FUNDAMENTALS OF DETERMINISTIC QUANTUM MECHANICAL THEORY

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Abstract: In part-I, well known quantum energy states of the electrons are derived from the classical continuum mechanics. At the end Schrodinger's matter wave equation is derived from the electromagnetic wave equation. In part-II, exact value of photon energy is derived. Introduction of Planck's constant in the photon energy formulae derived contradicts many physical laws and principles. Introduction of the Planck's constant is also responsible for statistical interpretation of quantum mechanics. These statements are proved in the many cases of physical phenomenon.

Key Words: **Integration of quantum mechanics with the continuum electromagnetism, Planck's constant, Photon Energy, Statistical interpretation.**

I. INTRODUCTION

In part-I, Electromagnetic field and energy are proved to be radiated in the form of smaller pockets (smaller than photons) of impulse energy spread over a narrow band of frequencies centered at the frequency of impulse train of the field. Therefore, photon energy radiated [1] [2] [3] [4] by atoms is proved to be only approximate values and physically exact value of the photon energy radiated is derived. In the previous article, quantum theory of radiation is derived from the continuum theory of radiation [5]. However, well known quantum energy states of the electron were not derived from the classical continuum mechanics. In another paper the velocity of a photon is proved to be square of the phase velocity of the electromagnetic wave [6]. In this article, by combining the theories of these two articles, well known quantum energy states of the electrons are derived from the classical continuum mechanics. At the end Schrodinger's matter wave equation is derived from the electromagnetic wave equation [1][2][3].

Actually, Planck speculated his quantum energy law from the spectral radiations of atoms /back bodies [1] [2] [3]. Then the theory was applied to explain photoelectric effect and atomic particles behaviors. However, the radiation theory of atoms as proposed by Albert Einstein and Neil's Bohr assumes that radiation is in the form of photons of single frequency. But the following theory proves that the radiation is in the form of smaller impulse energy pockets in which energy is spread over a narrow band of frequencies centered at the frequency of impulse energy train (Planck's photon frequency). Therefore, photon energy as defined by Planck's law is only an approximate value. Therefore, first atoms are proved to be radiating discrete pockets of energy spread over a narrow band of frequencies. Then the current flow and the field produced by the electrons in the atomic orbits analyzed and from such analysis, electrons are proved to exist only in certain discrete states of energy or orbits. Finally, Schrodinger's matter wave equation is derived from electromagnetic wave equation.

In part-II, Average and exact energy formulae of a photon for fundamental and complete band of frequency of quantum radiation are derived from continuum electromagnetic principles. Then the validity of these formulae are checked for the cases of energy of propagation as per Huygens's wave theory, reflection and refraction of waves at the boundary of medium, convergence and divergence of light, interference phenomena, diffraction phenomena, other optical signal processing cases, De Broglie's matter waves and Schrodinger's wave equation. In all the example cases introduction of Planck's constant in the formulae for photon energy is proved to be responsible for violation of conservation law and statistical interpretation of quantum mechanics. Exact value of photon energy depends on amplitude of the electromagnetic wave and the frequency and as a consequence conservation laws are not violated and statistical interpretation of quantum mechanics, wave - particle duality and uncertainty principle are proved to be in contradiction with the energy conservation law of classical physics.

II. PART-I: INTEGRATION OF QUANTUM MECHANICS WITH THE CONTINUUM ELECTROMAGNETISM

2.1 Radiation Theory of atoms

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 [1] [2] [3], 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 [3] [7].

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 a narrow band of frequencies. This type of radiator is called as a Hertzian radiator in the radiation theory of antennas [8]. The field radiated is directly proportional to Sin(ωt) where ω varies over a narrow band of frequencies in a specified direction and at a particular distance.

Therefore, exact value of photon energy could be derived using Poynting theorem [9] for a single frequency ω [5]. But this value of photon energy is only approximate value since photon energy is calculated for a single frequency. Since electrons jumps to higher energy level and comes back to the original level, continuously as long as the electrons are energized continuously, radiation from atoms is in the form of pockets of impulse energy spread over a narrow band of frequencies centered at the frequency of impulse train. 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.

2.2 Currents and Electromagnetic Fields produced by the Electrons of an Atom [10][11]

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. Similarly, current flow along the orbit is also an impulse current at a point of the orbital path at any particular time.

Therefore, this impulse train of current in the space domain could be described by $I_0 \sum \delta(x - x_0)$, x_0 = v. n. T, where x is the linear distance travelled by the electron, v is the linear velocity of the electron, T is the period of the electronic revolution and n is integer varies from -∞ to ∞. Similarly, current in the time domain could be described by $I_0 \sum \delta(t - m. T)$, where m is an integer varies from -∞ to ∞. Therefore, orbital current as a function of x and t is $I_0 \sum \delta(x - v. n.T , t - m. T)$.

Therefore, electrical power along the orbit flows in the form of impulse energy pocket train. As per the Planck's law photon energy of electrical power in the orbit is h. f where f = 1/T. This period of the current impulse train T= l/v where l is the circumference of the orbit. If we assume the orbit to be circular like in Bohr's atomic model, l = 2πr where r is the radius of the orbit. The frequency of the electronic impulse current train at a point in the orbit is f = v/l. Since this photon energy is calculated for a single frequency, it is only an approximate value.

The impulse electronic current and the electric field of the charged particles generate impulse train of electromagnetic field in the space and the time domains. Therefore, wave equation could very well be used to develop the theory developed in the previous paragraphs instead of using the current and voltage variables. The fact that electrons of atoms can exist only in discrete states of energy could be proved using continuum mechanics as in the following lines.

The current and the electromagnetic impulses produced by the moving electron in the orbit at the previous points to the current point, disappear since electron can exist only at one point of the space and time. But for mathematical convenience, waves could be assumed to spread over the entire orbital length. Therefore, the velocity of energy pockets (group velocity V_g) of the current and the field of the moving electron with the velocity equal to the phase velocity (V_p) of the current and field is = V_p^2 = V_p X velocity of the field [8]. Therefore, at all points in the space and time of the orbit there will be forward travelling waves and reflected travelling waves (reflected at l/2 where l is the circumference of the orbit). Therefore, current and field modes are produced by the travelling waves in the opposite directions like in a parallel plate waveguide. Therefore, electromagnetic energy and the field of the electron can exist only in the discrete orbits as speculated by the present day quantum mechanics.

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 and electromagnetic impulse 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 and electromagnetic field in nth and mth states of the electron. Since Planck's law is based on the single frequency of the quantum pockets of impulse energy train, this formula is only an approximate one. As per the theory of the earlier paper, exact value of energy of a photon = Energy of the impulse energy Pocket of a high frequency electromagnetic wave ($2hf^{2)}$ X Number of impulses within unit time (f) = $2hf^3$(a non linear function of frequency). This expression is also mathematically an approximate formula.

2.3 Matter and Electromagnetic waves [1][2][3][5][6][11]

As per the De Broglie's matter wave equation, matter is a state of electromagnetic energy. As per the standard model of cosmology matter particles originated from electromagnetic energy. Therefore, matter particles could be considered as particles made up of electromagnetic impulse 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, as explained in the previous article [6], De Broglie's matter wave equation is modified to $2hf^3 = m.C^4$ where $m = m_0.C^4/\sqrt{1-(V_p/C)^4}$ for $V_p \geq C$ where V_p is matter particle's velocity. Therefore, exact value of De Broglie's wavelength = $(2.h/ (m. C))^{1/3}$ This wavelength must be used in Schrodinger's wave equation [6].

Therefore, motion of electrons in the atomic orbits could be considered as motion of a electromagnetic wavelet. For mathematical convenience, this wavelet could be considered as a impulse electromagnetic train spread over the orbital path of the electron. Since, 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, modes of electromagnetic waves are generated and the electrons of atoms can exist only in the discrete set of orbits like explained in the previous paragraphs. Therefore, Schrodinger's wave function and equation are electromagnetic wave function and equation.

III. PART-II: CONTRADICTIONS AND THE STATISTICAL INTERPRETATION OF QUANTUM MECHANICS

3.1. Exact Value of Photon Energy [12 3 5 6]

As per Poynting theorem [9], power flow per unit area on the monochromatic plane wave is proportional to $(A^2\sin^2\omega t)/\eta$ for one dimensional wave propagation, where ω is angular frequency of monochromatic wave, η is intrinsic impedance of the medium and A is amplitude of the sine wave. Time average of this energy flow is equal to frequency times H where $H = T/2.A^2/\eta$ where T is the period of the sine wave. At high frequencies, T/2 becomes very small as compared with A^2/η in the equation for H and as the frequency increases the change in A^2/η 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 [10]. Atoms radiate energy in the form of particles (photons) at high frequencies. 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. Energy frequency spectrum of high frequency electromagnetic radiations is a periodic function of frequency. Therefore, velocity with which the energy travels is called as group velocity and this velocity is different from the velocity with which the field travels. Therefore, velocity of photons is different from the velocity of waves and the photon energy is approximately equal to $4.f^3.(A^2/\eta).T/2 \approx 4.f^3.h$.

For uniform plane electromagnetic wave propagation, as per Poynting theorem, power flow per unit area at a point is $A^2\mathrm{Sin}^2(\omega t)/\eta$ at the source point (r=0). Therefore, energy flow over a period of one second at the source point is $A^2Tf/2.(1 - \mathrm{Sin}(2\omega)/2\omega)/\eta \approx hf.(1 - \mathrm{Sin}(2\omega)/2\omega)/\eta$ where $h = (A^2/\eta).T/2 \approx$ Planck's constant since T is very small in such a way that variation of A^2/η does not changes $(A^2/\eta)T/2$. This energy flow is actual energy of the photon. This formula is also approximate one since photon energy is obtained only for fundamental frequency of the frequency spectrum.

In the Planck's law energy of a photon E = h.f. If the approximate Planck's constant h is replaced by (A^2/η). T/2, then $E = ½(A^2/\eta)$ which is independent of frequency and contradict with the experimental facts. This contradiction arises due to the fact that Planck's law is based on fundamental frequency of narrow band of higher frequency light signals. This is another approximation made in Planck's law. Therefore, actual photon energy which includes all frequencies = $4.f^3.h$ (as explained in the previous paragraphs) = $4.f^2.1/2.A^2/\eta = 2(fA)^2/\eta$. This formula does not introduce any contradiction. Introduction of Planck's constant in the photon energy formulae derived in the above lines contradicts many physical laws and principles. Introduction of the Planck's constant is also responsible for statistical interpretation of quantum mechanics. These statements are proved in the following cases of physical phenomenon.

3.2. Case I (Huygens Wave Theory) [3]

Photon energy at a distance from the source point is hf. (1 – Sin (2.(k.r – ω))/2ω) where r is the distance of propagation of the plane wave from the source point and h = Planck's constant ≈ $(A^2/\eta).T/2$. 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 – ω))/2ω). For spherical wave propagation, photon energy varies inversely with r^2 in addition to variations as per hf. (1 – Sin (2.(k.r – ω))/2ω). Therefore, photon energy has amplitude and phase angle variations and the photons could be split. In the all the examples, law of conservation of energy is violated if the Planck's constant is introduced in the formulae of photon energy.

3.4. Case II (Reflection and Refraction Phenomenon) [13]

In the reflection and refraction of high frequency electromagnetic signal at the boundary between two media should satisfy law of conservation energy. As per the wave theory of electromagnetic these conservation laws are satisfied. But Planck's law of quantum mechanics fails to satisfy the conservation laws due to the presence of Planck's constant. Instead if h is replaced by (A^2/η).T/2 conservation principles are satisfied. Then Photon energy is equal to $½.A^2/\eta$. As per this relationship, incident photon energy is split as per the laws reflection and refraction at the boundary. Therefore, photons could be split.

3.5. Case III (Convergence and Divergence Phenomenon) [3]

A plane electromagnetic wave could be focused or diverged at/from a point using lenses or mirrors. Energy at the point of focus or divergence is equal to total incident energy at the incident plane. In principle any amount of energy could be focused or diverged. Therefore, photon of any amount of energy could be made at a point by fusing or splitting photons.

3.6. Case IV(Interference Phenomenon) [3]

In the double slit interference experiment, the light intensity is $I_\theta = 4.I_0 \cos^2((\pi d\sin\theta)/\lambda)$ where d is the perpendicular distance between observation plane and the middle point (origin of coordinate system chosen) of the line connecting the centers of the two slits, λ is wavelength of the light and θ is the angle between distance vector **d** and **r,** where **r** is the radial vector from the origin to the point of interest on the plane of observation. Light intensity is directly proportional to the square of electric field intensity. Therefore, photon energy on the plane of observation is directly proportional to $I_\theta = 4.I_0 \cos^2((\pi d\sin\theta)/\lambda)$. Therefore, photon energy variation pattern is same as the radiation pattern of the slits. But as per the Planck's law, photon energy of the light is constant and light intensity variations are interpreted as probability of location of photons. Therefore, the statistical interpretation of quantum mechanics, wave particle duality problem and Heisenberg's uncertainty principle all originates due to the introduction of approximate constant in the photon energy formula.

3.7. Case V(Diffraction Phenomenon) [3]

Diffraction pattern of a single slit is $I_\theta = I_m((\sin\alpha)/\alpha)^2$ where $\alpha = (\pi a/\lambda)$. Sinθ, a is slit width, λ is wavelength of light and θ is the angle between **r** and the perpendicular line connecting the center of the slit and the center of the plane of observation. Radial vector **r** connects the center of the slit with the point of interest on the observation plane. Therefore, photon energy variation and the radiation pattern of the slit on the observation plane are one and the same. As per the statistical interpretation of quantum mechanics, I_θ is probability pattern of photon density. Again statistical interpretation, wave – particle duality and uncertainty principle all originates from the introduction of Planck's constant in this case also.

3.8. Case VI (Other optical signal processing phenomenon) [14]

In all the optical signal processing operations like integration, projection, inner product, outer product, linear filtering, etc. the photon energy variation on the plane of observation is same as the variation of output signal on the plane of observation. As per the statistical interpretation of quantum mechanics, output signal is probability pattern of photon density. Again statistical interpretation, wave – particle duality and uncertainty principle all originates from the introduction of Planck's constant in this case also.

3.9. Case VII (De Broglie's matter wave Equation) [3]

Modified De Broglie's matter wave equation as per the new photon energy formula is $E = mC^2 = 2(Af)^2/\eta$, where m is the mass of the matter particle and C is the velocity of light in free space. De Broglie matter wave equation is the fundamental equation for explaining wave – particle duality of matter particles. Since in the new formula E is directly proportional to A^2, the modified matter wave equation satisfies the energy conservation law in all cases of physical phenomenon. Like in the previous cases of optical phenomenon, statistical interpretation, wave – particle duality and uncertainty principle all originates from the introduction of Planck's constant in this case also. The modified De Broglie equation must be used in the Schrodinger's wave equation to comply with the energy conservation law and to avoid all problems which originate from statistical interpretation of quantum mechanics, wave – particle duality and uncertainty principle.

3.10. Case VIII (Schrodinger's Wave Equation) [3]

As per De Broglie's matter wave equation, energy of a matter particle is stored in mass and matter particle photon. In this letter and earlier letters Photon energy formulae were derived from electromagnetic waves. Therefore, matter particles are made up of electromagnetic waves. As per the standard model of cosmology, matter particles originated from photons. Photons are in the form of very thin line segments and always in motion in the natural world. But matter particles are in the form of a sphere of zero radius (form of a point) and not always in motion at the constant speed of light. Photons are in the form of electromagnetic energy wavelets as the new quantum theory presented. Therefore, matter particles are in the form of electromagnetic energy wavelets.

Therefore, when a beam or line of matter particles moves at a speed, the movement of a train of wavelets could mathematically represented by a periodic travelling wave function. Therefore, as per Fourier theorem, this periodic travelling wave could be represented by sum of modes different. Therefore, matter particles can exist only at discrete levels of energy. Since matter particles travel at different speeds in free space, they can exist only at different discrete energy levels. 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.

An electromagnetic signal always travels at a constant speed in the free space continuously they are seen at only one state of energy level. However, at higher frequencies, electromagnetic energy particles (Photons) also could be represented in mode form like matter particles. Therefore, in this case also Schrodinger's wave equation is invalid. This link between matter particles and photons through mode form of energy is responsible for the radiation of photons at higher frequencies by atoms. Atoms convert the mechanical energy of matter particles into high frequency electromagnetic energies.

IV. CONCLUSION

In part-I, well known quantum energy states of the electrons are derived from the classical continuum mechanics. At the end Schrodinger's matter wave equation is derived from the electromagnetic wave equation. In part-II, Planck's quantum law, De

Broglie's matter wave equation, Schrodinger's wave equation, wave particle duality, correspondence principle, uncertainty principle and the statistical interpretation of quantum mechanics are proved to be in contradiction with the law of conservation of energy due to the approximate nature of Planck's fundamental law of quantum physics. The energy formulae of photon derived from Poynting theorem of continuum electromagnetic are proved to be in compliance with the energy conservation law of the classical physics.

REFERENCES

[1] P.T.Mathews.1974.Introduction to Quantum Mechanics. Tata McGraw Hill Edition, New Delhi, pp. 3-35.

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

[3]. Halliday, Resnick and Krane.2000. Physics. John Wiley & Sons. Vol.2, 4th Edition, Singapore. pp. 677-685, 725-728, 903-980, 1021-1076, 1189-1213.

[4]. John Daniel. 2009. Advances in Astronomy. Madha Engineering College, Kundrathur, Chennai, India, pp.22-34.

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

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

[7]. J. A. Edminister. 1986. Theory and Problems of Electromagnetics. International Editions, Schaum's Outline Series, McGraw Hill Book Company, Singapore, pp.81-85.

[8] E. Jordan and K. Balmain.2009. Electromagnetic Waves and Radiating Systems. Prentice Hall of India Pvt. Ltd., pp.114-119, 557-563, 572-579, 317-322, 189-192, 726-729, 119.

[9] W. Hayt.1992. Engineering Electromagnetics. Tata McGraw Hill Edition, New Delhi, pp.353-357.

[10]. Johnny R. Johnson.2001. Introduction to Digital Signal processing. Prentice Hall of India Pvt. Ltd., New Delhi, pp.17-34.

[11]. Halliday, Resnick and Krane.2000. Physics. John Wiley & Sons, Vol.1, 4th Edition, Singapore, pp.467-487.

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

[13]. Justin Peatross and Michael Ware.2008. Physics of Light and Optics. Brigham Young University, August 14, pp. 59-78.

[14]. http://www.atto.physik.uni-muenchen.de/download/photonics1/photonics1-chap4_3.pdf. Electromagnetic optics - Concepts of optical signal processing and optical communication. pp.78-90.