PARTICLES AND FIELDS

Dr. John Daniel, D.Sc. degree researcher, Mumbai University, Mumbai, India.

Abstract: In part-I, structure and the dynamics of photons and matter particles are examined, enumerated and the existing contradictions in the quantum theory and special theory of relativity are explained as per the new theory formulated. All particles are proved be made up of electromagnetic waves and energy of the particles are distributed over a band of frequencies in the form of smaller pockets than the size of a photon. All particles are proved to exist only in discrete modes, irrespective of whether the particle is in motion or at rest. When the particle moves, electromagnetic waves of the particles move within the particles and jump to higher order energy states. Limitations of De Broglie's and Schrodinger's matter wave equations are also explained. In part-II, Velocity of the electromagnetic signal is proved to be much greater than the C= $3x10^8$ m/s in the regions close to the radiator. Velocity of a photon is proved to be square of the phase velocity of the electromagnetic wave. Gravitational force acting on an Einstein's particle and a general theory of fields are derived. An expression for finding number of photons present in a matter particle is obtained. A modified quantum field theory is formulated. The frequency and wavelength of matter wave when the matter particle is at static and dynamic conditions are discussed. Experiments to verify the theories presented are suggested at the end as concluding remarks.

Key Words: **Contradictions in quantum mechanics, Structure and dynamics of particles and formulation of new theory, Speed of electromagnetic signal, General theory of fields, Photons and matter particles, Modified Quantum Field Theory.**

I. INTRODUCTION

Since the time Christian Huygens (1629-1695), light was proved to be a wave and not as a particle as conceived by Sir Isaac Newton [1]. Then Max Planck's quantum law proved that energy behaves as particles. Based on Planck's law Albert Einstein proved the particle nature of light. Then later on Luis De Broglie and Erving Schrodinger proved the wave nature of matter particles. Therefore, particle behavior of light waves and wave behavior of matter particles were found to be new and created the problem of wave particle dual nature of light and matter particles. Since light was proved to be a wave for long period of time, photons and matter particles were conceived as particles associated with wave pockets and lead to the formulation of uncertainty principle of quantum mechanics [2]. Max Planck and De Broglie proved that energy is in the form of quanta. But in the formulation of uncertainty principle, waves are quantized. The quantization of waves or fields is not based on any valid proof and therefore, it is only an assumption.

Actually, this notion of wave pocket is incorrect since the wave pocket is assumed to be a wavelet of the wave and why and how the wavelet split from the wave is not explained in the case of light. Uncertainty principle also contradicts with the postulates of special theory of relativity. As per this postulate, speed of light in the free space is the maximum speed of the Universe. But as per the Uncertainty principle exact value of photon velocity can't be found.

Waves associated with particles were interpreted as probability waves by Max Born. Luis De Broglie and Erving Schrodinger proved these waves as physical realities. How can physical wave be described as a probability wave? Therefore, again a contradiction is created by the statistical interpretation of the quantum mechanics. Planck's law and the statistical interpretation of quantum mechanics also led to the violation of energy conservation laws in various optical phenomena and also by various laws and equations of quantum mechanics [3 4 5].

Recently, electromagnetic waves were proved to become discrete waves at higher frequencies and as a consequence, energy is proved to exist in the form of energy pockets and distributed over a band of frequencies. Accordingly, Planck's law, special theory of relativity, De Broglie's matter wave equation and the Schrodinger's wave equation were modified [3 4 5 6]. Therefore, in this paper, structure and dynamics of particles are examined based on the new quantum mechanical theory formulated and the contradictions in the currently available literature on quantum mechanics are removed.

Classical mechanics was founded and developed in terms of matter particles and the force/field generated by these particles. Electromagnetism was founded and developed in terms of electric charges and charged particles. Special theory of relativity was founded and developed based on the speed of matter particles as compared with the speed of light in absolute space. Quantum electromagnetism was founded and developed in terms of energy particles. Then quantum mechanics was founded and developed in terms of energy and matter particles. However, unlike the classical mechanics and electromagnetism, quantum electromagnetism and mechanics have failed to establish a proper relationship between the particles and fields. In the quantum theory, waves associated with the particles are interpreted as probability waves. How can physical waves be interpreted as mathematical waves? In electromagnetic field theory, fields behave as waves and energy behaves as particles at higher frequencies. Such a behavior led to the wave particle dual nature of light and matter. However, while formulating the uncertainty principle, waves or fields were localized or quantized even though energy was proved to be in quantum states. Therefore, the current literature on quantum mechanics and electromagnetism are filled with many contradictions, confusion and inconsistencies. As a consequence, quantum theory is not properly understood in terms of physical realities. The recently developed theory on quantum mechanics was derived from classical and continuum mechanics and electromagnetism [3 4 5]. Therefore, this theory eliminates many contradictions of the present day literature on quantum theory and proves that waves associated with the quantum particles are electromagnetic waves. Therefore, in the part-II, particles and the associated fields of the particles are analyzed based on the newly developed quantum theory and a proper relationship between particles and the fields are established.

II. PART-I: STRUCTURE AND DYNAMICS OF THE PARTICLES

2.1. Structure and dynamics of the particles [5 6]

As per De Broglie's wave equation $E = mC^2 = h.f$ and the velocity of the particle is $v = f.\lambda$. Therefore, $f = 0$, if the particle is at rest ($v=0$) and the mass $m = m_0$ = rest mass of the particle = 0. But this is obviously not true. Therefore, De Broglie's matter wave equation is invalid when the particle is at rest. Therefore, De Broglie's matter wave equation valid when the particle is at rest is $E = mC^2 = h/\lambda$ where $1/\lambda$ is the frequency of matter wave in the space domain (λ is the wavelength of the matter wave). If the De Broglie's matter wave relationship is applied to photons, the rest mass of the photon is $h/(\lambda.C^2)$. But if the electromagnetic wave is moving, $E = mC^2 = \infty$ and a singularity is created in the energy equation. Singularities are created due to unrealistic assumptions made while formulating or deriving and equation. Therefore, unrealistic assumptions were made in deriving the equation $E = mC^2$. Therefore, velocity of the energy particle (photon) must be different from the velocity of the wave. The photon is an energy particle and the electromagnetic field of the energy is a wave. Velocity of the energy particle (photon) (group velocity V_g) is proved to be different from the velocity of the wave (V_p phase velocity) at high frequencies [4]. This group velocity = $V_p^2 = V_g = C^2$. Therefore, velocity of a photon is the maximum velocity of the universe.

Moreover, particle or quantum behavior of electromagnetic energy indicates that electromagnetic waves are discrete at high frequencies or behaves as a train of impulses in space and time domains. Radiation theory of atoms at high frequencies also indicates the same. This means electromagnetic energy and waves at high frequencies is spread over a band of frequencies. Therefore, energy of a particle can't be measured by single or fundamental frequency. Therefore, photon energy must be calculated for the complete energy spectrum of energy pockets. Therefore, matter particle which is also a form of energy particle as per $E = mC^2$ can't be described by a single frequency. Therefore, in the special theory of relativity, phase velocity of light C must be replaced by the group velocity C^2 in $E = mC^2$ and the velocity of the matter particle must be replaced by V_p^2 (the group velocity of the matter wave or velocity of energy of matter wave) as per the modified De Broglie's matter wave equation. V_p is the phase velocity of the matter wave or velocity of the matter particle.

Therefore, matter or energy particle's energy is spread over a band of time domain or space domain frequencies depending upon whether the particle is in motion or at rest. At high frequencies, electromagnetic waves exist only in the form of impulse train in space and time domains. Therefore, as per Fourier theorem, this impulse train could be represented as a sum of sine and cosine waves of multiple frequencies or in the form of various modes in space and time domains. Therefore, energy of electromagnetic wave or matter particle or photons can exist only in the discrete states of energy, irrespective of whether a particle is in motion or rest. But as per Schrodinger's wave equation, modes for matter particles can't exist for freely moving matter particles in the absence of a potential well. Therefore, Schrodinger's wave equation is invalid for the case of freely moving matter particles.

Light exist always in the form of a long train of line segments and always seen in motion. But matter particles are finite and can move at different speeds in the same medium. Therefore, matter or energy particles must be in the form of electromagnetic impulse train of finite length. Since the energy of the particles travel with twice the phase velocity of the electromagnetic waves of the particles within the finite and very small dimensions of the particles, the waves must be travelling within the length of the particle by means of multiple reflections. Therefore, particles are represented by sum of Fourier modes in the space – time structure. Therefore, representation of particles by single frequency is only an approximate representation. Planck's quantum law, De Broglie's matter wave equation and the Schrodinger's wave equation are based on the assumption that particle is associated with a single frequency wave. This assumption is responsible for statistical interpretation of wave function and the formulation of uncertainty principle.

As per Euler's theorem, each sine or cosine wave function could be represented by sum or difference of two complex exponential and oppositely phased functions. Therefore, a particle is made up of combination of two series of oppositely phased sine and cosine electromagnetic wavelets within the size of the particle. These Fourier energy mode waves are at stationary state when the particle is at rest and circulates within the length of the particle at the speed of group speed ($V_g = V_p^2$), if the particle moves with the speed V_p. Electromagnetic field waves are moving at the speed of the particle or at the phase velocity of the wave V_p. Therefore, a particle is simply a combination of electromagnetic mode wavelets made as per Fourier theorem and these wavelet folded many times within the particle size is stationary when the particle is at rest and circulates within the length of the particle when the particle is in motion.

In the formulation of Schrodinger's wave equation, the matter wave associated with the particle is assumed to be spread over the path of travel of the particle and if the particle is trapped in a potential well, multiple reflections of the particle at the boundary is responsible for generating modes. The current impulse train generated by the charged particles also generates modes spread over the path of motion of the particle. Therefore, the assumption made in formulating Schrodinger's wave equation combines current modes generated with the internal energy modes of the particle into a single frequency wave function. Because of this assumption and combining two summations of modes generated as a consequence in formulating the Schrodinger's wave equation, statistical interpretation of quantum mechanics and formulation of uncertainty principle became necessary.

III. PART-II: A THEORETICAL ANALYSIS OF PARTICLES AND FIELDS

3.1. Velocity of the photons [9]

The average power flow from an isotropic radiator = $P(r, t) = P_0/4\pi r^2$, where P_0 is the total power radiated by the source and r is the radial distance of a photon from the source. P(r, t) is also equal to the time rate of change of average energy at the point (r, t). Therefore, $P(r, t) = P_0/4\pi r^2 = dE/dt = dr/dt = V^2$ (1)

= Group velocity or velocity of the energy = speed of photon. Notice that the speed of the photon declines with r and t due to the divergence of energy with the r and t from the source. The average electric field radiated = $F(r, t) = (\eta.P(r,t))^{1/2}$ where η is the intrinsic impedance of the medium $= (\eta. P_0/4\pi)^{1/2}(1/r) = \sqrt{\eta}\, V$ (2)

where V is the phase velocity of the electromagnetic wave. In the far field region

$$V(r, t) \approx C = 3x10^8 \text{ m/s} \quad (3)$$

Therefore, only for plane wave propagation, C is approximately constant and equal to $3x10^8$ m/s. Similarly, the group velocity or the velocity of energy or a photon in a cylindrical wave propagation = $P_0/2\pi rl = dE/dt = dr/dt = V^2$ (4)

where l is the length of the cylinder and the phase velocity of the wave is

$$V = (P_0/2\pi rl)^{1/2} \approx C \text{ (in the far field region)} \quad (5)$$

Therefore, the speed of an electromagnetic signal is greater than C in the regions close to the source of the radiation. This theoretical proof may be verified by measurements in the near field regions of an atomic or nuclear or spark radiations or a long wire antenna or an isotropic light source or an isotropic radiator.

3.2. Field acting on an Einstein's particle [7]

In the previous paper [8], field acting on a photon due to the pressure exerted by the source was discussed. In this section field acting on an Einstein's particle is discussed. The field acting on a particle = the acceleration of the particle = $d^2x/dt^2 = dv/dt$, where x is the distance travelled by the mass and v is it's velocity. From the special theory of relativity, energy of a particle $E = m.C^2 = m_0C^2/(1 - (v/C)^2)^{1/2}$ where m_0 is the rest mass of the particle. Therefore,

$$dE/dt = m_0 v.\, dv/dt.(1 - (v/C)^2)^{-3/2} \quad (1)$$

Therefore, the acceleration of the particle from the above equation $= dv/dt = dE/dt.(1 - (v/C)^2)^{3/2} \cdot (1/m_0v)$ = Field acting on Einstein's particle (2)

dE/dt is the velocity of the energy of the particle $= v^2$ (3)

Therefore, Field acting on Einstein's particle $= v.(1 - (v/C)^2)^{3/2} \cdot (1/m_0)$ (4)

If the field acting on the particle is gravitational field, then $v.(1 - (v/C)^2)^{3/2} \cdot (1/m_0) = G.M/r^2$ (5)

where G is gravitational constant and M is the mass of the particle at a distance r from the particle of rest mass m_0. The equation (5) could be written in the following form.

$$X^4 - 3X^3 + 3X^2 - X + (K/(\sqrt{C}.r))^4 = 0 \quad (6)$$

where $X = (v/C)^2$ and $K^2 = G.M.m_0$. The equation (6) is a fourth order algebraic equation and therefore, it will have 4 solutions for X. The solutions will be directly proportional to $1/r^n$ where n is a number. Therefore, the field dv/dt will also be directly proportional to $1/r^n$. As is well known the Newton's gravitational field is directly proportional to $1/r^2$ and Einstein's gravitational field is directly proportional to 1/r (Space r and field are equivalent as per the general theory of relativity). All matter particles are made up of atoms. The simplest model of an atom is an electromagnetic dipole radiator of field. This dipole field is directly proportional to $1/r^3$. By mathematical induction the fourth solution for gravitational field is directly proportional to $1/r^4$. An atom in general is made up of many orbiting electrons and many nuclear particles. Therefore, a body of mass M could be modeled as an array of electromagnetic dipoles placed very tightly close to each other at a point in the space. Therefore, the field radiated by a particle of mass M could be written as $\sum K_n/r^n$, where n is an integer varies from 1 to infinity and K_n are proportionality constants. Therefore, total nuclear field is directly proportional to $1/r^n$ where n varies from 3 to infinity. The maximum value of n for a body of mass M depends on the mass M and on the number of electrons, nuclear and sub nuclear particles of the atoms of the matter of mass M.

3.3. Photons and the matter particles

As per the De Broglie's matter wave relationship and the particle physics theory, matter particles originated from photons or energy. The photon velocity is proved to be the square of the phase velocity of the electromagnetic waves in the previous section. Due to this velocity difference, all particles are proved to be made up of electromagnetic wavelets of multiple folds. Photon energy as per Planck's law is h.f where h is Planck's constant and f is the frequency of the electromagnetic wave. Distance travelled by a photon per unit time = speed of a photon = C^2 (for a plane wave propagation).

Therefore, the energy density of a photon = $h.f/C^2$ since power flow per unit surface area normal to the direction of propagation is approximately equal to h.f (as per the Poynting theorem of classical electromagnetism) (1)

Since the matter particles originated from the photons, matter particles are made up of photons and the photon density must be equal to the density of a matter particle. Therefore, $hf/C^2 = \rho.C^2$ (Special theory of relativity) where ρ is the density of the matter particle (2)

But as per De-Broglie's matter wave equation energy of a matter particle = $E = h.F = mC^2$ where F is the frequency of the matter wave

(3)

Since a matter particle is made up of many photons as explained in the previous lines, the De Broglie's equation is, Energy of a matter particle = $E = mC^2 = nh.f$ where n is the number of photons in a matter particle and f is the frequency of the photon (4)

De-Broglie assumed that n.f = F = frequency of the matter wave. Therefore, in this way De-Broglie's assumption and equations also proved to be correct.

Therefore, the energy density of a matter particle = $\rho C^2 = hF$ per unit volume of matter particle = nhf per unit volume of the matter particle = hf per unit volume of a photon = Energy density of a photon = hf/C^2 (5)

Therefore, equation (2) is derived from De-Broglie's matter wave equation also. As per the Newton's law, a matter particle radiates gravitational field. Therefore, matter particle's energy is partly stored in the matter particle and partly in the gravitational field radiated by the matter particle. Therefore, the energy of a matter particle = $n.h.f = mC^2$ + the energy stored in the field radiated by m. Therefore,$h.f=(m/n).C^2$+the energy stored in the field radiated by m/n (6)

In the equation (6), $(m/n).C^2$ is the energy stored in the mass of single photon (m/n) of the matter particle. Therefore, Energy of a Photon = hf = Energy stored in the rest mass of the photon + Energy stored in the field radiated by the photon of the mass m/n. Therefore, energy of a gravitational field photon = $h.f - (m/n).C^2$ where m/n is the rest mass of a photon in the matter or n X Energy of a gravitational field photon = $h.F - m.C^2$ = Energy stored in the gravitational field radiated by a matter particle (7)

Energy density of the gravitational field = $K. E_g^2$ where K is proportionality constant and E_g is gravitational field radiated by the mass m. As per the Newton's law $E_g = G.m/r^2$ where G is the gravitational constant.

Therefore, energy stored in the gravitational field radiated by the mass m = $\int K.E_g^2 dv$, where the integration is performed over the volume in which the field is having non zero value (approximately) as the radius of the sphere of radiation tends to infinity (8)

By substituting the Gravitational field value into the equation (8) and performing the integration, we get, $h.F - m.C^2 = \int K.E_g^2 dv = K.4\pi G^2m^2/r_0$ – the energy stored in the field at the location of the mass m (as per the Newton's law, a singularity is created at this point, but as per the special theory of relativity this energy is equaltom.C^2) (9)

Therefore, from the equation (9) we get, $h.F = K.4\pi G^2m^2/r_0$ (10)

Therefore, De-Broglie's matter wave frequency $F = K.4\pi G^2m^2/(h.r_0) = n.f$ (11)

If the frequency of the field photon f is known, number of photons present in a matter particle could be calculated by using equation (11). The method of finding the value of f is described in the next section. By comparing Newton's law with the Coulomb's law charge-mass relationship could be established and equations similar to (2) – (11) could be obtained for electric and magnetic fields.

3.4. Modified quantum field theory [6 10 2]

As per the Planck's law of quantum mechanics, only energy exists in discrete states. Therefore, quantization or localization of field, while formulating uncertainty principle is not supported by any experimental or observational evidences. Moreover, quantum behavior of the waves and the wave behavior of matter particles could be explained by the discrete nature of waves at higher frequencies [3].

Therefore, quantum field theory is modified in this section. The static energy density of an electric field = $\varepsilon E^2/2$ (1)

where E is electric field intensity and ε is permittivity of the space. Energy density of the photon is $h.f/C^2$ as derived in the earlier section, where $f = 1/\lambda_0$, λ_0 is the photon wavelength when the photon is at rest. Therefore, $h.f/C^2 = \varepsilon.E^2/2$ (2)

From the equation (2), λ_0 value could be obtained. From the special theory of relativity, $E = m_0.C^2 = h/\lambda_0$ and therefore, rest mass of the photon value could be obtained (3)

Equations similar to (1) – (3) could be obtained for gravitational field by comparing Newton's law with the Coulomb's law.

Similar equations could be obtained for magnetic fields also from magnetic field energy density = $\mu.H^2$ where H is magnetic field intensity and μ is the permeability of the medium (4)

In this way, the photon energy of all fields could be found and quantum field theory could be developed. By applying same theory, all particles and the structure of the nucleus could be studied. This quantum field theory is based on energy quanta and not based on the quantization of the fields. The concept of field/wave quantization/localization led to formulate uncertainty principle and the statistical interpretation of quantum mechanics [2].

3.5. Frequency of the matter waves and rest mass of the photon

A matter particle is made up of many folds of electromagnetic wavelet. If the speed of the particle is zero, f = 0 since v = f. λ. As per the De Broglie's matter wave equation $E = mC^2 = h.f$. Therefore, the rest mass of a matter particle is $m_0 = h/C^2.\lambda_0$ where λ_0 is the rest mass matter wavelength.

If the matter particle is at motion, $v > 0$, $f > 0$ and $\lambda < \lambda_0$. $E = E_0/(1 - (v/C)^2)^{1/2} = h.f$ where $E_0 = m_0.C^2 = h/\lambda_0$ the rest mass energy (1)

Since $v = f.\lambda$, from the equation (1), we get, $\lambda = \lambda_0 v(1 - (v/C)^2)^{1/2}$, $f = 1/ (\lambda_0 (1 - (v/C)^2)^{1/2})$ (2)

The speed of a photon is C^2 where C is the phase velocity of the particle or electromagnetic wave.

Therefore, $E = mC^2 = m_0 C^4/(1 - (C/C^2)^2)^{1/2}$ (3)

Since $E = h.f$, the rest mass of the photon = $m_0 = (h.f/C^4).(1 - (1/C)^2)^{1/2}$ (4)

IV. CONCLUSION

All particles could be mathematically described by periodic travelling or stationary or standing waves and therefore, represented by Fourier series form. Therefore, if a particle is at rest, it could be described by a periodic wave in space domain and therefore, by space domain Fourier modes (Ground state modes or modes when particles are at rest). If the particle is at motion, a travelling electromagnetic wave in time domain is generated by the speed of the particle and therefore, modes of the particle pushed up to the higher levels. Notice that as per Euler's theorem and Fourier series, all particles of the Universe could be described by electromagnetic wave modes of opposite phases. This fact implies that the present day Universe originated from the expansion and contraction of electromagnetic energy at the initial phases of development of the material world.

The atomic and nuclear radiations are due to the quantum jumps of the particles between different energy states at almost zero time. But the distance between different orbits is finite and is very small. Therefore, speed of electromagnetic radiations close to the atomic electrons or nuclear particles are very larger than 3×10^8 m/s. This theoretical proof may be verified in the near field regions of nuclear radiations and radiators or in particle collider or in spark radiations of high voltage electrodes. This theoretical proof could also be experimentally verified by measuring the speed of the wave in the near field regions, radiated by a long wire antenna at low frequencies. A long wire antenna at low frequencies could be equated to a cylindrical radiator. Low frequency measurements could be carried out with greater accuracy as compared with high frequency measurements in the absence of high precision instruments at high frequencies. Similar measurements could be carried out in the near field regions of a hertz radiator at low frequencies which is close to an isotropic radiator. The formula derived for De Broglie's matter wave frequency could be verified from the results of De Broglie's classical electron diffraction experiment.

REFERENCES

[1]. George Gamow and J.M. Cleveland, "Physics-Foundations and Frontiers" Prentice hall of India Pvt. Ltd., New Delhi, 1989. pp. 371-374.

[2]. Halliday, Resnick and Krane, "Physics" John Wiley and Sons, Singapore, 4th Edition, Vol.2 Extended, 2000. pp. 1021-1065, 1043-1065, 903-980.

[3]. John Daniel.2019. Deterministic Quantum Theory. JETIR

[4]. John Daniel.2019. Velocity and Energy of Particles. JETIR.

[5]. John Daniel.2019. Fundamentals of Deterministic Quantum Mechanical Theory. Submitted to JETIR

[6] Robert Eisberg and Robert Resnick, "Quantum Physics", John Wiley & Sons, Singapore, 2003, pp.1-175.

[7]. Halliday, Resnick and Krane, *"Physics"*, pages 467-487, John Wiley & Sons, Vol.1, 4th Edition, Singapore, 2000.

[8]. John Daniel, "Radiation Theory of the Fields" Submitted to Journal of Experimental and Theoretical Physics, Russia.

[9] E. Jordan and K. Balmain, *"Electromagnetic Waves and Radiating Systems"*, pages 317-322, Prentice Hall of India Pvt. Ltd., 2009.

[10]. William Hayt, "*Engineering Electromagnetics"* pages 106-110, 296-298, Tata McGraw-Hill Edition, 5th Edition, New Delhi, 1992.