DETERMINISTIC QUANTUM THEORY

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

Abstract: In the part-I of the article, Planck's law of the quantum mechanics was speculated to explain the experimental results of radiation. This law is derived by applying the classical theory of propagation of electromagnetic waves and also the law is proved to be only an average law. By applying the same classical theory exact value of the photon energy is also derived. Finally, how the atoms radiate discrete electromagnetic waves is also explained. In the part-II of the article, a deterministic quantum theory of the particles is developed based on the classical electromagnetic theory and mass-charge equivalence principle. The interaction of electron with the discrete electromagnetic field is also enumerated.

Index Terms: **Classical physics, quantum mechanics and deterministic interpretation.**

I. INTRODUCTION

Quantum mechanics begins with the law speculated by Max Planck [1] [2]. This Max Planck's fundamental law of quantum mechanics is derived using Poynting's theorem of electromagnetism [3] [4] [5] [6]. This Planck's law is derived from average energy formula. Then actual Photon energy is derived. This relationship is non linear function of frequency, whereas Planck's law is a linear function of frequency which was derived from average energy formula. These equations are valid for uniform plane electromagnetic equation [7]. For cylindrical and spherical waves [7], photon energy varies inversely with distance of propagation and it's square respectively. Planck's linear law of photon energy also varies inversely with distance and square of distance for cylindrical and spherical waves respectively. This derivation of exact value of photon energy from Poynting theorem of electromagnetic wave propagation integrates the continuum mechanics with the quantum mechanics. This derivation of exact value of photon energy also disproves the Heisenberg's uncertainty principle [1] [2]. In the last section, quantum theory of radiation is derived from the continuum theory of radiation [1] [2] [7] [8] [9].

In the part-I of the article, continuous electromagnetic waves are proved to become discrete waves at higher frequencies [2]. Quantum laws were derived from such discrete waves. In the last section, how the atoms radiate such high frequency discrete waves is explained. If such quantum laws are deterministic, Schrodinger's wave mechanical equations should be deterministic. In the part-II of the article the quantum mechanics as applicable to the atomic particles are proved to be deterministic.

One of the merits of the classical physics is it's stronger relationship with the physical world while formulating, finding solution and interpreting the differential equations of any problem. But in quantum mechanical theory, the physical world problem is translated into quantum world problem and then solutions are found. Finally, the solutions are interpreted in terms of the physical world. But the equations of the quantum world are not yet understood in terms of the physical world. Due to this complexity, advancement of physics beyond certain limit is blocked. Therefore, derivation of quantum mechanical theory from the classical theory is required for understanding of the mathematical equations, interpretation of the theory in terms of physical world, gaining insights and further advancement of physics.

Therefore, in the part-II of this article, a deterministic quantum theory of the particles is developed based on the classical electromagnetic theory and mass-charge equivalence principle. The interaction of electron with the discrete electromagnetic field is enumerated. First mass-charge equivalence principle is established by comparing the Newton's gravitational force law and the Coulomb's electric force law. Then deterministic quantum wave mechanical equations are formulated from the classical physics in the next sections. Quantum solution to the deterministic wave mechanical equations is obtained by three methods in the subsequent sections. In the final section interaction of electrons with the electromagnetic waves of high frequencies is explained.

II. PART-I: EXACT VALUE OF PHOTON ENERGY AND QUANTUM RADIATION OF ATOMS

2.1 Planck's Law and wave-particle dual nature of light [1][2][3][4]

The 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 [5], power flow per unit area on the monochromatic plane wave is proportional to $A^2\sin^2\omega t$ for one dimensional wave propagation, where ω is angular frequency of monochromatic wave and A is amplitude of the sine wave. Time average of this energy flow is equal to frequency times H where $H = 1/2 .T.A^2$ where T is the period of the wave. At high frequencies, T/2 becomes very small as compared with A^2 in the equation for H and as the frequency increases the change in A^2 does not change the value of H significantly. Therefore, energy is directly proportional to the frequency. The constant of proportionality is Planck's constant. Therefore, Planck's constant is only an approximate value.

Therefore, at higher frequencies, electromagnetic waves become discrete waves [6] At lower frequencies, electromagnetic waves behave like continuous waves. The time period and therefore, the frequency of discrete waves is same as that of continuous waves. These discrete waves (approximate high frequency continuous waves) in time domain therefore, have continuous and periodic power frequency spectrum as per Fourier theory. Therefore, at higher frequencies electromagnetic waves have a continuous and periodic energy spectrum. Therefore, energy exists in the form of pockets or particles. We call these pockets of energy as quanta as the name was given by Max Planck. At lower frequencies, the electromagnetic waves are continuous and periodic functions in time domain. Therefore, their energy spectrum in frequency domain is discrete and periodic functions.

Planck's law of photon energy is valid only for uniform plane wave propagation. For cylindrical and spherical waves, Planck's law varies inversely with distance of propagation and it's square respectively. These Planck's linear laws were obtained from average energy formula at the source point and the same formula is valid at any point from the source point.

2.2 Actual photon energy [7]

For uniform plane electromagnetic wave propagation, as per Poynting theorem, power flow per unit area at a point is $A^2Sin^2(\omega t)$ at the source point (r=0). Therefore, energy flow over a period of one second at the source point is $A^2Tf/2.(1 – Sin(2\omega)/2\omega) \approx hf.(1 – Sin(2\omega)/2\omega)$ where $h = A^2T/2 \approx$ Planck's constant since T is very small in such a way that variation of A^2 does not changes $A^2T/2$. This energy flow is actual energy of the photon. Photon energy at a distance from the source point is hf. $(1 – Sin (2.(k.r – \omega))/2\omega)$ where r is the distance of propagation of the plane wave from the source point. So, photon energy for an uniform plane wave propagation is a non linear function of frequency and the distance of propagation. For cylindrical wave propagation photon energy varies inversely with the distance of propagation in addition to the variations as per hf. $(1 – Sin (2.(k.r – \omega))/2\omega)$. For spherical wave propagation, photon energy varies inversely with r^2 in addition to variations as per hf. $(1 – Sin (2.(k.r – \omega))/2\omega)$.

Maximum value of the Sinc function in the above equation is 1 and that occurs when $\omega = 0$. Therefore, at low frequencies Sinc function can't be neglected as compared with 1. But at high frequencies, Sinc function can be neglected and the photon energy reduces to that of Planck's energy. Therefore, Planck's value of Photon energy is only average value. This derivation of exact value of photon energy from Poynting theorem of electromagnetic wave propagation integrates the continuum mechanics with the quantum mechanics. Therefore, quantum mechanics of high frequency electromagnetic radiation is about the energy of electromagnetic waves. Since Planck's quantum law is an average value of the actual photon energy, quantum particles behaves in random fashion and lead to statistical interpretation of quantum mechanics [1] [2]. This derivation of exact value of photon energy also disproves the Heisenberg's uncertainty principle [1] [2]. This exact value of photon energy may be useful in the analysis and reduction of noises in photo electronic and electronic devices and circuits.

2.3 Radiation Theory of Atoms [1][2][7][8][9]

Actually, Planck speculated his quantum energy law from the spectral radiations of atoms /back bodies. Then the theory was applied to explain photoelectric effect and atomic particles behaviors. Therefore, in this section, quantum theory of radiation is derived from the continuum theory of radiation.

As per atomic theory of quantum mechanics, if electrons orbiting in an orbit gains sufficiently more energy than the energy corresponds to it's orbit, the electron jumps to the higher energy state and the energy gained is radiated as photons when the electron goes back to it's lower energy state from the higher energy state. Therefore, $E_n – E_m = h.f$ where E_n is energy of n th state and greater than E_m where E_m is energy of m th energy state of the electron. All systems have transient and steady states. Therefore, this quantum radiation must be steady state radiation. Since Planck's quantum law was derived from the continuum electromagnetic theory, the quantum radiation law of atoms may be derived from continuum mechanics.

Let us assume that a capacitor of capacitance C is charged to a potential V. Therefore, C = Q/V where Q is the charge stored in the capacitor at the potential of V. If this charged capacitor is connected to another capacitor of capacitance C with zero charge, the new capacitor gets charged to the value of Q/2. Therefore, total energy stored in the circuit at the steady state condition is equal to ½. $C.V^2/2$ whereas the initial energy stored in the first capacitor is ½ $C.V^2$. Therefore, the remaining energy is radiated into the space.

Electromagnetic radiation is possible only at higher frequencies and not possible if the current flow is constant. Therefore, radiation must have occurred during the transient state of the system. The transient current flow in the circuit is given by I_0e^{-at} where I_0 is initial current and a is a constant (very large number). The power frequency spectrum is given by $I_0^2/(a^2+\omega^2)$. Therefore, this transient current is composed of current waves of finite, continuous and multiple frequencies. This type of radiator is called as a Hertzian radiator in the radiation theory of antennas [6]. The field radiated is directly proportional to $Sin(\omega t)$ in a specified direction and at a particular distance. Therefore, exact value of photon energy could be derived like in the previous paragraphs.

The jumping of electron from lower state of energy to higher energy state and jumping back to the lower energy state comparable to charging and discharging phenomenon of capacitors in the electrical circuit considered in the previous paragraphs. Electron current in any particular orbit of the atom at a particular point could be described as a periodic impulse function of time. The frequency spectrum of this impulse train will be a periodic and continuous function of frequency. This period of the current impulse train is l/v where l is the circumference of the orbit and v is the linear velocity of the electron. If we assume the orbit to be circular like in Bohr's atomic model, $l = 2\pi r$ where r is the radius of the orbit. The frequency of the electronic impulse current train at a point in the nth orbit is $f_n = v_n/l_n$ and similarly frequency of the current train in mth orbit is $f_m = v_m/l_m$. Therefore, the frequency of the radiated wave depends on the parameters l and v. Therefore, energy of the photon emitted by the electron is $h.f_{nm} = h.(f_n – f_m) = h.(v_n/l_n – v_m/l_m) = E_n – E_m$ (like in Hertzian dipole), if the jumps are between n th and m th states. E_n and E_m are the photon energies of the electron current in nth and mth states of the electron.

III. PART-II: DETERMINISTIC QUANTUM MECHANICS

3.1 Mass and the charge Equivalence [8 10]

Mass and Charges are proved to be equivalent sources of fields, if we compare the Newton's Law of gravitation [10] with the Coulomb's law of electricity [8]. Electric Charge is equal to $\sqrt{G4\pi\varepsilon}$ X Mass. This relationship establishes the link between fundamental units of electric and gravitational fields. This is another evidence to prove that space is not curved.

3.2 Deterministic wave mechanical equations [7]

Consider a charged particle moving in an electromagnetic wave field as described by the following wave equations (1) and (2). The field acting on the particle could be expressed by Newton's force law and Lorentz's force equation, as per the mass charge equivalence principle. These well known equations are listed in the following lines.

$$\nabla^2\mathbf{E} = -(\omega/C)^2\mathbf{E} \quad (1)$$

$$\nabla^2\mathbf{H} = -(\omega/C)^2\mathbf{H} \quad (2)$$

Lorentz force acting on a moving particle of charge

$$Q = \mathbf{F} = Q(\mathbf{E} + \mathbf{v} \times \mathbf{B}) \quad (3)$$

where **E, H** are electric and magnetic field intensities acting on the particle of charge Q, ω and C are angular frequency and speed of the electromagnetic wave. $\mathbf{B} = \mu.\mathbf{H}$ and **v** is the velocity of the particle. Therefore, as per the Newton's law

$$\mathbf{F}/Q = d\mathbf{v}/dt = (\mathbf{E} + \mathbf{v} \times \mathbf{B}) \quad (4)$$

3.3 Solution of deterministic wave mechanical equation I

By Newton, Coulomb's law of forces and the mass-charge equivalence principle, all matter and (electric and magnetic) charge particles could be considered as highly concentrated electric or magnetic or gravitational fields. Therefore, all particles of the universe are made up of electromagnetic wavelets. De Broglie's matter wave equation also confirms this reasoning [1]. Therefore, a cycle or half cycle of electromagnetic wave is the most fundamental unit of the material universe. Therefore, all particles of the material universe could be mathematically expressed by multi periodic Fourier series. Therefore, a particle could be described as an array of dipoles.

Due to the potential difference between the poles, the electromagnetic wavelets or dipoles can't be in a stationary state. Therefore, the ends of electromagnetic wavelets in the particles must have been connected to form a loop and waves must be moving in the closed loop path. Such a dynamic system creates normal modes of electromagnetic waves. Therefore, matter or charge particles can exist only at discrete states of energy or field.

As discussed in the previous lines, all particles could be expressed by normal mode electromagnetic waves or discrete waves. Since the particle is made up of electromagnetic wavelet and the wavelet is moving in a closed path, the external field acting on the particle will increase the frequency of the internal field of the particle and therefore, goes to the higher energy state. Since the external field acting on the particle is also radiated by some other particle and all particles are made up of normal mode electromagnetic waves, the external field acting on the particle is also in normal mode form or discrete form. Therefore, the velocity and the distance travelled by the particle also in the discrete states. Therefore, as per the charge-mass equivalence principle, all particles of the universe can exist only in the discrete states of the space.

3.4 Solution of deterministic wave mechanical equation II

The above described theory of deterministic quantum mechanics could be explained by applying waveguide theory. An atomic particle is made up of a nucleus and electrons revolving around the nucleus. Since a nucleus is made up of many sub nuclear particles and all the particles are very closely packed, a nucleus could be modeled as a three dimensional array of electric dipoles. Due to the magnetic field produced by the electronic current and the movement of particles within the nucleus due to potential difference in the nucleus, nucleus is radiating electromagnetic waves of all orders. Therefore, electrons of an atom are moving in the electromagnetic field radiated by the nucleus. The equipotential closed surface on which electrons are moving around the nucleus and the outermost surface of the nucleus could be considered as the walls of a spherical waveguide. The electromagnetic waves due to the nucleus and the electronic current in the waveguide could be considered as normal mode waves travelling in the waveguide. Therefore, Lorenz's and Newton's force equations which describes the path of the electron will have discrete states.

3.5 Solution of deterministic wave mechanical equation III

Consider a beam of electrons moving in a constant field E and potential function V. Assume that the magnetic field acting on the electronic beam is zero. Therefore, equation (4) is reduced to the following equation.

$dv/dt = d^2x/dt^2 = E = - d\rho/dx$ (5)

where x is the distance travelled by an electron from the cathode and ρ is the electric potential at the distance x from the cathode. The equation (5) could be written as,

$-v.dv/dt = d\rho/dt$ (6)

By integrating the equation (6) we get,

$\rho - \rho_0 = ½ (v^{1/2} - v_0^{1/2})$ (7)

where ρ_0 and v_0 are initial values of ρ and v respectively. Since ρ and v are functions of x and t the electrons of the beam are accelerated and therefore, they radiate electromagnetic waves. These radiated electromagnetic waves will go through multiple reflections between the boundaries (anode and cathode) of the beam or potential well. Such multiple reflections will produce normal modes of electromagnetic waves. Similarly, electrons of an atom are trapped in a potential well and therefore, the orbiting electrons generate normal modes. Similarly, the light beam passing through the plasma generates normal modes (discrete states) to the electronic movement. Similarly, free electrons of conductors also generate normal modes. The theory of waveguides is also applicable in all cases of quantum behavior of electrons. Since the electrons generate normal modes of electromagnetic waves, the electrons will have discrete states as per the equation (4).

3.6 Solution of deterministic wave mechanical equation IV

The dynamics of an electron in a electromagnetic field is described by electromagnetic wave equation, Lorentz's force equation and Newton's law. In this system, electron's boundary defines the boundary conditions for electromagnetic field equations. Since the electron is in the state of motion, boundary of the problem is also moving. The motion of the electron is guided by the field acting on the electron. Therefore, the motion of the electron will be a periodic function of time and space. The motion of the electron generates a impulse electric current in the space. This impulse electric current produces impulse electromagnetic field. In other words, the electromagnetic waves incident upon the boundary of the electron is scattered. In other words, electron radiates pockets of electromagnetic fields or energy over a narrow band of frequencies. In the four dimensional space and time structure, the motion and radiation of the electron could be expressed by a four dimensional discrete electromagnetic wave. Therefore, the radiation of the electron could be expressed by Fourier series modes. In other words, the radiation of the electron in four dimensional space and time is quantum electromagnetic radiation.

The direction of the electronic motion changes with time and distance periodically. Therefore, direction of the radiated or reflected electromagnetic field also varies periodically in space and time while the electron is moving in the direction of electromagnetic wave motion. As explained in the previous section, the electromagnetic field acting on the electron itself is in discrete form at higher frequencies of radiation. Therefore, the velocity and the distance travelled by the electron will be in discrete states as per the equation (4).

IV. CONCLUSION AND FUTURE WORK

In part-I, it was proved that at high frequencies continuous waves behave like discrete waves and from that fact Planck's law was derived. Planck's law was proved to be an average photon energy law and therefore, exact value of the photon energy was derived. This discrete light wave or high frequency wave is radiated by the atoms. So, in the next section how the atoms radiate discrete waves was explained

In part-II, Deterministic wave mechanical equations were formulated by combining electromagnetic wave equations, Lorenz's force equation and Newton's law of force. Then the solution to wave mechanical equations were obtained by applying electromagnetic and gravitational field theories, normal mode waveguide theory, electric field and potential functions and discrete electromagnetic field theories.

In the part-II of this article, probability waves of Schrodinger's wave equation are proved to be electromagnetic waves. The Schrodinger equation demands potential functions to determine the quantum solutions. General potential functions to determine the quantum states of the nuclear and sub nuclear particles are not available in the current literature. So, a general unified field theory which integrates all fields of the nature will be derived in the future work. Application of the theory developed in the fields of nuclear and astrophysics and cosmology will also be explained.

After developing special and the general theories of relativity Albert Einstein attempted to integrate the gravitational field with the electromagnetic field. Since general theory was developed in Riemann's space and the electromagnetic theory was formulated in Euclid's space, the unified field theory developed by Albert Einstein was complicated and also not popular. Later on weak and strong nuclear forces were found and quantum field theory of elementary particles was developed. By applying the quantum field theory, electromagnetic fields were integrated with weak nuclear forces. The same theory was applied to integrate the strong nuclear forces also. But so far no complete unified theory of fields is developed. Therefore, in the future article, a simple, general and deterministic theory of fields which integrates all known and unknown fields will be developed. Application of the theory developed to study the nuclear structure will be explained. The unified theory developed will be applied to study the stars and the origin and the development of the material universe.

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