

VELOCITY AND ENERGY OF PARTICLES

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Abstract: Electromagnetic energy behaves like particles at higher frequencies, even though the fields behave as waves and energy waves become discrete waves. Therefore, energy is spread over a narrow band of frequencies around the discrete wave frequency. Velocity of these pockets of energy is shown to be C times greater than the phase velocity C of electromagnetic waves in free space. Since energy travels in the form of smaller pockets than the pockets of photon energy, the exact value of photon energy is proved to be different from the photon energy calculated as per Planck's law since Planck's law is based on discrete wave frequency. Special theory of relativity is modified by considering C^2 as maximum velocity in the material Universe for all relative velocities greater than or equal to C . Mass of the photon is also derived. Accurate value of energy of matter particle is derived as per the modified special theory of relativity. Then De Broglie's matter wave equation is modified and the exact value of De Broglie's matter wavelength is derived.

Key words: Deterministic quantum mechanics, velocity and energy of particles.

I. INTRODUCTION

The ray and wave theories of the light are based on continuous propagation of light. Newton's Corpuscular theory of light is also based on continuous propagation of light particles like the flow of the fluids. Newton believed that forces act between the light particles just like in fluid flow. Such theories do not create the problem of speed of wave and particles. But the wave particle dual nature of light and particles of modern physics creates the speed of wave and the particle. As per the special theory of relativity,

$$E = mC^2 = h.f \quad (1)$$

Where E is energy of particle of mass m and C is speed of light in the free space. h is Planck's constant and f is the frequency of the light.

$$M = m_0.C^2 / (1 - (v/C)^2)^{1/2} \quad (2)$$

Where m_0 is rest mass of the photon and v is the speed of the photon. From the equations (1) and (2), rest mass of the photon = $h.f/C^2$ since $v = 0$ if the photon is at rest. As per the modern theory of cosmology, the Universe originated from a very hot and highly energetic electromagnetic radiation. So, matter particles originated from the energy or photons. So, photons must have a finite mass.

As per the statistical interpretation of quantum mechanics, waves of light are probabilistic which indicates the probable position of the photon. This means if the intensity of light is higher at a place (like at the peak point of a sine wave), concentration of the photons is higher in that place and vice versa. So, the probability of finding a photon in that place is higher and vice versa. If the photons are flowing like in Corpuscular theory of light, waves can't be generated due to uniform motion of photons. Waves are generated in light due to bunching of photons while moving. This bunching mechanism creates non uniform distribution of photons and creates waves. This bunching process is possible only if speed of the photons is higher or lower than the average speed of the photons. So, the speed of the light $C = 3 \times 10^8$ m/s is simply the speed of the wave or average speed of the photons. Therefore, speed of the photons could be greater or smaller than C . This variation of speed of the photons is related to wave-particle dual nature of light and particle.

So, in the first section of the paper, wave-particle dual nature of light and matter is discussed in detail. In the second section, origin of waves and matter particles of the world is discussed. In the last section, velocity and energy of the particles is calculated.

II. WAVE – PARTICLE DUAL NATURE OF LIGHT AND PARTICLES [1, 2, 3, 4, 5, 6, 7]

As the Big Bang occurred the fire ball began to expand and matter particles originated from photons. These facts are confirmed by particle theory physics. Actually photon energy = hf where h is Planck constant and f is frequency of photon. Therefore, Photon is associated with a wave. How an electromagnetic wave becomes photons could be explained in the following way. Light contains both electromagnetic waves and photons. As per Poynting theorem, power flow per unit area on the monochromatic plane wave is proportional to $\sin^2 \omega t$ for one dimensional wave propagation. Time average energy flow is half of the amplitude of the wave. This average is equal to frequency times H where $H = 1/2 .T.A$ where T is the period of the wave. At high frequencies, area A becomes very small and as the frequency increases the change in A is negligibly very small. Therefore, energy is directly proportional to the frequency. The constant of proportionality is Planck's constant. Therefore, photons are made up of waves. Energy particles are made up of electromagnetic waves. All matter particles were made by highly energetic photons in the beginning of the universe. Therefore, all matter particles are made by electromagnetic waves. This fact implies that De Broglie's matter waves must be electromagnetic waves.

Energy of one cycle of electromagnetic wave at high frequencies is equal to Planck's constants. Therefore, this wavelet energy particle could be called as Planckan particles. (= Planck's Constant) This wavelet particle is the most fundamental particle of the universe. All particles originated from and made up of these wavelet energy particles. This wavelet particle is like an

electromagnetic dipole. Therefore, at high frequencies continuous electromagnetic waves become discrete electromagnetic waves. Therefore, discrete electromagnetic waves can behave both as waves or particles while interacting with other particles or objects. In Young's double slit experiment a discrete wave interacts with another discrete wave (approximately) or a wave interacts with another wave (exactly). Therefore, interference pattern is observed. When a light interacts with an electron, assumption of particle to particle interaction very easily yield the results. But if the problem is analyzed by particle and wave interaction, results are not obviously visible.

De Broglie has equated the energy of an electron with the energy of a photon in his famous equation $E = mc^2 = h.f$ where m is the mass of the electron, c is velocity of light, f is the frequency of matter wave and h is Planck's constant. Therefore, as per De Broglie's energy equation, field and wave are linked with the mass of the electron. These waves are popularly known as De Broglie's matter waves. In De Broglie's equation, energy of the mass is same as the energy stored in the field. Therefore, field exists in matter particles. In light and other electromagnetic radiations, field exists in photons as per Max Planck's quantum mechanical equation. Therefore, if the size of the particle is at the scale of an electron or photon, field, energy and mass are indistinguishable. This statement implies that matter particles are made up of electromagnetic waves. This implication is true since as per the modern theory of origin of early universe, matter particles originated from electromagnetic radiations. Therefore, De Broglie's matter waves are simply electromagnetic waves. The wave function in the Schrodinger's wave function is simply the field strength of electromagnetic wave of the matter particle.

Erwin Schrodinger applied the theory of de Broglie and developed the wave equation of matter particles. These wave equations indicate that particles can exist only in discrete states of energy in a bound system. These discrete or quantum states of particle energy be explained by Fourier theory. As per this theory a periodic signal could be expressed as a sum of sine and cosine wave forms. Frequency of these waves is integral multiple of fundamental frequency of the signal. Sum of all harmonic solutions of a normal mode wave equation is the general solution of the wave equation. This sum gives the total field strength of the wave or wave function. This total strength of wave function or wave is a continuous periodic function. Therefore, total energy in the waves associated with a quantum particle is a continuous function and finite. De Broglie's matter waves are related to EM waves. Therefore, De Broglie's matter waves are electromagnetic in nature. Therefore, Schrodinger's wave function is simply the field strength of EM waves generated by matter particle.

III. ORIGIN OF WAVES AND PARTICLES OF THE UNIVERSE [8, 9, 10, 11, 12, 13, 14]

The radiation in the early universe consisted of high energy photons. The dominant process in the early universe can be represented as [9]

Photons \leftrightarrow Particles + Antiparticles

As per the above equation and the famous $E = mC^2$ relationship, the material universe must have originated from high energy photons. Therefore, before the production of matter and antimatter particles, only high energy photons must have existed in the universe. In the absence of matter and antimatter particles, space should have been linear space, since only the presence of matter particles can disturb the linear space as per general theory of relativity. Therefore, before the formation of matter and antimatter particles, the space was linear and therefore, only special theory of relativity is applicable at the initial point of the space-time structure. The general theory of relativity is not valid at the initial point of space-time structure. That is why initial point singularity originates in general relativistic theory cosmological models. Special theory of relativity was formulated within Euclidian space-time structure. Therefore, the space in the beginning was absolute and no energy was present. Then suddenly within no time high energy photons appeared all over the absolute space from beyond this absolute space. The absolute space of Euclidian Geometry extends to infinity. Therefore, the speed of high energy photons or the light in the beginning of universe was infinity. Therefore, the speed of light was reduced to the present value when the matter particles originated, universe exploded, started to expand and cooled. Therefore, there was an implosion of radiation, before the explosion of early universe. The present day universe must have originated from transient oscillations of the universe and from such oscillations, energy cooled and matter particles must have originated. Since the photons are made up of waves and matter particles are made up of photons, all matter particles are made up of electromagnetic waves.

As per special theory of relativity time is just 4th dimension of space. This theory unites time and space. General theory of relativity unites space and the field (gravitational). As per general theory space is curved. Therefore, time is also curved. This means universe is not only expanding, but also converges back in time. However, entire electromagnetic field theory including special theory works in Euclid's space or linear space. Therefore, general theory of relativity which works in curved space of gravity unites special theory of relativity with general theory of relativity very beautifully. This means linear space - time of special theory is integrated with the curved space of general theory of relativity. Electromagnetic fields exist in linear and Euclid's space. Special theory is formulated using the relative speed of objects as compared with the speed of light. Mass of the particle depends on speed of the object if the speed is comparable to the speed of light. So, in the beginning of the universe, in the radiation dominated universe, space must have been linear or Euclid and special theory of relativity is applicable. Then in mass dominated universe, space and time became curved and general theory becomes valid. Space and electromagnetic fields are different as per special theory of relativity. Space and gravitational field are same as per general theory of relativity. Therefore, space of general theory of relativity exists within linear or Euclid's space.

As explained in the previous section, Universe originated from high density and high temperature radiations. Therefore, this initial fire ball existed in Euclid's space. Universe did not originate from a initial singularity as assumed in the present standard Big Bang cosmology. Then this fire ball exploded due to high pressure and temperature and universe began to expand and cool down. Now, the matter particles originated from photons of high energy. Therefore, electromagnetic fields originated first in Euclid space and then matter originated after big bang. Matter generated gravitational field. This gravitational field ties up all matters and energy of the Universe. Now, the general theory of relativity could be applied by assuming that space and gravitational field are the same.

To satisfy the first law of thermodynamics, material universe must follow the expansion and contraction phases alternatively. As explained in the previous sections, initial speed of energy was infinity and so, for the cooling of universe and formation of matter particles from the energy of the beginning there must have been declination of the speed continuously, contraction phase and the expansion and contraction of the universe must have happened alternatively. So, the universe had transient phase of expansion and contraction and the present day's steady state phase. In the both the transient and steady state phases, expansion and contraction of the universe occurred alternatively at different range of speed.

As the Universe expanded, matter formed, stars and galaxies originated and speed of expansion at outermost layers of universe is higher than that of inner parts of the universe. When the matter reached large distance of expansion, matter began to disintegrate and when it reaches the limit, matter is converted into energy once again. This energy radiates back towards to center of the world. Therefore, matter is created, preserved and then destroyed back to energy continuously in the universe. Therefore, at the center of the universe, always there is a big fire ball made up of high density and temperature energy. Then the middle layers are made up of matter and outermost layers are made up of matter and energy. Therefore, energy and matter are conserved and universe works as a perpetual machine.

IV. VELOCITY AND ENERGY OF PARTICLES

Since the continuous wave of low frequency electromagnetic wave becomes a discrete electromagnetic wave at higher frequencies as explained in the previous paragraph, electromagnetic energy of the wave behaves like particles. A discrete periodic wave has a continuous and periodic frequency spectrum [6]. Therefore, group velocity (V_g) of the wave which is interpreted as the velocity of the energy of the wave is different from the phase velocity (V_p) of the wave in general [7]. Therefore, the group velocity of the high frequency electromagnetic wave (velocity of a photon) is derived in this section.

A uniform plane electromagnetic wave at higher frequencies, travelling in free space could be represented by,

$$Y = A \sum \sum \sin(\beta \cdot x - \omega \cdot t) \quad (1)$$

where β and ω are phase constant and angular frequency of the wave respectively and $x = n \cdot \lambda$ and $t = m \cdot T$ where λ and T are wavelength and time period of the wave respectively and n, m are integers varies from $-\infty$ to ∞ . For $x \neq n \cdot \lambda$ and $t \neq m \cdot T$, $Y = 0$.

Since $\beta = 2\pi/\lambda$ and $\omega = 2\pi f$,

$$Y = A \sum \sum \sin 2\pi \cdot (n - m) \quad (2)$$

where the integers n, m varies from $-\infty$ to ∞ . At $x = 0$,

$$Y = -A \cdot \sum \sin 2\pi m \quad (\text{for } t = m \cdot T \text{ and } Y = 0 \text{ for } t \neq m \cdot T) = -A \cdot \sum \delta(t - 2\pi m) \quad (3)$$

where m varies from $-\infty$ to ∞ .

As per the Poynting's theorem of electromagnetics [5], power flow per unit cross sectional area of beam of EM wave at $x = 0$ is equal to

$$Y^2/\eta = P_i(t) = A^2/\eta \cdot \sum \delta(t - \pi m) \quad (4)$$

where η is the intrinsic impedance of the medium [7].

The time angular frequency (ω) spectrum of $P_i(t)$ = Time Angular Frequency Fourier transform [6] of

$$P_i(t) = F_i(\omega) = A^2/\eta \cdot \sum (\sin \omega/2(mT/2))/(\omega/2) \quad (5)$$

where m varies from $-\infty$ to ∞ . Therefore, power of each impulse of electromagnetic wave at higher time angular frequencies is spread over a narrow band of time angular frequencies centered at the impulse. Therefore, actually, these impulses are energy or wave pockets which behave like particles. Photon energy is average energy of f cycles of waves. Therefore, the speed of a photon is same as the phase velocity of the wave.

$$\text{Energy of impulse energy pocket} = \int A^2/\eta \cdot (\sin \omega/2(T/2))/(\omega/2) \cdot d\omega \quad (6)$$

over $\omega = -\infty$ to $\infty \approx A^2 \cdot f/\eta \approx h \cdot 2 \cdot f^2 = (2/h) (h \cdot f)^2 = (2/h) \times (\text{Energy of a Photon})^2 = 2f \times \text{Energy of a photon}$. Therefore, energy of an impulse of the electromagnetic wave train is $2 \cdot f$ times greater than the energy of a photon as this is average energy of the impulse energy. The band width of the impulse energy pocket is approximately equal to $2 \cdot f$. Therefore, impulse energy Pocket of a high frequency electromagnetic wave \approx Bandwidth of the impulse energy Pocket \times Energy of the photon. Therefore, this impulse energy pocket behaves as a particle and not the energy of a photon since it is just average energy of the impulse energy pocket. But in the literature of present day quantum mechanics photons are assumed to behave like energy pockets or particles. Such an assumption leads to the statistical interpretation of quantum mechanics and the formulation uncertainty principle [1] [2].

Similarly, at $t = 0$,

$$Y = A \cdot \sum \sin 2\pi n \quad (\text{for } x = n \cdot \lambda \text{ and } Y = 0 \text{ for } x \neq n \cdot \lambda) = A \cdot \sum \delta(x - 2\pi n) \quad (7)$$

where n varies from $-\infty$ to ∞ . As per the Poynting's theorem of electromagnetics, power flow per unit cross sectional area of beam of EM wave at $t=0$ is equal to

$$Y^2/\eta = P_x(x) = A^2/\eta \cdot \sum \delta(x - \pi n) \quad (8)$$

The space angular frequency (β) spectrum of $P_x(x) =$ Space Angular Frequency Fourier transform of

$$P_x(x) = F_x(\beta) = A^2/\eta \cdot \sum (\sin \beta/2(n\lambda/2))/(\beta/2) \quad (9)$$

where n varies from $-\infty$ to ∞ . The ratio of time angular frequency to space angular frequency $= \omega/\beta = f/\lambda = C$ where C is the velocity of electromagnetic wave in free space. Impulse energy pockets of electromagnetic wave travels at the speed $\partial F_t(\omega)/\partial t$ in the time frequency domain and the speed $\partial F_x(\beta)/\partial t$ in the space frequency domain.

$$\partial F_t(\omega)/\partial t = \partial F_x(\beta)/\partial t = C. \quad (10)$$

Time rate of change of time domain frequency $= \partial \omega/\partial t$ and Time rate of change of space domain frequency $= \partial \beta/\partial t$. Therefore, speed of time frequency domain power spectrum relative to the speed of space frequency domain power spectrum $= \partial \omega/\partial \beta$. Therefore, speed of impulse energy pockets =

$$\partial \omega/\partial \beta = (\partial F_x(\beta)/\partial \beta)/(\partial F_t(\omega)/\partial \omega) \times (\partial F_t(\omega)/\partial F_x(\beta)) = C^2 = \text{Group velocity of the waves}(V_g) \quad [7] \quad (11)$$

Therefore, velocity of impulse energy particles $= V_g = C^2$ is greater than the phase velocity of the electromagnetic wave (V_p).

Therefore, V_g , the velocity of impulse energy particles is the maximum velocity in the Universe. Therefore, this velocity must be taken as reference velocity instead of C in special theory of relativity for all relative velocities $V_g \geq C$ and the present postulates of the special theory of relativity [8] has to be modified accordingly. Actually, the current special theory of relativity contains a singularity at the point when the relative velocity (relative to C) is equal to C . Therefore, determination of accurate value of physical quantities of the special theory of relativity at this point becomes very complicated. Presence of singularities very often arises in physical theories due to unrealistic assumptions. In this way, quantum mechanics is integrated with the special theory of relativity.

Since $V_g = C^2$ and the velocity of electromagnetic wave is C , in $E = m C^2 = m_0 \cdot C^2/(1 - (v/C)^2)^{1/2}$, maximum velocity of the Universe, C must be replaced by C^2 and v by C for photons. So, the corrected equation for photons

$$E = m_0 \cdot C^4/(1 - 1/C^2)^{1/2} = m \cdot C^4 = h \cdot f \text{ and } m = m_0/(1 - 1/C^2)^{1/2}, m_0 = h \cdot f/C^4 \text{ and} \\ m = h \cdot f/(C^4 \cdot (1 - 1/C^2)^{1/2}) \quad (12)$$

As per the De Broglie's matter wave equation energy of a matter particle $E = mC^2 = h \cdot f$ where m is the mass of the particle [9]. Therefore, mass is just a state of energy with a wave of frequency f as defined by the De Broglie's equation. As per the standard model of cosmology, matter particles originated from highly energetic photons when the high temperature energy cooled down. High temperature radiation waves split into wavelets of lower energy, when the radiation cooled down and wavelets became matter particles [9]. This theory is verified by the De Broglie's equation. Therefore, matter particles are made up of electromagnetic waves of frequency f as defined by De Broglie's equation.

Therefore, all matter particles have particle velocity or phase velocity of the matter waves (V_p) and velocity of impulse energy pockets ($V_g = V_p^2$) like the electromagnetic waves. Therefore, in the special theory of relativity C must be replaced by $V_g = C^2$ and the velocity of the moving frame of reference with reference to the frame of observation must be replaced by $V_g = V_p^2$ for all relative velocities $V_p \geq C$. Therefore, energy equation for a matter particle is modified to

$$E = m \cdot V_g^2 = m \cdot C^4 \text{ since } V_g = C^2 \text{ and } m = m_0 \cdot C^4/\sqrt{1 - (V_p/C)^4} \text{ for } V_p \geq C \quad (13)$$

As per the discussion in the earlier paragraphs, exact value of energy of a photon = Energy of the impulse energy Pocket of a high frequency electromagnetic wave ($4hf^2$) \times Number of impulses within unit time (f) = $4hf^3$. Therefore, De Broglie's matter wave equation is modified to

$$4hf^3 = m.C^4 \text{ where } m = m_0.C^4 / \sqrt{1-(V_p/C)^4} \text{ for } V_p \geq C \text{ where } V_p \text{ is matter particle's velocity} \quad (14)$$

$$\text{Therefore, exact value of De Broglie's wavelength} = (4.h / (m. C))^{1/3} \quad (15)$$

This wavelength must be used in Schrodinger's wave equation [9].

V. CONCLUSION

Deterministic quantum theory of particles was explained by a discrete wave theory of energy. Then the origin of waves and particles of the universe was explained using modern theories of physics and cosmology. Energy of the electromagnetic wave is proved to be spread over a narrow band of frequencies at higher frequencies of electromagnetic spectrum. Therefore, velocity of energy or group velocity or velocity of photons or energy of matter particles is proved to be square of the phase velocity of the wave or matter particles. Energy spread over a narrow band of frequencies is proved to be travelling in the form of pockets smaller than the size of photons and therefore, exact value of energy of photon is calculated. Consequently, the special theory of relativity and the De Broglie's matter wave equation are modified as per the modified theory of particles.

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