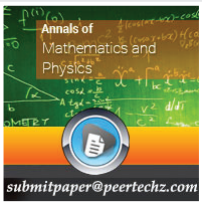
Peertechz



MATHEMATICS AND PHYSICS GROUP

ANNALS OF Mathematics and Physics OPEN ACCESS JOURNAL

ISSN: 2689-7636 DOI: https://dx.doi.org/10.17352/amp

Review Article

What is Light, Really? A Quantum Dialectical View

Abdul Malek*

Dialectical Contradictions in Mathematics and Physics, 980 Rue Robert, Brossard, Québec, J4X 1C9, Canada

Received: 08 October, 2024
Accepted: 18 October, 2024
Published: 19 October, 2024

***Corresponding author:** Abdul Malek, Dialectical Contradictions in Mathematics and Physics, 980 Rue Robert, Brossard, Québec, J4X 1C9, Canada, E-mail: abdulmalek@qc.aibn.com

ORCiD: https://orcid.org/0000-0003-2270-9849

Keywords: Radiant energy; Visible light; Quantum nature; Discrete point particle; Wavelet; Velocity of propagation; Quantum dialectical approach

https://www.mathematicsgroup.us

Check for updates

Abstract

Radiant energy in the form of visible light has been and still remains the most mysterious and venerated object in human history. Gradual understanding of the nature of light now in its very wide range of energy, both above and below the visible range; has led to the proliferation of technologies, especially after the recognition of its quantum nature. Although impressive knowledge about the nature of light, its properties, its source, and its interaction with other existing matter, etc., have been gained and profitably utilized in technologies; its fundamental unit as a discrete point particle or an extended continuous wavelet, as well as its mass, still remains a subject of intense debate among the physicists.

Understanding the enigmatic properties and the nature of light as difficult as it proved to be; understanding the velocity of its propagation proved to be the most misunderstood aspect of light. As has been shown through some recent publications by this author, the false axiomatic notion of Albert Einstein at the turn of the 20th century, about the universal and absolute constancy (in vacuum) of the velocity c of light; caused the century-long confusion, paradoxes, myths and ironically, the darkest period of modern physics and cosmology! Another wrong centuries-old axiomatic notion of Isaac Newton about the one-sided universal gravitational attraction of matter, acted in a synergistic way with Einstein's false axiomatic notion about light; to create the modern and sophisticated ruling mythology of the "Big Bang" creation of the universe, undermining scientific progress both in theoretical physics and in cosmology, since Copernicus and Johannes Kepler.

It can now be demonstrated that this new mythology has absolutely no basis in objective reality and is the product of brain-cooked and abstract mathematical fabrications based on an axiomatic truth and apparently willful deceptions by official science. A quantum dialectical approach reveals that light is composed of point particles (photons) with a wide range of energy, velocity, and mass; over the whole electromagnetic spectrum, from the microwave to the highest energy gamma-ray photons. The only difference from other matter particles is that photons exist only in their free elementary state and are created instantly (until absorbed) from their virtual existence in matter atoms or in the quantum vacuum; in this infinite, eternal, and ever-changing universe; thereby resolving all mysteries about light.

Introduction

Early history

Light (visible) has always been a mystery for man since prehistory; as something very different from other tangible objects, as it seems to arise instantly and also vanish instantly and travels at seemingly infinite speed. All kinds of mythology developed among most people of early civilization about light; as something holy, pure, and divine; causing reverence, worship, cultural rites and rituals, etc. The early concept of light arose from the need to understand natural phenomena, such as the sun, stars, lightning, fire, etc., which emitted light. The sun and fire in particular became objects of worship and rituals. The Egyptians (~ 1300 B.C.) for example considered the sun and the moon as the two eyes of the supreme God RA. The modern approach to learning about light and sight, but still in a mystical way goes back to the early Greeks. Pythagoras (580(?) – 520 B.C.) and Plato (429 – 347 B.C.) believed in the so-called tactile or extromission theory, in which vision

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135

is initiated in the eyes, in the process of reaching out to the object. The modern notion of the emission of light is credited to the Islamic scholar and scientist Ibn Al-Haytham (AD 965–1039), popularly known as Alhazen, who both experimentally and logically demonstrated that '*. . . Light comes to the surface of the eye from the light of the visible object*' [1,2].

Pre-quantum

In modern times, the study of the nature of light reached basically two concepts: wave and particle as a see-saw process. The early modern view of light goes back to Rene Descartes (1596–1650) who proposed that light is a pressure force that travels instantaneously and that microscopic globules called aether, can transmit forces, and pervade space. Isaac Newton [3,4] developed his corpuscular theory of light based on Descartes's idea and after extensive experiments with sunlight. Newton concluded that 'sunlight or white light is a mixture of rays differing in degree of frangibility and colour. Christiaan Huygens established the wave theory of light [5]; in his publication "Traité de la Lumière", published in Leyden in 1690. In 1801, Young's double-slit experiment [6] and Arago's experiment [4] revived Huygens' wave theory. A half-century later, the Scottish scientist James Clerk Maxwell [7] showed that electric and magnetic fields travel through space together in the form of intertwined waves. Maxwell further demonstrated that these "electromagnetic" (EM) waves travel at precisely the speed of light, leading him to propose that light was an electromagnetic wave. In 1887 Hertz experimentally confirmed Maxwell's electromagnetic theory.

Quantum

The quantum view of light (EM radiation) proposed by Max Planck [8] in 1901, was a revolutionary point of departure for physics, from classical mechanics, statistical thermodynamics, and Maxwell's electromagnetic theory. Planck tried to explain the so-called 'Blackbody Radiation'. (or 'Cavity Radiation', proposed by Kirchhof (1859). Kirchhof's law of radiation states that the ratio of the emissive and absorptive power of a body depends only on the temperature and is independent of its composition. The distribution of energy in blackbody radiation with respect to frequency or wavelength was measured experimentally by Lammer and others (around 1897). The general form of their results is shown in Figure 1. The horizontal (X) axis represents the wavelength of radiation in the micrometer and the vertical (Y) axis represents the relative intensity of radiation at any particular wavelength. The colored curves represent the change in the emission maxima with the change in temperature in Kelvin (K).

An empirical formula based on statistical thermodynamics, known as Stefan-Boltzmann's law for the total energy density E in this distribution was given as $E = \sigma T^4$; where T is the absolute temperature and σ is a constant. Later Wein in 1894 gave an improved energy distribution function for the above relation in the following form:

$$\rho(\upsilon,T) = \alpha^*\upsilon^3*e^{(-\beta\upsilon/kT)}, \quad (1)$$

Where $\rho(\upsilon,T)$ is an energy distribution function known as Wien's Displacement Law because as shown in Figure 1, the peaks of the curves for different temperatures shift towards higher frequency (longer wavelength) with increasing temperature. Wien's distribution law roughly fitted the experimental blackbody spectra. But it had the limitation that if $T = \infty$, it wrongly gives a finite value for $\rho(\upsilon,T)$. It also fails at long wavelengths, increasingly; more so as the temperature increases. However, Wien's distribution law was to be the important factor in Planck's Theorem [8] given by the following equation

$$\rho(\upsilon,T) = 8\pi h\upsilon^3/c^3*E(\upsilon,T) \quad (2)$$

Which is Wien's law, but includes *h* as a constant, $\alpha = 8\pi h/c^3$, $\beta = h/k$, and where, $\rho(\upsilon,T)$ is the frequency distribution function. $E(\upsilon,T)$ is the average equilibrium energy of a damped harmonic oscillator of frequency υ at temperature T in the cavity wall of the blackbody. Here the frequency υ refers to both radiation frequency and resonator frequency. Planck derived this empirical equation based on Wien's distribution law and Clausius' concept of entropy change in the irreversible thermodynamics process, but later gave a better scientific basis for experimental measurement based on the simple harmonic resonators in the blackbody cavity walls that emit and absorb energy discontinuously in multiples of small indivisible units of discrete 'energy elements' or $E = nh\upsilon$, where n is an integer 0,1,2... and *h now known as the Planck constant,* thus foreshadowing the revolutionary quantum concept of light. Max Planck's [8] theory brought the century-long investigations of light and heat, now commonly known as electromagnetic radiation, as a profound revolution of the ontological view of objective reality itself; conforming to earlier dialectical intuition of G.W.F. Hegel [9].

In 1905, Albert Einstein's discrete photon theory of light [10] revived, in some sense, the particle nature of light; which was a culmination of some major developments in the 19th century that arose from the study of the light from the sun and the flames; and from "blackbody radiation". This started with Herschel's work (1800) that heat radiation from the sun extended into infrared and beyond in the red end of the visible light spectrum. This discovery extended by the works of many, notably Fraunhofer (1822) and Kirchhoff (1859) led to the concept of "black body" radiation. Kirchhoff showed that for rays of the same wavelength, the ratio of the emissive power to the absorptivity, at the same temperature, is the same for all bodies. It meant that with such a "black body" one could have an equilibrium spectral distribution independent of everything except the temperature.

In 1923, de Broglie [11] suggested that the matter particles in motion can also behave like waves; thereby bringing a new dimension to the question of the wave-particle duality of light; from the direction of the atomic theory of matter. Throughout the 1800's speculative ideas about atoms were discussed and published. The discovery of the electron in cathode rays by J.J. Thompson (1897) led to the speculation of the nature and the structure of atoms. In a 1901 paper,[12] Jean Baptiste Perrin used Thomson's discovery in a proposed Solar System like model for

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135

atoms, with very strongly charged "positive suns" surrounded by "corpuscles, a kind of small negative planets", where the word "corpuscles" refers to what we now call electrons. A somewhat similar model proposed by Hantaro Nagaoka in 1904 used Saturn's rings as an analog [13] for electrons. Based on the experiments carried out with newly discovered alpha particle, Rutherford [14], in a May 1911 paper, presented his own physical model for subatomic structure, *"an atom having a positive central charge N e, and surrounded by a compensating charge of N electrons"*.

Meanwhile, the atomic spectra of the hydrogen atom could be given quantitative formulation. Beginning in the late 1860s, Johann Balmer and later Johannes Rydberg and Walther Ritz developed increasingly accurate empirical formulas matching measured atomic spectral lines. Critical for Bohr's later work, Rydberg expressed his formula in terms of wave number, equivalent to frequency [15]. These formulae contained a constant, $\upsilon = R(1/m^2 - 1/n^2)$, now known as the Rydberg constant, and a pair of integers indexing the lines. Based on the Rydberg formula, Niels Bohr (1913) put forth three postulates to provide an electron model consistent with Rutherford's nuclear model and proposed a discrete and quantized structure of the electron orbitals [16]. In Bohr's theory describing the energies of transitions or quantum jumps between orbital energy levels is able to explain Rydberg's formula [15]. Bohr's condition, that the angular momentum of the orbiting electrons be an integer multiple of ħ, was later reinterpreted in 1924 by de Broglie as a standing wave condition: the electron is described by a wave and a whole number of wavelengths must fit along the circumference of the electron's orbit: $n \lambda = 2 \pi r$. The difference in the energy levels represented the energy gained or lost by the electrons in their transition from one level to the other and is represented by the energy of the photons emitted or absorbed. This, explains the photoelectron effect, Compton and Raleigh scattering of electromagnetic radiation. The electromagnetic force between charged particles is now supposed to be mediated by the exchange of virtual photons, which gain or lose energy to become real photons with characteristic energy, during emission or absorption processes. In 1921, following the work of chemists and others involved in work on the Periodic Table, Bohr's model of hydrogen atoms was extended to give an approximate model for heavier atoms. This gave a physical picture that reproduced many known atomic spectra and chemical properties for the first time.

In 1927 Werner Heisenberg [17], proposed a revolutionary view, known as the Uncertainty Principle of the objective nature of quantum particles, like photons, which states that there is a limit to the precision with which certain pairs of physical properties of a quantum particle, such as position and momentum can be simultaneously known. This revolutionary principle, which questioned the historically venerated causality and determinism of the classical view of the world threw natural science into a great crisis. The Uncertainty Principle coupled with 1923, de Broglie's [11] suggestion that massive quantum matter particles like electrons in motion can also behave like waves; brought in a new dimension of the old question of the wave or particle nature of light and

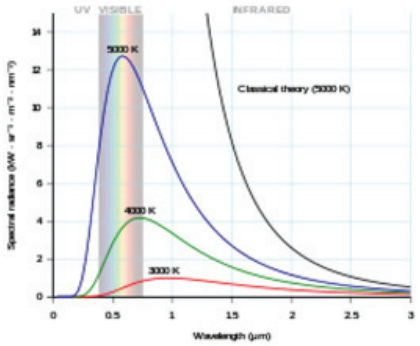


Figure 1: The distribution of energy in blackbody radiation with respect to frequency or wavelength.

put the particle concept and wave concept of light and the whole question of the light-quanta of electrodynamics, into confusion that still rages in modern physics. Between the years 1925 and 1927; the Copenhagen Interpretation of quantum mechanics, was developed principally by Heisenberg and Bohr, based on Born's statistical interpretation of the wave function. As a compromise for the seemingly contradictory wave/particle duality, Bohr proposed the complementarity principle; which states that the wave and particle phenomena cannot be observed simultaneously in the same experiment. Namely, if these two phenomena can be observed simultaneously in the same classical wave experiment, then the interpretations of the wave theories are not complete. The idea of wave-particle duality emerged from Bohr's rather opportunistic concept of complementarity; a concept of quantum mechanics, now held by most theoretical physicists.

A way out of this quandary of modern theoretical physics and cosmology is suggested by this author - a subject of the next section of this article. According to some recent reports, some novel experimental observations by H. Peng [18-20] suggest that Bohr's complementarity is not tenable, as light photons seemingly can propagate as particles along trajectories, and distribute as waves, depending on experimental set-up. A rational explanation based on the virtual particles of the quantum vacuum [21] and the extension of Hegel's philosophy of Space and Time - the dialectical ontology of "Being-Nothing-Becoming" to quantum electrodynamics [9,21] was given by this author back in 2014. A previous publication, S.A. Rashkovskiy [22], claimed a resolution of the wave/particle dualism, based on usual epistemological, mathematical, and scholastic cobweb spinning; characteristic of mainstem physics.

Discussion

"Light", historically known as the narrow perceptive range from infrared, visible, and ultraviolet range, is now known to cover an enormously wide range of radiant energy, which varies from the radio to gamma-ray region covering the range of frequencies approximately from 10^8 Hz to 10^{20} Hz [5], Figure 2 adapted from reference [5], represents the whole electromagnetic spectrum from "radio" to "gamma ray" frequencies. The radiant energy in the region from the near ultraviolet (UV) to near-infrared (IR) especially in the region

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135

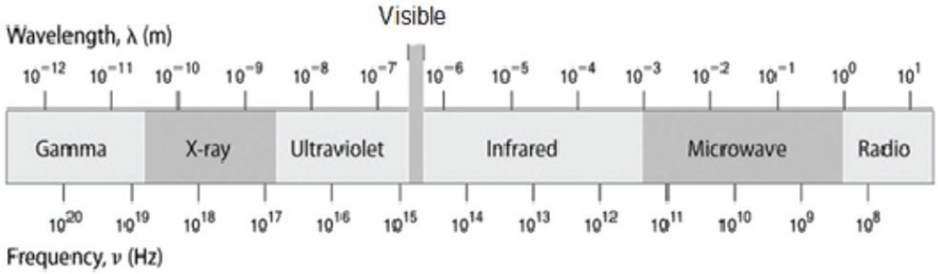


Figure 2: Electromagnetic spectrum from "radio" to "gamma ray" frequencies.

from about 310 nm in the ultraviolet to about 1100 nm in the near-infrared from the sun, has been objectively and primarily related to the photochemical synthesis of biomolecules in the evolution of life and consciousness on earth [23]. It is, therefore, very obvious why just after gaining minimum subjectivity by man to change the condition of his existence, light became of such importance. The importance of light to the development of human consciousness is evident from the recognition of the fact that light is the source of all sensations and perceptions that are *specific to vision*, and the United Nation's declaration of 2015 as the International Year of Light!

It is quite evident from the introduction that after all these centuries of effort, especially since Newton, a rational understanding of light still remains elusive. This fact and the recognition of the futility of the causality-based approach of modern official physics to deal with quantum phenomena was clearly articulated by Albert Einstein in the following statement: *"Many physicists maintain - and there are weighty arguments in their favour – that in the face of these facts (quantum mechanical), not merely the differential law, but the law of causation itself - hitherto the ultimate basic postulate of all natural science – has collapsed"*. A. Einstein, "Essays in Science", p. 38-39 (1934).

Causality, as an epistemology of the world, is the evolutionary heritage of man; gained through historical/social practice of everyday life and was given a formal philosophical form by the Aristotelian principle *"Unity, Opposition and the Excluded Middle", i.e., no contradiction*. This was in direct opposition to the earlier brilliant germ of dialectical epistemology, posited by Heraclitus (544 -483 B.C.) in the following immortal words, "*Everything changes due to inner conflict (or contradiction*"). Much later, G.W.F. Hegel (1770 – 1831 A.D.), differentiated these two-world views as *"the view of understanding"* or *Metaphysics* and *"the view of reason"* or *Dialectics* respectively. In Hegel's words, *"But it is one of the fundamental prejudices of logic as hitherto understood and of ordinary thinking that contradiction is not so characteristically essential and immanent a determination as identity; but in fact, if it were a question of grading the two determinations and they had to be kept separate, then contradiction would have to be taken as the profounder determination and more characteristic of essence. For, as against contradiction, identity is merely the determination of the simple immediate, of dead being; but contradiction is the root of all movement and vitality; it is only in so far as something has a contradiction within it that it moves, has an urge and activity"*.

In the evolution of life, of history, and of human thought, development, change, or progress makes its appearance by the negation or destruction of what exists. Of necessity, and because of their very nature as the conservative, the resisting, the preserving side of what exists, Metaphysics formed the ruling ideas of class-based societies of past history in support of the established order of the time, while dialectics represented the revolutionary side because dialectics denies the stability or the permanence of what exists. This is so because the view of *understanding* cannot comprehend *change*, except that from an *impulse ("force") from without*. For them, the world and God who created it (the first cause), aim at *preservation of what exists and at unchanging continuance.*

The light quanta (Lichtquanten) heralding quantum physics at the turn of the twentieth century was the most revolutionary development in physics, like never before; because it totally undermined the official world-view based on causality that guided physics since Isaac Newton. As would be evident later in this discussion, the reality of light quanta as discrete point particles (rather than an extended wave) of matter with infinitesimal but finite mass and a characteristic sovereign and unique velocity; ushered in a revolutionary change in the hitherto prevailing epistemology of theoretical physics and cosmology. The quantum phenomena in general opened the door to a much wider landscape and scope for a dialectical natural science from the quantum microcosm to the macrocosm of the galaxies and their clusters; in this infinite, eternal, and everchanging universe [24,25].

The Metaphysics of Aristotle dealt mainly with the questions of epistemology as questions of ontology were unclear at that time. According to this view, all existence in this finite (in extension and time) world was given as an act of creation by God, a mystery now known as the Big Bang theory. The causality-based epistemology came to a great crisis in philosophy by the time of David Hume (1711 – 1776 A.D.) and Immanuel Kant (1724 -1804 A.D.); to the extent that to save causality, Kant declared objective reality as an unknowable thing-in-itself and warned philosophy to abate any claim of knowledge of objective reality. Instead, Kant proposed subjective idealism in which philosophy can only develop thought-conceived logical categories about the phenomena of the world that man can know through sense-perception; while the noumena (ontology) remains out of its reach. Dialectics in the hands of Hegel, and contrary to Kant, brought in the ontological issue of objective reality as the domain of positive knowledge and independent of theology. Hegel's dialectical contradiction "Being-Nothing" is at the

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135

root of the existence of all matter particles including light, and motion; and "Becoming" is the resolution of the ontological contradiction. For Hegel, (particulate) matter and motion as the outcome of the resolution of the contradiction of abstract space and abstract time; constitute objective reality. Motion is the intrinsic mode of the existence of matter. There can be no matter without motion and no motion without matter. This is in sharp contrast to the view of causality and Metaphysic; which has to depend on the creator, for both matter and motion.

The discovery of the photon quanta and radioactivity at the turn of the 20th century abolished the notions of certainty, continuity, determinism, etc., of classical physics and cosmology, based on causality and metaphysics at the level of the microcosm and questioned the validity of those notions at all levels of objective reality. Dialectics starting from Heraclitus, insisted that the Universe, Nature, Life, Society, and Thought are mediated by dialectical chance and necessity, rather than cause followed by an effect as ordinary everyday life experience indicates. However, since the Copernican revolution overthrew the theological notions of the heavens, vigorous attempts were and are being made by official theoretical physics and cosmology to impose God's rule on Nature. Isaac Newton infused subjectivity into so-called "objective" science by separating force (motion) from matter and imported "motion" (force) from outside objective reality, from God (in the form of a "First Impulse"), as if objective Nature has to be governed by an external omnipotent "force" and it is impossible to explain or understand Nature by discovering its own inherent objective laws! This fatal blow to the essence of natural science came in spite of vigorous opposition from the brilliant astrophysicists, J. Kepler and T. Brahe and dialectical thinker and mathematician G.W. Leibniz [26]. Newton, with strong support from the powerful British Monarchy and the Church, infused mysticism into natural science, which is at the root of its miseries – now only raised by a few orders of magnitude, by Albert Einstein's (1879 – 1955) theories of relativity! The fight against the "Evil Quanta" was led by Einstein, ironically, the man who discovered light quanta from the photo-electric effect – a major element of modern technological advance!

The quantum dialectics of elementary particles and light photons

a) The Fatal Flaw of Metaphysics: Two approaches were taken to fight the "Evil Quanta"; the esoteric and apparently non-material nature of light provided the fuel for both. One led by Einstein adopted Kantian subjective idealism along with British empiricism to elevate the divine and absolute nature of light and theoretical physics itself, to the realm of thought, where brain-cooked logical/mathematical categories and causality could be used with wanton will; without any contradiction or antinomies of objective reality. This approach considers matter and motion as myths; objective reality is considered as a continuous field of divine energy in the form of "spacetime" and matter particles as locations where the energy density of the energetic field is particularly high. This is a foolish approach as Frederick Engels described it the following way, *"It is the old story. First of all, one makes sensuous things into abstractions and then one wants to know them through the senses, to see time and smell space. The empiricist becomes so steeped in the habit of empirical experience, that he believes that he is still in the field of sensuous experience when he is operating with abstractions*". The other approach credited to N. Bohr and W. Heisenberg (Uncertainty Principle) treats the indeterminism of the quantum phenomena as a statistical error, a problem of precise experimental measurement of permanently existing quantum objects. They resort to the crass positivism of Bishop Berkeley's philosophical principle, *esse est percipi*, or *to be is to be perceived*; a form of solipsism. For this view, quantum particles exist only when measured, to explain the "spookiness" of the quantum phenomena.

It is not possible to go into detail about these approaches in this discussion. Suffice it to assert that these approaches are based on Kantian subjective idealism regarding objective reality, which absolutely has no scientific validity; and no relevance to the real world; as far as quantum particles are concerned. For the light quanta, Einstein (along with others) used the concept of "zero rest-mass" (a fantastic idea for dialectics) and velocity of the photon as an absolute and invariable constant c (in vacuum); an assumed axiomatic truth, in effect reducing the subsequent theories of relativity as mere tautologies like geometry theorems. Some abstract mathematical tools known as the Lorentz transform, especially the "spacetime" 4D abstract geometrical manifold and the gamma factor' were cooked up from thought alone to deal with the problems of physics and cosmology; based on the insensitive measurement of the exceptionally high velocity c of light. But this author in a recent publication [27] has clearly demonstrated that these mathematical tools are mere artificial geometrical fabrications based on the axiomatic truth of the absolute constancy of the velocity of light c! All these mental and mathematical constructs, especially the much-touted "spacetime" manifold and the gamma factor, used in general relativity and other myths of Big Bang creation, dark/black cosmic entities are deduced from the axiomatic truth of invariant c, as mere tautologies, where the conclusion is inherently and already contained in the premise of the axiom, like all geometrical deductions. These thought-created categories have no basis in objective reality. By the end of his life, Einstein himself came to this conclusion, in a letter to his lifelong friend Mechelle Besso (1954); about a year before his death: *"All these fifty years of conscious brooding have brought me no nearer to the answer to the question, 'What are light quanta?' Nowadays every Tom, Dick and Harry thinks he knows it, but he is mistaken... I consider it quite possible that physics cannot be based on the field concept, i.e., on continuous structures. In that case, nothing remains of my entire castle in the air, gravitation theory included, [and of] the rest of modern physics"*: Albert Einstein, quoted by A Pais, 'Subtle is the Lord ... ': The Science and the Life of Albert Einstein". Oxford University Press, (1982) 467.

As the discussion above shows, the fatal flaw in the understanding of light and the quantum phenomena itself, lies in mysticism imported into natural science from the epistemology of causality and metaphysics and Kantian subjective idealism. This epistemology can provide no positive knowledge of objective reality; beyond everyday life experience,

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135

classical mechanics, and ordinary thought of specific epochs of historical evolution. Another fatal flaw of causality-based philosophy, theology, physics, and mathematics is their inability and the lack of understanding of the Infinite; as pointed out by B. Spinoza (1632 -1677 A.D.) and later by Hegel [25]. Only the epistemology of materialist dialectics, based on the notions of contradictions, matter in eternal motion, chance and necessity, etc., which manifest in objective reality, and are now immensely reinforced after the recognition of the light quanta in particular and the quantum phenomena in general; can provide progressively better positive knowledge of the universe, without any mystery. Positive knowledge can only be gained progressively through the evolutionary history of Man and Nature; but without ever coming to any completion or a "theory of everything" – a foolish dream and endeavor of causality-based official theoretical physics and cosmology.

b) The Mass and Velocity of Light Photons: This author has extended Hegel's ontological contradiction (Being-Nothing) to the quantum phenomena. It has been shown that Hegel's dialectics in a very obscure and highly speculative way anticipated the quantum phenomena. The contradiction "Being-Nothing" is represented by the "virtual particles" of the quantum vacuum; where matter-antimatter virtual particle pairs (including light photons) eternally pop in and go out of existence. These virtual particles become physically existing real particles (light photons included) through a phenomenon known as quantum tunnelling and/or when positive energy corresponding to the mass of the quantum particles becomes available [9,24,25]. It is now possible to speculate following Hegel, that the quantum vacuum represents a "virtual" (mirror image) dialectical 'unity of the opposites' of objective reality, and constitutes both the source and the sink of real elementary matter in motion, eternally *"coming into being and passing out of existence"* as Heraclitus speculated.

There is now enough experimental, observational, scientific, mathematical, and philosophical reasoning to assert that Heisenberg's uncertainty principle is not merely a measurement problem, as assumed before; but the uncertainty lies in the very nature of objective reality at the quantum level. Previous concepts of 'ex nihilo nihil fit', the conservation laws of physics, and thermodynamics are invalid at the quantum level of objective reality and the quantum vacuum [9, 25, 27]. The uncertainty is rooted in the quantum nature of the particle itself [28]. The law of the conservation of mass/energy of thermodynamics and physics breaks down at the quantum level and creation "ex nihilo" is practically feasible [29-30]! It can be demonstrated that the quantum vacuum is full of "virtual particle/antiparticle pairs" that continuously pop in and out of existence and their effect on the spectral lines of atoms known as the "Lamb Shift" [31] and the Lande factor of the magnetic moment of electrons that rely on the concept of virtual particles and can be very accurately measured. This effect can also be measured as the Casimir force with much less efficiency. The permittivity and the permeability of the classical vacuum can be attributed to the collective effect of the momentary existence of an infinite number of virtual particles of the quantum vacuum. At the macroscopic (human) scale the objective reality is just a gross, averaged-out, summed-up, and apparently stable superstructure of the micro-level substructure of quantum uncertainty.

The "virtual particles" can become "real particles" if sufficient energy equivalent to compensate for their mass is available. There is also a finite probability that a "virtual particle" can become "real" (even without sufficient energy for mass equivalence) through a phenomenon known as **"quantum tunnelling".** In fact, it is possible that this spontaneous creation (ex nihilo) of fundamental particles from the quantum vacuum (and not through the Big Bang) is how the galaxies (along with all other things) evolve, "come into being and pass out of existence" and maintained throughout this infinite and eternal universe as asserted by dialectics [9,24,32].

c) The Derivation of the Quantum-Dialectical (New) Mass-Energy-Velocity Relation: Quantum dialectics enables us to show that Einstein's idea of zero rest mass and the absolute constancy (in vacuum) of light is false. Light from the lowest energy in the microwave to the highest energy of the gamma rays must have infinitesimal but finite mass and an intrinsic velocity in each energy range [33]. For Hegel's dialectics, a quantum of matter is the chance persistence of a quantum of abstract space in abstract time, and a unit of motion is the chance persistence of time (t) in space in the form of virtual particles, eternally flipping in and going out of existence, in the infinite quantum vacuum. This can be expressed quantitatively as a quantum energy-action relation according to the modified uncertainty principle, as follows:

$$\text{delta } L^3 \times \text{delta } t = h/4\pi \quad (1)$$

Where 'Delta L^3' represents a quantum unit cube of space of length L; 'delta t', represents a quantum of time of the existence of the quantum of energy and h is the Planck constant. Hegel quantified the ratio L^2 (L^3/t^2 vs. L/t^2 (of Keplerian and Galilean gravity) as the "Absolute Free Motion" of elementary matter at its creation in the quantum process. This free motion of a quantum particle can only be of kinetic (translational) motion and in its real manifestation can be expressed as $1/2(mv^2)$, where v is its velocity. Rewriting equation (1) for a single quantum act (eliminating delta) and L^2 substituted as $1/2(mv^2)$, we get:

$$1/2(mv^2) \times L \times t = h/4\pi, \quad (2)$$

Where L, the distance is given by $L = v \times t$. Substituting L in equation (2), energy $E = h\upsilon$ as par Planck Law and $\upsilon = 1/t$, after rearranging for the mass m we get:

$$m = h/2\pi/(v^3 \times t^2) = \dot{k} \times E/(v^3) \quad (3)$$

Where $\dot{k}$ is a proportionality constant given as $1/2\pi t^3$ and E is the real energy involved in the appearance of a particular quantum particle from its virtual state. It should be mentioned that t, the lifetime of a real singular quantum particle in this quantum action, is a constant for that particle, and has no significance in the above relation. At the virtual level, any range of virtual particles can continuously arise and pass away as "Being-Nothing", where their mass, motion,

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135

and lifetime are determined by the relation (3). But there has to be a selection rule for the probability of a virtual particle becoming a real particle dictated by its necessity in the real world! This must be the reason for the abundance (matter-antimatter pair) of photons (a photon is its own antiparticle), electron-positron, proton-antiproton, etc.; which mutually aggregate to form other matter mass in the universe; mediated by chance and necessity, and following the laws of quantum dynamics and dialectics. Now, the most important significance of equation (3) for this discussion, lies in the relation between, mass, energy, and velocity of an emergent quantum particle, photons included; and unlike in the theories of relativity, where a photon must be massless. For the quantum-dialectical relation like equation (3), any quantum particle at all must have mass, otherwise the original contradiction of abstract space and time and hence "Being-Nothing" will vanish, which is an impossibility for dialectics! It can also be shown that Einstein's most famous equation E = mc^2 is wrong [34], as the equation (3) above implies it must be E = K mV^3, where K = 1/ ħ. It must be pointed out that this energy, mass, and velocity relation (3) is only valid for an independently existing and elementary quantum particle, like a light photon, and does not strictly apply to any aggregates of matter particles; as Einstein's equation, E = mc^2 implies.. Photons as real particles exist only in their elementary state or as virtual particles in the quantum vacuum. In aggregates of elementary particles like atoms and molecules, photons exist in their confined state as virtual particles and are emitted almost instantly with their characteristic masses and velocities, when equivalent energy is available and until absorbed by other matter particles.

Conclusion

It can now be asserted with some confidence that there is no mystery about light, nor it is esoteric, nor divine. Unlike previous notions, a light particle is a form of matter with mass and characteristic free motion and energy (vis viva); like any other forms of matter. The only difference is that, unlike other quantum particles like electrons positrons, etc., light photon quanta in their real form exist only as independent particles and never as aggregates. The light photons are created almost instantly from their virtual state in the quantum vacuum or in atoms and molecules, either through quantum tunnelling and/or when enough positive energy is available. Once created, the photons exist and propagate as independent particles until absorbed back into their virtual state.

The other important difference of light photon is that at the time of its creation from the virtual state, its inherent velocity is enormously high because of its near negligible mass and because its mass is inversely proportional to the cube of its velocity; so for all practical purpose and at terrestrial scale, the velocity of light photons of all energy/mass range can be considered to be a constant – a case that led Einstein to make an ordinary fact to an absolute truth and a geometrical axiom, with all the adverse consequences that followed. As has been reported in the previous publication [33], the difference in the velocities of photons with wide energy/mass difference can only be observed at the cosmic scale. The high energy/mass gamma-ray photons from very distant "Gamma Ray Bursts" (GRBs) arrive on the earth as late as four minutes after lower energy/mass (microwave, visible) photons, even though all were generated at the same instant.

It is to the credit of the quantum dialectical view of the world that the mystery of light as the greatest enigma of entire human history – the source of mythology, fantasy and an aid for the exploitation of man by man, continuing even in the most technologically advanced modern times; could be brought to a scientific resolution. This portentous new positive knowledge about light removes centuries of confusion and represents a point of departure for natural science and cosmology; like the previous Copernican Revolution.

References

1. Oon PTE, Subramaniam S. The nature of light: I. A historical survey up to the pre-Planck era and implications for teaching. Phys Educ. 2009;44(4):236-241. Available from: http://dx.doi.org/10.1088/0031-9120/44/4/007
2. Lindberg DC. Alhazen's theory of vision and its reception in the West. Isis. 1967;58:321-324. Available from: https://doi.org/10.1086/350266
3. Waldman G. Introduction to light: The physics of light, vision, and color. Englewood Cliffs, NJ: Prentice-Hall; 1983. Available from: https://sfu-primo.hosted.exlibrisgroup.com/primo-explore/fulldisplay/01SFUL_ALMA21137973550003611/SFUL
4. Shapiro AE. Newton's optics and atomism. In: Cohen IB, Smith GE, editors. The Cambridge companion to Newton. Cambridge: Cambridge University Press; 2002; 227-255.
5. Sliney D. What is light? The visible spectrum and beyond. Eye. 2016;30:222-229. Available from: https://doi.org/10.1038/eye.2015.252
6. Young T. The Bakerian lecture. Experiments and calculation relative to physical optics. Philos Trans R Soc Lond. 1804;94:1-16. Available from: https://doi.org/10.1098/rstl.1804.0001
7. Maxwell JC. A dynamical theory of the electromagnetic field. Philos Trans R Soc Lond. 1865;155:459-512. Available from: https://doi.org/10.1098/rstl.1865.0008
8. Planck M. Ueber das Gesetz der Energieverteilung im Normalspectrum. Ann Phys. 1901;4(3):553-563. Available from: https://www.scirp.org/reference/referencespapers?referenceid=1839679
9. Malek A. The Philosophy of Space-Time: Whence Cometh Matter and Motion? J Adv Phys. 2016;12(2):4270-4277. Available from: https://www.researchgate.net/publication/328359746_The_Philosophy_of_Space-Time_Whence_Cometh_Matter_and_Motion
10. Einstein A. On a heuristic point of view concerning the production and transformation of light. Ann Phys. 1905;17:132-148. Available from: https://www.scirp.org/reference/referencespapers?referenceid=2291185
11. de Broglie L. Waves and quanta. Nature. 1923;112(2815):540. Available from: https://www.scirp.org/reference/referencespapers?referenceid=2291567
12. Perrin J. Les hypothèses moléculaires. Revue Scientifique. 1901;15(15):449-461. Available from: https://philsci-archive.pitt.edu/16017/1/Coko-Jean%20Perrin%20and%20the%20Philosophers%27%20Stories.pdf
13. Kragh H. Before Bohr: Theories of atomic structure 1850-1913. RePoSS: Research Publications on Science Studies. 2010;10. Aarhus: Centre for Science Studies, University of Aarhus. Available from: https://css.au.dk/fileadmin/reposs/reposs-010.pdf

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135

14. Rutherford E. The scattering of α and β particles by matter and the structure of the atom. Philos Mag J Sci. 1911;21(125):669-688. Available from: https://uni-tuebingen.de/fileadmin/Uni_Tuebingen/Fakultaeten/MathePhysik/Institute/IAP/Forschung/MOettel/Geburt_QM/rutherford_PhilMag_21_669_1911.pdf

15. Bohr N. Rydberg's discovery of the spectral laws. In: Kalckar J, editor. Collected works. Vol. 10. Amsterdam: North-Holland Publ. Co; 1985; 373-339. Available from:https://lucris.lub.lu.se/ws/files/5895394/1600630.pdf

16. Bohr N. The quantum postulate and the recent development of atomic theory. Nature. 1928;121(3050):580-590. Available from: https://www.nature.com/articles/121580a0

17. Heisenberg W. Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik. Z Physik. 1927;43(3):172-198. Available from: https://www.scirp.org/reference/referencespapers?referenceid=1713939

18. Peng H. Incompleteness of wave interpretations of double slit and grating experiments. Int J Phys. 2022;10(3):154-173. Available from: http://dx.doi.org/10.12691/ijp-10-3-4

19. Peng H. Comprehensive-double slit experiments violating wave description and trajectory description—Exploring mystery of double slit experiments. TechRxiv. Preprint; 2022. Available from: https://doi.org/10.36227/techrxiv.19158329.v1

20. Peng H. Comprehensive-double slit experiments violating wave description and trajectory description—Exploring mystery of double slit experiments. TechRxiv. Preprint; 2022. Available from: https://doi.org/10.36227/techrxiv.19158329.v1

21. Malek A. The real/virtual exchange of quantum particles as a basis for the resolution of wave-particle duality and other anomalies of quantum phenomena. Prog Phys. 2014;10(4):0. Available from: https://progress-in-physics.com/2014/PP-39-03.PDF

22. Rashkovskiy SA. Is a rational explanation of wave-particle duality possible? 2013. Available from: https://arxiv.org/pdf/1302.6159

23. Larsson R, Malek A. Origin of prebiotic organics and oxygen on Earth: A case for the pre-photosynthetic and carbonyl sulfide catalyzed reduction of carbon dioxide by water, methane, ammonia, and hydrogen sulfide. J Adv Phys. 2020;17:0. Available from: https://rajpub.com/index.php/jap/article/view/9506

24. Malek A. Ambartsumian, Arp and the breeding galaxies. Apeiron. 2005;12(2):0. Available from: http://redshift.vif.com/JournalFiles/V12NO2PDF/V12N2MAL.pdf

25. Malek A. The infinite as a Hegelian philosophical category and its implication for modern theoretical natural science. Prog Phys. 2014 Oct;10(4):212-216. Available from: https://progress-in-physics.com/2014/PP-39-04.PDF

26. Malek A. KEPLER – NEWTON – LEIBNIZ – HEGEL: Portentous and conflicting legacies in theoretical physics, cosmology and in ruling ideas. J Adv Phys. 2021;19:221-232. Available from: http://dx.doi.org/10.24297/jap.v19i.9106

27. Malek A. The mystery of the Lorentz transform: A reconstruction and its implications for Einstein's theories of relativity and cosmology. J Adv Phys. 2021;19:174-184. Available from: https://inspirehep.net/literature/2158754

28. Erhart J, Sponar S, Sulyok G, Badurek G, Ozawa M, HasegawaY. Experimental demonstration of a universally valid error-disturbance uncertainty relation in spin-measurements. Nat Phys. 2012;8(3). Available from: https://www.nature.com/articles/nphys2194

29. Cowan TE, Zganjar EF. Electron-positron pair production and annihilation. Access Science. 2020. Available from: https://www.accessscience.com/content/electron-positron-pair-production-and-annihilation/224710

30. Choi CQ. Something from nothing? A vacuum can yield flashes of light. Sci Am. 2013. Available from: https://www.scientificamerican.com/article/something-from-nothing-vacuum-can-yield-flashes-of-light/

31. Lamb WE, Retherford RC. Fine structure of the hydrogen atom by a microwave method. Phys Rev. 1947;72(3):241-243. Available from: https://journals.aps.org/pr/abstract/10.1103/PhysRev.72.241

32. Malek A. The cosmic gamma-ray halo – New imperative for a dialectical perspective of the universe. Apeiron. 2003;10(2). Available from: http://redshift.vif.com/JournalFiles/V10NO2PDF/V10N2MAL.pdf

33. Malek A. New physics – The negation of Einstein's theories of relativity. J Adv Phys. 2024;22:54-61. Available from: https://doi.org/10.24297/jap.v22i.9594

34. Malek A. New physics II – Quantum-dialectical derivation of new mass-energy relation invalidates Einstein's famous equation E = mc². J Adv Phys. 2024;22:178-184. Available from: https://doi.org/10.24297/jap.v22i.9642

Citation: Malek A. What is Light, Really? A Quantum Dialectical View. Ann Math Phys. 2024;7(3):292-299. Available from: https://dx.doi.org/10.17352/amp.000135