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ELEMENTARY PHOTON: REVIEWING THE ALTERNATIVE TO UNDERSTAND THE HUBBLE CONSTANT, THE UNIVERSAL GRAVITY, THE TULLY-FISHER RELATION AND THE COSMIC BACKGROUND MICROWAVE RADIATION

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ABSTRACT

This review paper touches several points. A lightly damped oscillator model is applied to the propagation of photons in the free space from a mechanical perspective. It is elicited that the Hubble constant is an extremely low frequency with its origin from the time constant, the ratio between the equivalent inertial mass of the travelling photon particle and the weak resistance of the free space. The exponential correlation between the Cosmic Redshift and the Hubble constant is derived. The energy dissipated by a photon during one cycle is elicited as the product of the Planck constant and the Hubble constant. The tiny fragment of the energy dissipated per photon in each cycle is defined as an Elementary photon. An Elementary photon turns out to be a fundamental unit of energy and mass in dynamic circulation. Through the analysing of the extremely weak interactions between photons, immersed particles, and the vast ocean of Elementary photons, an Elementary photon theory is developed quantitatively. The correlation between the Gravitational constant and the Hubble constant is deduced. A generalised Law of the Universal Gravity, the Modified Newtonian Dynamics, and the Tully-Fisher relation are derived theoretically. The dynamic circulation of energy and mass of the Universe is revealed. The temperature and the spectrum of the Cosmic Microwave Background Radiation are determined quantitatively and explained theoretically. The capability of a photon particle travelling at the constant speed of light in the vast free space with an extremely weak friction force is verified. Further supporting evidences to support the Elementary photon theory are provided. It is predicted that either with the James-Webb Space Telescope or with more advanced space telescopes in the future, complex and mature galaxies will always be observed, no matter how close to the starting point of the assumed Big Bang or even beyond.

Keywords: Tully-Fisher law, elementary photon, universal gravitation, dynamic equilibrium and circulation, modified Newtonian dynamics, telescope.

INTRODUCTION

In 1929, Hubble obtained a linear distance-redshift relation based on astronomical observations. He then derived the celebrated Hubble's law – a distance-velocity relation by using the Doppler effect to interpret the redshift (Hubble, 1929). Hubble's law correlates the recessional velocity of a galaxy predicted based on the Doppler effect with the distance between the galaxy and the Earth, which is a hypothesis that has good agreement with one of the predictions of de Sitter's cosmology and thus has been widely accepted. About half a year later, Zwicky (1929) proposed a Tired Light (TL) hypothesis to explain the distance-redshift relation, who suggested that photons might slowly lose energy (E) as they travelling the vast space through a relatively static universe by interaction with matter or other photons, or by some novel physical mechanism. Since a decline of energy corresponds to an increase in the wavelength $\lambda = hc/E$, where h is the Planck constant and c is the constant speed of light in the vast free space, this effect would produce a redshift in spectral lines that increase proportionally with the distance of the light source just as Hubble obtained. These two explanations of the distance-redshift relation are mathematically equivalent, but entirely different in physics. Zwicky acknowledged that any sort of scattering of light would blur the images of distant objects. Zwicky's TL hypothesis has not been accepted by most cosmologists and astronomers up to today because the vague nature of the original hypothesis and the problem of blurring images. On the other hand, the Expanding Space (ES) model, which was derived theoretically from Einstein's General relativity and supported by Hubble's law that has been taken as a concrete proof of the recession of the distant stars and galaxies, became the mainstream cosmological model. However, a variety of problems related to the ES model and later the Big Bang cosmology have been gradually realized by cosmologists and astronomers initiated from Hubble himself (Hubble, 1937; Burbidge, 1971; LaViolette, 1986; Assis, 1992). Many observational evidences made Hubble highly

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sceptical with an Expanding Space. The observational evidences were better accounted for by an infinite and relatively static universe. The evidences Hubble found were (LaViolette, 1986; Assis, 1992):

i. The huge and unrealistic values for the "recession" velocities of the distant stars and galaxies with the redshifts interpreted as velocity-shifts.
ii. The "number effect" test that is the running of nebulae luminosity with redshift. Hubble found that a relatively static universe is, within the observational uncertainties, slightly favoured. The "number effect" test is equivalent to the modern "Tolman effect", for galaxy surface brightness, whose results are still a matter of dispute.
iii. The smallness of the size and the age of the expanding universe implied by the expansion rate.
iiii. The fact that a uniform distribution of galaxies on large scales is more easily obtained from galaxy counts, when a relatively static and flat model of the Universe is considered.

These points, which made Hubble highly sceptical, are still not well resolved by the ES model and the Big Bang cosmology up to today. Hubble remained against the ES model and the Big Bang cautiously until the end of his life. In order to account for redshifts in a relatively static universe, Hubble called for a new principle of nature, like the kind of TL mechanism. On the other hand, he was aware of the theoretical difficulties of such a radical assumption that was in conflicted with Einstein's General Relativity. Einstein's General Relativity is a kind of beautiful and abstractive mathematical description of the Universe under some ideal approximations. Although the differential geometry used in General Relativity is technically useful and predictive, it has limitations. General Relativity spring out of Maxwell's equations. Hence, the ideal approximation of frictionless free space is inherited, it also does not include the self-rotational effect. Friction, together with the dissipation and the absorption of energies of celestial movements are not handled by the abstractive theory of General Relativity. LaViolette (1986) compared the performance of the TL and the ES models on four cosmological tests: the angular size-redshift test, the Hubble diagram test, the galaxy number-count-magnitude test, and the number-count-flux density test ($\log(dN/dS) - \log(S)$). It was determined that on all four tests, the TL exhibited superior performance. That is, it makes the best fit to the observed data with the fewest number of assumptions. LaViolette also did a brief review of the mechanisms of continuous matter creation that did not require creation to take place all at once in a singular primordial explosion. Burbidge (1971) pointed out that there was no direct evidence that the helium abundance in the universe might be related to the occurrence of a Big Bang, and there were a number of alternative ways of understanding the large helium abundance found in some stars and galaxies. For instance, it appeared that helium could have been synthesized in massive objects evolving in the nuclear regions of galaxies. Burbridge (1971) concluded that the evidence in favour of a Big Bang cosmology was much less definite than was widely realized and he called for a much more open-minded approach with original thinking.

Although Gravitational Redshift contributes only a small percentage to the total Cosmic Redshift, it has been theoretically and experimentally verified precisely (Brault, 1963; Pound and Rebka, 1960; Pound and Snider, 1965; Puthoff, 2002). Gravitational Redshift and blueshift manifest the two-way energy exchange of γ photon particles with the gravitational field through interactions. It is also theoretically verified that a moving particle in vacuum experience a force resembling friction through interacting with the electromagnetic field in it (Kardar and Golestanian, 1999; Manjavacas and García de Abajo, 2010; Sonnleitner *et al.*, 2017). Furthermore, this frictional force can cause a change in momentum due to a change in internal energy and inertial mass while the velocity remains constant (Sonnleitner *et al*., 2017). Photon particles with equivalent inertial masses propagate at constant velocities (c and v) in the free space and other transparent media. Therefore, it can be postulated that photon particles shall experience a force resembling friction in the vast free space and other transparent media through extremely weak interactions. The friction force in the vast free space is extremely weak and it is generally negligible. However, it is not negligible on a cosmological scale (Broberg, 1981, 1993; Zhang, 2021a, 2021b, 2021c, 2021d). Hence, from a mechanical perspective, a lightly damped oscillator model (MIT. 2013. http://web.mit.edu/8.01t/www/materials/modules/chapter23.pdf; Garret, 2017) is proposed to elucidate the properties and propagations of photons in the vast free space and other transparent media (Zhang, 2021a, 2021b, 2021c, 2021d). Based on the analysis of the lightly damped oscillator model for photon particles travelling in the vast free space, an alternative for the understanding of the physical origin of the Cosmic Redshift and the Hubble constant are elucidated. It is elicited that the Hubble constant is an extremely low frequency with its origin from the time constant, the ratio between the equivalent inertial mass of the travelling photon particle and the weak resistance of the vast free space. The empirical exponential correlation between the Cosmic Redshift and the Hubble constant is derived theoretically. The energy dissipated by a photon over one cycle is elicited as the product of the Planck constant and the Hubble constant, which is defined as an Elementary photon (Super-photon). The Elementary photons and normal photons in gigantic number in the Universe create the weakly interacting free space, a vast ocean of photons. Through the analysing of the weak interactions between Elementary photons, normal photons, immersed particles and the ocean of

Elementary photons, an Elementary photon theory is developed quantitatively. The correlation between the Universal Gravitational constant and the Hubble constant is deduced. The dynamic circulation and dynamic equilibrium of energy and mass in the Universe are uncovered. A Generalised Law of Universal Gravity is derived. Afterwards, the approximated Virial relation within the Solar system, the Tully-Fisher relation and the Modified Newtonian Dynamics relation and acceleration in Galaxies are quantitatively derived. The capability of a photon travelling at the constant speed of light in the vast free space with a weak friction force is theoretically verified and explained. The temperature and the spectrum of the Cosmic Microwave Background Radiation are calculated accurately and explained theoretically using the Elementary photon theory together with the fluctuation-dissipation theorem. Further supporting evidences to support the Elementary photon theory are provided. It is predicted that either with the James-Webb Space Telescope or with even more advanced space telescopes in the future, complex and mature galaxies will always be observed, no matter how close to the starting point of the assumed Big Bang or even beyond. A direction of designed experiments is proposed for the further proof of the Elementary photon theory.

Lightly Damped Oscillator model, the Cosmic Redshift, and the Hubble constant

The friction force of the vast free space is extremely weak but not negligible on a cosmological scale. Consequently, it is important to add a dissipative element to the harmonic oscillator model of a photon particle from a mechanical perspective. This will enable a tiny portion of the energy to be dissipated, thereby reducing the energy of the oscillation of the photon particle, then the inertial mass–spring–damper system can come to a dynamic equilibrium with its surrounding space. With the adding of the dissipative element to the simple harmonic oscillator, a two-way street for the energy exchange opened (MIT. 2013. http://web.mit.edu/8.01t/www/materials/modules/chapter23.pdf; Garret, 2017). This is a path for energy to leave the oscillator. This path also allows energy to be fed back to the oscillator from its surrounding. A dynamic equilibrium shall be achieved with an equal and nonzero absolute (Kelvin) temperature for the vast free space containing the weakly interacting ocean of photons and the immersed travelling particles. This nonzero temperature of dynamic equilibrium at a cosmological scale shall be the origin of the temperature of the Cosmic Background Microwave Radiation (CBMR), which had been predicted through several methods well before the Big Bang hypothesis (Assis and Neves, 1995). The detailed explanation and quantitative derivation of the CBMR temperature and spectrum based on the Elementary photon theory and the fluctuation-dissipation theorem will be presented later. Let us first start from the most common and useful dissipative element, which is the viscous damper shown in Figure 1 as a dashpot.

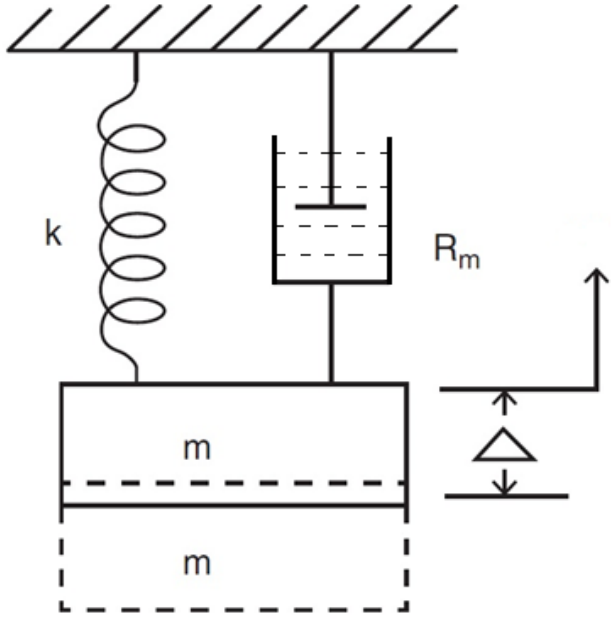

Fig. 1. The dashpot representing the viscous resistance, R_m, added to the simple harmonic oscillating mass (m) - spring (k) system.

A dashpot is typically consisting of a cylinder filled with a viscous fluid in which the motion of a movable vane is resisted by viscous drag. The friction force F_{vis} is

$$F_{vis} = -R_m v \tag{1}$$

where R_m is the viscous resistance coefficient, $v = \dot{x}$ is the velocity of the inertial mass of the particle. The equation of motion for a viscously damped harmonic oscillator is

$$\ddot{x} + \frac{R_m}{m}\dot{x} + {\omega_0}^2 x = 0 \tag{2}$$

where $\ddot{x}$ is the acceleration, $\omega_0 = (k/m)^{1/2}$ is the natural angular frequency of the un-dampened harmonic oscillator, m is the inertial mass of the oscillating particle. When $(R_m/2m)^2 << \omega_0^2$, it is called a lightly dampened oscillator. The propagation of a photon particle in the vast free space can be treated as a lightly dampened oscillator in cycloid motion at constant velocity from a mechanical perspective. The solution of equation (2) for a lightly dampened oscillator is

$$x(t) = A\, e^{-\frac{t}{\tau}} \cos(\omega t + \varphi) \tag{3}$$

The choice of $\tau = 2m/R_m$ makes a sense because τ has the unit of time as required for dimensional homogeneity. It may be specifically explained that a photon particle with a larger equivalent inertial mass will have a larger effective interacting cross-section area, thus having a higher viscous resistance coefficient. Consequently, the ratio of the inertial mass versus the viscous resistance coefficient of the free space shall be a constant for photon particles as the vast free space could be viewed as an approximately homogeneous transparent medium. The damping force is extremely weak, hence, the resonant frequency ω is approximately equal to the natural frequency ω_0. Therefore, the energy dissipated by the viscous force over a cycle (a period time of $T << \tau$) from the n^{th} cycle of the photon (Zhang, 2021a, 2021b, 2021c, 2021d) shall be

$$\begin{aligned}\Delta E_T &= -\left(k + \frac{m}{\tau^2}\right)\frac{A^2}{2}\left(1 - e^{-\frac{2T}{\tau}}\right) \approx -\left(\frac{k}{m} + \frac{1}{\tau^2}\right)\frac{m\,A^2\,T}{\tau} \\ &\approx -2\pi m A^2 \omega f_\tau \left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right] = -h f_\tau \left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right]\end{aligned} \tag{4}$$

$$f_\tau = \frac{1}{\tau} = \frac{R_m}{2m} \ll \omega_0 \tag{5}$$

where ω and A are subsequently the angular frequency and the amplitude of the oscillating of the photon particle at the n^{th} cycle, $k/m = \omega^2$, $\omega = 2\pi/T$. And $h = 2\pi m A^2 \omega$ (Zhang, 2021c) that is the Planck constant for photons. A period time of one cycle (T) is relatively a short time, hence,

$$\frac{dE}{dt} \approx \frac{\Delta E_T}{T} \approx -hf f_\tau \left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right] = -E f_\tau \left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right] \tag{6}$$

Both sides of equation (6) divided by E and multiplied by dt lead to

$$\frac{dE}{E} \approx -f_\tau \left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right] dt \tag{7}$$

Integrating both the sides of equation (7), it is derived theoretically that

$$E \approx E_0\, e^{-f_\tau\left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right]t} \tag{8}$$

where t is the time taken by the photon travelling the distance from the emission point to the observation point, it is a variable parameter. As $f_\tau << \omega$ for a lightly damped oscillator, equation (8) can be further approximated to

$$E \approx E_0\, e^{-f_\tau t} \tag{9}$$

The cosmic redshift is defined (Hubble, 1929, 1937; Zwicky, 1929; LaViolette, 1986; Assis, 1992) as

$$z = \frac{\lambda_{ob} - \lambda_{em}}{\lambda_{em}} = \frac{\lambda_{ob}}{\lambda_{em}} - 1 = \frac{E_{em}}{E_{ob}} - 1 \approx H\,\frac{D}{c} \tag{10}$$

where D is the Euclidean space distance from the emission point to the observation point of the photons. c is the speed of the photons in the free space. H is the Hubble constant. λ_{ob} and λ_{em} are subsequently the wavelengths of the stream of photons at observation point and at emission point. E_{ob} and E_{em} are subsequently the energies of the stream of photons at observation point and at emission point. E_{ob} in equation (10) is equivalent to E in equations (8) and (9), and E_{em} in equation (10) is equivalent to E_0 in equations (8) and (9). By the combination of equations (8), (9), and (10), it is derived that

$$z = e^{f_\tau\left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right]t} - 1 \approx e^{f_\tau t} - 1 \tag{11}$$

For $f_\tau t << 1$ as the time $t << \tau = 1/f_\tau$ (τ is approximately 10^{10} years for photons as revealed at the end of this section) equation (11) can be further approximated to

$$z \approx f_\tau\, t \approx f_\tau\,\frac{D}{c} \tag{12}$$

Comparing equation (10) with equation (12) leads to

$$H \approx f_\tau = \frac{R_m}{2m} \tag{13}$$

Taking into account equations (10) and (11), more precisely, H has a weak dependence on the frequency and wavelength of the photons, namely:

$$H = f_\tau \left[1 + \left(\frac{f_\tau}{\omega}\right)^2\right] = f_\tau \left[1 + \left(\frac{f_\tau \lambda}{2\pi C}\right)^2\right] \approx f_\tau \tag{14}$$

The frequency and wavelength dependence terms in equation (14) are extremely weak because $f_\tau \approx H << \omega$. The extremely weak dependence has been observed experimentally (Espey *et al.*, 1989; Kriss *et al.*, 1995; Nishihara *et al.*, 1997) and it is derived theoretically here. This wavelength dependence cannot be explained by ES model; hence, this dependence is a strong observation evidence against the ES model (Shao, 2013). Combining equations from (10) to (14), an accurate and widely applicable relationship of z and H is theoretically derived as follows:

$$z = \frac{E_{em}}{E_{ob}} - 1 = e^{\frac{H}{c}D} - 1 = \exp\left(\frac{H}{c}D\right) - 1 \tag{15}$$

Both the TL and the ES models have proposed similar exponential correlation between the cosmic redshift z (or expanding recessional velocity ratio $z = v/c$) and the Hubble constant H (Hubble, 1929, 1937; Zwicky,1929; LaViolette, 1986; Assis, 1992; Riess *et al.*, 1996; Perlmutter *et al.*, 1998; Shao, 2013; Traunmüller, 2014; Marosi, 2019) and (Marmet, L. 2018. On the Interpretation of Spectral Red-Shift in Astrophysics: A Survey of Red-Shift Mechanisms – II. https://arxiv.org/pdf/1801.07582), either from the best fit of observational data or from theoretical derivations based on ad hoc assumptions. The exponential relationship with clearly defined physical meaning for every parameter is derived here upon the analysing of a simple physical model from a mechanical perspective. A reliable cosmological model should be able to derive the exponential relationship between the cosmic redshift z and the Hubble constant H without ad hoc assumptions. The theoretically derived exponential relationship here without ad hoc assumptions is strong supportive evidence for the suitability of the lightly damped harmonic oscillator model applying to photon particles travelling through the vast free space on a cosmological scale. The Elementary photon theory proposed here based on the lightly and viscously damped harmonic oscillator model is a kind of advanced TL theory. This mechanism is crystal clear and it will not lead to the dilemma of the blurring images of distant stars, because a photon particle keeps its identity and direction while travelling through the vast free space with approximately homogeneous and extremely low viscosity on a cosmological scale. The conservation of angular momentum is fundamentally associated with rotational symmetry and can be calculated using Noether's theorem. The photons with different energies have the same angular momentum. A mechanism to explain the conservation of velocity, momentum, angular momentum and energy of a photon during photon-photon interactions and how a photon could keep its direction after releasing a tiny segment of energy through interacting with other photons in the vast free space was treated by Broberg (1981).

Interestingly, the exponential relationship has been explained by the ES hypothesis and the Big Bang cosmology as supportive evidence of accelerating expansion of the free space far away from us at speeds that are astonishingly faster, even faster than the speed of light in a vacuum, which leads to the mysterious accelerated escape of the distant galaxies from us. Physics is built upon model, the aim is the finding of the best possible model, which is the simplest and most precise for understanding realities and predicting something testable. Inverting equation (15), the Euclidean space distance D estimated based on the measured value of z can be calculated as follows:

$$D = \frac{c}{H}\ln(1+z) \tag{16}$$

In a nonexpanding Euclidean universe, the angular size δ of an object is $\delta = 2\arctan(d/2D)$ (LaViolette, 1986; Assis, 1992; Traunmüller, 2014; Marosi, 2014, 2019) and (Marmet, 2018. On the Interpretation of Spectral Red-Shift in Astrophysics: A Survey of Red-Shift Mechanisms – II. https://arxiv.org/pdf/1801.07582), where d is a diameter (e.g. major or minor axis of a galaxy) and D is the Euclidean space distance to the object. In a small-angle approximation, we have

$$\delta \approx \frac{d}{D} \tag{17}$$

In the TL theories, equation (17) holds in close approximation for galaxies and galaxy clusters. However, the ES and Big Bang model predict an angular size as follows:

$$\delta \approx (1+z)\frac{d}{D} \tag{18}$$

The observed data are more compatible with the TL theories in a nonexpanding Euclidean universe (LaViolette, 1986; Assis, 1992; Traunmüller, 2014; Marosi, 2019) and (Marmet, 2018. On the Interpretation of Spectral Red-Shift in Astrophysics: A Survey of Red-Shift Mechanisms – II. https://arxiv.org/pdf/1801.07582). From 2017 to 2020, the measured values of the Hubble constant (Abbott *et al.*, 2017; Riess *et al.*, 2018; Marosi, 2019; Reid *et al.*, 2019; Pesce *et al.*, 2020; Shajib *et al.*, 2020; Wong *et al.*, 2020) varied from 67.6 to 74.2 [km × s^{-1} × Mpc^{-1}]. This article will focus on the Hubble constant originated from the weak viscous resistance of

the vast free space on a cosmological scale on average for photons. Hence, an averaged value approximately 70.8 [km × s^{-1} × Mpc^{-1}] is initially taken to be representative to the average behaviour of the vast free space. Converting this value into SI units, it is approximately 2.29×10^{-18} [s^{-1}], as $H \approx f_\tau$, hence, we have $\tau = 1/f_\tau \approx 1.38 \times 10^{10}$ years. Apart from stars, planets, neutrinos, cosmic rays and photons, there are all sorts of matters and voids in space, for example, intergalactic matters and interstellar matters containing electrons, protons, atoms and molecules that are mostly transparent to photons (Mo *et al.*, 2010). Photon-matter interactions affect the measured *z* values thus causing data scatter, which make the calculated *H* values based on the measured *z* values' scatter because the energy dissipation thus the wavelength increase of the photons depends on the contents of substances along the path where the lights travel through. The relative movement velocities between the emitter and the observer shall contributes a small amount to the cyclic variation of the calculated *H* values based on the measured *z* values. The oscillating fluctuation of the dynamic equilibrium state of the vast free space shall have impacts at small amplitudes as well. The main reason behind this initial value of the chosen average value of 70.8 [km × s^{-1} × Mpc^{-1}] is that $H \approx f_\tau = Rm/2m$, it is theoretically a good starting point by first considering the average behaviour of the vast free space on a cosmological scale, which shall be approximately isotropic and homogeneous with fluctuations at small amplitudes.

Photon and photon interactions

It has been revealed that the Hubble constant is an extremely low frequency with its physical origin from the time constant, the ratio between the viscous resistance of the vast free space and the equivalent inertial mass of a photon particle travelling through. As mentioned in last section, this article focuses on the vast free space on a cosmological scale, which is full of gravitational and electro-magnetic fields, cosmic rays and neutrinos. The product of the Hubble constant *H* and the Planck constant *h* are linked with the tiny portion of the internal energy and its equivalent inertial mass dissipation of a photon particle into the free space per cycle, which can be elicited from equations (4), (9), and (14). Incorporating *H* from equation (14) into equations (4) and (9) leads to

$$\Delta E_T \approx -hH \approx -1.517 \times 10^{-51} [J] \tag{19}$$

$$E \approx E_0 \, e^{-Ht} \tag{20}$$

In equations (4) and (19), ΔE_T represents the energy dissipated into the free space by one photon over one cycle, which is an extremely small portion of energy. With such extremely low energy and frequency, we may name it an Elementary photon to distinguish it from normal photons. For an Elementary photon, applying $\lambda_s = c/f_s$, taking into account $f_s \approx H$ and equations (14) and (19), it can be derived that the wavelength of an Elementary photon is $\lambda_s \approx 1.31 \times 10^{26}$ [m], which is approximately the dimension of the observable Universe. A normal photon particle may be perceived as a packet of a number (*N*) of Elementary photon particles in a dynamic local agglomeration, the energy of an Elementary photon particle ($E_s = \Delta E_T$) may be assigned as the basic energy unit. Therefore, the energy of a normal photon (*E*) equals to

$$E = N \, E_s \tag{21}$$

The relationships between a normal photon (Broberg, 1981; Zhang, 2021a, 2021b, 2021d) and an Elementary photon can be expressed as

$$f = NH, \lambda = \frac{\lambda_s}{N}, m = \frac{h}{c \, \lambda} = N \frac{h}{c \, \lambda_s} = N m_s \tag{22}$$

where *f*, λ, and *m* are subsequently the frequency, wavelength, and equivalent inertial mass of a normal photon. *H*, λ_s, and m_s are subsequently the frequency, wavelength, and equivalent inertial mass of an Elementary photon. There are an enormous number of normal photons in the Universe. Every normal photon oscillates an enormous number of cycles and releases an Elementary photon per cycle. Hence, the total number of Elementary photons in the Universe must be gigantically vast. There is an unnoticeable and vast ocean of Elementary photons in the Universe. The ocean of Elementary photons with internal energy and equivalent inertial mass might be linked with the so-called dark matter, dark energy or weakly interacting massive particles, but they are naturally ordinary matter and energy with intrinsic properties similar with normal photons. The ocean of Elementary photons forms a weakly interactive thermal bath spreading over the observable Universe. Experiments based on the Bell inequalities, have verified the quantum entanglement of photons over long distances in space (Ren *et al.*, 2017). The mystery of long-distance quantum entanglement may be explained based on that normal photons are dynamic packets of Elementary photons. Two entangled photons emitted from a single source are connected together by a number of coupled Elementary photon pairs, therefore, even after they are separated long distance from each other, they are still connected together as a pair through their coupled Elementary photon pairs with extremely long wavelength. Broberg (1981) proposed the theory of elementary quanta with outstanding thoughts based on ad hoc hypothesises. It is a challenging to build a new theory upon ad hoc hypothesises which are not fully comprehensive, like a pioneer exploring an unknown

field, who can only quest in the darkness. By combining some of his brilliant concepts for example elementary quanta, the interacting strength and effective cross-section area of a photon particle, with the Elementary photon theory, which is based on a simple, reliable and clear physical model, a quantitative Elementary photon theory is developed. And from the Elementary photon theory, several new concepts are proposed. Thereafter, the origin of the Universal Gravity and the dynamic circulation and equilibrium of energy and mass are elucidated. A Generalised Law of the Universal Gravity is derived, the Virial relation, the Tully-Fisher relation, the Modified Newtonian Dynamics equation and acceleration are elicited quantitatively. The temperature and the spectrum of the CMBR are determined theoretically. Let us first focus on the interactions between photons and Elementary photons.

We firstly introduce the interacting strength between a normal photon (having energy = NE_s) and an Elementary photon (having energy E_s) as an effective cross-section area $\sigma_p = N\sigma_s$, here σ_s is the interacting strength thus effective cross-section area between two Elementary photons. We further define the average numerical density of the Elementary photons in a unit of space as ρ_n. During the time interval Δt, the normal photon we are investigating will sweep through an effective volume of space as $\sigma_p c\Delta t = N\sigma_s c\Delta t$, where c is the speed of light in the free space. Therefore, the normal photon will meet a number ($\rho_n N\sigma_s c\Delta t$) of Elementary photons during the time interval Δt. A number of $\rho_n N\sigma_s c\Delta t$ Elementary photons interact with the normal photon during the time interval Δt. Hence, the normal photon exchanging energy with the ocean of Elementary photons during the Δt is

$$\Delta N = -\rho_n N\sigma_S\, c\, \Delta t \tag{23}$$

The negative sign means releasing energy to the ocean of Elementary photons. Both sides of equation (23) can be divided by N, then we can get

$$\frac{dN}{N} \approx \frac{\Delta N}{N} = -\rho_n \sigma_S\, c\, \Delta t \approx -\rho_n \sigma_S\, c\, dt \tag{24}$$

Integrating both sides of equation (24), it is derived that

$$N_t = N_0\, e^{-\rho_n \sigma_S\, c\, t} \tag{25}$$

where N_t is the number of Elementary photons remaining in the dynamic packet of the normal photon at time t, N_0 is the number of Elementary photons in the dynamic packet of the normal photon at time $t = 0$. Multiply both sides of equation (25) by Es and using equation (21) leads to

$$E = E_0\, e^{-\rho_n \sigma_S\, c\, t} \tag{26}$$

Comparing equation (26) with equation (20), we have

$$H = \rho_n \sigma_S\, c \tag{27}$$

Hence, the interacting strength and the effective cross-section area between a normal photon and an Elementary photon is

$$\sigma_p = N\sigma_s = \frac{N\,H}{\rho_n\, c} \tag{28}$$

It is now possible to define the average mass density of the ocean of Elementary photons as ρ_0. Taking into account the number density of Elementary photons ρ_n and the equivalent inertial mass of the Elementary photon m_s leads to

$$\rho_0 = m_s \rho_n = \frac{h}{c\,\lambda_s}\rho_n \rightarrow \rho_n = \frac{\rho_0\, c\, \lambda_s}{h} \tag{29}$$

Inserting ρ_n from the formula above into equation (28) and using equation (22), we have

$$\sigma_p = \frac{h\,H}{\rho_0\, c^2 \lambda_s / N} = \frac{h\,H}{\rho_0\, c^2 \lambda} = \frac{m\,H}{\rho_0\, c} \tag{30}$$

While $\lambda \rightarrow \lambda_s$, $m \rightarrow m_s$, and $\sigma_p \rightarrow \sigma_s$, hence, equation (30) is applicable to both normal photons and Elementary photons. It is interesting to calculate the following ratio A_0 between the effective cross-section area and the equivalent inertial mass of a photon from equation (30) (applicable to both normal photons and Elementary photons):

$$A_0 = \frac{\sigma_p}{m} = \frac{H}{\rho_0\, c}\,[\mathrm{m}^2/\mathrm{kg}] \tag{31}$$

Therefore,

$$\sigma_p = A_0 m \tag{32}$$

$$A_0 \rho_0\, c = H \tag{33}$$

The volume of space, which is swept through by the effective cross-section area of a photon during one cycle is

$$V_0 = A_0\, m\, \lambda = \frac{h\, H}{\rho_0\, c^2} \tag{34}$$

While the Elementary photon has such an extremely long wavelength and such an extremely low internal energy and inertial mass, and Elementary photons are spread out in the observable Universe and they have a vast huge number. Hence, the average mass density of the ocean of Elementary photons ρ_0 must be a constant on a cosmological scale. It is highlighted here that ρ_0 is an important Universal constant on a cosmological scale. Therefore, from equations (31) and (34), we can see that A_0 and V_0 are two Universal constants as well on a cosmological scale. While normal photons releasing energy and mass every cycle during travelling through the space, the ocean of Elementary photons gains the energy and mass released by the travelling photons. The interactions between normal photons and Elementary photons create a weakly interacting thermal bath of photons, which may be named the ocean of photons or more fundamentally the ocean of Elementary photons. The vast numbers of Elementary photons and normal photons interacts with each other and they are in a state of massive quantum occupation number. Consequently, it would surely lead to Bose-Einstein condensation of photons. A new description as mixed two-fluid of photons is proposed in a separated article (Zhang, 2021b). To sustain a dynamic equilibrium, there must be a mechanism of absorbing the Elementary photons released by the travelling normal photons, which will be discussed in the following section.

The interactions between Elementary photons and matter particles, the origin of the Universal Gravitation

Imagining a relatively stationary particle of normal matter immersed in the ocean of Elementary photons as shown schematically in Figure 2, the relatively stationary matter particle with the mass m_p would receive an inflow of Elementary photon particles and neutrinos at light speed from its surrounding space. This article focuses on Elementary photon particles (including normal photon particles that are dynamic packets of Elementary photon particles) because neutrinos are fermions that are supposed to make negligible contribution to the long-distance force of the Universal Gravity. As mentioned above, the average numerical density of Elementary photon particles is ρ_n, assuming a percentage β_1 ($-100\% \leq \beta_1 \leq 100\%$) of the ρ_n Elementary photon particles interacting with the relatively stationary matter particle with the momentum of every Elementary photon as,

$$p_s = \frac{h}{\lambda_s} = \frac{E_s}{c} = m_s\, c \tag{35}$$

where h is the Planck constant, p_s, λ_s, E_s, and m_s are subsequently the momentum, the wavelength, the energy, and the equivalent inertial mass of an Elementary photon. If $\beta_1 = 100\%$, it means that the matter particle absorbs all the inflow Elementary photons from its surrounding space. The 100% absorbing without emitting cannot last forever from a dynamic equilibrium point of view, eventually it will emit to achieve a dynamic equilibrium with its surrounding. If $\beta_1 = -100\%$, it means that the matter particle emits all its mass and energy away, the matter particle will eventually be dissolved into the vast ocean of Elementary photons; all its mass and energy will be spread out into the vast free space. The number of Elementary photons interacting with the matter particle during the time Δt is

$$\Delta N = \beta_1 \rho_n \sigma_p\, c\, \Delta t \tag{36}$$

The restricted occasion of a net number of Elementary photons flowing into the matter particle will be investigated in this article, which means $0 < \beta_1 \leq 1$. The corresponding mass and energy flowing into the particle is

$$\Delta m_p = \Delta N\, m_s = \beta_1 m_s \rho_n \sigma_p\, c\, \Delta t \tag{37}$$

$$\Delta E_p = \Delta N E_s = \beta_1 m_s \rho_n \sigma_p\, c^3\, \Delta t \tag{38}$$

Inserting $\sigma_p = A_0 m_p$ (equation (32)) and $\rho_0 = m_s \rho_n$ (equation (29)) into equations (37) and (38) leads to

$$\Delta m_p = \frac{\Delta E_p}{c^2} = \beta_1 A_0 \rho_0 m_p\, c\, \Delta t \tag{39}$$

Because $H = A_0 \rho_0 c$ from equation (33), it is derived that

$$\Delta m_p = \frac{\Delta E_p}{c^2} = \beta_1 H m_p \Delta t \tag{40}$$

where m_p and E_p are subsequently the mass and energy of the relatively stationary matter particle. The mass and energy of the matter particle as the function of time by the integration of equation (40) are

$$m_p\,(t) = m_p(0)\, e^{\beta_1 H t} \tag{41}$$

$$E_p(t) = E_p(0)\, e^{\beta_1 Ht} \tag{42}$$

where $m_p(0)$ and $E_p(0)$ are the mass and energy of the matter particle at its state of the lowest mass and energy at $t = 0$.

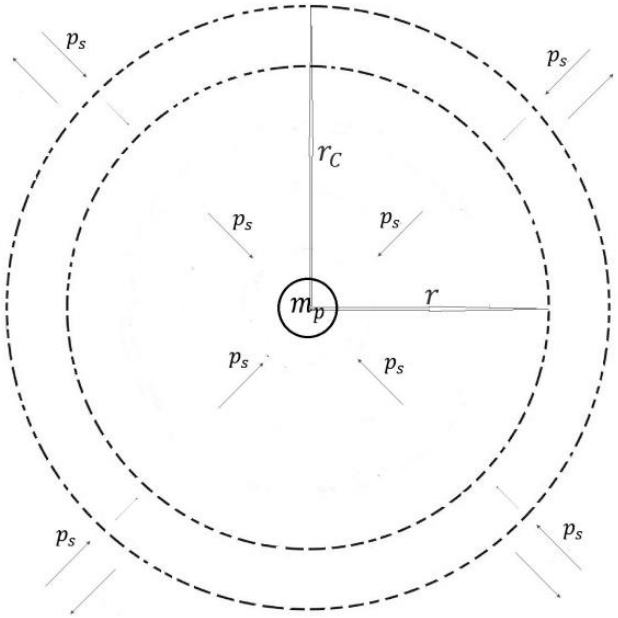

Fig. 2. The schematic diagram showing the inward flow of Elementary photon particles with the momentum p_s per Elementary photon towards a relatively stationary matter particle with the mass m_p.

Remembering H is approximately 2.29×10^{-18} [s^{-1}] and $0 < \beta_1 \leq 1$. Therefore, during a relatively short period of time, for example days or years, the mass and energy change are extremely tiny. However, the tiny change of mass and energy accompanies an inward force, the force leads to contracting, vibrating and spinning of the matter particle around its equilibrium position because the interacting with photons with linear and circular polarizations. It may be explained further as following. It is verified that the effect of the two kinds of polarization of photons (linear and circular) at a certain range of frequencies on silica nanoparticles is quite different (Ahn *et al.*, 2018). Linear polarization causes the particles to vibrate along the line of polarization while circular polarization causes the particles to spin. This may help to explain the spinning and vibrating of the galaxies, the stars and the planets. Interacting with Elementary photons and normal photons with circular polarization may be the cause of the spinning of the galaxies, the stars and the planets. The contracting, vibrating and spinning of the compositions of the matter particle induce friction forces, which cause the increase of the internal temperature and pressure. The increase of temperature and pressure inside the matter particle trigger off expanding and thermal radiation, therefore, photons are released into surrounding space. Part of the energy absorbed is emitted as thermal radiation. It can be predicted that the total energy radiated will be at the maximum while the radius of the matter particle is at its minimum and the total energy radiated will be at the minimum while its radius is at the maximum. While the author searched literature for supporting evidence, it was found that the above prediction has been confirmed by the quantitative measurement of the relation between the total irradiance and the radius variations of the Sun (Pap *et al.*, 2001). To maintain a relatively stable state of temperature and movement (including the spinning and the orbital velocity), the matter particle needs continuously absorbing mass and energy through interacting with the vast ocean of Elementary photons, which means $0 < \beta_1 \leq 1$. The matter particle also emits photons as thermal radiations. Hence, a dynamic circulation and thermodynamic equilibrium state is achieved. The secret of the dynamic circulation and thermodynamic equilibrium of mass and energy of the Universe is uncovered. Quantitative details of the dynamic circulation mechanism are worth for further research. Flavour oscillations observed in neutrinos (Cai *et al.*, 2017) may be viewed as the evidence of lightly damped and driven oscillating particles that undergo two-way energy exchanges with the vast weakly interacting ocean of Elementary photons to achieve dynamic equilibrium.

For a normal photon, it releases an Elementary photon every cycle, its wavelength continually increases. It is the normal photons that are expanding, it is not the space expanding. The matter particles absorb mass and energy through interacting with the vast ocean of Elementary photons to maintain their characterized temperatures and movements. And the matter particles release mass and energy as thermal radiations, the emitted mass and energy as photons eventually return the mass and energy to the vast free space by releasing Elementary photons every cycle while travelling at light speed to achieve mass and energy balance with the vast ocean of Elementary photons. The nuclear reactions and element generations inside galaxies and inside stars are probably merely by-processes because of the impinging of photons, neutrinos and cosmic rays from all directions and the high temperature and high pressure induced by impinging and frictions, and including some electromagnetic mechanisms, which worth further research. In a parable, all the galaxies, stars and planets are music instruments with different keys and strings, meanwhile, Elementary photons, normal photons, neutrinos and cosmic rays flowing towards the music instruments are the fingers of a glorious musician. All sorts of emitted matters, visible and invisible lights are melodies spew out from the music instruments. It is interesting that the melodies can

eventually turn back to the wonderful fingers of the glorious musician. Matter particles with different size and mass absorb and release a range of frequency and wavelength of photons to sustain their characterized movements and temperatures, to achieve dynamic equilibriums with their surrounding space – the vast ocean of Elementary photons. Dynamic equilibriums are achieved, which is manifested by the relatively stationary spectrums of radiations from majority of the galaxies, the stars, the planets, the fundamental particles and elements with their characteristic range of temperatures, colours, brightness and movements in the Universe.

Another exciting point is that Newton's gravity law could be derived from the Elementary photon theory, which can help to gain deeper insight into the origin of the Universal gravity. There are some basic believes that the total mass and energy are conserved within the whole scale of the Universe. The interactions between localized masses and energies follow the same set of physical laws in the Universe. The interactions between localized masses and energies help to establish dynamic circulation and equilibrium. If under some condition for some reason the oscillation goes too far outside the dynamic equilibrium locally, a new state of dynamic equilibrium will eventually be established because of the mechanism of the viscously damped harmonic oscillating for the energy exchange in two ways. As shown schematically in Figure 2, we define r_C to represent the radius of the equivalent effective interacting cross-section area ($4\pi r_C^2 = A_0 m_p$ from $\sigma_p = A_0 m$ in equation (32)) of the matter particle with the mass m_p,

$$r_C = \sqrt{\frac{A_0\, m_p}{4\pi}} \tag{43}$$

Outside the ball of the effective radius r_C there will be a random distribution of Elementary photons. From equation (36) written above, the number of Elementary photons flowing through the effective interacting cross-section area ($4\pi r_C^2$) during the period of Δt towards the matter particle is

$$\Delta N = \beta_1 \rho_n \sigma_p\, c\, \Delta t = \beta_1 A_0 \rho_n m_p\, c\, \Delta t \tag{44}$$

Because the matter particle is in a dynamic equilibrium with its surrounding around the effective radius, the number of Elementary photons flowing towards the matter particle should be approximately 50% of the total number of Elementary photons to maintain a random distribution of Elementary photons in average outside the ball of the effective radius r_C. Hence, $\beta_1 \approx 0.5$ (fluctuating around 0.5 with an average at 0.5) for the specified dynamic equilibrium state. At a distance $r \le r_C$ from the centre, the fluid towards the matter particle must carry the same number of Elementary photons but flow through a smaller area, if we define the local numerical density of Elementary photons as $\rho_n(r)$,

$$4\pi r^2 \rho_n(r)\, c = \beta_1 A_0 \rho_n m_p\, c \tag{45}$$

The local numerical density with a local gradient of Elementary photons around the matter particle as a function of r is therefore,

$$\rho_n(r) = \frac{\beta_1 A_0 m_p \rho_n}{4\pi r^2} \tag{46}$$

Similar to equation (44) but applied at the radius r, the inward flowing rate of Elementary photons is

$$\frac{dN}{dt} = \rho_n(r)\, \sigma_p\, c = A_0 \rho_n(r) m_p\, c \tag{47}$$

This represents a directed rate of momentum or a force transferred to the matter particle corresponding to

$$F = -\frac{dp}{dt} = -p_s \frac{dN}{dt} = -\frac{\beta_1 A_0^2\, c^2\, \rho_0}{4\pi} \frac{m_p^2}{r^2} \tag{48}$$

The force in equation (48) represents the Universal Gravity force between the centre mass m_p and an equivalent effective mass $-m_p$, which represents the average counter interactions from the rest of the Universe outside the ball with the effective radius r_C through the ocean of Elementary photons to achieve a mass, energy and force balance. The negative sign simply means when the centre mass m_p of the matter particle absorbing Elementary photons and contracting, the equivalent effective mass of the rest of the Universe $-m_p$ releasing Elementary photons and expanding. While the centre mass m_p of the matter particle releasing Elementary photons and expanding, the equivalent effective mass $-m_p$ absorbing Elementary photons and contracting. If locally two matter particles with different mass interact with each other, like the Sun and the Earth, a net gravitational attracting force is induced between them because they shield each other in the roaming ocean of Elementary photons. Hence, they tend to become closer to each other. If the Sun and the Earth are viewed together as a whole, a net contracting and local increasing of the density of mass and energy happens, thus a counter force for orbital movement emerged to cancel out the attracting force. These reactions are for achieving a dynamic equilibrium of mass and energy and also maintaining approximately

even distribution of mass and energy on a cosmological scale. Detailed analysis and calculation will be done in next section. Now let us compare equation (48) with Newton's gravity law, they are the same if we assign that

$$G = \frac{\beta_1 A_0^2 \, c^2 \, \rho_0}{4\pi} \tag{49}$$

By using equation (33), we get

$$G = \frac{\beta_1 A_0 H \, c}{4\pi} = \frac{\beta_1 H^2}{4\pi \rho_0} \tag{50}$$

The Universal Gravitational Constant may be interpreted as the interacting and coupling constant of a matter particle with the rest of the Universe through its interacting with the ocean of Elementary photons. Newton stated in his letter to Richard Bentley (https://plato.stanford.edu/entries/newton-philosophy/):
"It is inconceivable that inanimate brute matter should, without the mediation of something else which is not material, operate upon and affect other matter without mutual contact, as it must be, if gravitation in the sense of Epicurus, be essential and inherent in it. And this is one reason why the author desired the reader would not ascribe innate gravity to me. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity that the author believes no man who has in philosophical matters a competent faculty of thinking can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, the author has left open to the consideration of my readers".

Physical science is mainly about the correlation of physical quantities. The correlation between the Universal Gravitational constant and the Hubble constant is disclosed quantitatively from equation (50). For fully understanding its implications, further research is worthwhile. By inserting $H \approx 2.29 \times 10^{-18}$ [s^{-1}], $G \approx 6.6739 \times 10^{-11}$ [$m^3/(kg \cdot \times s^2)$], and $\beta_1 \approx 0.5$ into equation (50), the average mass density of the ocean of Elementary photons on a cosmology scale can be derived as follows:

$$\rho_0 \approx 3.13 \times 10^{-27} [\mathrm{kg/m^3}] \tag{51}$$

The value of the constant A_0 can be estimated as follows:

$$A_0 \approx 2.44 \, [\mathrm{m^2/kg}] \tag{52}$$

Then we can derive the following parameter:

$$G \approx 1.273 \times 10^{25} H^2 \tag{53}$$

The accuracy of the numbers in equations (51)-(53) depends on the accuracy of the measured G and H. Having ρ_0 and A_0 at hand, we can do some interesting calculations. As an example, let us start from using equation (43) to calculate the effective radius of the Solar System and the Milky Way Galaxy based on their known total masses. In the Solar system, 99.86% of the system's known mass concentrates in the Sun (Woolfson, 2000), the total mass in the solar system is approximately 1.99×10^{30}, inserting this value and A_0 into equation (43), we get $r_C \approx 6.21 \times 10^{14}$ [m]. The border where the Solar System terminates is not precisely defined, because its outer boundaries are shaped by two separate forces: the solar wind and the Sun's gravity. The limit of the solar wind's influence is roughly four times Pluto's distance from the Sun, the heliopause, the outer boundary of the heliosphere, is considered the beginning of the interstellar media, which is approximately 2×10^{13} [m]. The Sun's Hill sphere, the effective range of its gravitational dominance, is thought to extend up to a thousand times further, which approximately reaches 10^{16} [m] (Littmann, 2004). Our simple calculation of $r_C \approx 6.21 \times 10^{14}$ [m] sits approximately in the middle of these two estimated radii based on observations and calculations. Regarding the Milky Way Galaxy, recent studies (Phelps *et al*., 2013; Kafle *et al*., 2014) indicate a range in mass, as large as 4.5×10^{12} $M_\odot$ and as small as 8×10^{11} $M_\odot$, where $M_\odot$ is the standard mass of the Sun. If we take both values, which are approximately from 1.59 to 8.95×10^{42} [kg] and inserting them into equation (43), we have r_C in a range from 5.56×10^{20} to 1.31×10^{21} [m]. The Milky Way is the second-largest galaxy in the Local Group, with its stellar disk approximately 30 [kpc] in diameter. If we believe that the ring-like filament of stars wrapping around the Milky Way belongs to the Milky Way itself, which are rippling above and below the relatively flat galactic plane, its stellar disk can reach a diameter of 46-55 [kpc] (Xu *et al*., 2015). The radius based on a diameter from 30 to 55 [kpc] are between approximately 9.27×10^{20} and 1.70×10^{21} [m], which are in good agreement with our simply calculated values from equation (43), which is between 5.56×10^{20} and 1.31×10^{21} [m]. Vice versa, the total mass based on the observed effective radius may be estimated. For instance, if we use the observed approximately 9.27×10^{20} [m] and 1.7×10^{21} [m] as the effective radius, the estimated mass of the Milky Way from equation (43) would be between 2.22×10^{12} $M_\odot$ and 7.48×10^{12} $M_\odot$. Such good agreements are supporting evidences of the

Elementary photon theory. The dimensions and masses of other galaxies and stars could be simply estimated in similar way.

The gravitational force between two bodies, the generalised law of Universal Gravitation, the Tully-Fisher law, and the Modified Newtonian Dynamics

The total momentum rate carried by the Elementary photons from background space to the body of a matter particle corresponds to a limited force from equations (44) and (48) plus (29), (31), and (35) as follows:

$$F_L(m_p) = -p_s \frac{dN}{dt} = -\frac{h}{\lambda_s}\,\beta_1 A_0 \rho_n m_p\, c = -c\,H\,\beta_1\,m_p \quad (54)$$

Specifically, for the Sun (with $\beta_1 \approx 0.5$ at dynamic equilibrium state) we have

$$F_L(M_{Sun}) = -c\,H\,\beta_1\,M_{Sun} \approx -6.83 \times 10^{20} N \quad (55)$$

To be compared with the following gravitational force on the Earth from the Sun according to Newton's Law:

$$F = -\frac{G\ M_{Sun}\ M_E}{r^2} \approx -3.54 \times 10^{22} N \quad (56)$$

This would not imply that the Earth itself receives a larger total momentum per second than the limited momentum flow rate towards the Sun from the Sun's back-ground space. How can the Newtonian gravitational force between two bodies be explained? The solution is hidden in the difference between the flows of the Elementary photons absorbed by the matter particles in each of the two participating bodies and the number of interactions that takes place between Elementary photons and the two participating bodies. Each matter particle absorbs Elementary photons corresponding to the rate of:

$$\frac{dN}{dt} = \beta_1 A_0\, m_p\, c\, \rho_n = \frac{\beta_1 H\, m_p}{m_s} \quad (57)$$

where m_s is the mass of an Elementary photon, m_p is the mass of the matter particle. Specifically, the m_p would be the mass of the Earth if we aim to calculate the gravitational force between the Earth and the Sun. Let us imagine an Elementary photon in the Sun-Earth two-body system while it interacts with both the Earth and the Sun to create the pushing together force. The Earth absorbs $\beta_1 H \Delta t m_p/m_s$ Elementary photons from its surrounding space during the time interval of Δt. Meanwhile, the Earth interacts with a total of $A_0\rho_n(r)m_p c\Delta t$ Elementary photons inflow towards the Sun. From equation (46), $\rho_n(r) = \beta_1 A_0 M_{\text{Sun}}\rho_n/(4\pi r^2)$ for the Sun-Earth system. There shall be a small percentage β_2 ($0 < \beta_2 < 1$) of the Elementary photons absorbed by the Earth is not from the Elementary photons flowing towards the Sun. Therefore, the probability for absorption by the Earth is P_{abs}:

$$P_{abs} = \frac{\beta_1 H\,\Delta t\, m_p/m_s}{\beta_1\beta_2 H\,\Delta t\, m_p/m_s\ +\ A_0\,\rho_n(r) m_p\, c\,\Delta t} \quad (58)$$

The item containing the percentage β_2 in the denominator of equation (58) is for avoiding double counting. Therefore, equation (58) can be simplified to

$$P_{abs} = \frac{1}{\beta_2 + \frac{A_0\rho_{n(r)} c\, m_s}{H\beta_1}} = \frac{1}{\beta_2 + \frac{A_0 M_{Sun}}{4\pi r^2}} \quad (59)$$

The probability for interaction without absorption is $P_I = 1 - P_{abs}$. Inserting the numerical values for M_{Sun} (the mass of the Sun) and r (the distance between the Sun and the Earth), it can be calculated as $A_0 M_{\text{Sun}}/4\pi r^2 \approx 1.7 \times 10^7$. As we know β_2 is a small percentage, the small percentage β_2 can be neglected in comparison with 1.7×10^7 for the Sun-Earth system, $P_{abs} \approx 1/(1.7 \times 10^7) \approx 5.9 \times 10^{-8}$ and $P_I \approx 1$. Therefore, as an average, an Elementary photon in the flow towards the Sun would interact with the Earth approximately 1.7×10^7 times before it eventually being absorbed, and it would each time supply the momentum of $p_s = m_s c$ to the Earth directed towards the Sun. It may be noted here that the wavelength of an Elementary photon is comparable with the observable Universe. Therefore, the discussed interactions may take place simultaneously over long distances. Our universe is entangled together with a gigantic number of Elementary photons with a super long wavelength. For wider applications, using M represents the centre mass inside the system, like the M_{Sun} for the solar system, equation (59) can be generalised as follows:

$$P_{abs} = \frac{1}{\beta_2 + \frac{A_0 M}{4\pi r^2}} \quad (60)$$

In accordance with equations (50), (54), (57), and (59) written above, the total force acting in between the Earth and the Sun can be derived as follows:

$$F = -\frac{1}{P_{abs}}\, c\,H\,\beta_1 M_E \quad (61)$$

$$= -c\,H\,\beta_1\beta_2 M_E - \frac{G\ M_{Sun}\ M_E}{r^2} \approx -\frac{G\ M_{Sun}\ M_E}{r^2}$$

where M_E is the mass of the Earth. Therefore, for a two-body system interacting via gravity, the equation of Newton's gravity law is an ideal approximation while $cH\beta_1\beta_2 M_E << GM_{Sun}M_E/r^2$, which is the case in the solar system. For wider applications, using M represents the mass of the centre body, m represents the mass of the obiter and r represents the distance between them, equation (61) can be generalised as follows:

$$F = -cH\beta_1\beta_2 m - \frac{GMm}{r^2} \tag{62}$$

Equation (62) may be named the Generalised Law of Universal Gravity of a two-body system. The generalised acceleration of a two-body system can be derived from equation (62) by dividing the mass of the obiter, hence,

$$a = -cH\beta_1\beta_2 - \frac{GM}{r^2} = a_0 + a_N = \eta a_N \tag{63}$$

The Newtonian acceleration a_N is

$$a_N = -\frac{GM}{r^2} \tag{64}$$

The Universal acceleration a_0 is

$$a_0 = -cH\beta_1\beta_2 \tag{65}$$

and

$$\eta = 1 + \frac{a_0}{a_N} = 1 + \frac{cH\beta_1\beta_2 r^2}{GM} \tag{66}$$

The minus sign in equations (61)-(65) simply means that the direction of the force is towards the centre. Because $0 \le \beta_1 \le 1$ and $0 < \beta_2 < 1$, from equation (65), the absolute value of the Universal acceleration $|a_0| < cH \approx 6.86 \times 10^{-10}$ [m/s^2]. Inserting the estimated $\beta_1 \approx 0.5$ (approximately half of the Elementary photons flowing towards the centre of the system from the background space at a dynamic equilibrium state around the effective radius r_C and beyond) and the estimated $\beta_2 \approx 0.167$ (approximately 1/6 of the Elementary photons absorbed by the orbiter is not from the Elementary photons flowing towards the centre of the system, which is a reasonable assumption because of one of six faces in a cubic) we obtain that the calculated $|a_0|$ is approximately 0.57×10^{-10} [m/s^2]. For stars rotate around its rotational axis located in the galaxy centre in a velocity v, the centripetal acceleration ($-v^2/r$) shall equal to the acceleration from equation (63), hence,

$$v^2 = cH\beta_1\beta_2 r + \frac{GM}{r} = -a_0 r + \frac{GM}{r} \tag{67}$$

Therefore,

$$v^4 = a_0^2 r^2 - 2GMa_0 + (\frac{GM}{r})^2 \tag{68}$$

If $GM/r >> |a_0 r|$, which is the case in the solar system, it can be derived from equation (67) that $v^2 \approx GM/r$ (the Virial relation that has been proved in the Solar system) then we are in the Newtonian regime. For galaxies with much larger and distributed masses, when r becomes distant enough, $(GM/r)^2$ becomes negligible, a regime is entered with approximately constant density of Elementary photons,

$$\frac{\rho_n(r)}{\rho_n} = \frac{GM}{cHr^2} \approx \beta_1 \text{ leads to } r^2 \approx \frac{GM}{cH\beta_1} \tag{69}$$

Combining equations (65), (68), and (69), we have

$$v^4 \approx a_0^2 r^2 - 2GMa_0 = GM|a_0|(2+\beta_2) = GMa_M \tag{70}$$

Equation (70) reveals the Tully-Fisher relation (Binney *et al.*, 2008) and the modified Newtonian dynamics (MoND) relation proposed by Milgrom (1983a, 1983b). a_M is the acceleration of the MoND, $a_M \approx 1.24 \times 10^{-10}$ [m/s^2] according to the results by Milgrom if taking the Hubble constant as approximately 70.8 [km × s^{-1} × Mpc^{-1}], which is in good agreement with the theoretical calculation from the Elementary photon theory from equations (65) and (70) written above. Astronomical observations show that for disk galaxies, the fourth power of the orbital speed (v_f^4) of stars moving around the core of the galaxy at the flat end of the rotation curve is proportional to the total luminosity L_u of the galaxy. L_u is proportional to the observable mass M of the galaxy (Faber and Jackson, 1976; Tully and Fisher, 1977; Faber and Gallagher, 1979):

$$\frac{L_u}{m} \cong 10^{-5} \text{ [W} \times \text{kg}^{-1}\text{]} \tag{71}$$

Hence, it is obtained that $v_f^4 \propto M$, this is well known as the Tully-Fisher relation, which is a widely applicable relation and it is originated from empirical fitting of astronomical observations and calculations. This type of

rotation curve differs drastically from that of planets rotating around the Sun, whose orbital speed according to Newtonian mechanics and General Relativity in the weak field and small velocity approximations, which is $v^2 \sim GM/r$ (the Virial relation). The physical basis of the Tully-Fisher law is the relation between a galaxy's total observable mass M and the velocity at the flat end of the rotation curve v_f. In 1983, Milgrom interpreted the Tully-Fisher relation as an indication of a deviation from Newtonian gravity, claiming a MoND (Milgrom, 1983a, 1983b; Binney *et al*., 2008). Milgrom hypothesized that this relation should hold exactly, thus interpreting it as an inductive law of nature instead of an empirical relation (Milgrom, 1983a, 1983b) and (de Haas, EPJ. 2018. The 'constant Lagrangian' fit of galaxy rotation curves as caused by cosmic space expansion under energy conservation conditions. https://vixra.org/pdf/1805.0342v1.pdf). According to Milgrom's results, the deeper significance of this relation between this special galactic acceleration and the Hubble constant should be revealed by future cosmological insights. Now the Elementary photon theory has revealed the cosmological insights into the physical origin of both the MoND and the Tully-Fisher empirical relations, which have been sought after for over thirty years (Milgrom, 1983a, 1983b; Bekenstein, 2006; Binney *et al*., 2008; McGaugh, 2011) and (de Haas, EPJ. 2018. The 'constant Lagrangian' fit of galaxy rotation curves as caused by cosmic space expansion under energy conservation conditions. https://vixra.org/pdf/1805.0342v1.pdf). If taking the distribution of the observable mass and including the mass and flow distribution of Elementary photons, the rotation curve of Galaxies will be able to be determined accurately without the assumed dark matter.

Further supporting evidences of the Super photon theory, the origin of the CMBR, and the theoretic determination of the temperature and the spectrum of the CMBR

There may be a doubt that how a photon particle with an inertial mass can travel at a constant speed c along a straight direction inside the free space with a viscous friction force. The explanation is that the photon particle behaves similarly as a rotation wheel that releases an extremely tiny fragment of energy every cycle to combat the weak viscous friction force and maintain the constant speed of the centre of its inertial mass in a straight direction without the loss of its direction and its identity. Let us do a simple calculation, first assuming that v is the speed of the photon particle with an inertial mass of m travelling through the free space with a viscous friction force F_{vis}. According to equations (1), (5), and (14), for keeping a speed of v, the average energy dissipation $<E_{DIS}>$ of the photon particle needed to combat the friction force within one second of time, it shall be

$$< E_{DIS} > = \frac{1}{2} |F_{vis} \cdot v| = \frac{1}{2} R_m v^2 = \frac{R_m}{2m} m v^2 = Hmv^2 \quad (72)$$

Within the short period of one second, the frequency of the photon (f) can be viewed as a constant value, hence, the photon rotates a total of f cycles within the period of one second. According to the Elementary photon theory, the photon releases an Elementary photon every cycle with the energy of hH, in combination with Planck-Einstein equation $hf = mc^2$, it can be derived that the energy releasing of the photon within the period of one second shall be

$$< E_{DIS} > = Hhf = Hmc^2 \quad (73)$$

The energy releasing of the photon within the period of one second shall be the average energy dissipation $<E_{DIS}>$ of the photon needed to combat the friction force within one second of time to keep its movement in a straight direction at a constant speed, hence equalling equations (72) and (73), we can derive $v = \pm c$, the photon particle in the free space is indeed propagating at a constant speed c. From an electromagnetic point of view, the speed of photons in the free space is a constant such as $1/(\varepsilon_0\mu_0)^{1/2}$ because ε_0 is the electric constant of the free space, and μ_0 is the magnetic constant of the free space. These two constants imply that there is substance inside the free space. The speed of light is sorely determined by the intrinsic properties of the subtle substance inside the free space. Interestingly, Maxwell derived the expressions for the dielectric constant and the magnetic permeability of the free space in terms of transverse elasticity and the density of a subtle substance inside the free space named it ether (Maxwell, 1865; Rubik and Jabs, 2018). It is not well known that Einstein called for a relativistic aether, in his 1920 speech given at the University of Leiden (Rubik and Jabs, 2018), he proclaimed in German, "According to the General Theory of Relativity, space without aether is unthinkable." Now it is theoretically derived that the subtle substance in the free space is a dynamic and weakly interacting ocean of Elementary photons spreading all over the observable Universe. The subtle substance in the vast free space - the dynamic and weakly interacting ocean of Elementary photons is worth for further research to understand it better. As far as we already know, the subtle substance has an elastic modulus, a stress tensor, a shear tensor, a dielectric constant, a magnetic permeability coefficient, and the following constants: the gravitic, torsionic, gravitoelectric, torsionoelectric, gravitomagnetic, and torsionomagnetic constants (Zakharenko, 2020) as well as the magnetic susceptibility and the characteristic electromagnetic wave impedance of 376.73 Ohms. And the subtle substance is polarizable (Puthoff, 2002;

Gitman, 2016; Konstantinov, 2018; Zhang, 2022). From a mechanical perspective, high energy photon particles roaming at light speed together with cosmic rays and neutrinos in the vast free space that is full of the dynamic and interactive subtle substance, the vast ocean of Elementary photons, there shall be frictions thus energy dissipations, hence there shall be energy fluctuations according to the Fluctuation-dissipation theorem (Kubo, 1966; Kardar and Golestanian, 1999). While cosmic rays, neutrinos and high-energy photons travelling through the vast polarizable ocean of Elementary photons (Zhang, 2021b, 2022), the weak interactions between them will lead to a linear increase of the energy of the ocean of Elementary photons above its dynamic equilibrium of energy level transiently. Consequently, a tendency of relaxing to its original energy level builds up. While the process of relaxing to the dynamic equilibrium of energy level happens, the CMBR is emitted. The energy fluctuations of the ocean of Elementary photons caused by cosmic rays, high-energy photons and neutrinos travelling through shall be the origin of the spectrum of the CMBR. Hence, the origin of the CMBR shall be non-redshifted, thus it can preserve its black-body radiation spectrum. There is an excellent large-scale homogeneity because of the dynamic equilibrium between the immersed travelling particles and the vast ocean of Elementary photons across the observable universe. A piece of supporting evidence is as following: the Pierre Auger Collaboration discovered that the anisotropy signal of cosmic rays appears to be consistent with the sources of cosmic rays in a cosmic-ray frame coincident with the reference frame of the CMBR (Aab *et al*., 2017). The author believes that the CMBR is the manifestation of the energy fluctuations of the vast ocean of Elementary photons, the weak afterglow of the vast free space where cosmic rays, high-energy photons and neutrinos travelling through it. The weak anisotropy of the CMBR shall be linked with the anisotropy distribution of cosmic rays, high-energy photons and neutrinos, which shall be a promising direction for further research.

Now let us calculate quantitatively the temperature and the spectrum of the CMBR. The average mass density of the ocean of Elementary photons is known from equation (42) as $\rho_0 \approx 3.129 \times 10^{-27}$ [kg/m^3]. Employing the Stephan-Boltzmann law for the cavity black-body radiation (Bradt, 2008) in combination with Einstein's mass-energy equation plus equation (50), it infers that

$$\frac{4\sigma}{c}T^4 \approx \frac{\Delta E_V}{E_V}\rho_0 c^2 \approx \frac{\Delta E_V}{E_V}\frac{H^2 c^2}{8\pi G} \tag{74}$$

where σ is the Stephan-Boltzmann constant, c is the speed of light in the free space. The amplitude of the energy fluctuation ($\Delta E_V/E_V$) can be estimated based on information from references (Assis and Neves, 1995; Pap *et al*., 2001; Bradt, 2008; Huang *et al*., 2012; Leff, 2015; Cai *et al.*, 2017; Hill *et al.*, 2018; Batista *et al*., 2019) as approximately 0.015%, which will be explained in detail later on. Substitute all these data into equation (74), the temperature of the CMBR is determined as $T \approx 2.73$ K theoretically, which is quantitatively a nice match to the measured value by COBE's instruments (Bradt, 2008). The theoretic modelling of the fluctuation-dissipation theorem may be traced back to Rayleigh-Jeans law, Wien radiation formula, and Planck radiation formula for the interpretation of blackbody radiation spectrum (Boya, 2003). The vast ocean of Elementary photons spreading over the observable Universe shall be a perfect cavity blackbody because it fulfils the following two conditions:

i. The vast ocean is in a thermodynamic equilibrium at a relatively stable temperature.
ii. The localised external perturbation from the extremely week interactions between the vast ocean of Elementary photons and the cosmic rays, high-energy photons and neutrinos travelling through is in a linear response regime because the viscosity coefficient of the ocean is extremely low.

Hence, it can be asserted from the fluctuation-dissipation theorem that the spectrum of the CMBR shall obey the Planck radiation formula and shall have an excellent match with the radiation spectrum of an ideal blackbody at the temperature of approximately 2.73 K determined quantitatively above. The normal photons of starlight can be treated as an ideal gas, the amplitude of the energy fluctuation is theoretically calculated (Leff, 2015) as follows:

$$\frac{\Delta E_V}{E_V} \approx \frac{\delta N}{N} \approx \sqrt{\frac{1.369}{2.029 \times 10^7 T^3}} \approx 0.00557\% \tag{75}$$

According to reference (Assis and Neves, 1995), the energy density of the flux of cosmic rays is comparable with the energy density of the starlight. So, the amplitude of the fluctuation of the ocean of Elementary photons shall be doubled to approximately 0.011% by including the influence of the cosmic rays. If further adding the estimated small amount of energy fluctuation caused by high energy neutrinos (Cai *et al.*, 2017; Batista *et al.*, 2019), the total amplitude of the fluctuation shall reach approximately 0.015%. The fluctuation-dissipation theorem is a powerful tool in interrelating the interactions between the vast ocean of Elementary photons and the immersed travellers as cosmic rays, neutrinos, fundamental particles, elements, molecules, planets, stars and galaxies. It is predicated that the approximately 0.015% amplitude of energy fluctuation of the vast ocean

of Elementary photons—the vast free space is ubiquitous and it shall be able to be detected accurately in many different ways using modern technologies.

An example experiment is proposed which may distinguish the Elementary photon theory with the theories of the Expanding Space model. Firstly, suppose that we have a well-shielded vacuum chamber, inner surface coated with graphite, with two well-aligned and transparent windows at two opposite sides, locating in a laboratory at a constant low temperature. If we shine different electromagnetic waves through the vacuum chamber in transients and measure the temperature fluctuations and associate secondary radiations inside the chamber, what can we expect? If we shine intense *X* rays, γ rays or even high energy particles through it, there will be a detectable temperature fluctuation and associate secondary radiations according to the Elementary photon theory. If we shine intense radio waves with the wavelength of tens of centre meters through it, there will have no detectable temperature fluctuation because the energy dissipation is at a negligible low level. However, according to the theories based on photons or particles travelling through frictionless free space with no energy dissipation, like the theory of General Relativity, Expanding Space and Big Bang, there will be no measurable difference no matter what kind of photons or particles travelling though the vacuum chamber. The key distinguish factor is if there is friction and energy dissipation when particles travel through free space. Other experiments may be designed and performed along this direction of thinking, which should be achievable using modern technologies. The author is confident that the proposed direction of experiments will be able to demonstrate clearly the limitations of General Relativity, Expanding Space, and Big Bang models, which are all based on particles travelling through frictionless free space with no energy dissipation.

There is another common problem of modern cosmology. Many model dependent assumptions employed during the analyses of astronomical observational data create bias and confusion. For instance, cosmology models based on General relativity taking account of the effect of time dilation (Melia and Maier, 2013), however time dilation is not generally applicable. No time dilation was observed in the light curves of quasars or in duration measures of gamma-ray bursts (Hawkins, 2010; Kocevski and Petrosian, 2013; Littlejohns and Butler, 2014). The time dilation of Supernova Ia light curves could be explained as clocks retardation because of the local increase of apparent viscosity, or being the signature of some special evolutionary process (Drell *et al.*, 2000), or due to cosmology-dependent assumptions made during the analyses of the light curves (Melia and Maier, 2013; Crawford, 2017). The calculated values of the luminosity, mass and size of distant galaxies observed using the James Webb Space Telescope (JWST) can be distorted significantly by the assumptions associated with the Expanding Space and Big Bang cosmological models. The observed morphology and angular size of the distant galaxies by using the JWST are relatively reliable. The author strongly believes that employing equations (16), (17), (43), and (71) written above to calculate the luminosity, mass and size of distant galaxies observed at high redshifts by using the JWST will give more realistic and more reliable estimations. The Big Bang cosmological models claim that the CMBR is composed by photons that is a remnant from an early stage of the universe, known as relic radiation dating back to the epoch of recombination (photon decoupling) with a redshift of approximately 1100. It is a questionable claim that those photons can travel in space containing a variety of distributed matters for such a long time without being absorbed and without being scattered. It is well known that matters of a variety of size, density and temperature spread over the Universe, they absorb and scatter photons, and re-emit photons in a spectrum of their own characters. Hence, all normal photons shall have a mean and a maximum free travel path length, also have a mean and a maximum free travel time. The free travel path lengths and free travel times of a certain spectrum of normal photons shall fall in a statistic distribution around a mean value, including the CMBR spectrum. Photons with a much longer wavelength shall have a relatively longer free travel path length and a relatively longer free travel time. Hence, telescope using infra-red will be able to see further than using visible light, telescopes using radio waves will be able to see further than using infra-red and visible light. If we continue to build better telescopes like the JWST and see further away into the space, the Expanding Space and Big Bang cosmology model predicts that only small and young -appearing blue galaxies with lower and eventually none metallicity will be able to exist and to be observed while approaching the starting point of the Big Bang. However, the Elementary photon theory and other relatively Static Universe models predict that we will keep observing the same sort of complex and mature galaxies that we have observed in the space so far, no matter how close to the point of the starting point of the assumed Big Bang or even beyond it.

CONCLUSION AND FURTHER WORK

A lightly damped oscillator model for the propagation of photon particles in the vast free space is analysed from a mechanical perspective on a cosmological scale. Based on the model, an alternative to understand the Cosmic Redshift, the Hubble constant, the Cosmic Background Microwave Radiation, the Universal Gravity and the Tully-Fisher Relation is elucidated. An equation is deduced displaying the exponential relationship between the Cosmic Redshift z and the Hubble constant H, with

clearly defined physical meaning of every parameter involved in the equation. The Hubble constant is an extremely low frequency with its origin from the time constant, the ratio between the equivalent inertial mass m of the photon particle and the weak viscous resistance R_m of the vast free space that the photon travelling through. The energy dissipated by a photon during one cycle is deduced as the product of the Planck constant and the Hubble constant. The tiny fragment of energy dissipated per photon in each cycle is defined as an Elementary photon (Super-photon). An Elementary photon is a fundamental unit of energy and mass in dynamic circulation. There is an unnoticeable and vast ocean of Elementary photons in the Universe. Through the analysing of the weak interactions between Elementary photons, normal photons, immersed matter particles and the vast ocean of Elementary photons, the Elementary photon theory is developed quantitatively. The equation of inertial mass and its effective interacting radius is derived from the Elementary photon theory and it is employed to calculate the effective radius of the Solar System and the Milky Way Galaxy based on their known masses, or vice versa. The calculated results are in good agreement with the estimated values based on astronomical observations and calculations. The dimensions and masses of other galaxies and stars could be simply estimated in similar way.

The Universal Gravitational Constant is derived from the Elementary photon theory and it is interpreted as the interacting coupling constant of the immersed matter particle with the rest of the Universe through the ocean of Elementary photons. The correlation between the Universal Gravitational constant and the Hubble constant is deduced theoretically. The mysteries behind the dynamic circulation and equilibrium of energy and mass of the Universe are uncovered; supporting evidences, demonstrating signs and validation methods are presented. Immersed matter particles absorb roaming Elementary photons and normal photons and cosmic rays thus mass and energy from the ocean of Elementary photons because they locate at places with low potential energies, they convert the absorbed energy to kinetic energy and higher-grade thermal energy through interactions of photon-photon, photon-matter and matter-matter to sustain their characteristic movements and temperatures. Immersed matter particles emit mass and energy to their surrounding spaces though radiation to achieve dynamic circulation and equilibrium. Immersed matter particles with different size and mass absorb and emit a range of frequency of photons, demonstrating relatively stable characteristic masses, temperatures, colours, brightness and movements, which manifests the states of dynamic equilibrium are achieved.

A generalised Law of Universal Gravity is derived while applying the Elementary photon theory to a two-body system. Thereafter, the Virial relation within the solar system, the Tully-Fisher relation, and the MoND relation and acceleration within galaxies are derived theoretically. The cosmological insights into the origins of both the MoND and the Tully-Fisher empirical relations, which have been sought after for over thirty years, are revealed quantitatively based on the Elementary photon theory. The temperature and the spectrum of the CMBR are explained theoretically and determined quantitatively using the Elementary photon theory together with the fluctuation-dissipation theorem. The capability of a photon particle with an equivalent inertial mass travelling at a constant speed c along a straight pass inside the free space with a weak viscous friction force is theoretically verified. The speed of light is sorely determined by the intrinsic properties of the subtle substance inside the free space. A direction of experiments is proposed, which may further distinguish the Elementary photon theory from the theories of General Relativity, Expanding Space and Big Bang cosmological models.

It is predicted from the Elementary photon theory that either with the James-Webb Space Telescope or with even more advanced space telescopes in the future, complex and mature galaxies will always be observed, no matter how close to the point of the assumed Big Bang or even beyond. The Elementary photon theory is still in its stage of infancy. However, the author believes that the theory has a huge potential to be further developed to explain phenomena that have plagued the physical world for many years. For example, solve the conflictions between quantum mechanics and the General Relativity by taking acount the effect of the vacuum friction, solve the Hubble Tension and the theoretic explanation of the tiny anisotropic distribution of the CMBR. Wider research directions and frontiers may be further developed. For example, research and explore the detection and application of electromagnetic waves with extremely low frequency and extremely long wavelength, and further understand the interacting and recirculating of photons, neutrinos, cosmic rays and all sorts of immersed matter particles in the vast ocean of Elementary photons quantitatively. It may also help in the understanding of the mechanisms of the creation and the stability of fundamental particles and elements, predicting the relative abundance of the elements in the Universe, for example the relative abundance of hydrogen and helium. Further development of the Elementary photon theory together with the fluctuation-dissipation theorem may help to develop a unified theory of physics, which would be applicable in both the microcosms and the macrocosms. There is a wide and bright window, which is open for vast opportunities for new research directions and frontiers in physics and science, and in turn,

opportunities for the advance of technology and engineering may follow.

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