. The Compton Effect of low-energy photons and free electrons is very weak and neglected.

When a photon interacts with a large number of electrons, each scattering angle θ_i is very small. The random scattering angles cancel each other, it spreads approximately in a straight line along the original propagation direction. The final angle of each photon entering the observer is $\left(\sum\theta_i\right)_j$ (Subscript j marks different photons), the probability distribution of $\left(\sum\theta_i\right)_j$ is Gaussian distribution, the axis ($\mu = 0$) is the line connecting the light source and the observer. Therefore, the FEC effect will not cause the images of distant galaxies to become blurred. As the redshift z increases, the aberration also increases.

When the interaction is between relatively cold CMBR photons and hot free electrons, it is known as the thermal Sunyaev-Zel'dovich effect (Inverse Compton effect), the cold CMBR photons are blueshifted [13] [14]. When the interaction is between relatively hot photons and cold free electrons, will relatively hot photons be redshifted by cold free electrons?

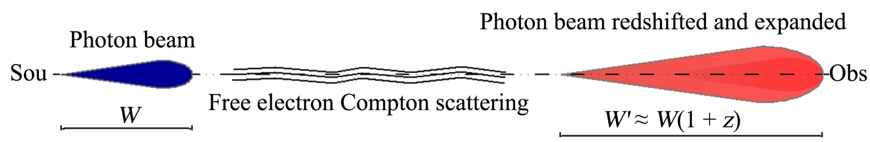

Figure 1. FEC cosmic model: Free Electron Compton scattering (FEC). FEC causes photons to redshift and the photon eam expands. Where W is the width (time) of the photon beam, FEC create the illusion that the Universe is expanding.

Nonlinear Compton scattering has been observed when several photons from a high-intensity low-frequency (low-energy photons) laser beam are scattered by a free electron to produce a photon of different energy, this process has been calculated theoretically and successfully measured [15] [16] [17] [18] [19]. These show that low-energy photons have not only wave properties but also particle properties. This means that both high-energy photons and low-energy photons interacting with free electrons will undergo Compton scattering.

(Figure 2) The interaction between free electrons and photons: the electrons are affected by the force $\boldsymbol{F}$ of electromagnetic radiation, $\boldsymbol{F} = \boldsymbol{F}_A + \boldsymbol{F}_B$, $\boldsymbol{F}_B = \boldsymbol{B} \times \boldsymbol{V}$, $\boldsymbol{V}$ can be regarded as the current or displacement current generated by the movement of electrons. When the initial velocity of electron is neglected, the electron is always affected by the electric field force $\boldsymbol{F}_E$ and moves perpendicular to the $\boldsymbol{k}$ -direction, so the electron always suffers recoil in the $\boldsymbol{k}$ -direction by $\boldsymbol{F}_B$, and Photon recoil is opposite to the $\boldsymbol{k}$ -direction. When the photon is low-energy, $\boldsymbol{F}_B \ll \boldsymbol{F}_E$, $\boldsymbol{F}_B$ is ignored, the electron recoil and the photon recoil are ignored because they are too small, the process is called Thomson scattering. Otherwise, it is called Compton scattering.

When the free electron is in the high-intensity low-frequency laser field, the frequency of the radiation field is high enough to make the electron velocity relativistic, $\boldsymbol{F}_B$ cannot be ignored, the electron recoil is obvious [15] [16] [17] [18]. So when the free electron is in the low-intensity low-frequency field, although $\boldsymbol{F}_B \ll \boldsymbol{F}_E$, and $\boldsymbol{F}_B$ can be ignored, but $\boldsymbol{F}_B$ exists, Compton scattering exists, but it is too small to be observed and is ignored, the wavelength of scattered photon is almost the same, and the energy loss of the photon can be ignored. When photons interact with a large number of free electrons, FEC effect appears: Photons are redshifted and the photon beam is expanded by FEC along the propagation direction.

Compton shift $\Delta\lambda = h/m_e c \times (1 - \cos\theta)$, where h is Planck constant, m_e is the electronic mass; c is the speed of light; θ is the scattering angle; the initial velocity of the electron is ignored, the electron is completely free. $\Delta\lambda$ and θ are independent of the wavelength of the photon, $\Delta\lambda$ is only related to θ. Compton shift

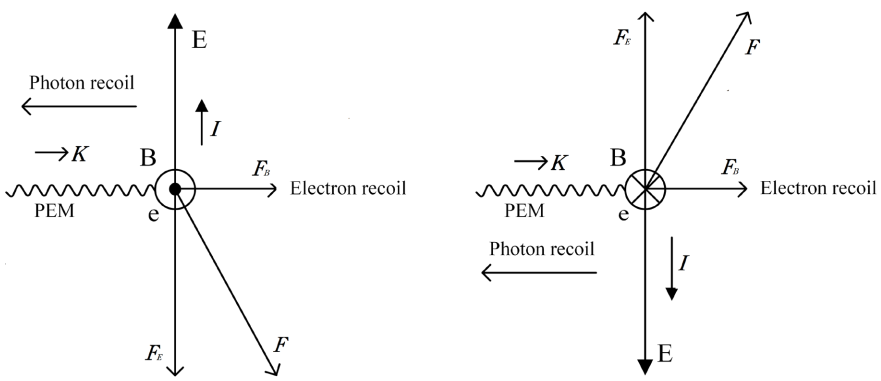

Figure 2. Photon PEM (plane electromagnetic wave) interacts with a free electron. Where E is the photon's electric field, B is the photon's magnetic field, and $\boldsymbol{k}$ -direction is the photon's propagation direction.

is inversely proportional to the mass of charged particles, so the Compton shift is mainly caused by the electrons. When a photon collides with a large number of electrons repeatedly, the photon redshifted by FEC:

$$Z_{FEC} = \sum z_i = \frac{Nh}{\lambda m_e c} \times \langle 1 - \cos\theta_i \rangle \quad (1)$$

where z_i is the FEC redshift caused by the *i*-th collision, N is the total number of collisions; $\langle 1-\cos\theta_i \rangle$ is the average of $(1-\cos\theta_i)$ Equation (1) is established under the condition that the wavelength change caused by the collision is negligible.

Since photon is plane electromagnetic wave [15] [16], the number of collisions N is proportional to the wavelength λ and optical path D and electron density n_e, $N \propto \lambda D n_e$, let: $K \propto h/m_e c \times \langle 1-\cos\theta_i \rangle$ We get:

$$Z_{FEC} = K n_e D \quad (2)$$

That is to say, cosmological redshift and Hubble parameters are not only related to distance, but also related to corresponding electron density. Where K (unit: m^2) is a coefficient,

$$K = f(n_e, T_e) \quad (3)$$

When the electron density increases, the coupling force between electrons and other charged particles increases, and the K value decreases; when the electron temperature T_e increases, the temperature of photon relative to electron decreases and K decreases. Equation (3) is still unknown.

Since θ is independent of the wavelength of the photon, so K and Z_{FEC} are independent of the wavelength of the photon as well, similarly as for the Doppler effect, it is sometimes difficult to distinguish them.

The condition for Equation (2) to be satisfied is $Z_{FEC} \ll 1$, moving to high redshifts:

$$Z_{FEC} = \exp(K n_e D/c) - 1 \quad (4)$$

Due to the existence of the scattering angle and the difference in size, the paths of different photons are different, and the beam is expanded, see **Figure 1**. Set l as the one-dimensional scale parameter of the beam. Similar to Equation (4), then:

$$\frac{\Delta l}{l} = \exp(K n_e D/c) - 1 \quad (5)$$

Therefore, the expansion factor of one-dimensional length of the beam is $(1+Z_{FEC})$; the expansion factor of two-dimensional plane is $(1+Z_{FEC})^2$; the expansion factor of three-dimensional volume is $(1+Z_{FEC})^3$.

2.2. Evidence of FEC Redshift in Flare Redshift

Flare redshift is a common phenomenon [20] [21] [22] and it is difficult to explain with the Doppler effect, which is evidence of FEC redshift. The surface temperature of the Sun is 5700 K in the quiet Sun and almost all solar atmospheric spectral lines do not show any redshift [23] [24]. The gravitational redshift of the Sun is known to be less than 1 km·s^{-1} [25]. When solar flares occur, their spectral profile has a redshift asymmetry that is difficult to explain with the Doppler effect. The redshift asymmetry rules out the Stark effect because Stark-induced shift occurs in dense plasma (plasma with electron concentration about and above 10^{16} cm^{-3} [26]). The electron density of solar flares is generally in the range of 10^{12} - 10^{14} cm^{-3} [27] [28]. When solar flares occur, the temperature of the solar atmosphere increases and ionization increases. A typical characteristic is that the spectral profile of the solar flare is significantly broadened and simultaneously redshifted. In flare AR 12205 [20], there is a clear evidence of the relationship between the spectral broadening, the redshift, and FEC redshift. It excludes the Doppler Effect.

In flare AR 12205 [20], the formation temperature of Si IV 1403 Å, C II 1335 Å, Mg II h 2803 Å, H α 6563, CA II K 3934 Å, CA II 8542 Å in log T [k] is 4.8, 4.3, 4.0, 4.0, 4.0 and 4.0, from the highest to the lowest. The distance between the spectral line forming region and the core of the flare increases and the influence of the flare decreases. These are consistent with the spectral line width [20].

The flare energy comes from the interior of the photosphere: 1) The flare erupts in the lower part of the chromosphere; 2) The fermi 29 - 31, 50 - 102 keV erupts earlier than 17 GHz (fast radio burst) for about 10 s at the highest point [20], which indicates that the energy comes from fermi 29 - 31, 50 - 102 keV. If the energy comes from the external high-energy electron beam, the electron beam will inevitably collide with the chromosphere particles during transportation to produce bremsstrahlung and heat the surrounding material, the 17 GHz and 1 - 8 Å signals are earlier than for fermi 29 - 31, 50 - 102 keV and the trajectory of the electron beam should be observed before the flare eruption, but the electron trajectory has not been obtained [20].

The radiation at 1 - 8 Å is caused by the free thermal electrons [20]. When the first burst of feimi 29 - 31 keV (T = 150 - 200 s) occurred, there were no significant corresponding bursts at 1 - 8 Å, due to the lack of free electrons in the chromosphere at the beginning of the flare. The radiation at 1 - 8 Å gradually increases when the thermal expansion, the number of free electrons, and the temperature of the electrons increase. When the second burst of fermi 29 - 31 keV (T = 240 - 360 s) occurred, 1 - 8 Å followed fermi 29 - 31 keV, the spectrum lines Si IV 1403 Å, C II 1335 Å, Mg II h 2803 Å, Hα 6563 Å began to broaden and redshift at the same time (See the Figure 7 in the reference [20]). The onset and the duration of the apparent broadening and redshift of these lines are consistent with the 1 - 8 Å radiation. This indicates that: 1) The apparent broadening and the redshift of these lines fully correlates with the increase number of free electrons. 2) The apparent broadening and redshift of these spectral lines is not caused by the Doppler Effect from particle motion, but by FEC because the change in particle velocity caused by the thermal expansion takes time and the radiant ionization makes the free electrons increase immediately.

A possible explanation for the red asymmetry is proposed. After the flare occurs, the thermal expansion (the Balmer and Ca II H lines showed blue asymmetry Doppler effect [20]), and the number of free electrons gradually increases. The FEC effect also gradually increases, and the spectral linewidth gradually broadens [20] [21]. When the FEC effect is larger than the Doppler effect, the blue asymmetry changes to a red asymmetry. The redshift occurs at the position where the intensity is highest and tracks the outer edge of the ribbon, which visually illustrates this phenomenon [21]. Similar phenomena include the high redshift of gamma-ray bursts [29] [30].

The FEC redshift and the Doppler effects were used to simulate the spectral line velocity in flare AR 12205. The electron density of the flare was in the range of 10^{12} - 10^{14} cm^{-3}, $\log T_e[k] = 4\text{ - }4.5$ [27] [28], the value of K was roughly estimated around 2×10^{-28} m^2.

3. Results

FEC causes photon redshift and photon beam expansion:

1) FEC will not blur the imaging of distant galaxies.

2) The FEC redshift is not only related to the distance but also to the corresponding electron density, this can explain why the Hubble parameter is not a constant.

3) From Equations (4); (5), the exponentially "expanding" Universe can be obtained.

If CMBR was not formed by the Big Bang, how was CMBR formed? CMBR is almost perfect 2.725 K blackbody radiation [31]. The Big bang theory successfully predicts CMBR and the relationship [32] [33] of the local CMBR temperature T_0 and the CMBR temperature T_z (where the redshift is Z), $T_z = T_0(1+z)$.

The assumption of this paper is: The local CMBR (T_0) is mainly created by distant large-scale interstellar medium (Mainly Interstellar neutral atoms, molecules, dust) radiation (T_z), due to the FEC effect, the photon density of CMBR (T_z) is diluted by $(1+z)^3$ times and the temperature T_z is reduced by $(1+z)$ times. The temperature T_z of the interstellar medium is about 10 - 100 K. The interstellar medium in the Universe is almost uniform and isothermal, and local is transparent, when the distance is greater than $z = 4.7$, the interstellar medium gradually formed a fog and progressively made the Universe opaque, forming a blackbody with a temperature of T_z. In this way, CMBR comes from the distant Universe [3] ($z > 4.7$).

Most of the energy of starlight is absorbed by the intergalactic and the interstellar medium, and a small part of it becomes microwave background radiation. The intergalactic medium and the interstellar medium absorb the radiation energy and emission radiation. CMBR is formed indirectly by starlight, which is diluted and redshifted by the FEC effect.

It can be derived from the FEC cosmic model that the emissivity of CMBR is greater than 1. The emissivity of the Universe expansion theory will be less than

1 due to space expansion. The best fit emissivity is 1.09 [34]. The number of faint radio sources of the FEC model will increase, and of cosmic expansion mode will decrease and dilute. The number of faint radiation sources can distinguish FEC model and the Universe mode. For more details, see: Edward L. Wright's "Errors in the Steady State and Quasi-SS Models".

4. Discussion

The FEC redshift depends on the free electron fraction, is it constant in the Universe? On a large scale, CMB has a perfect blackbody radiation and an almost perfect isotropy [35], indicating that the intergalactic medium has an almost uniform temperature and that the density of intergalactic electrons is almost uniform and isotropy as well. Dispersion measurements (DM) of fast radio bursts (FRB) also indicate that the density of intergalactic electrons is almost uniform on a large scale, and may be related to the redshift [36] [37] [38]. If the Hubble parameter not only depend on the distance fraction but free electron fraction then FEC redshift can perfectly explain why the Hubble parameter is isotropy but not perfect isotropy. Stars, red giants, Cepheid variable stars, supernovas, and quasars have a different atmospheric electron density, which leads to deviations in the Hubble parameter for different samples. A higher star mass results in a higher temperature and a larger the redshift. This is why the Hubble parameter measured based on CMB and the red giants and Cepheid variable stars are different. This is also why quasars are abnormally redshifted [39] [40] and why the Hubble parameter measured over a century is not "constant".

Because Equation (3) is unknown, hypothesis: the K of the intergalactic electrons is the same as the K of the flare electrons, $K = 2\times10^{-28}\ \text{m}^2$, the average electron density $\overline{n}_e(H_0)$ (obtained by this theory that produces H_0 67.8 km·s^{-1}·Mpc^{-1}) is around 4×10^{-5} cm^{-3}. The interstellar electron density is within 1 - 10^{-3} cm^{-3} [36] [37] [38], therefore the average intergalactic electron density $\overline{n}_{IGe}(H_0)$ is less than 4×10^{-5} cm^{-3}. This value is much greater than the present value of the critical density, but if the Universe is infinite, then the critical density is meaningless. The intergalactic electron density $n_{IGe}(DM)$ obtained from the DM of fast radio bursts is about 10^{-7} cm^{-3} [36] [37] [38]. The reason for the radiation broadening of DM is that the scattering is caused by a thin slab of fluctuating electron density [36] [41], therefore the value of 10^{-7} cm^{-3} is not the true intergalactic electron density, is greater than 10^{-7} cm^{-3}. So $\overline{n}_{IGe}(H_0) < 4\times10^{-5}\ \text{cm}^{-3}$ is also reasonable.

5. Conclusion

The Compton Effect of free electron and low-energy photons has been observed in the laboratory. As long as there is a reasonable density of free electrons in the Universe, the FEC effect will exist. FEC redshift and FEC cosmic model may work. The FEC cosmic model is straightforward.

What is the truth about the "expanding" universe: Is space expanding? Or is the beam expansion photon redshift caused by FEC? Or other gravity theories [42]? All of these are worth discussing in the future.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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